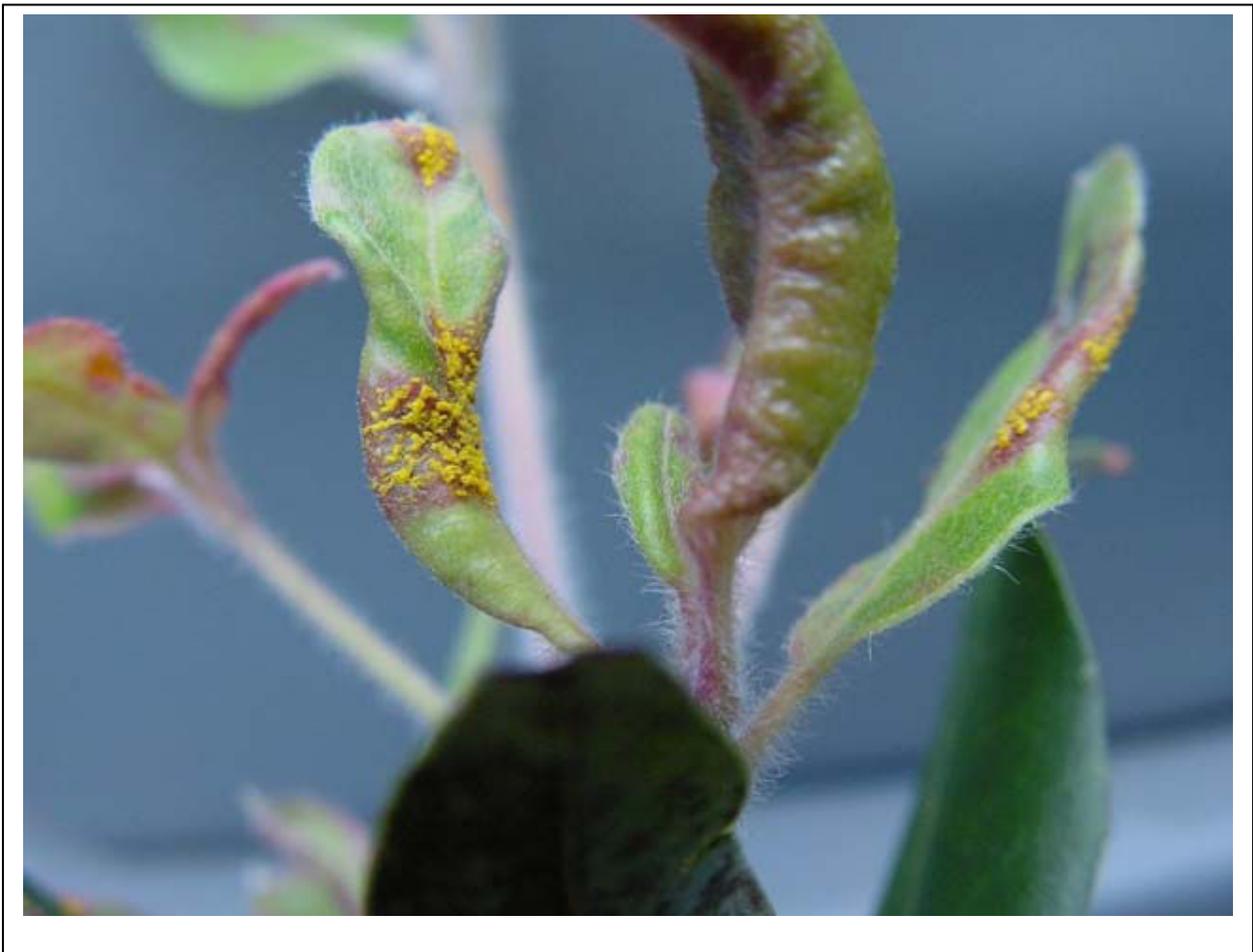


BRIEFING DOCUMENT ON MYRTLE RUST, A MEMBER OF THE GUAVA RUST COMPLEX, AND THE RISK TO NEW ZEALAND

Tod Ramsfield, Margaret Dick, Lindsay Bulman, Rebecca Ganley

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TABLE OF CONTENTS

Abstract.....	1
An introduction to rust diseases.....	1
Summary – rust life cycle.....	3
<i>Uredo rangelii</i> – what is it?.....	4
Hosts of <i>Uredo rangelii</i> (May 2010).....	4
Relationship of <i>Uredo rangelii</i> with <i>Uredo psidii</i>	4
Variation within <i>Puccinia psidii</i>	4
Summary – <i>U. rangelii</i>	5
Probability of introduction.....	6
Rust biology.....	6
Long distance dispersal.....	6
Summary - Probability of introduction.....	7
Potential distribution in New Zealand.....	8
Background.....	8
CLIMEX Compare Locations and Match Regions.....	8
CLIMEX Compare Locations.....	8
CLIMEX Match Regions.....	9
NAPFAST.....	9
Summary - potential distribution.....	10
Potential hosts in New Zealand.....	11
Potential impact in New Zealand.....	12
Australian Response.....	13
Initial Detection.....	13
Initial Response.....	13
Responsibilities.....	13
Domestic quarantine and ongoing response.....	14
Recommendations.....	15
References.....	15

Abstract

This document outlines the background and risks to New Zealand associated with the recent discovery of *Uredo rangellii* (Myrtle rust) in Australia. Recommendations are also provided to ensure readiness for potential arrival of the pathogen in New Zealand. The myrtle rust pathogen, *U. rangellii*, is very closely related to *Puccinia psidii*, the causal agent of guava rust (Simpson 2006). The latter has a wide host range on plants in the family Myrtaceae. In this report, we agree with other authors and consider *U. rangellii* and *P. psidii* as synonymous and we cite the literature associated with *P. psidii*. Based on the biology of the organism, and the fact that other rust diseases have been introduced into New Zealand from Australia, we feel that it is highly likely that this pathogen will cross the Tasman to New Zealand if the Australian authorities are unable to eradicate it. In New Zealand, we have the benefit of time; MAF have the opportunity to be fully prepared for the arrival of the pathogen here.

An introduction to rust diseases

Rust diseases are caused by basidiomycete fungi in the order uridinales. There are over 6000 species in 150 genera and the genus *Puccinia* contains approximately 4000 species. Rust fungi are obligate parasites of vascular plants and can be highly host specific with a very narrow host range; some are restricted to a single family, others a single genus or even a single species within a genus. The lifecycle is relatively complex because rusts can have up to five spore stages in their lifecycle and may require an alternate host to complete their lifecycle. If an alternate host is not required, the rust is autoecious, while those that require an alternate host are heteroecious. If all five spore stages are required, the rust is macrocyclic, while if all five spore stages are not required, the rust is microcyclic.

Cronartium ribicola, the causal agent of white pine blister rust, is a typical heteroecious macrocyclic rust that we will use to illustrate the lifecycle (Figure 1). Basidiospores produced on *Ribes* leaves initiate infection on the alternate host, 5-needle pines. Basidiospores infect the pine needles, hyphae grow down the needle into the branch and along the branch to the main stem where pycnia are formed. The following year, aeciospores are formed on the stem of the pine. Aeciospores are released in the spring and are blown to *Ribes* where they initiate infection on the *Ribes* plant. Aeciospore infection results in the formation of urediniospores, which are released and serve to intensify the infection on *Ribes* over the summer. At the end of summer, teliospores another spore stage, are formed. The teliospores fuse together on the underside of the leaf to produce telial columns, from which basidiospores are produced.

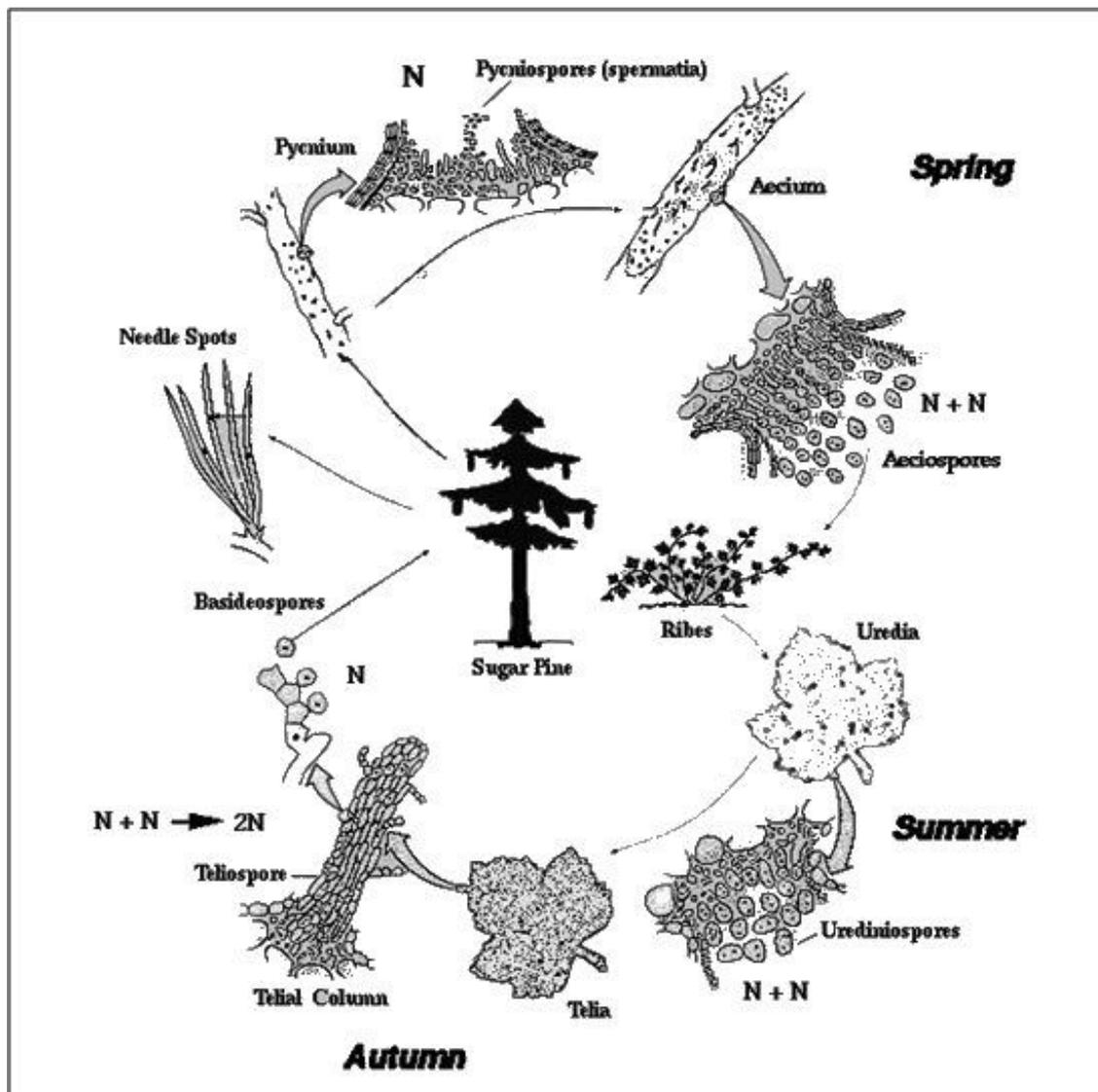


Figure 1. Diagrammatic representation of the lifecycle of *Cronartium ribicola*.

Rust taxonomy can be difficult if the alternate host is unknown. As with other fungi, the anamorph / teleomorph designation can be made based on whether the spores are produced asexually or sexually. For example, in New Zealand *Caecoma peltatum* on *Phyllocladus* spp. and *Uredo fuchsiae* on *Fuchsia* spp. were described separately. Crane and Peterson (2007) were able to show through inoculation studies that these two “species” were in fact alternate lifestages of the same rust species on different hosts, which they named *Mikronegeria fuchsiae*. As teliospores of *M. fuchsiae* are produced on *Fuchsia excorticata*, it is designated as the primary host and *Phyllocladus trichomanoides* is the alternate host.

The taxonomy of *Puccinia psidii*, the causal agent of guava rust is complicated by the fact that it is autoecious (Figure 2) and it is difficult to differentiate aeciospores and urediniospores based on morphology. When Simpson *et al.* (2006) described the species *U. rangelii*, it was done on the basis of urediniospore morphology; the urediniospores of *U. rangelii* have a smooth area on their surface, while the urediniospores of *U. psidii* are completely covered with small spines. Langrell *et al.* (2008) dispute the description of *U. rangelii* because it was made based on limited material (two samples) and did not include any molecular analysis to support the species designation. Glen *et al.* (2007) compiled a table of species that they consider to be synonymous with either *P. psidii* or *U. psidii*, the guava rust pathogens. Glen *et al.* (2007) included *U. rangelii* in this table. See below for more detail.

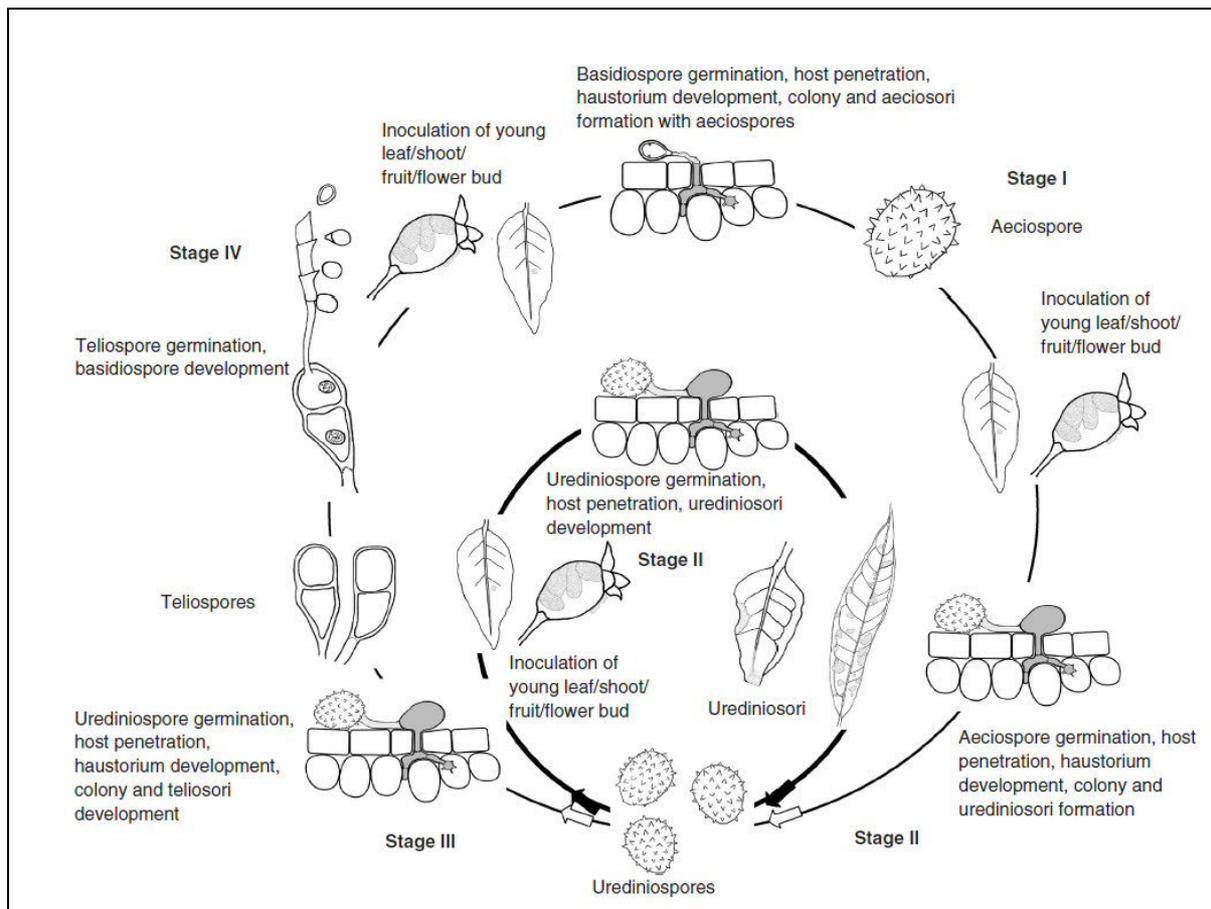


Figure 2. Diagrammatic representation of the lifecycle of *Puccinia psidii* (from Glen *et al.* 2007).

Summary – rust life cycle

Rusts have complicated lifecycles and their taxonomy can be difficult. Given the seriousness of *P. psidii* and the limited work that has been done on *U. rangelii*, we share the opinion of Glen *et al.* (2007) and consider *P. psidii* and *U. rangelii* to be the same. Therefore, the remainder of this document is based on the extensive work that has been done on *P. psidii*.

***Uredo rangelii* – what is it?**

Uredo rangelii J.A. Simpson, K. Thomas & C.A. Grgurinovic was described as a new species of rust fungus in a review of rust fungi on Myrtaceae (Simpson *et al.* 2006). The two specimens on which the description is based were herbarium specimens held at the Plant Pathology herbarium at Orange, New South Wales; one (on *Myrtus communis*) being part of an Argentinian specimen, and the other (on *Syzygium jambos*) part of a specimen from Jamaica.

Uredo rangelii was separated from other species of rust fungi on Myrtaceae largely because all of the spores (which were asexual urediniospores) examined in the two collections had a bald patch on the lower half of the spore, a feature that no other species of *Uredo* recorded on myrtaceous plants possesses. No DNA sequence data was gathered for *U. rangelii* and hence no phylogenetic comparison of its relationship with closely related species has been made.

No telial (sexual) state is known for *U. rangelii*.

There have been no other published records of *Uredo rangelii* prior to the April 2010 outbreak in New South Wales.

Hosts of *Uredo rangelii* (May 2010)

Myrtus communis ex Argentina

Syzygium jambos ex Jamaica

Agonis flexuosa ex New South Wales, Australia

Syncarpia glomulifera ex New South Wales, Australia

Callistemon sp. ex New South Wales, Australia

Relationship of *Uredo rangelii* with *Uredo psidii*

Species of *Uredo* are asexual stages of members of the genus *Puccinia*. Thirteen species of *Uredo* have been described on myrtaceous hosts (dating from 1884). Nine of these were regarded as synonyms of *Uredo psidii*, the valid name for the asexual stage of *Puccinia psidii*, by Simpson *et al.* (2006). Glen *et al.* (2007) added two further species of *Uredo* to the list of synonyms of *U. psidii*, one of these being *U. rangelii*. A further species of *Uredo* (*U. seclusa*) was reported on an unidentified species of Myrtaceae from S~ao Paulo, Brazil in 1931 and is known only from the type collection and this record can probably be considered doubtful.

Apart from the spore ornamentation the urediniospores of *U. rangelii* are very like those of *U. psidii*. The shape of the urediniospores, pyriform to ellipsoidal, was reported by Simpson *et al.* (2006) as possibly diagnostic, however these shapes have been reported from some collections of *U. psidii* (Kawanishi *et al.* 2009). The leaf spots and fruit bodies of *U. rangelii* on *Myrtus communis* and *Syzygium jambos* were reported to be slightly smaller than those of *U. psidii* (Simpson *et al.* 2006). These differences have not been considered sufficient to warrant retaining *U. rangelii* as a species separate from *U. psidii* by a number of researchers (Glen *et al.* 2007; Global Invasive Species Database 2010).

All known hosts of *U. rangelii* are also recorded as hosts of *Puccinia psidii*.

Variation within *Puccinia psidii*

Susceptibility to infection by *P. psidii* is affected by the genetics of both the host and pathogen. *Puccinia psidii* is a species containing many races, or biotypes, which vary in their ability to infect different host plants. Inoculation tests on a single plant species with fungal isolates from different hosts and locations (races) may invoke a response ranging through immune to tolerant to susceptible (Old *et al.* 2003; Tommerup *et al.* 2003). Differentiating races can be difficult because of the very wide host range which includes both co-evolved and non co-evolved host species.

Hence when determining host susceptibility each race must be evaluated as a separate individual.

Summary – *U. rangelii*

Simpson *et al* (2006) stated “There is a need for further critical taxonomic studies of the *Puccinia psidii* complex including *U. seclusa* and *U. rangelii*.” There are no published records of these studies having been carried out. However it is apparent that *U. rangelii* is deemed by other researchers to be a further synonym of *U. psidii*.

Probability of introduction

As stated in the introduction, we agree with Glen *et al.* (2007) that *U. rangellii* and *P. psidii* are synonymous. Additionally, there is a dearth of information on *P. rangellii* but plenty to draw on for *P. psidii*. The probability of rust establishment in New Zealand is affected by many different interacting factors, which are outlined below.

Rust biology

Rust pathogens are able to rapidly colonise new areas and disperse from them because their lifecycles include the production of large numbers of aeciospores and urediniospores. Both of these spore types have thick walls that resist desiccation and contain pigments that reduce the effects of UV radiation. The survivability of the urediniospores of *P. psidii* is discussed in Glen *et al.* (2007). As the temperature and relative humidity increase, the long term survival of urediniospores decreases. Viability was maintained after 90 days storage at 15°C and 35-55% relative humidity, but only 10 days after storage at 35°C or 40°C. Thus, the probability of urediniospore survival would be lower following a slow sea voyage under ambient conditions compared with rapid air travel in an air conditioned aircraft.

Although large numbers of spores are produced yearly, rust epidemic size can vary from year to year because if the host material is not susceptible or the weather conditions are not conducive, infection will not occur. Years with a large epidemic are termed “wave years”. Wave years demonstrate the importance of the disease triangle; several conditions must be satisfied before infection can occur.

Another biological factor that may affect establishment success is that different “races”, or host specialisations, exist in *P. psidii*. Furtado & Marino (2003) inoculated different host plants with inoculum from a range of host plants. They observed that the most severe infection was from inoculum that was collected from the same host. This demonstrates that races do exist within *P. psidii*; therefore, we cannot assume that all hosts will be equally susceptible to inoculum from Australia. To prepare for this, the host range of the pathogen in Australia should be assessed, and if possible, any risk assessments involving the inoculation of New Zealand native plants should include an isolate from Australia.

Long distance dispersal

The risk to New Zealand from *P. psidii* is a probability that is related to the several steps on the incursion pathway. If the Australian authorities are not able to eradicate the rust, it is doubtful that they will be able to contain it because the urediniospores are readily transportable; as a result, the volume of urediniospores emitted into the atmosphere will also increase. This will increase the sheer number of urediniospores available for long distance dispersal across the Tasman. The arrival of urediniospores in New Zealand is proportional to the number of days of favourable atmospheric conditions that allow trans-Tasman dispersal. If urediniospores are able to cross the Tasman, and they remain viable, they need to land on susceptible host material under environmental conditions that favour disease development that allow infection to occur. In order for the pathogen to become established in New Zealand, all of these conditions must be met. Although the probability of establishment in New Zealand is low, it is not zero and there are examples of long distance dispersal of fungi from Australia, such as the poplar rust fungi *Melampsora larici-populina* and *M. medusae* which arrived in New Zealand from Australia in 1973. It is likely that the pathogen that causes Dothistroma needle blight of pines crossed the Tasman from New Zealand to Australia in moist airstreams.

Other incursion pathways that must be considered are: 1. The inadvertent movement of urediniospores on clothing or footwear that may occur as a result of tourism. As with long distance dispersal, establishment would require the urediniospores coming into contact with

susceptible plant material under favourable environmental conditions. 2. The importation of infected plant material, and 3. Deliberate introduction of urediniospores or infected material by persons of questionable character. MAF has procedures in place to prevent these human vectored incursion scenarios, but they should be assessed in light of *P. psidii* in Australia.

Summary - Probability of introduction

Although many different factors are involved, the poplar rusts have demonstrated that rust pathogens can be wind dispersed across the Tasman. As the size of the infected area increases in Australia, the quantity of urediniospores available for dispersal will increase. Taking these two factors into account, it is likely that the rust will arrive in New Zealand, but it may take a period of years while inoculum builds up in Australia. The CLIMEX study suggests that the highest risk is to myrtaceous plants on the North Island. MAFBNZ should be working now to develop surveillance and a contingency plan for this disease because it is highly probable that it will arrive in New Zealand if it cannot be eradicated from Australia.

Potential distribution in New Zealand

Background

Booth *et al.* (2000) used a homoclimate analysis to estimate the potential threat to Australia, Magarey *et al.* (2007) used NAPPFAST to estimate the potential for *P. psidii* persistence on a global scale, and Kriticos & Leriche (2008) used the distribution based programme CLIMEX to predict the risk of *P. psidii* to New Zealand. Booth *et al.* (2000) and Magarey *et al.* (2007) provide little detail on the threat to New Zealand in comparison with Kriticos & Leriche (2008), which analyses the threat on a regional scale.

Kriticos & Leriche (2008) used three modelling techniques to estimate the climatic suitability of New Zealand for *P. psidii* under a range of climate scenarios. The three approaches used were: CLIMEX Compare Locations and Match Regions (Sutherst *et al.* 2007), and NAPPFAST (Magarey *et al.* 2007).

CLIMEX Compare Locations and Match Regions

The climatic suitability of New Zealand for *P. psidii* was modelled using CLIMEX under a range of different climate scenarios. The current climate dataset used in this project was the 0.5 degree climate normals for 1971-2000. Six climate change scenarios were used, which were developed from three Global Climate Models run using two standard International Panel on Climate Change scenarios, representing medium (A1B) and high (A2) emissions (IPCC, Solomon *et al.* 2007). The two main sources of information for fitting the Compare Locations and Match Regions models were the geographical distribution data and the ecophysiological observations of Ruiz *et al.* (1989). The parameters used to fit both models are described in Kriticos & Leriche (2008).

CLIMEX Compare Locations

Under the current climate scenario, much of the North Island and some of the South Island of New Zealand are suitable for *P. psidii*. Northland, Auckland, Waikato, Taranaki, Bay of Plenty, and Hawke's Bay are the most suitable (Figure 3). The Chatham Islands also appear to be suitable for *P. psidii* (Figure 3). According to the model, cold stress and an inadequate annual heat sum for development limit the southern distribution of *P. psidii*.

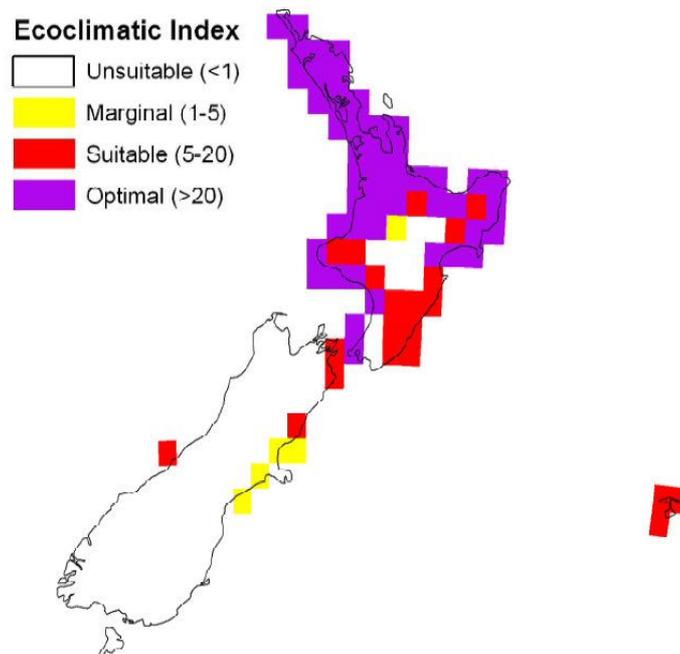


Figure 3: New Zealand showing climate suitability for *P. psidii* under current climate

Analysis of seasons suitable for *P. psidii* in Auckland showed there is a year round potential for infection to occur. Summer conditions are most favourable for the pathogen because conditions for spore germination would be near optimal.

Under future climates, the projected threat to New Zealand from *P. psidii* increases under the A2 scenario for 2030 and in the later simulations for 2070. Under the warmer scenarios the area of suitable habitat extends to the south eastern coastal fringe of Southland. Although there were variations between the three Global Climate Models used (CSIRO Mark 3.0, NCAR – CCSM and MIROC - H), all models showed an increase in area predicted to be suitable for *P. psidii*. The area around Mt Ruapehu remained climatically unsuitable under all scenarios examined.

CLIMEX Match Regions

The CLIMEX Match Regions model predicted a similar distribution for *P. psidii* to that predicted by the CLIMEX Compare Locations model. Overall, the model predicted that Northland and Auckland would be at highest risk (Figure 4). Other areas likely to have suitable climate for *P. psidii* were the majority of the coastal region of the North Island and east coast of the South Island (Figure 4). Only match index values above 0.7, which are considered biologically meaningful, are presented. As with the CLIMEX Compare Location model, risk from *P. psidii* is expected to increase throughout New Zealand under the six climate change scenarios modelled.

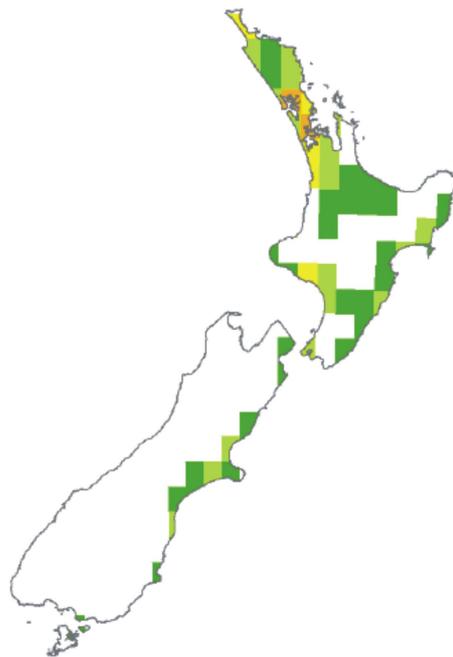


Figure 4: CLIMEX composite match index for predicted *P. psidii* distribution where 0.7 < CMI < 0.75 (dark green); 0.75 < CMI < 0.8 (light green); 0.8 < CMI < 0.85 (yellow); 0.85 < CMI < 0.9 (brown); 0.9 < CMI < 0.95 (orange); 0.95 < CMI < 1.0 (red).

NAPPFAST

NAPPFAST is an internet-based system for mapping the conditions necessary for plant pathogen infection and was used to map the suitability for infection of *P. psidii* (Magarey *et al.* 2007). An updated version of the model (Jessica Engel, unpub. data) was run using 28 km USA National Centre for Environmental Prediction (NCEP) weather data for New Zealand. Details are described in Kriticos & Leriche (2008).

The NAPPFAST model predicted that all of New Zealand was climatically suitable for *P. psidii* infection (Figure 5). The predicted accumulated infection levels ranged from 20 to 120 days. This means that under current climatic conditions, in a given year, the conditions necessary for

Potential hosts in New Zealand

Native plants in the family Myrtaceae are listed, along with a selection of commercially important introduced species (Table 1). There are more than 90 introduced species in the family that are grown widely. There are over 360 taxa of myrtaceous plants which have been cultivated in New Zealand. The National Forest Herbarium holds a list of 240 *Eucalyptus* species that have been recorded growing in New Zealand.

The two unnamed kanuka included below are listed in "Eagle's complete trees and shrubs of New Zealand". We have listed them to indicate that there are unnamed native species, particularly in the genera *Kunzea* and *Leptospermum*. The varieties included in the list will probably all be named as distinct species in the near future. Manuka is important for honey production and a variety of products that are marketed for their medicinal properties, and kanuka is used for essential oils and makes excellent firewood. Some of the other species are important in the cut flower industry. Many of the *Eucalyptus* species have potential to be used for wood products and others are important for ornamental planting.

Table 1: Potential native and introduced hosts (from Rebecca Stanley of Auckland Regional Council and Chris Ecroyd of the National Forestry Herbarium, Scion)

Status	Native species	Common name
Declining	<i>Kunzea ericoides</i> var. <i>linearis</i> (Kirk) W.Harris	rawiri, manuka-rauriki
Nationally Critical	<i>Metrosideros bartlettii</i> J.W.Dawson	rata moehau, Bartlett's rata
Uncommon	<i>Kunzea ericoides</i> var. <i>microflora</i> (G.Simpson) W.Harris	prostrate kanuka, geothermal kanuka
Uncommon	<i>Kunzea sinclairii</i> (Kirk) W.Harris	Great Barrier Island kanuka
Non Threatened	<i>Kunzea ericoides</i> (A.Rich) Joy Thomps. var. <i>ericoides</i>	manuoea, titira, atitira, manuka-rauriki,
Non Threatened	<i>Leptospermum scoparium</i> var. <i>incanum</i> Cockayne	manuka, tea tree, kahikatoa
Non Threatened	<i>Leptospermum scoparium</i> J.R.Forst. et G.Forst. var.	manuka, tea tree, kahikatoa
Non Threatened	<i>Lophomyrtus bullata</i> Burret	mamarama, New Zealand myrtle
Non Threatened	<i>Lophomyrtus obcordata</i> (Raoul) Burret	rohutu, New Zealand myrtle
Non Threatened	<i>Metrosideros albiflora</i> Sol. ex Gaertn.	white rata
Non Threatened	<i>Metrosideros carminea</i> W.R.B.Oliv.	crimson rata, carmine rata
Non Threatened	<i>Metrosideros colensoi</i> Hook.f.	Rata
Non Threatened	<i>Metrosideros diffusa</i> (G.Forst.) Sm.	white rata
Non Threatened	<i>Metrosideros excelsa</i> Sol. ex Gaertn.although pohu	pohutukawa, New Zealand Christmas
Non Threatened	<i>Metrosideros fulgens</i> Sol. ex Gaertn.	rata
Uncommon	<i>Metrosideros kermadecensis</i> W.R.B.Oliv.	Kermadec pohutukawa
Non Threatened	<i>Metrosideros parkinsonii</i> Buchanan	Parkinsons rata
Non Threatened	<i>Metrosideros perforata</i> (J.R.Forst. et G.Forst.) A.Rich.	white rata
Non Threatened	<i>Metrosideros robusta</i> A.Cunn.	Northern rata
Non Threatened	<i>Metrosideros umbellata</i> Cav.	Southern rata
Non Threatened	<i>Neomyrtus pedunculata</i> (Hook.f.) Allan	rohutu, myrtle
Non Threatened	<i>Syzygium maire</i> (A.Cunn.) Sykes et Garn.-Jones	swamp maire, maire tawake
Uncommon	<i>Kunzea</i> aff. <i>ericoides</i> (A)	kanuka – unnamed species
Uncommon	<i>Kunzea</i> aff. <i>ericoides</i> (B)	kanuka – unnamed species
Host of <i>P. psidii</i>	Introduced species of commercial significance	
Not known	<i>Eucalyptus bosistoana</i> F.Muell.	
Not known	<i>Eucalyptus botryoides</i> Sm.	
Not known	<i>Eucalyptus cinerea</i> F. Muell. Ex Benth	
Not known	<i>Eucalyptus delegatensis</i> R.T.Baker	
Not known	<i>Eucalyptus eugenioides</i> Spreng.	
Not known	<i>Eucalyptus fastigata</i> (J.B.Armstr.) H.Deane & Maiden	

Not known	<i>Eucalyptus fraxinoides</i> (Dumort.) H.Deane & Maiden	
Not known	<i>Eucalyptus globoidea</i> (Hiern) Blakely	
Known	<i>Eucalyptus globulus</i> Labill.	
Not known	<i>Eucalyptus macarthurii</i> (Cheeseman) H.Deane &	
Known	<i>Eucalyptus microcorys</i> (Delise) F.Muell.	
Not known	<i>Eucalyptus muelleriana</i> (Vill.) A.W.Howitt	
Known	<i>Eucalyptus nitens</i> (H.Deane & Maiden) Maiden	
Not known	<i>Eucalyptus obliqua</i> (G.Forst.) L'Her.	
Not known	<i>Eucalyptus pilularis</i> (J.R.Forst & G.Forst.) Sm.	
Not known	<i>Eucalyptus regnans</i> F.Muell.	
Known	<i>Eucalyptus saligna</i> (A.Cunn.) Sm.	
Known	<i>Acca sellowiana</i> (O.Berg.) Burret	feijoa
Known	<i>Psidium guajava</i> L.	yellow guava

Metrosideros excelsa (pohutukawa) and *M. kermadecensis* have both been reported as hosts of *P. psidii* in Hawaii (Forest Health Highlights 2009). It is not currently known how seriously these species are affected there. We have contacted our Hawaiian colleagues to obtain more information.

Potential impact in New Zealand

It is not known how members of the guava rust complex would affect myrtaceous plants growing in New Zealand. The susceptibility of native plants has not been tested. Of primary concern are important genera that guava rust has been recorded on overseas. *Metrosideros*, *Kunzea*, *Syzygium*, and *Eucalyptus* are in that category. One of the reasons that *P. psidii* is considered to be a high risk organism is the fact that it has become established in Hawaii and is affecting the native myrtaceous plants there. Impact is difficult to assess because, as stated above, pathogens in the guava rust complex are highly variable in their virulence on different hosts and hosts are variable in their susceptibility to the pathogen, even within host species. For instance, one provenance of *Eucalyptus globulus* may be highly susceptible to a particular race of *P. psidii* while another provenance may be quite resistant to that same race. Alternatively, a host may be highly susceptible to one race of *P. psidii* and completely unaffected by another.

Guava rust causes lesions and damage on young foliage and shoots. In some hosts it affects flowers and fruit. Severe infection can result in tip dieback and shoot death. Stem lesions and stem swelling have been recorded on some hosts. Prolonged infection may result in stunted and/or bushy growth. *Puccinia psidii* is unable to initiate infection on mature foliage though a lightly infected leaf may still have urediniosori when it is older. Guava rust rarely kills plants, apart from extremely susceptible individuals.

This pattern of damage may not appear to be particularly important, but for some plants it may have serious consequences. For instance, although pohutukawa is not listed as threatened above, many thousands of trees have been lost due to human intervention and possums (Bergin & Hosking 2006). Possums eat new buds in spring and mature foliage. Damage may be exacerbated by guava rust.

Myrtaceous plants that have evolved without exposure to *P. psidii* are more likely to be highly susceptible to serious damage from guava rust than plants that have evolved with the rust (Simpson *et al* 2006). This assumption is supported by the outbreak in Jamaica in 1934 that destroyed the pimento oil industry there (MacLachlan 1938) and the sudden severe outbreak in Florida on *Melaleuca* in January 1997 (Rayachhetry 1997).

Australian Response

Initial Detection

On 23 April 2010, *Uredo rangellii*, a causal agent of myrtle rust, was confirmed to be present at a NSW cut flower and foliage nursery. This was the first detection of myrtle rust in Australia. The disease is identified as a disease of significance in the Nursery Industry Biosecurity Plan. The nursery was at Wyee, about 70 km north of Sydney. Ironically, this is very close to where *Melampsora medusae* (American poplar rust) was first discovered in Australia in January 1972. The nursery was placed in quarantine when the outbreak was discovered but has since resumed trade. Myrtle rust was found on *Agonis flexuosa* (willow myrtle), *Syncarpia glomulifera* (turpentine) and *Callistemon* sp. (bottlebrush) on the property. DAFF (2010a), in the official pest report to IPPC, states that the rust was found on another property 8.5 km from the initial find on 29 April. Rust infection was detected there on six *Callistemon* trees at low levels. As at 12 May 2010, the rust has not been reported on *Eucalyptus* spp. in Australia.

Initial Response

A Consultative Committee on Emergency Plant Pests (CCEPP) was formed to provide technical advice on the response. The CCEPP prepared an identification sheet and media release (DAFF 2010b). The CCEPP agreed that surveys are needed around the infected property. Initially it recommended that it was not feasible to eradicate the rust (DAFF 2010b) but a subsequent report stated that “authorities think it may still be possible and a national committee will make that decision soon” (ABC Rural News 11 May 2010). Trace forward and trace back actions were initiated to find other possible occurrences of the rust and to direct surveillance activities. Infected plant material was treated with fungicides to contain the infection on site while further surveys are undertaken and fungicidal treatment is continuing (NGIA 30 April 2010). The NGIA pest alert stated that “Once more is known about the extent of spread of the rust, a response plan will be written and considered”. The timeframe for completing the response plan was not stated.

Responsibilities

A National Management Group met on 30 April to consider a response to the detection. The National Management Group is comprised of the chief executive officers of the national and state/territory departments of agriculture and primary industries across Australia and also representatives of peak industry bodies. The CCEPP was set up by the Department of Forestry, Fisheries and Agriculture, and provides advice directly to the National Management Group. The National Biosecurity Committee, comprised of senior representatives of the national and state/territory environment and primary industries departments, oversees continued surveillance and assessment of the implications of Myrtle rust and is responsible for developing options for its management. Both the National Management Groups and the National Biosecurity Committee are chaired by the Secretary of the Australian Government Department of Agriculture, Fisheries and Forestry, Dr Conall O’Connell.

The structure is thus:

Group	Role
Consultative Committee on Emergency Plant Pests	Provision of technical advice
↓	
National Management Group	Guiding response, making operational decisions
↓	
National Biosecurity Committee	Developing response strategy and management
↓	
Sector	Feedback to the above Committees

Domestic quarantine and ongoing response

On 4 May Tasmania imposed import requirements on cut flowers and material other than seed of any myrtaceous plant species originating in all mainland Australian states with the exception of Western Australia. It required that all myrtaceous plant material must be presented to Quarantine Tasmania for identification and inspection for signs of myrtle rust. Cut flowers and plant material of myrtaceous plants showing signs of myrtle rust will be re-exported or destroyed. Plants not of the family Myrtaceae that have been packed with myrtaceous plants showing signs of myrtle rust will also be re-exported or destroyed (DPIPWE 2010). Tasmania hopes that it will be able to relax the import restrictions entirely in months if research shows that Tasmania will not be badly affected by the rust (Get Regional 2010, quoting DPIPWE's General Manager of Biosecurity and Product Integrity Alex Schaap)

On 11 May Western Australia imposed similar restrictions. The ABC report stated that "Some in the industry say it's the "foot and mouth" of native tree species" (ABC News 11 May 2010).

Other states have not imposed bans or restrictions, although South Australia is considering doing so. Queensland and Northern Territory have released fact sheets similar to that released by DAFF on 4 May requesting that members of the public report any suspicious symptoms to the appropriate authority.

There have been calls for stronger action from the Committees. Weekly Times Now (2010) quotes Elders research and development manager Dr Marie Connett as saying the disease "would be quite devastating" to forestry plantations and native bush. Connett goes on to say "It is a nightmare scenario, not just to plantations but to other species which are key parts of the Australian ecosystem. A number of species have been tested for resistance to myrtle rust by the US Department of Agriculture - none of the species tested, including fruit and ornamental trees, have had any resistance." The Chairman of the WA Division of the Institute of Foresters of Australia, David Wettenhall, in a press release stated "This is a major bio-security incursion and the consequences to our native flora and plant industries are potentially enormous – and in relative terms much greater than the potential impact of equine influenza on the equine industries, to which there was a much more active response. The rust has the potential to severely damage our forests, including our conservation reserves." He goes on to say "While there are uncertainties to some aspects of the rust incursion, as interim measures we must immediately take every possible action to eradicate and contain the rust." (IFA 2010).

The Weekly Times Now reported that it had seen correspondence from the Government of Western Australia raising concerns that the incursion "could be used to invoke restrictions on the trade of wood and timber products from Australia" (Weekly Times Now 2010).

At time of writing (12 May 2010) Tasmania and Western Australia have imposed import restrictions although Tasmania hopes to release these restrictions if research shows that the rust will have a low impact there. Concerns have been raised that restrictions or bans could be placed on Australian wood and timber exports, and cut flower trade will be seriously affected.

The National Management Group is due to meet and the CCEPP are collecting more information on the extent of the rust in NSW in terms of geographical distribution, host range, and severity of infection. Research on potential impact is being carried out in Tasmania.

Recommendations

New Zealand has some time available to develop a plan and initiate a pre-emptive response to the introduction and establishment of guava rust. To start, we recommend the following steps are taken.

- a. The impact of *P. psidii* on New Zealand natives that are growing in Hawaii, where the disease is present, should be established.
- b. A list of researchers actively working on the disease should be made. They could be asked to assess the susceptibility of NZ natives. Preferably these tests should be carried out in a number of countries or regions.
- c. A molecular phylogenetic analysis to establish the relationship between *P. psidii* and the anamorphs in *Uredo* spp should be done to clarify the species boundaries.
- d. A collaboration with NIWA should be established to model air currents across the Tasman Sea to develop an early warning system. This early warning system could be used to predict potential dates and places for inoculum arrival from Australia. This data, in combination with the CLIMEX distribution data could be used for targeted surveillance.
- e. Establish collaborations with Australian researchers to assess infection of New Zealand natives growing in Australia. Because of the issues associated with races, it is important to understand the risk associated with the Australian race.
- f. Langrell *et al.* (2008) have published a molecular diagnostic method for *Puccinia psidii*. Although *U. rangelii* was not tested with the primers, we suggest that the IDC lab prepare for the incursion by having the primers in stock because Langrell *et al.* (2008) state that the priming sites are conserved among the isolates of *P. psidii* that were used to develop the test.

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