# Beyond Myrtle Rust: towards ecosystem resilience

## Five year MBIE-funded Endeavour Programme 2018–2023

<u>Research framed around these four questions:</u>

1. How is the pathogen adapting to New Zealand?
2. How does it impact New Zealand ecosystems?
3. How do we control or mitigate the impacts of this pathogen?
4. How can we enhance kaitiakitanga and Māori-led solutions in pathogen-affected ecosystems?

NEW ZEALAND'S BIOLOGICAL HERITAGE

National SCIENCE Challenges

NGĀ RĀKAU TAKETAKE

# Saving Our Iconic Trees

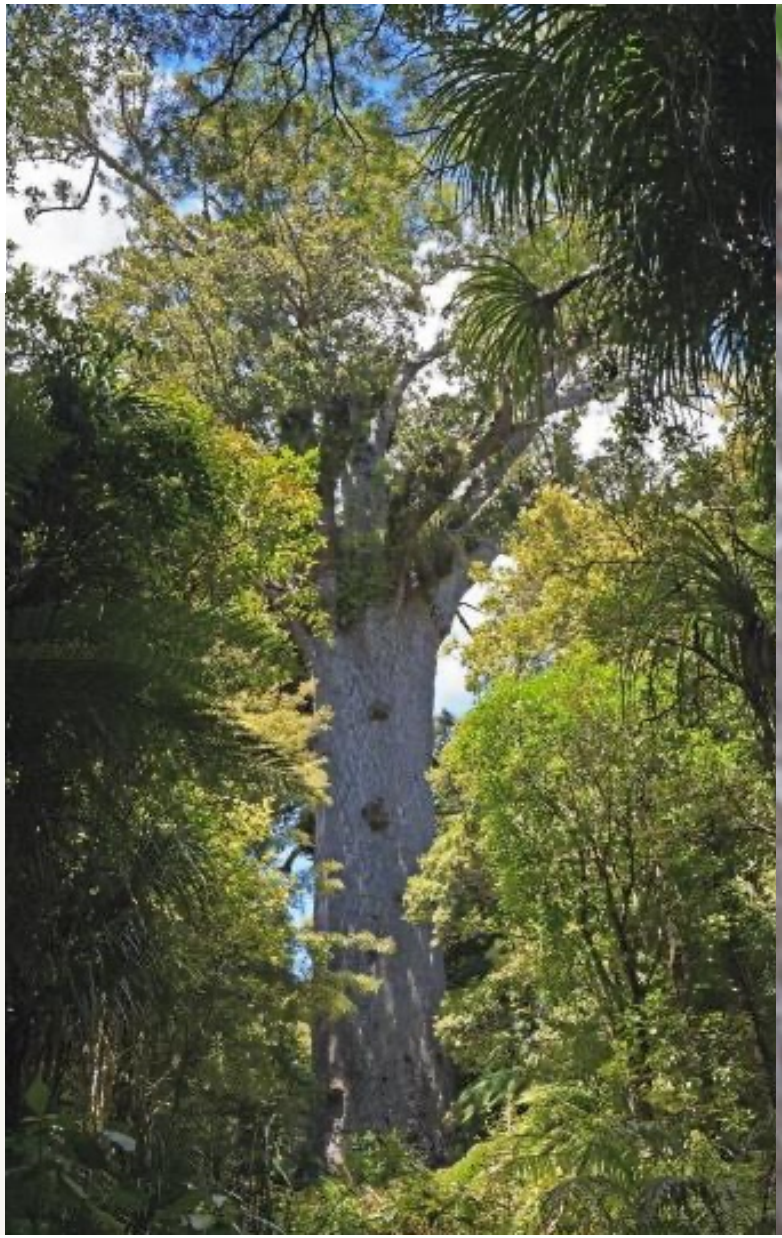
*from Kauri Dieback & Myrtle Rust*

MBIE Strategic Science Investment Fund

Myrtle Rust research
$5M over 3 years

Alignment with MR Strategic Science Plan and *Beyond Myrtle Rust*

www.bioheritage.nz



NGĀ RĀKAU TAKETAKE

# Saving Our Iconic Trees

*from Kauri Dieback & Myrtle Rust*

## Impact 1: Whakamana • Empower

1. Oranga
2. Mobilising for Action

## Impact 2: Tiaki • Protect

3. Risk Assessment & Ecosystem Impacts
4. Integrated Surveillance
5. Control, Protect, Cure

## Impact 3: Whakahou • Restore

6. Host, Pathogen & Environment
7. Conservation & Restoration

# Ngā Rākau Taketake

https://bioheritage.nz/research/saving-our-iconic-trees/

| | Oranga | Mobilizing for Action | Risk Assessment, Ecosystem Impact | Integrated Surveillance | Control, Protect & Cure | Host, Pathogen & Environment | Conservation & Restoration |
|---|---|---|---|---|---|---|---|
| **Lead Organisation** | Te Tira Whakamātaki Foundation | The University of Auckland | Scion | Manaaki Whenua Landcare Research | Scion | Plant & Food Research | Manaaki Whenua Landcare Research |
| **Leads**<br>Female 8 (57%)<br>Male 6 (43%)<br>Māori 7 (50%) | Melanie Mark-Shadbolt<br>Valance Smith | Marie McEntee<br>Natasha Tassell-Matamua | Simon Wegner<br>Luitgard Schwendenmann | Dean Anderson<br>Waitangi Wood | Tara Strand<br>David Milner | Beccy Ganley<br>Julianne Chetham | Peter Bellingham<br>Alby Marsh |

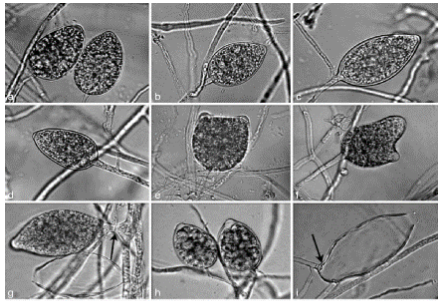
Best practice protocols for germplasm collection & protection (agency partnerships)

Characterise shared values (building block to behaviour change & on-ground action)


Surveillance data prototypes tested in modelling framework

High-risk seed & scope fast-fail projects

Novel tool selected for further development



@McCarthyEcology

Manaaki Whenua
Landcare Research

MANAAKI WHENUA – LANDCARE RESEARCH

# Predicting Refuges from Myrtle Rust

**James McCarthy**[1], Susan Wiser[1], Peter Bellingham[1], Rob Beresford[2], Rebecca Campbell[2], Richard Turner[3], Sarah Richardson[1]

[1] Manaaki Whenua – Landcare Research

[2] Plant and Food Research

[3] NIWA

# Myrtle rust

(aka guava rust, Eucalyptus rust)

- *Austropuccinia psidii*
- Rust fungus, native to South America
- Wind dispersed
- Wide host range, Myrtaceae family
  - ~ 6,000 spp. worldwide
  - 480 confirmed host spp. (currently)

# Globetrotter

Native to South America

- Infections usually mild on native species
- More severe on introduced species, e.g. *Eucalyptus*

1900 – 2000

- Caribbean area (1930s)
- Mexico (1970s)
- Florida (1977)

2000 –

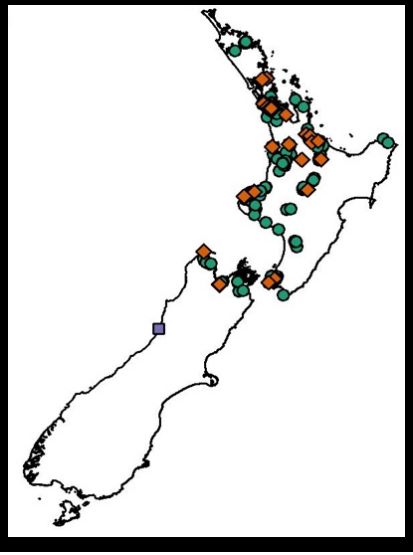
- Hawaii (2005)
- Japan (2007)
- Southern China (2009)
- Australia (2010)
- New Caledonia (2013)
- Sumatra (2015)
- Singapore (2016)

- And…

# … in 2017 it was detected in New Zealand

- March 2017 – Raoul Island (Kermadecs)

- May 2017 – Northland
- April 2018 – Tasman (South Island)
- May 2019 – West Coast (South Island)




# Myrtaceae in New Zealand

- 27 native species (26 endemic)
  - *Metrosideros* (12 species)
  - *Kunzea* (10 species)
  - *Lophomyrtus* (2 species)
  - *Leptospermum* (1 species)
  - *Neomyrtus* (1 species)
  - *Syzygium* (1 species)

- 200+ introduced
  - Feijoa
  - *Eucalyptus* spp.
  - Bottlebrush (*Melaleuca* spp.)
  - etc.

Pōhutukawa


Mānuka

Kānuka

Ramarama


P. Creighton
N. Goldwater

# Pōhutukawa (*Metrosideros excelsa*)

## Present

## Absent

Photo: Janet Wilmshurst

# Pōhutukawa (*Metrosideros excelsa*)

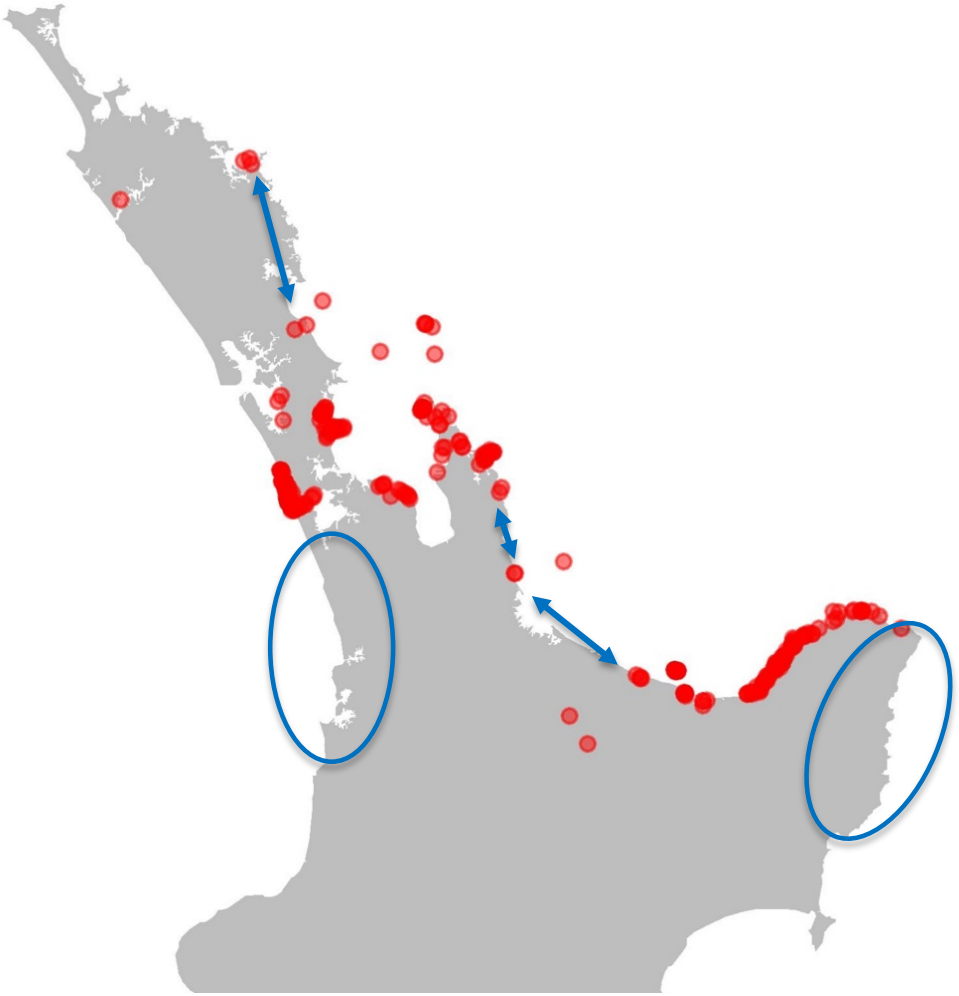
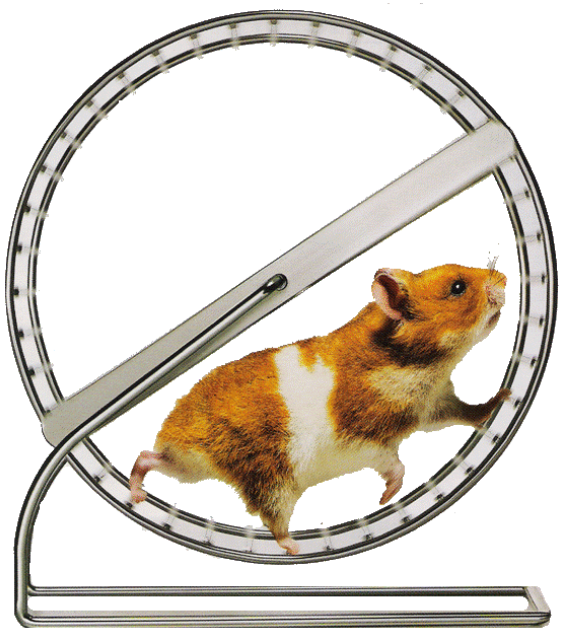
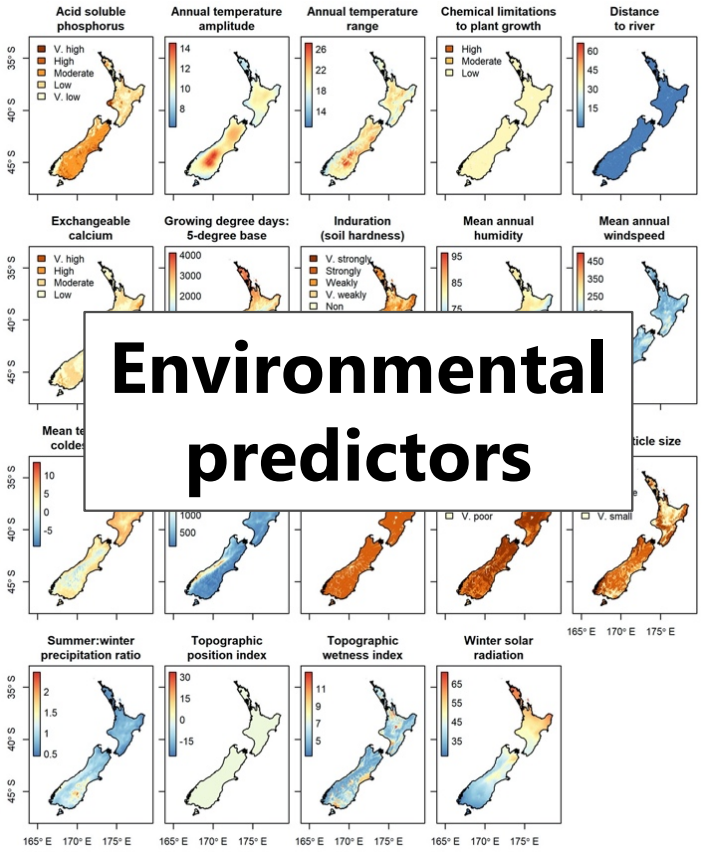


Photo: Janet Wilmshurst



**Model**




**Environmental predictors**

# Pōhutukawa (*Metrosideros excelsa*) – prediction

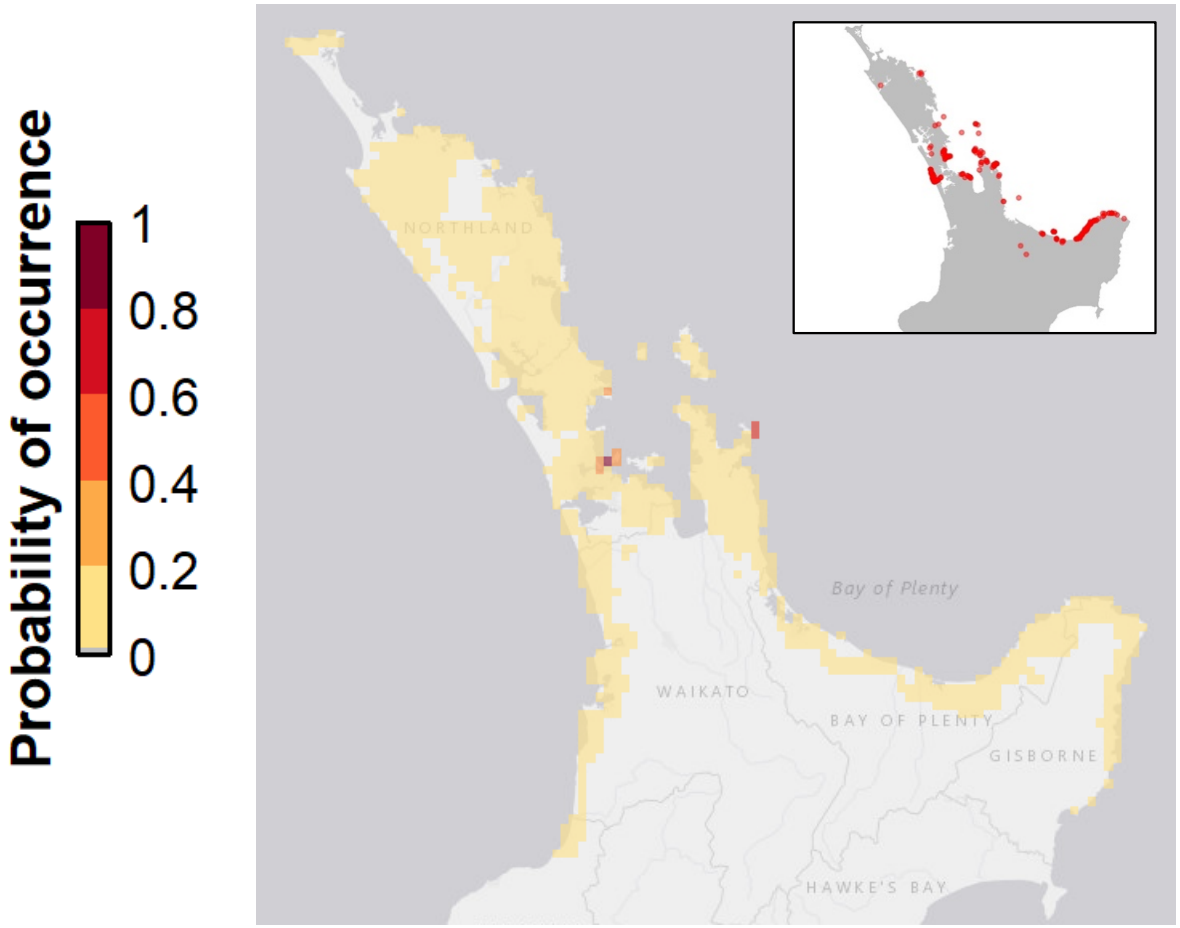
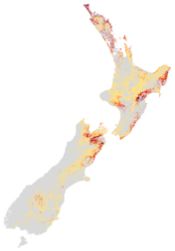
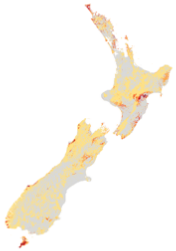



Photo: Janet Wilmshurst

*Kunzea ericoides* s.l.



*Leptospermum scoparium*



*Lophomyrtus bullata*



*Lophomyrtus obcordata*



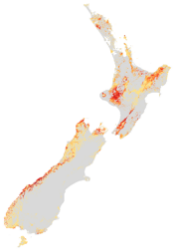
*Metrosideros albiflora*



*Metrosideros colensoi*



*Metrosideros diffusa*



*Metrosideros excelsa*



*Metrosideros fulgens*

*Metrosideros parkinsonii*

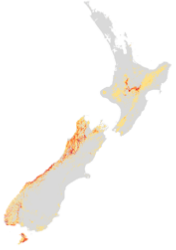


*Metrosideros perforata*

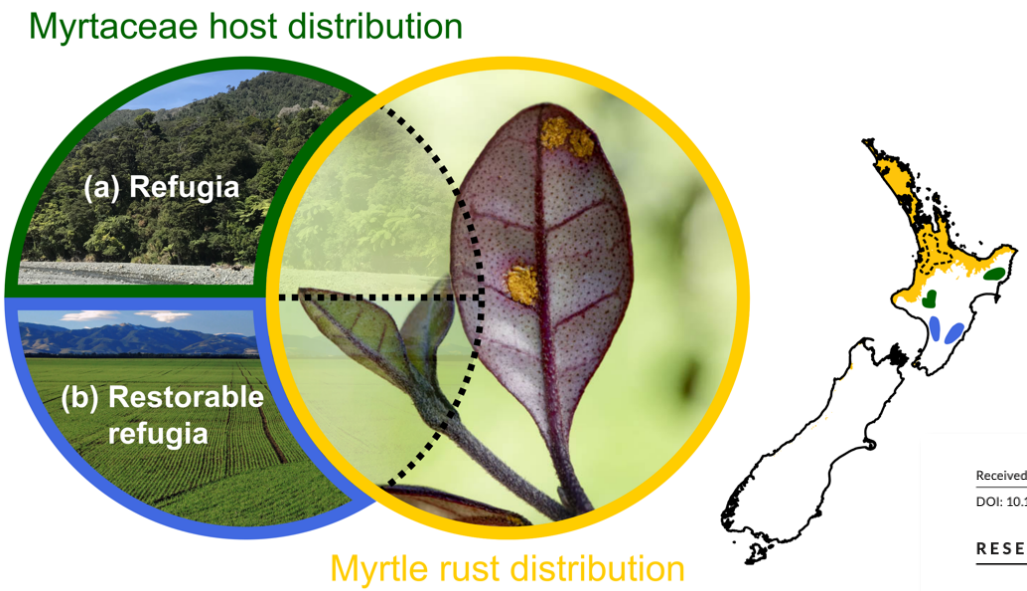
*Metrosideros robusta*

*Metrosideros umbellata*

*Neomyrtus pedunculata*



*Syzygium maire*

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RESEARCH ARTICLE

Journal of Applied Ecology

# Using spatial models to identify refugia and guide restoration in response to an invasive plant pathogen

James K. McCarthy[1] | Susan K. Wiser[1] | Peter J. Bellingham[1,2] | Robert M. Beresford[3] | Rebecca E. Campbell[4] | Richard Turner[5] | Sarah J. Richardson[1]

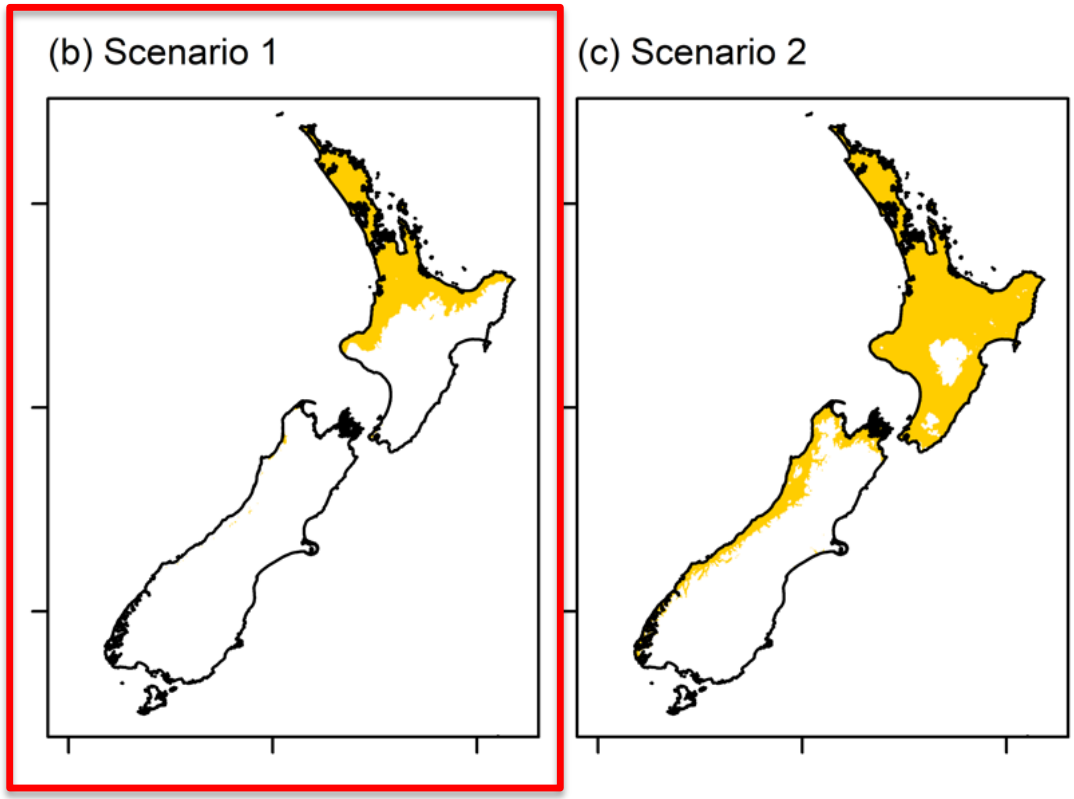
[1]Manaaki Whenua – Landcare Research, Lincoln, New Zealand
[2]School of Biological Sciences, University of Auckland, Auckland, New Zealand
[3]The New Zealand Institute for Plant and Food Research Ltd, Auckland, New Zealand
[4]The New Zealand Institute for Plant and Food Research Ltd, Motueka, New Zealand
[5]National Institute of Water and Atmospheric Research Ltd, Wellington, New Zealand

**Abstract**

1. The global spread of invasive plant pathogens is increasing, putting natural forests and ecosystem services under threat. Spatial data can quantify range non-overlap between invasive pathogens and their hosts to identify existing and potentially restorable refugia to enable 'escape' from the pathogen.
2. In 2017, myrtle rust *Austropuccinia psidii* was detected in New Zealand. New Zealand has 27 native woody and liana species in the plant family susceptible to the disease (Myrtaceae), many of which are ecosystem dominants and economi-

# Identifying 'refugia'

Areas ***within*** a species range, but ***outside*** the disease range






**Predicting the climatic risk of myrtle rust during its first year in New Zealand**

Robert M. Beresford[1,*], Richard Turner[2], Andrew Tait[2], Vijay Paul[2], Gregor Macara[2], Zhidong D. Yu[3], Lorin Lima[3] and Rebecca Martin[3]

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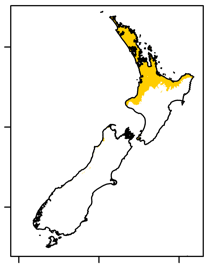
[2]*National Institute of Water and Atmospheric Research, Ltd, Private Bag 14901, Wellington, New Zealand*
[3]*Ministry for Primary Industries, PO Box 2526, Wellington 6140, New Zealand*
**Corresponding author: robert.beresford@plantandfood.co.nz*

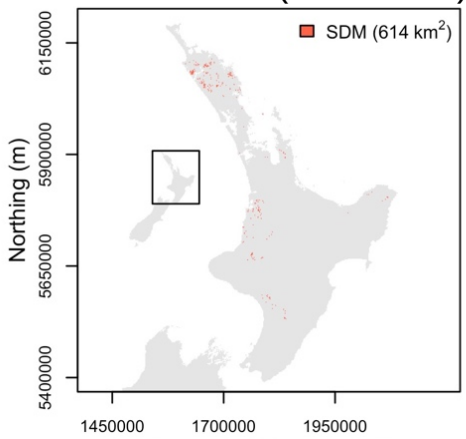
**Abstract** After the first detection of myrtle rust (*Austropuccinia psidii*) on mainland New Zealand in May 2017, the Ministry for Primary Industries sought information about how weather conditions would affect regional and seasonal risk of disease establishment to help

# Identifying ‘refugia’

Areas ***within*** a species range, but ***outside*** the disease range



Ramarama (*L. bullata*)

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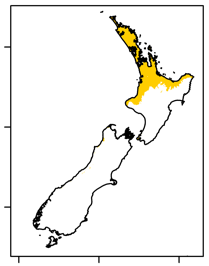

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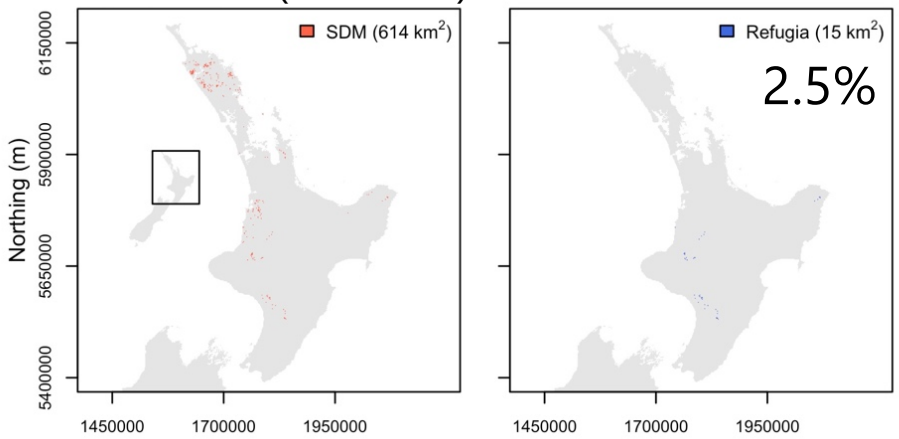


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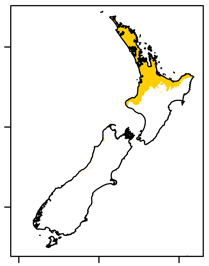

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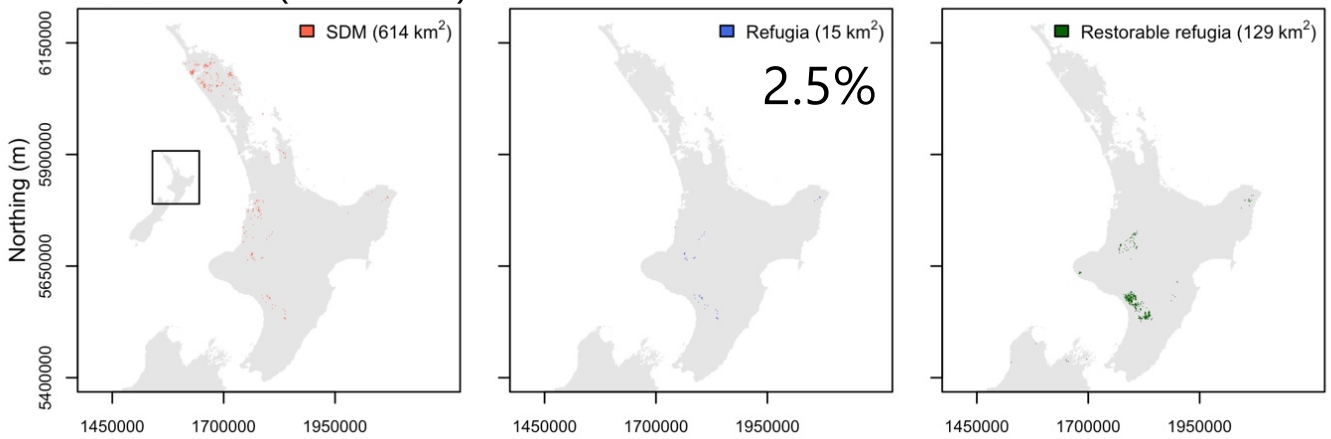
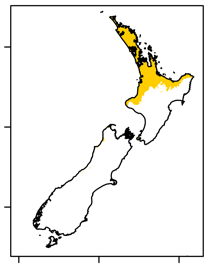



# Identifying 'refugia'

## Areas ***within*** a species range, but ***outside*** the disease range



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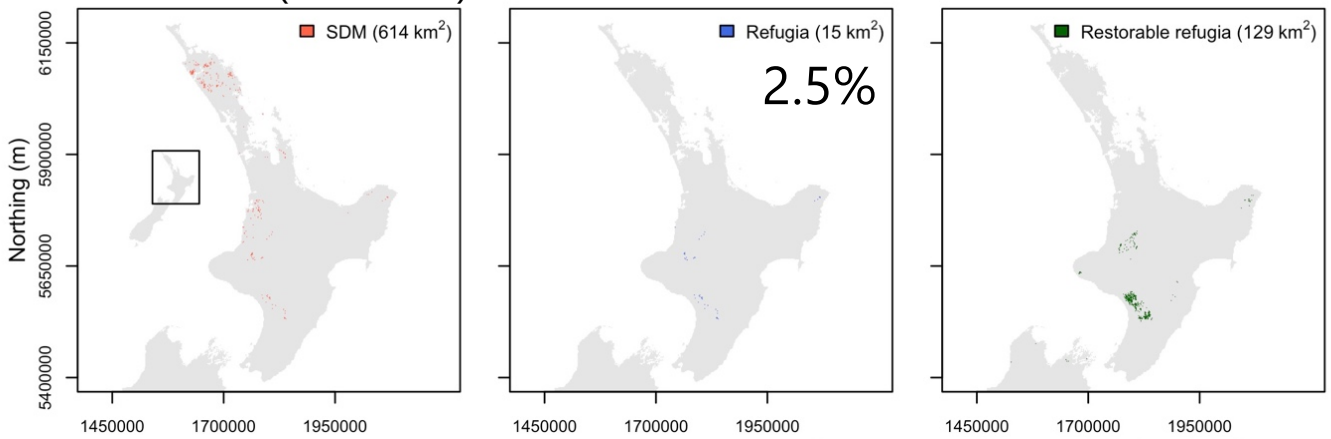
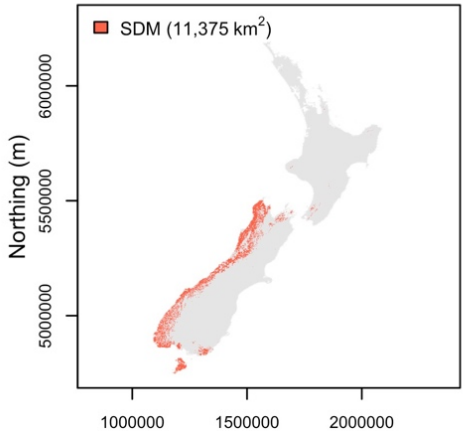



Southern rātā (*Metrosideros umbellata*)




iNaturalist: Alex Fergus

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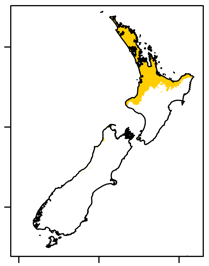

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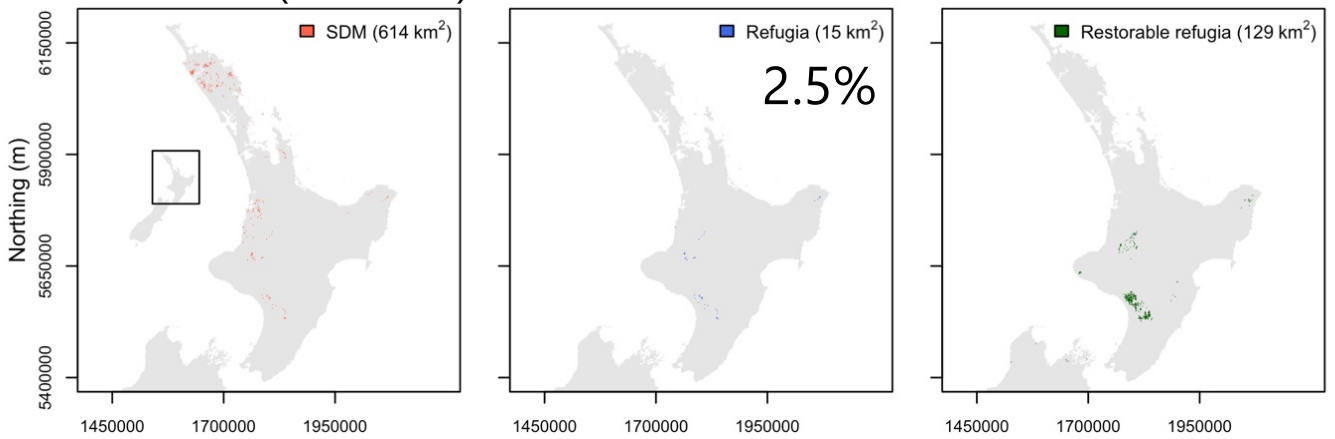


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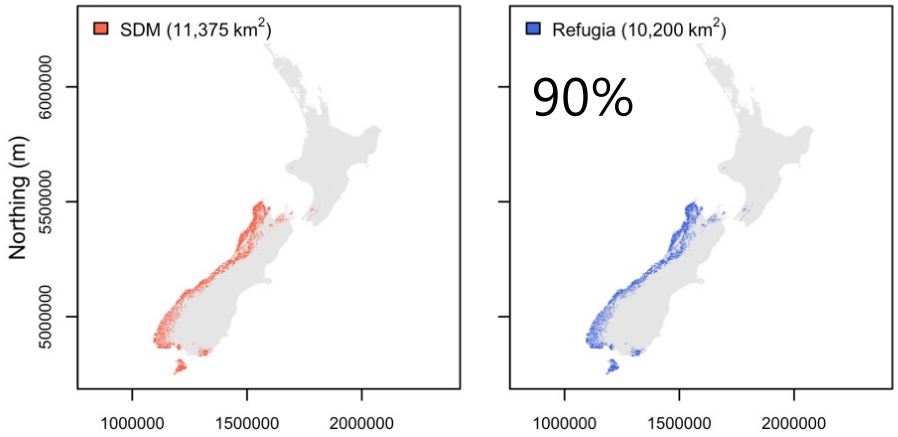


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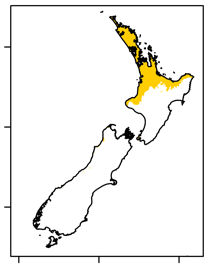

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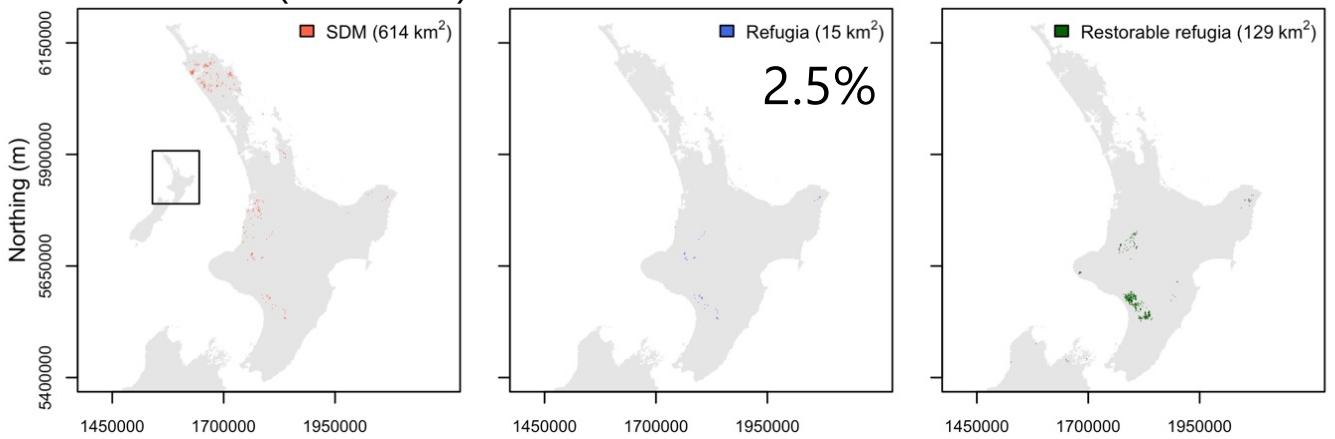


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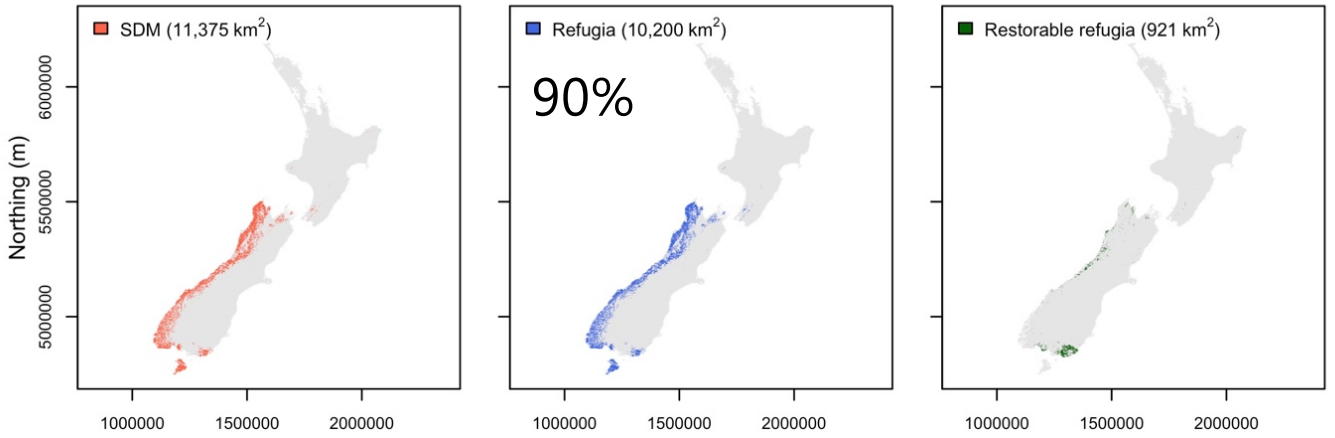


iNaturalist: Alex Fergus

| Species | SDM ($km^2$) | Scenario 1 Refugia ($km^2$) | Refugia (%) | Restorable refugia ($km^2$) |
|---|---|---|---|---|
| *Metrosideros albiflora* | 451.5 | 0.2 | 0.1 | 0.4 |
| *Syzygium maire* | 252.7 | 1.4 | 0.6 | 8.4 |
| *Lophomyrtus bullata* | 614.4 | 15.3 | 2.5 | 129.2 |
| *Metrosideros excelsa* | 569.3 | 99.6 | 17.5 | 130.9 |
| *Lophomyrtus obcordata* | 804.5 | 211.2 | 26.3 | 1,935.5 |
| *Metrosideros robusta* | 5,091.4 | 1,565.6 | 30.7 | 663.8 |
| *Metrosideros perforata* | 7,589.2 | 2,825.0 | 37.2 | 2,845.1 |
| *Metrosideros parkinsonii* | 109.2 | 45.8 | 42.0 | 3.8 |
| *Metrosideros fulgens* | 7,664.1 | 3,363.9 | 43.9 | 1,077.8 |
| *Leptospermum scoparium* | 10,642.7 | 4,785.7 | 45.0 | 4,096.0 |
| *Metrosideros colensoi* | 569.3 | 300.6 | 52.8 | 1,776.4 |
| *Kunzea ericoides* sensu lato | 13,203.9 | 7,014.3 | 53.1 | 6,307.0 |
| *Metrosideros diffusa* | 15,534.7 | 9,504.4 | 61.2 | 9,225.4 |
| *Neomyrtus pedunculata* | 6,407.1 | 4,885.1 | 76.2 | 3,097.8 |
| *Metrosideros umbellata* | 11,375.0 | 10,200.0 | 89.7 | 920.7 |

*Metrosideros albiflora*

## What's next?

- Ground truthing the predictions
  - Especially at regional and local scales
- Improving data = more accurate models
- Incorporate refugia into reserve management
- Think about native restoration opportunities (One Billion Trees)
- Targeted seed collection (genetic diversity)
- Ex situ conservation – "Rescue gardens"

@McCarthyEcology

Manaaki Whenua
Landcare Research

# Thank you!


- MPI and Beyond Myrtle Rust for funding
- Elise Arnst, Aaron Wilton, John Sullivan, Vijay Paul – data access
- Olivia Burge, Tom Etherington, Jane Elith – modelling advice
- Larry Burrows, Alex Fergus, Shannel Courtney – checking species records




Beyond
Myrtle Rust

Towards Ecosystem Resilience