2021 Waitākere Ranges Kauri Population Health Monitoring Survey

Webinar Questions & Answers

June 2022

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Questions and Answers from the Webinar hosted on 30 June 2022

1. **Was it science that informed the coastal track upgrades?**

A combination of best practice track standards combined with mātauranga is used in our approach to track design. The National Pest Management Plan- *Phytophthora agathidicida* and its associated Draft National Mitigation Standards require the Landowner/Occupiers of public tracks to "Implement measures to minimise the risk of PA spread that may arise as a result of the transport of soil on feet or on articles (walking poles, wheels, cycles, the feet of pets etc) having soil on them, or the transport of any PA host plant material to, within, or from any Kauri Hygiene Area."

They also include a list of measures that can be undertaken to minimise the risk of spread, for example:

- Closure of public access to the Kauri Forest Area through the use of effective barriers, signage and publicity,
- Re-alignment of tracks or portions of tracks to avoid passage within a Kauri Hygiene Area,
- Installing Hygiene Stations for removal of soil and applying disinfectant to feet and equipment.
- Installing track surfacing and/ or structures that minimises the potential for soil particles to be carried by feet or other articles into, within, or from a Kauri Hygiene Area, or for feet and articles to come into contact with kauri fibrous roots,

Auckland Council is utilising these measures across its track network. However, the installation of track surfacing and/ or structures that minimise the potential for soil particles to be transported is the most practical option when working with tracks that intersect with multiple kauri hygiene zones.

Practical considerations are also important when thinking about where to begin upgrade work when dealing with coastal tracks. The alternative would be to install hygiene stations at every Kauri Hygiene Area entry and exit point with a transition zone between each. In addition to being impractical from a maintenance perspective, it is also less effective with mud being readily transported into each station and creating cross contamination. An additional risk is that it is entirely reliant on a high level of user compliance.

2. **There is no *P. agathidicida* in the centre of the Waitākere Ranges Regional Park. Is it possible that the soil conditions are responsible for the absence of *P. agathidicida*?**

We asked this question of our pathology experts while we were writing the report and they responded that soil conditions should not affect pathogen detection. If the pathogen has not been detected with a large sampling effort, it is most likely that it is not present and has not reached its potential distribution range.

However, we also note in the report that other unmeasured factors such as soil type and chemistry may also affect the presence of *P. agathidicida* in soil. When the soil samples for this study were collected, additional volumes of soil were taken for distribution to a range of collaborating researchers, and soil chemistry or microbiota relationships may become clearer when their research is completed.

3. **What is the land status classification for the Waitākere Ranges Regional Park?**

As specified in the Regional Parks Management Plan (2010-2020), the land status specifies that the bulk of the park contains land held and managed in terms of the Local Government Act, 2002. A smaller proportion (approximately 17 per cent) of the land area is held and administered under the Reserves Act 1977, including land at Cascades-Kauri, Cornwallis, Lake Wainamu, Pae o Te Rangi, Parau and Whatipu. This places additional management obligations in relation to administering this land classified as recreation, scenic and scientific reserves under that Act

The Waitākere Ranges Heritage Area Act (WRHAA) acknowledges the park lies within the rohe of Te Kawerau ā Maki and Ngāti Whātua. It also states that we must establish and maintain processes to provide opportunities for Ngāti Whātua and Te Kawerau ā Maki to contribute to the decision-making processes and the implementation of the Act.

4. **Where can we find scientific data on the difference that closing the Waitakere Ranges for the last 5 years has made**

We have established a baseline prevalence of pathogen and of symptomatic kauri spatially distributed across the forest. This provides a baseline for further monitoring to compare change over time.

Looking at intervention activities within stream sub-catchments will be a good way to assess effectiveness in the future. For example, stream sub-catchments with tracks that remain closed but are in the pipeline to be upgraded can be compared in the future once they have been upgraded.

This is a long-term management approach of a very long-lived host (kauri) and a pathogen with an extended latency and incubation period (time between infection and visible disease), and it will take some time to gather enough data to measure the impact of difference management interventions.

5. **Please advise why such huge & high bridges have been built and what was the approval sign off**

This report details the results of a comprehensive survey of kauri within the Waitākere Ranges Regional Park. While the report findings may inform future decisions around recreational activities this question is outside the scope of the report content.

The internet connection here keeps cutting out - will there be a video of this presentation available afterwards?

There were two peak internet traffic events that unfortunately resulted in buffering of the live event for some people. The recorded version is available at the same link https://watchlive.watch/kauri/

6. **How did you decide whether or not to take a soil sample?**

The 761 soil sample locations were randomly pre-selected, regardless of disease state, prior to the field team entering the forest. Samples were taken for all sites that were pre-selected, unless the sample tree was not found or was inaccessible.

7. **Has there been an attempt to find a correlation between symptomatic Kauri and drought - prone sites?**

The risk analysis study was established to explore correlations between risk and impact factors associated with either the pathogen or disease.

We found that symptomatic kauri was most strongly associated with proximity to sites where *P. agathidicida* had been detected.

We agree that drought is likely to be making hosts more vulnerable to infection, where *P. agathidicida* is present and that it could explain some symptoms that are similar to kauri dieback in areas where *P. agathidicida* wasn't detected.

We found that the depth to surface water index, which gives an indication of areas more prone to being moist or dry, was not associated with increased symptomatic kauri prevalence or *P. agathidicida.* Similarly, distance to overland flow path (watercourses) did not indicate a relationship with symptomatic kauri or with *P. agathidicida* detection. It may be that the depth to water index used was not a good model for wet or waterlogged sites. The report authors stated it was important to investigate this relationship further in future research.

8. **Reflections shared during Q & A time on increasing risk factor association between low elevation and presence of pathogen:**

   Part 1: high Pa in lower elevation compared to higher is indeed congruent with observations made with most soilborne pathogens.

   Part 2: I call it washdown effect. water pulls all the pathogens down as it rains etc. made similar observations in plantations infested with F. oxysporum

We agree with these observations and state the following in the report:

As a soil-borne water-mould, it is more likely that prevalence due to natural spread would be greater at lower elevations as water is carried downhill. This is consistent with the direction of effect in the model and with research on other *Phytophthora* species showing that propagules are washed down catchments (Redondo et al., 2018).

9. **Is there soil sampling across the slopes between Parau and Huia Dams as a control? The slopes are tawa, rimu, kahikatea, kanuka with regenerating kauri.**

The soil sampling approach was to obtain samples from randomly selected kauri, irrespective of health status, across the entire kauri population in the Waitākere Ranges Regional Park as opposed to creating sampling plots in specific locations. A few of the randomly selected kauri where soil samples were taken do occur between Parau and the lower Huia dam. Please refer to Figure 2.8 of the [2021 Waitakere Ranges kauri population health monitoring survey (knowledgeauckland.org.nz)] for more information. This is a spatial point map showing the location of kauri trees in the study area that had soil samples taken for diagnostic testing.

10. **Wouldn't the recent track upgrades be a significant disturbance factor? Most of the upgraded tracks have been very widely cleared, and extensively gravelled.**

All maintenance or upgrade work in the current kauri track mitigation programme is undertaken under extremely specific guidelines to avoid disturbance to kauri roots, including using no-dig piles for boardwalks and the installation of geocell products to provide a separation between aggregate mixes and kauri root plates that are adjacent to the track.

Helicopters are also used to avoid transporting materials over large distances on the ground and strict hygiene protocols are required when working within individual kauri hygiene areas. Historic clearance and benching (cutting) of the tracks is likely to have been a significant disturbance factor.

11. **Was there an opportunity to keep any of the soil sample material collected in this study for later PCR/ LAMP analysis to compare results? Or must you resample?**

When undertaking the field work, we collected sufficient quantities of soil and root material so that additional work, other than the standard soil culture and bioassay test (including LAMP analysis and other academic research including DNA analyses), could be performed.

It was also our original intention to undertake the test performance analysis of the LAMP diagnostic test process at the same time as the standard soil culture and bioassay test. The lab diagnostic work was carried out at different facilities and unfortunately a large number of the soil samples that were being processed for LAMP were compromised due to being partway through the baiting process when the COVID lockdown occurred. The remaining samples which were not impacted by this event are still being processed. While we do not have enough remaining samples to undertake the same test performance evaluation, the results will continue to add to the overall understanding of the spatial pathogen distribution.

It is hoped that surveillance projects planned through the National Programme will seek to determine sensitivity and specificity parameters for LAMP.

12. **Given humans have been on these tracks for decades, if we are a significant vector of PA why don't we see more tracking of it along tracks and into centre?**

Looking at spatial overlaps between pathogen presence and the track network can help inform risk assessment (purpose and intention of the 2017 Waitākere Ranges Kauri dieback report) as opposed to designing a methodology to specifically determine a correlation between pathogen and the track network itself. To achieve this, the Epidemiology and Risk Analysis Lab at Massey University carried out multivariable risk factor modelling to account for associations between risk factors and either pathogen or disease. This allows us to account for confounding factors, something that cannot be achieved by looking at proximity relationships alone (e.g., proportion of infected trees within 50 meters of a track).

If you are referring to our findings that suggest a localised distribution of the pathogen around the periphery of the Regional Park and the absence of it in the heart of the forest, then there are two key points for consideration.

The first is that the heart of the Waitākere Ranges remained as a water catchment area, inaccessible for public recreation until the 1990s. Secondly, our findings suggest that the distribution of *Phytophthora* *agathidicida* is consistent with that of a slow-moving invasive soil-borne pathogen that has not yet achieved its full potential range. In that, there is a lag period between the introduction of the pathogen to a new area and the dispersal (via natural or human assisted means) around the area.

13. **Do you now think from the data presented that the pathogen is not as impactful as previously thought and that the control measures can scale back accordingly?**

While it is heartening to find that the horse has not proverbially bolted, we found a strong association between *P. agathidicida* and symptomatic kauri. We also found localised distribution of *P. agathidicida* in the forest, indicating several points of introduction. This evidence reinforces our knowledge that *P. agathidicida* is an 'infectious' disease, in that it is actively spread between hosts (naturally and through soil movement). The first principles of infectious disease control of isolation, hygiene and treatment can be applied.

This evidence supports the continuation of strategies to slow or stop the spread of *P. agathidicida* within and beyond the Waitākere Ranges.

14. **Hi great study and presentations, do you have any indication of how long it may have been in the area**

The study design and results are not able to shed any light on the timeline of the introduction of the pathogen .However, the spatial distribution of the pathogen which supports distinct individual introduction points at Piha and Huia is broadly consistent with the discovery of different genetic isolates for these areas which were published in a paper by Winkworth et al. (2021) titled 'The mitogenome of *Phytophthora agathidicida*: evidence for a not so recent arrival of the "kauri killing" *Phytophthora* in New Zealand'.

15. **To confirm an infection of P.a. in Kauri do you test the tree itself or only the soil around the tree?**

We use soil sampling, which is carried out in accordance with the national kauri protection programme specifications at cardinal points around the base of the tree and includes kauri root material (which is where the pathogen first invades the host). An alternative method of testing in limited situations previously is called cambium testing and is no longer generally adopted due to the invasive nature of this sampling approach, and because it can only be used on symptomatic trees (only those with basal bleeds).

16. **In terms of the field methodology used, what were the learnings that may look to inform alternative methodologies or a combination of other methods.**

We have developed a long-term kauri health monitoring framework which specifies three different tiers of monitoring effort: landscape-scale (all of forest) monitoring, individual tree monitoring and incursion monitoring (risk-based pathogen freedom monitoring where *P. agathidicida* has not been detected). These can be utilised at different sites depending on the objectives of the sampling effort.

For the first time, we used a remote sensing technique to identify kauri for sampling in the field, which was the core of our new survey design as it allowed us to undertake randomised sampling of the kauri population.

During our field survey, we were able to validate the presence of kauri as found via remote sensing analyses, which will provide learnings and allow iterative improvements in the technique.

We are constantly looking to improve our methods and use the latest technology available. There are some new diagnostic tools which may have greater sensitivity parameters which could add value, particularly in catchments with low or zero pathogen prevalence.

We are also interested in the use of water catchment monitoring for early detection or incursion purposes. The new diagnostic test parameters (Sensitivity and Specificity) will also allow us to calculate the best sample size so that we sample what is needed to inform management and no more.

17. **There are some large plantings planned in the Ranges e.g., Anawhata – is kauri planned to be planted?**

The planting of kauri near existing kauri ecosystems is discouraged unless strict conditions can be met including suitability of site and the sourcing of kauri from nurseries that are accredited via the NZPPI Plant Pass scheme. They have not been included in the Anawhata revegetation work.

18. **Has *P cinnamomi* been found in soil samples; and associated with KDB?**

P. cinnamomi was detected in just over half of all soil samples with an average prevalence of 53 per cent and a widespread distribution across the entire park. What we found in the study was a very strong association between *P. agathidicida* and symptomatic kauri, and interestingly no association at all between *P. cinnamomi* and symptomatic kauri. This tells us that the main driver of disease is *P. agathidicida*. However, we also know that it is very rare for presence of a pathogen alone to cause disease without favourable host and environmental (including human modification) conditions. We have found associations with a range of other factors that could be contributing to disease that need to be explored further.

19. **Do you have interventions in mind (technical and mātauranga-based options) to combat the pathogen and improve kauri health?**

In addition to the isolation, hygiene and pathway management methods e.g pest control, infrastructure upgrades and fencing that we have in place, we have been undertaking research into treatment measures for stands of diseased kauri. This includes a project that is exploring the effects of phosphite from treated trees on neighbouring trees. There is potential that this could be applied as a buffer between infected and non-infected catchments as well as to slow, or reverse, the progression of disease on treated trees.

In addition, there is promising research from Monica Gerth's lab in Victoria University of Wellington that is applying mātauranga Māori knowledge to determine bioactive compounds from native trees that can disrupt different stages of the lifecycle of *P. agathidicida*. Kānuka is one such example of a bioactive compound that is showing promise. For more information, please see Mātauranga Māori could stop kauri dieback in its tracks | School of Biological Sciences | Victoria University of Wellington (wgtn.ac.nz)

20. **Questions relating to use of spatial data and proximity associations with track network.**

While we can use the data to compare it for a single risk factor (i.e. tracks), it is better presented as a multivariable spatial model. The cross-sectional design that was implemented across the three studies (baseline prevalence, multivariable analysis and test performance) was more effective at assessing a number of potential risk factors and variables as that is how the data was collected to be analysed and addresses any confounding (extraneous variables) that might be present.

21. **From the 761 Kauri checked for PTA how many are within 50m of a track?**

127

This is the number used in the analysis below called Exposed <=50 m from track/ Total.

22. **How many of the PTA positive Kauri are within 50m of a track?**

17

This is the number used in the analysis below called Exposed <=50 m from track/ ***P.ag Detected***

With the limitations noted above, we can apply the data to a single exposure context in the following way: If we split the pathogen data into two exposure groups of <=50m from a track (exposed to the risk of track) and a nominal >300m from a track (a representative point where we would expect the effect of 'track' to no longer exist (unexposed to the risk of track)) and analyse it in a two by two table [1] against *Phytophthora agathidicida* (P.ag) detected/not detected we get the following results:

Observed values (two x two table)

	P.ag Detected	**P.ag Not Detected**	**Total**
Exposed <=50 m from track	17	110	127
Unexposed > 300 m from track	12	206	218
Total	29	316	345

[1] A two-way or contingency table is a statistical table that shows the observed number or frequency for two variables, the rows indicating one category and the columns indicating the other category

Measures of association

	Estimate	Lower 95% limit	Upper 95% limit
Overall Incidence/Prevalence	0.08	0.06	0.12
Incidence/Prevalence in Exposed	0.13	0.08	0.21
Incidence/Prevalence in Unexposed	0.06	0.03	0.09
Odds Ratio	2.65***	1.22	5.76
Relative Risk (Cross-sectional study)	2.43***	1.2	4.93

*****With a p-value of 0.02 (Yates corrected Chi-square test) i.e. the result was significant.**

However, as mentioned above, this is not the best way to test the data as it doesn't take spatial clustering or potential confounding into account and excludes all data between 50-300m from a track, which does not occur when distance to track is modelled. Using the data in this way and presenting unadjusted odds ratios is possibly overstating the relationship.

The inference calculated above would be stated as: Trees within 50 meters of a track are around **2.65 times** as likely to have P.a. in the soil compared to those that were greater than 300m from a track, and the true risk lies between 1.22 times and 5.76 times as likely (p-value of 0.02; Yates corrected Chi-square test).

23. **From the 2140 randomly selected Kauri how many are within 50m of a track?**

433.

Note this number is higher than the totals in the table above as it is the full dataset, rather than the randomly selected subset of trees that were tested for *P. agathidicida*.

Also note that if you plan to use this value in a two-by-two table it should be compared to trees well away from tracks (as noted above >300 m is nominally 'away') there were 531 trees >300 m from a track.

24. **How many of the symptomatic Kauri are within 50m of a track?**

Symptomatic kauri <=50 m from track = 22 per cent (96/433).

We modelled actual distance in meters from a track in our risk factor study, which is a more accurate way to test the relationship between track proximity and symptomatic trees. This showed a higher prevalence of symptomatic kauri closer to tracks, however more investigation is needed to understand the relationship.

Note this number is higher than the totals in the table above as it is the full dataset, rather than the randomly selected subset of trees that were tested for *P. agathidicida*.

It is also worth noting that if you plan to use this value in a two-by-two table it should be compared to trees well away from tracks (as noted above >300 m is nominally 'away') there were 86 symptomatic trees >300 m from a track.

To assist with the analysis here are the results:

Observed values (two x two table)

	Symptomatic kauri	Non-symptomatic kauri	Total
Exposed <=50 m from track	96	337	433
Unexposed > 300 m from track	86	443	529
Total	182	780	962

Measures of association

	Estimate	Lower 95% limit	Upper 95% limit
Overall Incidence/Prevalence	0.19	0.16	0.22
Incidence/Prevalence in Exposed	0.22	0.18	0.26
Incidence/Prevalence in Unexposed	0.16	0.13	0.2
Odds Ratio	1.47***	1.06	2.03
Relative Risk (Cross-sectional study)	1.36***	1.05	1.77

*****With a p-value of 0.02 (Yates corrected Chi-square test) i.e. the result was significant.**

Again, as mentioned above, this is not the best way to test the data as it doesn't take spatial clustering or potential confounding into account (other variables) and excludes all the data between 50-300m from a track which does not occur when distance to track is modelled.

As stated, using the data in this way and presenting unadjusted odds ratios is possibly overstating the relationship.

The inference calculated above would be stated as: **Trees within 50 meters of a track are around 1.47 times as likely to be symptomatic compared to those that were greater than 300 m from a track, and the true risk lies between 1.06 times and 2.03 times as likely (p-value of 0.02; Yates corrected Chi-square test).**