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Forest Protection SSIF research on species other than radiata pine 2021/22

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Report information sheet

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Executive summary

Plantation species other than *Pinus radiata* (radiata pine), such as Douglas-fir, cypresses and eucalypts, continue to be of pivotal importance to ensuring New Zealand has a diversified forest estate resilient against biosecurity threats. As part of the Specialty Wood Products Partnership (SWP), Forest Protection (now the Ecology and Environment research group) contributes with Strategic Science Investment Fund (SSIF) research that is highly responsive to biosecurity threats in the diverse species areas, to ensure sustainable growth of alternative tree species. This report summarises research findings in the last financial year in the aligned projects.

A new polyphagous ambrosia beetle known as GAB, *Xylosandrus crassiusculus*, has been introduced into New Zealand in 2019. It is native to East Asia and has been a highly successful invader worldwide. Like most invasive ambrosia beetles, *X. crassiusculus* can attack a wide range of woody plants. Adult females colonize physiologically stressed trees by excavating galleries in which they lay eggs and inoculate a symbiotic fungus, *Ambrosiella roeperi*. Both the founding female and its larval progeny feed on the fungus, not on the wood. Often the first sign of an attack is the sawdust released by the excavating adult, which takes the form of compacted “noodles” extruding from the tree trunk. Scion completed monitoring in Kumeu using flight intercept traps and wood bolts. Wood bolts not soaked in ethanol received zero attacks. We hypothesize that *Eucalyptus* trees (among other hardwoods), but only those under stress (emitting ethanol as a stress response), will be under threat of attack from this pest, but may not be as susceptible as other species of woody trees in New Zealand. The manuscript has been submitted to Agricultural and Forest Entomology.

Significant progress has also been made through the Better Border Biosecurity collaboration (b3nz.org.nz) on the safety of insect releases for biological control (through the development of a risk assessment model). Recognition of biosafety risks associated with introduced biocontrol agents (BCAs) is globally increasing, and pre-release assessments of these agents have become more rigorous in many countries, especially New Zealand. We advocate for adoption of a more comprehensive, ecologically-based, probabilistic risk assessment approach to BCA releases. An example is provided using a Bayesian network that can integrate information on probabilities and uncertainties of a BCA to spread and establish in new habitats, interact with non-target species in these habitats, and eventually negatively impact the populations of these non-target species. The new model, BAIPA (for “Biocontrol Adverse Impact Probability Assessment”), could eventually be incorporated into a structured decision-making framework that has potential to support national regulatory authorities such as the EPA (Environmental Protection Authority) in New Zealand. The authors have completed the publication and initiated testing the model with seven additional case studies. The manuscript is now published, but it would violate copyright for a copy to be made freely available on the FGR website. The link is supplied in this report and individuals can obtain copies directly from the author.

Cypress canker disease expression is observed irregularly within New Zealand; however, it tends to be more severe in warmer areas. Because species of *Seiridium* on Cupressaceae in New Zealand have not been well characterised, there is a lack of knowledge regarding pathogenicity and distribution. Molecular research has continued this year with an additional gene region sequenced. Maximum Likelihood analysis grouped the 47 isolates into four different clades, representing two known species, namely *Seiridium cancrinum* and *neocupressi*, and two novel clades. Future work should seek to accurately identify the isolates within the NZFS collection and provide pathogenic data. This information will help us understand which are the more important *Seiridium* species and the threat they pose to cypress and pine in New Zealand. Scion had insufficient resources to complete this research to publication stage.

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Introduction

Plantation species other than *Pinus radiata* (radiata pine), such as Douglas-fir, cypresses and eucalypts, form an important part of a diversified forest estate. The Forest Growing Science and Innovation Strategy 2020-2035 provides a roadmap for achieving the forest growers vision for 2050. This includes a key science and innovation theme (Theme 2) "Ensuring the long-term sustainability of commercial forestry through realising value from emerging species (exotic and indigenous) and developing new models for forestry". The strategy clearly recognises the need to grow investment into science and to take emerging tree species into mainstream forestry. Doubling the planting of eucalypt species (and cypresses and redwoods) by 2035 is a medium priority focus area for Theme 2. This will be achieved by increased confidence in their resilience, achieved by a multitude of pathways, but relying heavily upon the successful biological control for suppressing the negative impacts of pests of *Eucalyptus* species. Breeding for resistance to pests and diseases and silviculture will also contribute significantly to all alternative tree species. Theme 3 covers future proofing forest growing, and another outcome is "minimising biotic risk to trees from pests and pathogens".

Research being undertaken at Scion continues to support all the aspects of the FGR strategy. *Eucalyptus* species remain important to New Zealand. The biggest threat to many *Eucalyptus* plantations has historically been from the *Eucalyptus* tortoise beetle, *Paropsis charybdis*. SWP, MPI, and large commercial growers have been supporting Scion's attempt to improve the biological control of tortoise beetle by introducing a new parasitoid. However biological control is likely to be a slow process before improved pest control and therefore crown health and growth will become measurable. Meanwhile Scion continues to be an active partner within the Better Border Biosecurity collaboration (b3nz.org.nz) with researchers working on pre-release assessments of biological control agents (BCAs).

In addition to eucalypts, a number of cypress species are grown in New Zealand for timber and other purposes. Cypresses have long been a favourite alternative to radiata pine for New Zealand's farm foresters, small-scale plantation owners, and some large-scale growers. The total area of cypresses in New Zealand is around 10,000 hectares. The most commonly grown species are (i) *Cupressus macrocarpa* – 'macrocarpa' and (ii) *Cupressus lusitanica* – 'lusitanica' or Mexican cypress.

These two cypresses represent only a small portion of the overall SWP programme, and the priorities are to maintain the breeding populations (growth, form, canker tolerance). In recent years, controlled crossing of cypresses has been undertaken to produce new hybrids. Many species of Cupressaceae are affected by a pathogen that causes cypress canker. The distribution of cypress canker is irregular within New Zealand, however it tends to be more severe in warmer areas. Because species of *Seiridium* (Ascomycota: Amphisphaeriaceae) on Cupressaceae in New Zealand have not been well characterised, there is a lack of knowledge regarding pathogenicity and distribution. Continuing research on cypress canker-resistance will benefit from research into the genetics of the canker pathogens (*Seiridium* spp). Characterisation of Scion's *Seiridium* culture collection has been an important step towards providing understanding of what species are present in New Zealand. This knowledge will improve future research and biosecurity response. We update the research undertaken this financial year.

Recommendations and conclusions

Ambrosia beetles (of which the newly invasive *Xylosandrus crassiusculus* belongs) efficiently locate and preferentially attack living, weakened plants, especially those physiologically stressed by flooding, inadequate drainage or frosting. Our research shows that *X. crassiusculus* in Auckland can have two, and possibly three generations per growing season and is likely to have an increasing negative impact as it disperses and spreads beyond the current infestation in Auckland. It adds another invasive beetle along with the pinhole borer *X. saxesenii*, both now targeting a wide range of hardwood commercial, ornamental and native trees and shrubs. Our results showed that both panel traps baited with ethanol release lures at or above 0.1 to 2 g/day, and wood bolts pre-soaked with low percentage ethanol solution are suitable tools for monitoring population phenology and geographic spread. Currently, no clear effective management method exists for *X. crassiusculus*. Research efforts into methods of reducing its impacts are a high priority for New Zealand, as well as other countries within the rapidly expanding geographic range of this invasive species. We recommend FGR support Scion in their planned MBIE bid for more indepth research to understand this pest along with management methods of other pin hole borers and bark beetles, and how we can keep additional species out of New Zealand.

Scion continues to be an active partner within the Better Border Biosecurity collaboration (b3nz.org.nz) with researchers initiating a new project called “Testing the Toolbox” from 2022 which will trial a range of methods’ ability to predict and therefore reduce risk from biocontrol agent introduction. We believe the research underway at Scion, will help biological control to maintain its cultural and social licence and continue to be a key management tool for managing invasive pest and weed species in New Zealand.

Molecular research has continued this year on cypress canker with an additional gene region sequenced. Maximum Likelihood analysis grouped the 47 isolates into four different clades, representing two known species, namely *Seiridium cancrinum* and *neocupressi*, and two novel clades. These results could have implications for management and resistance breeding programmes. Research to confirm these findings will continue if Scion obtains funding, and we recommend host pathogenicity trials are required in the future, these could be supported by the Forest Industry.

Granulate Ambrosia Beetle Trapping research

The following manuscript has been submitted to the journal "Agricultural and Forest Entomology".:
Title: **First record, phenological observations, and trapping tactics for the granulate ambrosia beetle *Xylosandrus crassiusculus* (Coleoptera: Curculionidae, Scolytinae) in New Zealand**
Authors: Roanne Sutherland[1],5, Nicolas Meurisse[1], Andrew R. Pugh[1]*, Christopher M. Ranger2, Michael E. Reding2, Jessica L. Kerr3, Jessica Russell4, Toni M. Withers[1]

1. Xylosandrus crassiusculus was first formally detected in New Zealand in 2019. Since then, GAB has subsequently been found infesting numerous species of deciduous trees in the Auckland region.
2. Flight intercept traps baited with ethanol lures were deployed from October 2019 to May 2021 at three sites in the Auckland region to ascertain the phenology of GAB in New Zealand. Two distinct peak flight periods were identified in early and late summer, while a smaller and inconsistent third peak was detected in autumn. Logistical analysis of GAB captures in the ethanol-lured traps and degree-day (DD) accumulation indicated that 90% of flight activity is completed by 800 DD
3. To assess monitoring tactics, flight intercept traps were baited with three different ethanol lures with varying release rates, or ethanol-soaked or non-soaked wood bolts from three species of trees. A lure releasing 2 gm ethanol per day was most effective at capturing GAB. Ethanol-soaked bolts were less effective than the lures.
4. Xylosandrus crassiusculus represents a significant risk for shrubs and trees native to New Zealand, as well as exotic horticultural and forestry trees, we recommend using ethanol-lured panel traps for monitoring purposes.

When the manuscript is published, a live link or a pdf copy will be made available to SWP depending on copyright issues.

Update on the diversity of Seiridium species associated with Cypress Canker Disease (CCD) in New Zealand

Several morphologically cryptic species of Seiridium cause cypress canker disease (CCD) of Cupressaceae. Historically, *Seiridium cardinale, S. cupressi* and *S. unicorne* have been responsible for the disease in New Zealand, limiting the expansion of the ~10,000 ha of planted cypress. A 2018 phylogenetic study sought to resolve the taxonomic status of *Seiridium*, which led to the description of new species, such as *S. cancrinum* and *S. neocupressi*. Many of the *Seiridium* isolates in Scion's National Forest Culture Collection (NZFS) have been identified morphologically and contain cryptic species that can only be identified phylogenetically. To explore the *Seiridium* diversity associated with CCD in New Zealand, forty-seven isolates obtained from species in the Cupressaceae and Pinaceae were selected for analysis. Sequences of the partial region of the translation elongation factor-1α gene region (TEF) were concatenated with a β-tubulin (BTUB) dataset generated previously (PAD ID File Note 36317015) to construct a maximum likelihood (ML) phylogenetic tree. The ML analysis grouped the 47 isolates into four different clades, representing two known species, namely *Seiridium cancrinum* and *neocupressi*, and two novel clades. Future work should seek to accurately identify the isolates within the NZFS collection and provide pathogenic data. This information will help us understand which are the more important *Seiridium* species and the threat they pose to cypress and pine in New Zealand. This research is summarised in Scion report PAD ID 47691441. It is not yet at publication stage.

Published Bayes Net (BAIPA) model for predicting biocontrol impacts

Risk Analysis Frameworks Used in Biological Control and Introduction of a Novel Bayesian Network Tool

Nicolas Meurisse,[1,2,*] **Bruce G. Marcot**,[3] **Owen Woodberry**,[4] **Barbara I. P. Barratt**,[5,2] **and Jacqui H. Todd**[6,2]

Classical biological control, the introduction of natural enemies to new environments to control unwanted pests or weeds, is, despite numerous successful examples, associated with rising concerns about unwanted environmental impacts such as population decline of nontarget species. Recognition of these biosafety risks is globally increasing, and prerelease assessments of biological control agents (BCAs) have become more rigorous in many countries. We review the current approaches to risk assessment for BCAs as used in Australasia, Europe, and North America. Traditionally, these assessments focus on providing assurance about the specificity of a proposed BCA, generally via a list of suitable versus nonsuitable hosts determined through laboratory specificity tests (i.e., by determining the BCA's physiological host range). The outcome of interactions of proposed agents in the natural environment can differ from laboratory-based predictions. Potential nontarget host testing may be incomplete, additional ecological barriers under field conditions may limit encounters between BCA and nontargets or reduce attack levels, and BCAs could disperse to habitats beyond those used by the target species and adversely affect nontarget species. We advocate for the adoption of more comprehensive, ecologically-based, probabilistic risk assessment approaches to BCA introductions. An example is provided using a Bayesian network that can integrate information on probabilities and uncertainties of a BCA to spread and establish in new habitats, interact with nontarget species in these habitats, and eventually negatively impact the populations of these nontarget species. Our new model, Biocontrol Adverse Impact Probability Assessment, aims to be incorporated into a structured decision-making framework to support national regulatory authorities.

KEY WORDS: BAIPA; ecological risk assessment; nontarget impact; probabilistic risk model

The manuscript has been published in the journal Risk Analysis: Volume 42, Issue 6

Special Issue: Bayesian Networks for Risk Analysis and Decision Support

Pages 1255-1276. The entire paper can be accessed at the published at
https://onlinelibrary.wiley.com/doi/abs/10.1111/risa.13812

If a pdf is required, it can be obtained by requesting a single copy from emailing the author at:
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