Preliminary survey for *Phytophthora* taxon Agathis

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Preliminary survey for *Phytophthora* taxon Agathis

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Objectives

- Determine if *Phytophthora* taxon Agathis (PTA) is present in the soil at selected kauri forest locations.
- Determine association of PTA in soil with symptomatic/asymptomatic trees.
- Collect baseline information on site type for current and future evaluation of site/disease associations.

Introduction

Phytophthora taxon Agathis (PTA) was first reported from a natural stand of unhealthy kauri at Whangaparapara on Great Barrier Island (Gadgil 1974) and was recorded then as *Phytophthora heveae*. Symptoms of disease in this stand included yellowing of foliage, canopy thinning and lesions on the lower trunk which sometimes encircled the stem and were bleeding copious amounts of resin (kauri gum). Lesions were also found on the main roots. Some trees had died. PTA was recovered from the stem lesions, roots and the soil at the Whangaparapara site. It was also found in soil in a second stand of kauri on Great Barrier Island at Kaiaraara where the trees had healthy crowns and no sign of gummosis on the stems. In pathogenicity tests PTA has been demonstrated to be capable of rapidly killing kauri seedlings (Gadgil 1974; Beever et al. 2010).

PTA has subsequently been isolated from soil in a number of locations in Northland and Auckland where there are unhealthy kauri (Waipara et al. 2010; S. Bellgard pers. com.). The distribution of PTA has not however been systematically established. Beever et al. (2007) proposed that collar rot caused by PTA is an emerging disease caused by an introduced pathogen that is spreading slowly from a number of disease foci. It therefore poses a threat to kauri, both at the individual and at the population level, with flow-on effects to kauri ecosystems.

Understanding of the epidemiology of the disease is limited. We know little about the length of time for a visible lesion to develop after infection has taken place; the influence of site factors on survival of PTA in soil or on initiation of infection. We don't know if other species of *Phytophthora* (five species of *Phytophthora* have been recorded from soil in kauri forests) also play a role in kauri collar rot. However, to-date, the only *Phytophthora* recovered from symptomatic kauri trees is PTA.

The goal of the Kauri Dieback Joint Agency Response (KDJAR) is to slow the spread of PTA and to undertake measures to limit its effect on individual trees and on

ecosystems. Essential to this goal is a base knowledge of the distribution of PTA, and its association both with unhealthy and with healthy kauri. Therefore, as part of this preliminary survey process, site information will be gathered so that factors that are common to sites with PTA, and any associations with symptomatic or asymptomatic trees, can be determined.

Due to financial and time constraints this first survey will not be a full delimiting survey but will instead inform management decision by identifying whether PTA is present in a given forest or not. The survey design will therefore be based on the assumption that PTA has been introduced and that it has likely been initially spread through human-mediated activities such as logging and road and track construction. To-date there has been a strong correlation between disease incidence and proximity to tracks, roads and other pathways for the pathogens' introduction into kauri rhizosphere (D. Hammond pers. com.; T. Beauchamp pers. com.; N. Waipara pers. com.). Hence the initial survey will be confined to those areas within each location that have roads and tracks.

Resinosis of kauri can be the result of physical injury or of pathogenic attack by fungi other than Phytophthora's. Recent work in Northland has given a good indication of the types of lesions that are likely to be positive for PTA (R. Beever pers. com.; T. Beauchamp pers. com.). This information will be used to assist in the gathering of relevant site information.

The primary goal of this sampling programme is to inform management of the coarse distribution of PTA, rather than the minutiae of its presence within a locality. This information is required by the management team so that they are able to prioritise activities to limit the effect of PTA on the kauri population. For example: if PTA is present widely in Northland and Auckland locations but is not found on the Coromandel Peninsula then the management approach will be different than if distribution is more scattered in locations north of Auckland City.

Because of the possibility of false negatives a soil sampling programme that is expected to optimise the likelihood of recovering PTA if it is present has been devised.

Terms, definitions and abbreviations used in the text are given in Appendix 1.

Preliminary mapping

To date a considerable body of information has been gathered from various activities of the Auckland Regional Council; such as the Terrestrial Biodiversity Monitoring Programme, the Passive Surveillance Programme, Protected Natural Area Surveys and ARC kauri dieback site inspections. The Department of Conservation, and Landcare Research have also gathered site information and have isolation results from a number of locations. Special surveys such as the COST Short Term Scientific Mission undertaken by Dr Andrea Vannini from Italy in March 2010 have contributed further validated positive records of PTA presence. Staff at Scion are involved in kauri plantation research and have location and health records of these stands, aged up to 60+ years, from around the country. The Kauri 2000 Trust has overseen inter-planting of kauri within scrub on the Coromandel Peninsula over the past decade and these plantings have recently been examined for vigour and health (D. Bergin pers. com.).

It would be valuable to collate and map this information centrally so that the situation is readily apparent. Information would include natural and planted kauri locations, and could cover crown condition, symptoms of resinosis as well as validated PTA presence. This knowledge could direct final site and plot selection for this survey and would be useful for monitoring change.

Selection of Locations

Locations for the survey were selected at two meetings of the Planning and Intelligence group. Criteria used in the process were geographical cover (Northland, Auckland, Waikato and Bay of Plenty), stand or forest type, and history. The list was based on NZ Forest Service and DOC records. Selected locations are listed in Appendix 2. This list may be modified when current knowledge on validated positive records for PTA are collated.

This list was not intended to be exhaustive or final, but rather a preliminary cut. Any kauri forest or even individual iconic trees could either be added upon review (by the Kauri Dieback Joint Agency partners and iwi) or surveyed further later as resources allowed.

Proposed Methods and Materials

Locations can be divided into two broad categories:

> ***Category 1*:** those for which there are records of symptomatic kauri trees, either crown dieback or resin bleeding on the stem at the base, and these trees have been mapped
>
> ***Category 1*:** no information or limited information

Survey strategy within a location

Category 1

For locations fitting category 1. maps and coordinates will be supplied. Surveyors will go directly to the points indicated and sample according to the appropriate scenario. Additional randomly selected points may be assigned to ensure that that there will be one plot per 100 ha.

Category 2

For locations where there is no information a stratified random process will be employed.

A grid with plots of 1000 x 1000 m (= 100 ha area) will be overlayed on a location map with roads and tracks marked.

Locations are variable in size. From those plots bisected with a road or track the relevant number of sampling points (for the size of the location) to ensure that there will be one sample per 100 ha will be randomly selected. As some areas will have a very sparse road/track network the number of sampling points per individual plot will be adjusted to ensure this coverage. The survey manager will have the flexibility to adjust survey points on the map to allow for access but give fair coverage of the area. Within each pre-selected plot one or more points alongside a track or road will be randomly selected. These sample points will be marked on the map and loaded into the GPS unit before surveys commence. An example of this process is given in Appendix 3.

At the assigned plot the surveyor will record site information on the data logger or plot sheet (page one of the data collection sheet). Subsequent sampling will vary depending on presence of kauri trees and on symptoms of kauri dieback. Variability in distribution of kauri, of symptomatic kauri, in the terrain and in the thickness of the understorey means that surveyors will need to be flexible and to make some instant decisions about the suitability of sampling points. Four scenarios have been described and the surveyor will select the most appropriate for the site.

Sampling Scenarios

Multiple symptomatic trees

1. Look for the closest symptomatic kauri to the pre-selected point (if none apparent at the site walk 100m along the route either side of the point) and collect soil from beneath according to the protocol. If there is a choice of up or down slope – select the down slope side of the track. Record coordinates of the tree. Record tree characteristic information (page two of the data collection sheet). This will be sample no. 1 for the point. ***Note:*** Select trees with fresh resin bleed if possible.
2. From this point move to the nearest symptomatic tree in one direction and repeat the procedure. This will be sample no. 2 for the point.
3. Then move to the nearest symptomatic tree in the opposite direction from the original point and repeat the procedure. This will be sample no. 3 for the point.
4. Three soil samples are thus collected from around the pre-selected point. Each of these 3 samples will be comprised of soil from 8 spots beneath the chosen tree. Each sub-sample will be around 125 g, resulting in approximately 1 kg composite for each tree.

5. If the sample point is a group of seedlings or rickers, move at least 15m between trees.
6. It may be necessary to return to the point in the future for lesion sampling of symptomatic trees. Mark the point at the road/track edge with coloured tape. Write on the tape the compass direction and approximate distance to the relevant tree(s).

Occasional symptomatic trees in plot

1. If there few, or a very sporadic distribution of, symptomatic trees at the pre-selected point travel along the track or road until a tree with symptoms is found within the plot area.
2. Record coordinates of the tree. Record tree characteristic information.
3. From this point move up to 50 m into the stand in one direction to another symptomatic tree and repeat the procedure.
4. Then repeat procedure in the opposite direction from the original point to another symptomatic tree.
5. If no further symptomatic trees are found within the 50m distance from the source tree collect soil samples from beneath healthy trees at approximately 50 m (again a composite sample of 8 aliquots bulked into about 1 kg composite).
6. It may be necessary to return to the point in the future for lesion sampling of symptomatic trees. If this applies the point should be marked at the road/track edge with coloured tape. Write on the tape the compass direction and approximate distance to the relevant tree(s).

No symptomatic trees in plot

1. Go to the closest kauri to the pre-selected point and sample soil from beneath according to the protocol. Record coordinates of the tree. Record tree characteristic information.
2. From this point move up to 50 m in one direction to another kauri and repeat the procedure.
3. Then repeat procedure in the opposite direction from the original point to another kauri.

No kauri in plot

1. Record “no kauri in plot” on data logger. Do not sample.

Discretionary sampling

1. Within each location the surveyor has the discretion to add up to 6 additional sample points. As there is limited knowledge of the kauri component within the forest at some locations the pre-selected points may fit the criteria but not be ideal. If other points are apparent to the surveyor as better fitting the criteria then the relevant protocol (described above) should be used for additional points.
2. If, while en route to a specified site, a surveyor finds trees with classic symptoms the site should be sampled.

It is envisaged that a qualified plant pathologist would be part of the initial survey or training, to ensure that the protocol is indeed practicable.

Recording

If palm-top data loggers are provided the required information will be entered directly into the on-line form. Alternatively plot sheets (Appendix 4) will be provided to be filled in by hand.

Illustrations of crown and gummosis symptoms will be provided on laminated sheets to aid categorisation. See Appendix 5.

Soil sample collection protocol

Remove leaves and other plant material that has not broken down from a small area of ground. Using a trowel or planting spade take a volume of soil/duff/roots (about 1-2 cups) from each of 4 cardinal points at approximately 20 – 100 cm from the base of the selected tree and another 4 further out towards the drip line of the crown. Penetrate to about 100 mm deep. Put all 8 soil samples into one zip-lock plastic bag. Total amount should be in the range of 1 – 1.5 kg. The weight will vary depending on soil type and moisture levels but this is not important. Clearly label the bag with location, plot number and the sample number. A duplicate, second label, written on waterproof note paper is to be inserted into the bag (in case the ink rubs off the bag in transit).

Example of labels from one point:

Coromandel 1/ Plot 4/ tree 1

Coromandel 1/ Plot 4/ tree 2

Coromandel 1/ Plot 4/ tree 3

Important: Clean the trowel and/or spade before moving to the next tree. Clean both trowel and boots before moving away from the plot (see section on cleaning of equipment).

Bags of soil will be placed in a chilli bin each time the surveyor returns to the vehicle. At the end of the day soil samples will be stored in a refrigerator until dispatch to the assigned laboratory.

Cleaning of equipment

1. Surveyors will have a container of 2% Trigene, a plastic spray bottle of Trigene which can be replenished as needed, paper towels, scrubbing brush and a rubbish sack.
2. *Cleaning trowel or spade:* Remove as much soil etc as possible and spray blade with Trigene. If necessary wipe down with a paper towel which is then placed in the rubbish sack.
3. *Cleaning boots:* Using the brush remove soil and duff from the sole and sides of boots. Spray sole of boots with Trigene. Spray the brush with Trigene.

Equipment list

1. Data logger with GPS or GPS unit (GPS points preloaded for each location). Data sheet loaded into data logger if provided.
2. Large container of 2% Trigene
3. Plastic spray bottle
4. Scrubbing brush
5. Packets of paper towels
6. Trowel
7. Planting spade
8. Ziplock plastic bags (`200 x 250mm)
9. Rubbish sack(s)
10. Marker pens
11. Large chilli bin
12. Clipboard, data collection sheets and pens/pencils
13. Waterproof note book for soil labels
14. Compass
15. Rolls of tree tape
16. Maps

Laboratory addresses

Landcare Research Ltd

231 Morrin Rd

St Johns

Auckland

Attention: *Dr S Bellgard*

Plant and Food Research

Cnr Crosses and St George's Roads

Havelock North 4130

Attention: *Dr Ian Horner*

Forest Protection

Scion

49 Sala St

Rotorua

Attention: *Margaret Dick*

References

Beever, RE; Waipara, NW; Ramsfield, TD; Dick, MA; Horner, IJ 2007: Kauri (*Agathis australis*) under threat from *Phytophthora*? Proceedings of the the 4th IUFRO Working Party 7.02.09. Monterey, California, 26-31 August 2007

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Gadgil, PDG; 1974: *Phytophthora heveae*, a pathogen of kauri. New Zealand Journal of Forestry Science 4: 59-63

Waipara, NW; Davis, A; Hill, SL; Brooks, J; Pengelly, M; Barr, JA; Bellgard, SE; Beever, RE 2010: Management of Kauri Dieback and *Phytophthora* taxon Agathis. Presentation at the 5th IUFRO Working Party 7.02.09. Rotorua, New Zealand, 8-12 March 2010

Appendix 1: Terms, definitions and abbreviations

Resin bleed

Fresh resin bleed	Resin is soft to touch and often in small droplets “pus-like”
Old resin bleed	Solidified

Kauri categories

Seedling	< 1m tall
Sapling	1m – 4m tall
Ricker or pole	> 4m tall, generally 10 - 30 cm dbh

Understorey

Kauri grass	refers to two grass-like plants, *Astelia trinervia* and *Gahnia setifolia*

Other

Rhizosphere	soil zone immediately surrounding roots

KDJAR	Kauri Dieback Joint Agency Response
PTA	*Phytophthora* taxon Agathis

Appendix 2: Location list

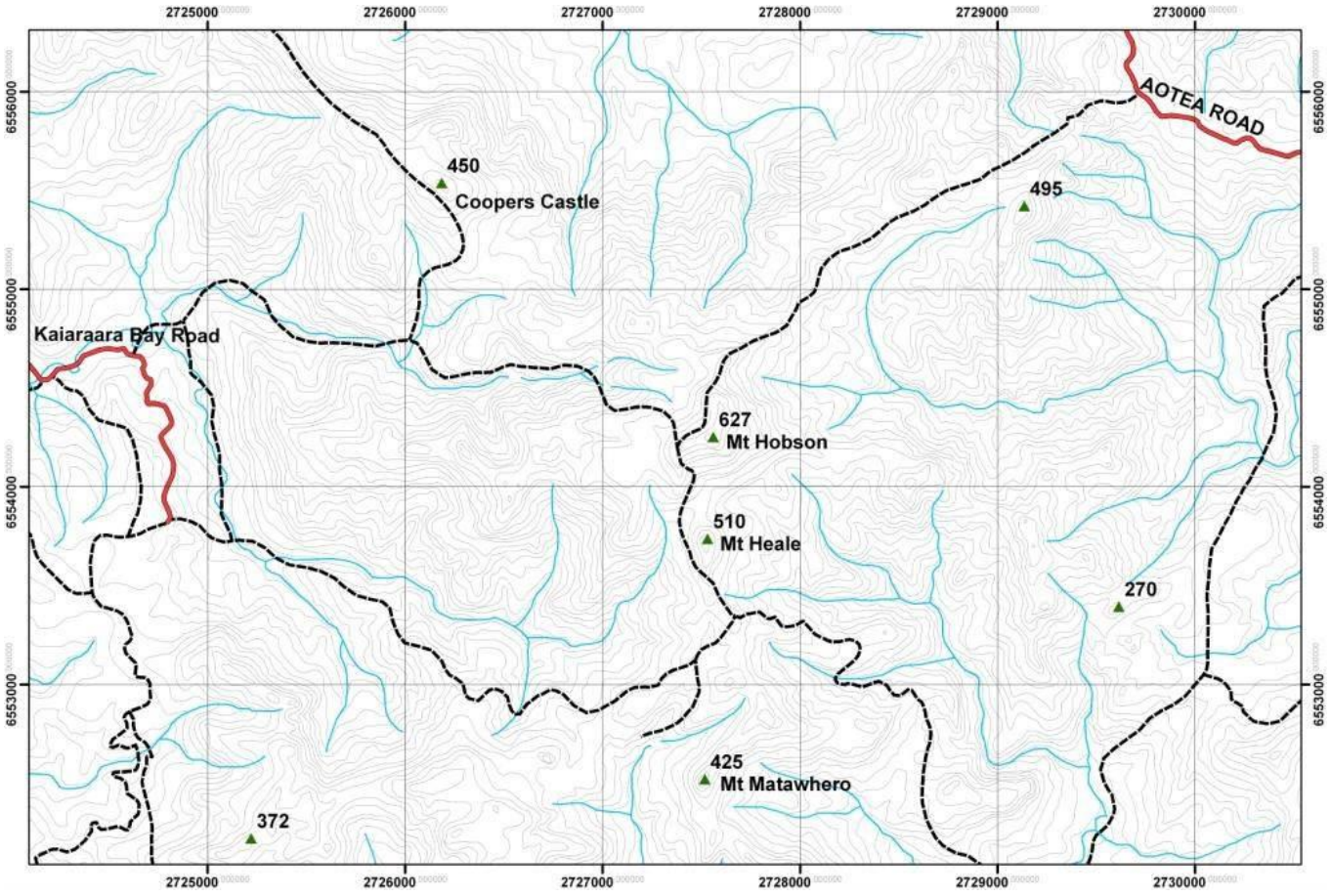
Region	Site	Key
Auckland	Great Barrier 1	Kaiaraara - plantation
	Great Barrier 2	Whangaparapara - Gadgil site
	Great Barrier 3	Mt Hobson - central natural site
	Great Barrier 4	Okiwi
	Little Barrier	
	Hunuas 1	Plantation plot
	Hunuas 2	Natural site
	Waitakere's	
Waikato/BOP	Kawhia	
	Kaimai	
	Coromandel 1	Whenuakete - plantation
	Coromandel 2	Manaia
	Coromandel 3	Moehau
Northland	WaraWara	
	Trounson	
	Waipoua 1	Tane Mahuta
	Waipoua 2	Yaccas - 4 Sisters
	Waipoua 3	ToaToa Track
	Russell 1	Healthy area
	Russell 2	NZFS area - disturbed
	Russell 3	2nd generation forest
	Mangawhai	
	Bratty's Bush	

	Raetihi	
	Glenburnie	
	Puketi 1	2nd generation site
	Puketi 2	Old growth site
	Omahuta 1	2nd generation site
	Omahuta 2	Old growth
	Omahuta 3	Plantation
	Herekino	
	Coopers Beach	
	Paranui	
	A.H. Reed Memorial Park, Whangarei	
	Taheke Bush	

Appendix 3: Survey grid

Example of proposed survey grid for a selected location

Great Barrier Island 3. Natural site - Mt Hobson


2725000
2726000
2727000
2728000
2729000
2730000
6556000
6555000
6554000
6553000
AOTEA ROAD
450
Coopers Castle
495
Kaiaraara Bay Road
627
Mt Hobson
510
Mt Heale
270
425
Mt Matawhero
372

Appendix 4: Plot sheet

Location	
Site No.	
Date	
Collector	

General site information

TOPOGRAPHY	Flat	Steep slope	Gentle slope	Undulating	Gully	Ridge

ASPECT	N	NE	E	SE	S	SW	W	NW

SOIL DISTURBANCE	None	Pig rooting	Other animals	Foot traffic	Erosion

PIG ROOTING	Minor	Moderate	Extensive

Stand characteristics

KAURI STAND	Old growth forest	Regrowth forest (e.g. rickers, saplings)

	Single tree	Dispersed	Small group	Stand	Single tree	Dispersed	Small group	Stand

KAURI STAND	Plantation			
	Single tree	Dispersed	Small group	Stand

KAURI CLASSES PRESENT	Canopy /emergent	Rickers or poles (> 4 m tall)	Saplings (0.5 – 4 m tall	Seedlings (< 0.5 m tall)

UNDERSTOREY	Too thick to traverse	Scattered understorey, easy to move around	No understorey

PREDOMINANT UNDERSTOREY	Manuka/kanuka	Kauri grass	Mixed broadleaf/ podocarp	Other

COMMENTS

Appendix 4: Plot sheet (continued)
Sample tree characteristics

Tree 1

NZMGE	MZMGN	Altitude	COMMENTS

CLASS	Canopy/ emergent	Ricker/pole (> 4 m tall)	Sapling (1 – 4 m tall)	Seedling (< 1 m tall)

CANOPY	Good condition	Foliage thinning	Some branch dieback	Severe dieback	Dead

OLD RESIN AT BASE	None	<10% circum.	10-50% circum.	51-80% circum.	81-100% circum.

FRESH RESIN BLEED AT BASE	None	<10% circum.	10-50% circum.	51-80% circum.	81-100% circum.

TOP HEIGHT OF FRESH RESIN BLEED	<20 cm	20-50 cm	50-100 cm	51-80% circum.	>100 cm

ROOTS	Dense mat of live roots	Mat of live and dead roots	No root mat

PIG ROOTING AROUND TREE	Minor	Moderate	Extensive

Tree 2

NZMGE	MZMGN	Altitude	COMMENTS

CLASS	Canopy/ emergent	Ricker/pole (> 4 m tall)	Sapling (1 – 4 m tall)	Seedling (1 m tall)

CANOPY	Good condition	Foliage thinning	Some branch dieback	Severe dieback	Dead

OLD RESIN AT BASE	None	<10% circum.	10-50% circum.	51-80% circum.	81-100% circum.

FRESH RESIN BLEED AT BASE	None	<10% circum.	10-50% circum.	51-80% circum.	81-100% circum.

TOP HEIGHT OF FRESH RESIN BLEED	<20 cm	20-50 cm	50-100 cm	51-80% circum.	>100 cm

ROOTS	Dense mat of live roots	Mat of live and dead roots	No root mat

PIG ROOTING AROUND TREE	Minor	Moderate	Extensive

Tree 3

NZMGE	MZMGN	Altitude	COMMENTS

CLASS	Canopy/ emergent	Ricker/pole (> 4 m tall)	Sapling (1 – 4 m tall)	Seedling (1 m tall)

CANOPY	Good condition	Foliage thinning	Some branch dieback	Severe dieback	Dead

OLD RESIN AT BASE	None	<10% circum.	10-50% circum.	51-80% circum.	81-100% circum.

FRESH RESIN BLEED AT BASE	None	<10% circum.	10-50% circum.	51-80% circum.	81-100% circum.

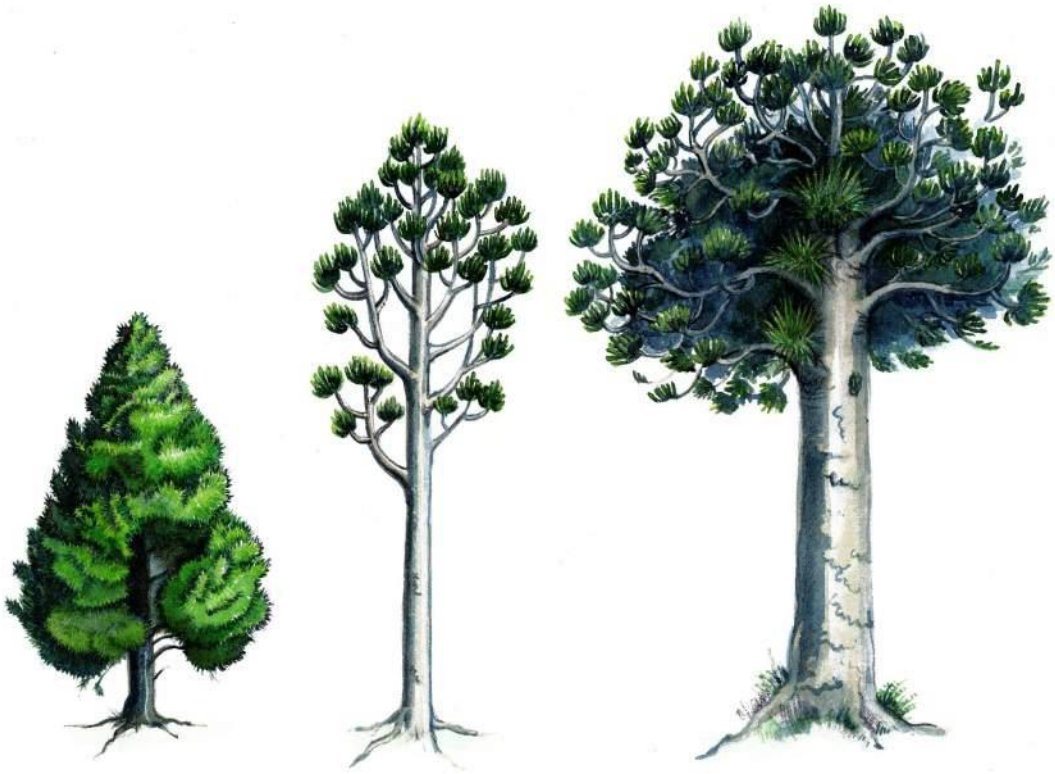
TOP HEIGHT OF FRESH RESIN BLEED	<20 cm	20-50 cm	50-100 cm	51-80% circum.	>100 cm

ROOTS	Dense mat of live roots	Mat of live and dead roots	No root mat

PIG ROOTING AROUND TREE	Minor	Moderate	Extensive

Appendix 5: Crown and resin categories illustrated

Healthy crown types



Juvenile kauri tree **Kauri ricker/pole** **Mature kauri canopy**

Crown Rating Sequence 1- 5

Crown Rating Sequence 2- 5


3
4
2
5

Crown Health Categories

Healthy crown



Foliage thinning



Some branch dieback


Severe dieback

Resinosus

Fresh resin bleed ("pus-like" i.e. soft and squishy)

Old resin – hard to the touch

Understorey vegetation categories

Kauri grass in ricker stand

broadleaf/podocarps