Predicting Refuges from Myrtle Rust

The following questions were asked during our live webinar with James McCarthy, Mahajabeen Padamsee and Maureen O'Callaghan but due to time restrictions, we were unable to answer these in the session.

Is myrtle rust intolerant of colder conditions?

Yes, myrtle rust is intolerant of cooler temperatures and low humidity.

What are the likely distributional changes for MR from various climate change scenarios?

We know that the risk of myrtle rust is heightened in higher temperatures and humidity and that solar radiation is also important. In NZ, broadly, temperatures are expected to increase under climate change, humidity is predicted to decrease, and predicted solar radiation changes are variable. This is a difficult question to answer because it hasn't been investigated yet, but if temperatures increase then the disease range may push further south, but a loss in humidity may moderate this shift, or even make currently affected areas unsuitable. Hopefully this question will be addressed explicitly one day. See the Discussion section of our paper for a brief overview of this: https://besjournals.onlinelibrary.wiley.com/doi/10.1111/1365-2664.13756

What is the natural southern distribution of rust in South America?

I wasn't sure about this myself, so I looked it up and found the following: "Puccinia psidii is indigenous to Brazil, and probably also to parts of Paraguay, Uruguay and northern Venezuela, Ecuador, Colombia, and parts of Central America" from the following paper: https://www.scionresearch.com/__data/assets/pdf_file/0005/59189/NZJFS333P420_428TOMMERUP.pdf

What is the current situation of rust in Raoul island pohutukawa?

See this link for a summary of myrtle rust work on Raoul Island. I don't have any information in addition to this. https://www.doc.govt.nz/nature/pests-and-threats/diseases/myrtle-rust/our-work-on-raoul-island/

Why did Pohutakawa have very low probabilities of occurrence (0 - 0.2) over most of its predicted range?

Pōhutukawa has a naturally patchy distribution owing to its particular habitat requirements, and its role in early succession -- properties difficult to capture using our environmental data. My interpretation of the low probability of occurrence is that due to these properties, the model predicted the species to occur over a relatively wide region but was never particularly "confident" that it would occur in any location.

Can you model the impact of different climate change scenarios on these refugia?

Yes, we could. This would involve knowing something about future climate, and carefully predicting distributions of host and pathogen into these conditions spatially. Any exercise like this would need to consider the ability of the host and disease to shift distribution under a changing climate, which would happen at different rates (being windborne, I imagine the disease would be able to shift faster). Unfortunately, at the moment, I am unaware of any funding dedicated, or efforts underway, to explore this.

Do you know how many of these species have good representation in seed banks/have germplasm stored securely?

I don't know much about this except that DOC led an effort to collect and store seed shortly after the incursion, and that there was an attempt for these samples to capture some genetic variation. You might find the following paper interesting:
https://www.tandfonline.com/doi/full/10.1080/0028825X.2020.1754245

What about enrichment planting?

Enrichment planting in areas of refugia would be a great idea. Checking first for evidence of past infection would be a crucial first step though, because young individuals planted in an infected area would get heavily affected by myrtle rust as they put on new growth (these are the plant tissues susceptible to the disease).

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Do you feel there is the political will to convert land that is currently used for other purposes to refugia?

There can be -- with initiatives like "One Billion Trees" there are some incentives to restoring land to native forest (especially areas marginal for farming). It would be great if these areas could also contribute to refugia for species threatened by myrtle rust.

What has been so far the impact of Myrtle rust in native ecosystems?

This is still being investigated. We know from the experience in Australia that the effects can take years to become obvious. This is because myrtle rust only really affects young tissues (leaves, stems, flowers, fruit), with older tissues being immune, and plants may take a while to die if they are still able to use their old leaves. Ecosystem-level impacts may occur if species fail to recruit without seed being produced, or if seedlings are immediately infected once they germinate. Now, we know that in places ramarama is affected heavily due to these factors (see https://newzealandecology.org/nzje/3414 for a paper that investigated this), but we need to keep monitoring even if the effects aren't obvious at present.

Why is introduced Pohutukawa in southern areas (such as Wellington and Akaroa) not important to study? Is it not a significant enough vector for spread of the fungus?

They are important to study, but we were interested in natural populations for this work and we didn't consider vectoring explicitly because it's a very easily dispersed fungus.

Should the threat status of manuka be revised, based on the fact that 45% of its range is likely to be refugia?

I'm not sure. All native Myrtaceae were elevated to a listed threat category (if they weren't already) after the arrival of myrtle rust because they had the potential to be affected. When these classifications are revisited, I'm sure that evidence like this will be considered, alongside up-to-date knowledge of species-level susceptibility.