



Kauri Ora: Caring for Kauri

Best practice guide for
looking after Kauri on
your property



KA RAUHĪ TE TUPU O TE KAURI — GIVE KAURI SPACE TO GROW



Tiakina Kauri is an agency based within Biosecurity New Zealand that provides national direction for the achievement of the objectives of the National Plan for Kauri, through active partnership with mana whenua and collaboration with regional councils and the Department of Conservation.

For more information about protecting Kauri, visit www.kauriprotection.co.nz

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About this guide

This booklet is for landowners, managers and occupiers with Kauri on their land. It explains the ecology of Kauri, common diseases and gives advice about care and propagation. This booklet has three main sections:

Kauri ecology - a description of the Kauri family, how Kauri grow and reproduce, and diseases that affect these trees.

How to care for Kauri - providing advice on how to reduce stress and care for Kauri.

How to grow Kauri - a description on how to gather seed, propagate and plant out Kauri.

A glossary of terms used is also included.

Protecting Kauri

Kauri are threatened by a microscopic soil-borne pathogen known as *Phytophthora agathidicida* (PA).

PA infects Kauri trees through their roots and restricts the ability to transport water and nutrients between the roots and the leaves. This causes the condition known as kauri dieback disease, which eventually starves the Kauri.

There is no proven way to cure a Kauri tree that has been infected by the PA pathogen, and there are limited treatment options.

PA is spread through soil movement, including through human activity. This means that when undertaking any activity around Kauri, preventing the spread of potentially contaminated soil is critical.

The survival of Kauri depends on all of us taking action to stop the PA pathogen from spreading. This means working together and having strong hygiene and biosecurity practices.

This includes arriving clean, staying clean and leaving clean. Clean your footwear and all gear that will touch the forest floor, so it is dirt-free before you enter and leave the forest.

If you think a Kauri tree is showing symptoms of disease on your land, let Tiakina Kauri, your regional council or the Department of Conservation know.

For more information, visit www.kauriprotection.co.nz

The National Pest Management Plan for Kauri

In August 2022, a National Plan was launched to help protect Kauri from the *Phytophthora agathidicida* (PA) pathogen. The National Plan includes 10 rules that apply to anyone who grows Kauri, goes into Kauri forests, or lives or works around Kauri.

By following this guide and the rules of the National Plan, we can all help protect Kauri for generations to come.

How do the National Plan rules for Kauri work?

The Tiakina Kauri | Kauri Protection programme helps people understand and comply with the National Plan rules through education and awareness programmes.

In cases of clear and substantial or continued non-compliance with the rules, prosecution or infringement fees could be applied.

For more information about the National Plan, visit www.kauriprotection.co.nz/national-plan

Biosecurity Act 1993

Under the Biosecurity Act, PA is an unwanted organism. This means it is an offence to release PA, cause PA to be released, spread, propagate, or act in a manner likely to encourage the propagation of PA. For more information about unwanted organisms, visit: www.mpi.govt.nz/biosecurity or email info@mpi.govt.nz

Kauri ecology

The Kauri family

The New Zealand Kauri (*Agathis australis*) belongs to the Araucariaceae family, which is one of the world's oldest families of conifers and comprises of 21 tree species. Kauri is the largest of the *Agathis* genus and is only found in Aotearoa New Zealand.

Many of these great forest giants were felled by early pioneers for their high-quality timber. One of the largest Kauri trees ever recorded was Kairaru of Tutamoe, with an estimated diameter of 6.4 metres and a height of 65 metres. Unfortunately, Kairaru was destroyed in a fire before 1900.

The largest Kauri alive today is Tāne Mahuta, found in Northland's Waipoua Forest. Tāne Mahuta has a diameter of 4.6 metres and height of 52 metres and is estimated to be between 1200 and 2000 years old.



Simulated comparison of Tāne Mahuta (left) and Kairaru (right).

History of Kauri

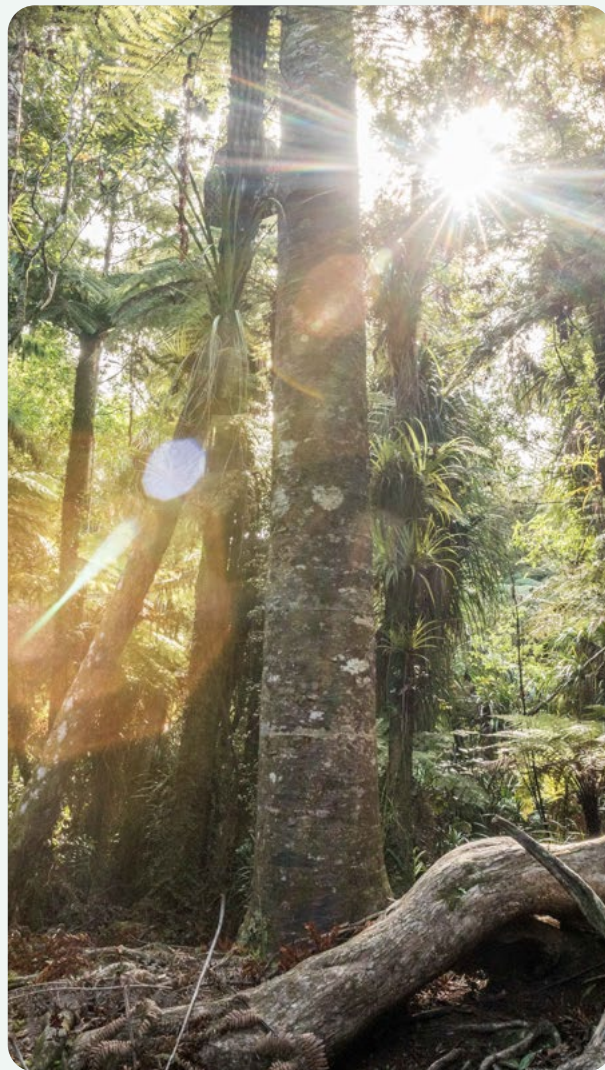
Kauri - Te Ao Māori

Kauri are considered a taonga (treasure) by many New Zealanders, particularly Māori who see the health of Kauri as a sign of general wellbeing of the ngahere (forest) and the people - hence their value cannot be understated.

Kauri play an important role in Māori culture, through cosmogeny and ceremony, for use as weapons, tools, shelter and transport, and in many other aspects of everyday life. Many larger Kauri are given names and are revered as rangatira (chiefs) through their ability to bring together and support numerous other living creatures, as chiefs and leaders do in any culture and society.

When required, particular Kauri were felled and carved into waka (canoes) for various purposes – sea-voyaging, fishing, trading and transporting war parties to name some. This latter type, waka taua (war canoe) are commonly seen today on ceremonial occasions.

Kauri gum had many valuable functions. Gum was burnt as an insecticide for kūmara gardens, wrapped in flax for use as torches at night, and also as kāpia or ngaungau (chewing gum). Kauri resin was also burnt and mixed with fat and/or charcoal for tā moko (tattooing).



Creation story

At the beginning of the world, Tāne, along with his siblings, lived in the darkness between their parents, Ranginui (the sky father) and Papatūānuku (the earth mother). Tāne and his siblings separated their parents, creating light and life to exist and prosper. So began time, the world of light, and the title of Tāne Mahuta, God of the forest and all its living creatures.

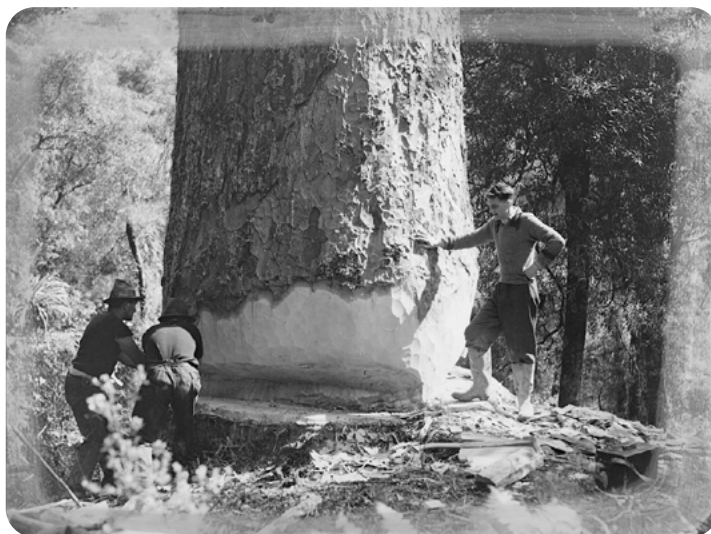
In this way, the great Kauri, working together with all manner of forest creatures, created the space between earth and sky for life to exist. Such is the nature of life and the position and role of Kauri as the greatest rangatira of our forests.

Te Roroa of Waipoua regard the legs of Tāne as being giant Kauri, as do many other iwi.

Early European influence

By the mid-1800s, early Europeans had developed a thriving timber and gum industry based on Kauri. Large areas of Kauri were felled for their timber, which was valued for the strength and ability to withstand seawater conditions, making it ideal for boat masts and hulls. Kauri wood was also knot-free and so was considered perfect for high-end furniture.

Kauri gum was used in varnishes, paint, and linoleum and to create ornaments. Gum was largely collected from the ground; however, some was gathered by deliberately injuring or “bleeding” trees.



Three men cutting down kauri tree
Photo: Tudor Washington Collins, 1898-1970

Estimates of the extent of Kauri forest before European settlement in New Zealand are between 1 million and 1.5 million hectares. This was reduced to an estimated seven thousand hectares (0.5% of original extent) by exploitation for timber or destruction by fire and clearance in the late 19th and early 20th century. An estimated 60,000 hectares of secondary forest and scrubland contain some stands of younger Kauri regenerating after this harvest.

In 1985, recognition of the intrinsic value of native forest finally led to the end of logging of live Kauri trees in state forests.

Environment

Kauri are naturally found throughout the warmer regions of the upper North Island, above the latitude of 38°S (north of Kawhia/Hamilton/Tauranga) – also known as Kauri lands. This means if you are in native bush in the Northland, Auckland, Waikato, or Bay of Plenty regions, then you’re likely to find Kauri.

The National Pest Management Plan contains 10 rules relating to protecting Kauri from PA. **Rules 1-3** apply to all of New Zealand and **rules 4-10** apply to Kauri lands.

There is no “typical Kauri forest”. They can exist as solitary trees in broadleaf dominant bush, or together in dense stands. The type of forest that can support Kauri is dependent on the site, soil and temperature.

Kauri require high levels of light to grow, but they can tolerate low soil nutrient levels. Kauri seedlings are often suppressed under dense canopies of faster growing species in fertile soils. Consequently, they are often restricted to less fertile soils on ridges or can establish themselves en masse after a large disturbance such as a fire.

In a forest environment, mature Kauri emerge above the canopy of other native trees. The lower forest can contain a variety of other native tree species, including tōtara, tānekaha, tarairae, tawa, miro and rewarewa growing alongside juvenile Kauri. At the shrub level, a range of plant species can be found, including tree ferns, nīkau palms, lancewood, hangehange and mingimingi. Kauri grass (a species of *Astelia*) is commonly found covering the ground below Kauri.

A range of orchids and epiphytic plants are also often found growing high amongst the branches of mature trees.

Reproduction

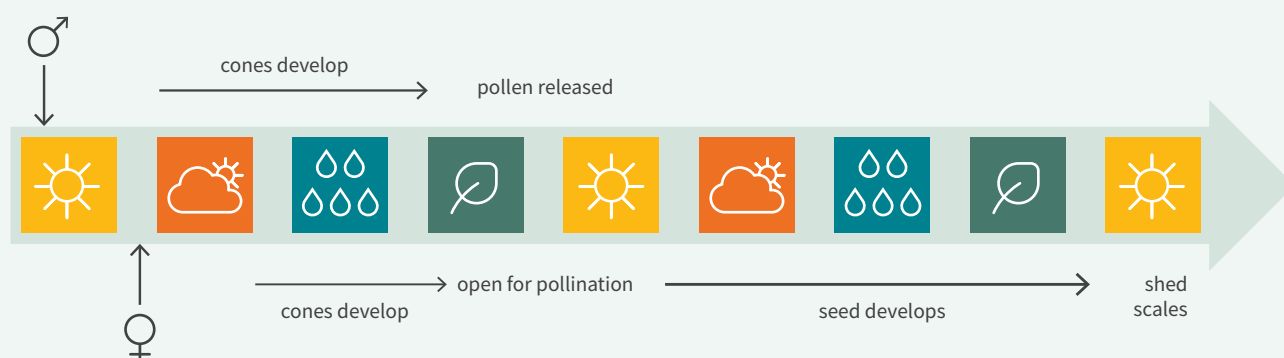
Kauri reproduce through cones, which are formed every year. The age of reproduction is dependent on tree development which is often limited by light. Consequently, trees may not produce cones until they are 20–40 years of age.

Kauri trees have both female and male cones. Male cones release pollen which is carried by the wind to fertilise the female cones. Seeds then develop over a two-year period within female cones, with one seed attached to each scale of the cone.

Up to 100 seeds can be released from mature cones, although on average only half of these will typically survive. Kauri seeds rely solely on the wind to be dispersed and have a small wing which enables them to catch even light winds. A gentle breeze can carry seeds 100–150m from the parent tree, although distances of up to 1.5km have been recorded.

Kauri seeds lose their viability over a few months and are easily damaged by the cold and wet. Seeds need to land on soil to germinate. A viable seed needs favourable conditions, including good light, moisture, warmth and easily accessible soil nutrients, which are generally not found under the parent tree. If the seed reaches suitable conditions, germination takes place within 10–20 days.

Figure 1: Kauri reproductive cycle



Kauri cone

Telling Kauri age

It is not always easy to age Kauri trees. The growth rate, final height and life span of Kauri depends on their growing conditions. Growth is suppressed in areas with compacted and poor soils, competition from other plants and lack of overhead light.

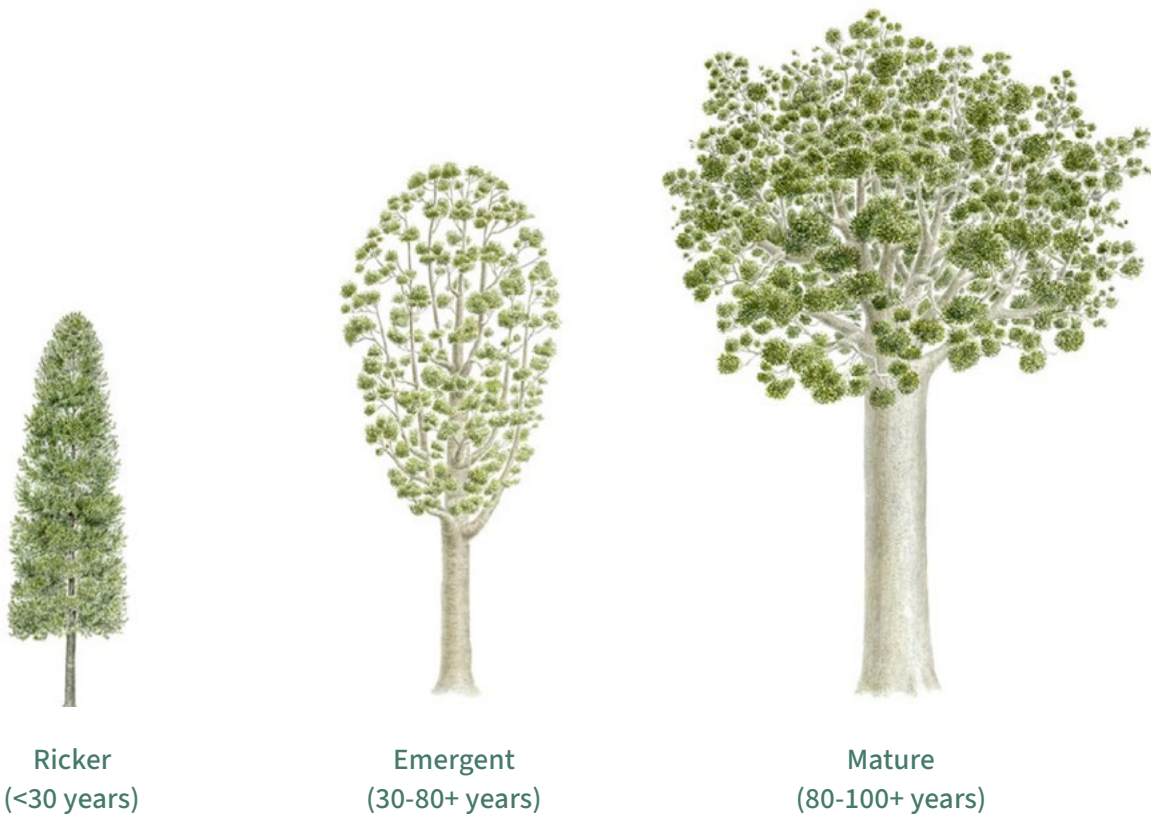
However, Kauri trees always have the same four main stages of growth.

1. Seedlings

Kauri seedlings emerge as two leaves and develop into bushy seedlings. The colour of these young trees can be green or a red-bronze depending on the amount of rhodoxanthin (red) pigment present in the leaves. Both red and green seedlings are equally healthy, and red seedlings will turn green as they mature into the typical cone-shaped saplings.

2. Rickers

The cone shape becomes more apparent at this stage. These pole-stage trees, or “rickers”, become free of branches on the lower trunk and have narrow, conical crowns. As a ricker grows into an emergent tree (> 30 years), they begin to grow outwards, expanding the narrow trunk and crown.



3. Emergent or intermediate

In the “teenage years” Kauri tree growth is focused upwards towards the canopy of the forest. Like humans, Kauri develop into gangly teenagers with long slender bodies/trunks. During this stage (usually 30–80+ years) Kauri self-prune. They begin to drop the lower, shaded branches in a process known as “abscission”, which leaves the trunk without knots or scars.

4. Mature Trees

Mature Kauri trees (80-100+ years) emerge above the forest canopy with large straight trunks (free of branches from up to 12–25m), which support flattened/spreading crowns with large permanent branches that will not normally be dropped.

On average, Kauri grow to heights of 30–40m and can live for more than 1000 years, with trunk diameters of several metres. In suitable conditions, Kauri aged 400–800 years old will have diameters of 1–2m (sometimes up to 3–5m).

Small shoots off the main trunk can be found on some mature Kauri. These “epicormic” shoots can appear when the trunk is suddenly exposed to increased light levels and/or in stressful situations. These shoots may be a means to gain more energy from the sun to cope with stress.

Kauri typically have one main trunk, but if the growing tip is damaged at any stage (for example, by frost, wind or physical damage), two or more “leader shoots” (trunks) can develop.

Kauri generally have a spurt of new growth once a year in spring, but a second “flush” of growth can occur in warm and wet autumns. In young trees, this new growth is obvious by the appearance of shoots with a blueish tinge. In older trees, this can be seen as bright green foliage.

In crowded sites, Kauri will naturally thin themselves, with the weaker trees dying off and the strongest trees surviving.

Bark

Juvenile Kauri have a typically “pimply” bark with a reddish to grey colouring. In mature trees this develops into thick scales which frequently flake off and leave the trunk with a pattern of hammer-like markings or indentations.

Shedding bark is a natural trait which prevents vines from clinging to and smothering Kauri. In some cases, trees may shed large amounts of bark at a time and appear unusually smooth. This is thought to be associated with a sudden spurt of growth.

Gum

A small amount of bleeding (gummosis) is natural for Kauri trees. Kauri naturally produce gum as a defence in response to stress. Events such as strong winds, drought, insect attack, large growth spurts and disease can all cause gum to ooze through the bark.

Kauri gum also acts as a natural bandage to seal physical injuries and prevent infection via the bark by insects, fungi and bacteria.



Bleeding gum

Kauri with more than one leader shoot (two or more main trunks) often bleed gum from the joint in response to injury caused by wind stress.

In the late 19th century, some Kauri were deliberately injured to increase gum production for collection and export. Bleeding of Kauri was banned in state forests from 1905 after it was shown that it caused damage to the trees and a decline in health. There are still trees alive today that show scars from injuries caused by early gum collectors.

Roots

Kauri seedlings initially have a fine lateral root system associated with one main ‘tap root’. In some cases, this can be up to three times longer than the height of the seedling. Tap roots continue to develop in young trees, reaching up to two metres deep.

The root system develops to incorporate three different kinds of roots in mature Kauri trees. Large lateral roots spread out from the base of the trunk with deep “peg” roots running off these (up to five metres deep) to anchor the tree to the ground. A network of fine “feeder” or surface roots run up from the laterals into the thick layer of litter in the forest to absorb nutrients. Kauri are also able to grow in dry areas with low nutrient levels through the help of mycorrhizal fungi. These fungi attach to the roots of Kauri trees and significantly increase their ability to absorb water and nutrients.

The root zone of mature trees extends out at least as far as the canopy is wide. In dense areas, the root zones of neighbouring Kauri may overlap – in these situations the lateral roots of neighbouring trees can fuse. This trait can result in the re-sprouting of Kauri from stumps that have been cut down.

Soil nutrients are largely absorbed by the delicate surface roots of Kauri, so if the health of the surface roots is compromised through damage/disturbance (for example, trampling or digging), then the health of the whole tree can decline.

Figure 2: The root zone of a Kauri

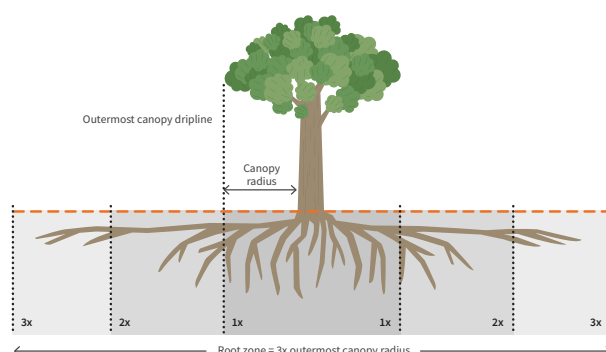


Figure 3: Kauri Hygiene Zone

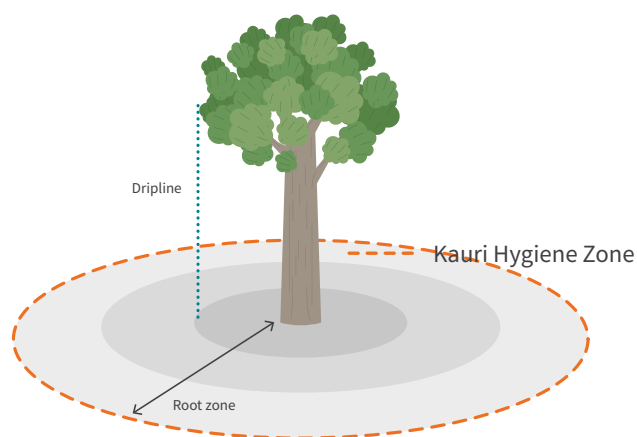
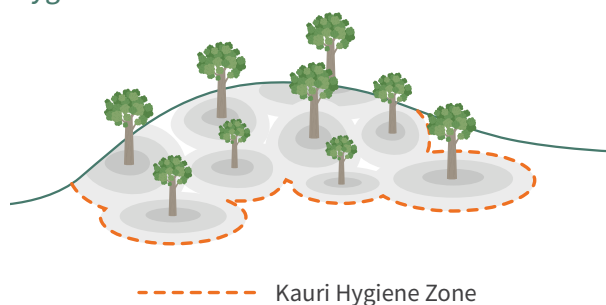


Figure 4: Interconnected stand of Kauri Hygiene Zones



Kauri diseases

It is natural for Kauri to bleed small amounts of gum and shed bark as a way to protect a wound from a fallen branch. However, this can also be a symptom of disease.

If you see a sick Kauri, you must let Tiakina Kauri, or your regional council know. This is **Rule 1** of the National Pest Management Plan.

Disease caused by PA

The PA pathogen infects Kauri trees through their roots and restricts the ability to transport water and nutrients between the roots and the leaves. This causes the condition known as kauri dieback disease, which eventually starves the Kauri. This can infect and kill Kauri of all ages, from seedlings to large trees.

There is no proven way to cure a Kauri tree that has been infected by the PA pathogen, and there are limited treatment options.

The injection of phosphite into the trunk of an infected Kauri can help keep the disease at bay, but it is not a cure.

The survival of Kauri depends on all of us taking action to stop the PA pathogen from spreading.

Obligation to clean items

If you are going off track or onto a track where you will touch the forest floor, you must clean all visible soil and organic matter off items that may touch the ground, both before you enter and when you leave the forest. Items considered a risk include tools, cars, bikes, sticks, shoes, gloves etc. This is **Rule 8** of the National Pest Management Plan. Heat treatment provides the best protection against PA, where it can be feasibly applied.

Some ways to reduce the risk of spreading PA include:

- Don't move or work around Kauri in wet conditions. The PA pathogen spreads more easily in wet conditions.
- Arrive clean, stay clean, leave clean. Clean your footwear and all gear that will touch the forest floor, so it is dirt-free before you enter and leave the forest.
- Have separate footwear and clothing to wear in Kauri forests – and remove or clean them before moving to another area.
- Make sure that everyone who intends to go into Kauri forests and/or move within Kauri Hygiene Zones on your property (including visitors and contractors) follows the hygiene protocols to remove all dirt/soil from footwear, clothing, gear, bikes, vehicles, machinery, animal hooves and dog paws etc. Keep stock out of areas with Kauri areas and undertake pest animal control. There are several physical visible symptoms of disease caused by PA. However the absence of these signs doesn't mean a Kauri tree is healthy.

Assessing Kauri trees for symptoms is critical in finding where PA is located. The more information known about the location of PA, the better our management of the risk posed and the lower the likelihood of introducing or spreading the pathogen. The most common symptoms can include:

- **Bleeding gum:** Basal trunk lesions or “bleeding” of gum can be a symptom – although not all infected trees will show lesions, and not all lesions are caused by PA. Bleeding that is associated with PA develops from the ground up, forming a contiguous lesion which is usually confined to the lower part of the trunk. The oozing gum is generally discoloured.
- **Yellowing of leaves:** Kauri tree leaves may turn yellow, red, or brown as the disease takes effect.
- **Thinning canopy:** The disease damages the tree’s fine feeding roots, which prevents the movement of water and nutrients throughout the tree. This results in the reduction or thinning of the canopy over time. The degree of thinning can vary. This symptom also includes branch dieback where some branches die and other remain alive.



PA pathogen infection can cause bleeding gum



View of Kauri canopy with dead branches

The last stage of disease is death of the tree, and where there is no canopy of the tree. Disease can take years to show, **so it is important to act like every tree is infected.**

Other diseases

***Phytophthora cinnamomi*:** This introduced soil pathogen is now found throughout New Zealand. It affects many plant species, particularly plants that are weak or stressed. A slow decline in health, occasionally with small, scattered bleeds up the trunk can be caused by the disease. In Kauri trees, *P. cinnamomi* infection causes damage to the feeder roots of Kauri, however, the impacts are not as severe as PA.

Damping off: This root rot disease is caused by a range of microbes found commonly in poorly drained soils. Signs include yellowing and wilting of leaves, and death of seedlings. Strict hygiene practices in nursery situations are essential to avoid this disease.

Core rot disease: This often affects large mature Kauri trees and causes rotting of the heart wood, leaving the giant trees hollow inside and causing a slow decline in health. Core rot is caused by several different species of native wood-rotting fungi. Physical damage to younger Kauri can also allow these fungi to enter and infect the inner tissue.

Cone disease: Warm and wet summers can give rise to the infection of cones by the *Pestalotiopsis funerea* fungus. This reduces seed viability and can cause cones to drop prematurely.

Leaf disease: Kauri leaves can be affected by the fungus *Vizella tunicate*, which causes small black spots on top of the leaves. Damage is normally superficial and will not cause a major decline in the health of the tree. Leaves may also be affected by *Trichopelthea asiatica*, a sooty mould which can live on secretions made by insects. This mould covers the leaves in black soot but does not cause any physical damage.

***Armillaria mellea*:** Kauri can be affected by this introduced fungus. The symptoms of this fungus include poor canopy health and bleeding in the lower to mid trunk area.

Impact of insects and animals

Kauri are a food source for both native and introduced animal species. At the seed stage, the ripening cones of Kauri are often broken open and eaten by kākā in the forest. Ripe seed that falls to the forest floor may be eaten by the common wētā, ground-feeding kākārīki, the Australian rosella, mice and rats. While native species have evolved with Kauri, the imbalance created with the introduction of non-native species means this effectively reduces seedling regeneration.

Throughout their lives, the root systems of Kauri trees can easily be damaged by feral goats, pigs and stock. Such damage can lead directly to loss of health and injury points can be entry points for various pathogens. To maximise Kauri health, effort should be made to control non-native pest species.

Although Kauri leaves are leathery and resilient to many pests, they can suffer feeding damage from weevils, caterpillars of Kauri leaf rollers, the Kauri leaf miner and the bronze beetle. Such insect damage is usually superficial and will not cause a decline in otherwise healthy Kauri.

How to care for Kauri

Fencing

Kauri growing in paddocks with stock normally suffer root compaction and damage. Trees in agricultural situations therefore benefit from being fenced off from stock to prevent the trampling of their roots.

Consider covenanting native forested areas – which in most cases includes a requirement to fence off such areas to prevent stock from entering.

Fencing will also allow natural mulch to build up and soil health to improve. If fencing around Kauri, be sure to allow sufficient distance out from the tree to protect the root zone. It is recommended that at least the area of the Kauri Hygiene Zone be fenced off to protect the root system.

To help protect and enhance stands of Kauri, consider planting a buffer around the outside of the trees consisting of plant species that are naturally found growing in and around Kauri, while remembering to allow sufficient room for growth. This will help to provide shelter and protection for the trees and increase humidity in the stand, which will encourage natural regeneration. If funds are limited, focus planting on the side of the prevailing winds. Ideally you should use eco-sourced (plants from your local area) species that are hardy and fast-growing and are from non-PA infected areas. Contact your local or regional council for advice on the best species to plant for your area.

Mulch

Kauri benefit from having mulch around their root zone. Mulch holds moisture in the soil, insulates the soil and minimises weed growth which creates a good environment for the growth of feeder roots.

In natural forests, Kauri provide their own mulch with large amounts of litter (up to two metres deep).

In urban and agricultural situations, this natural litter is often removed or blown away. In some cases, this can lead to exposed roots which are susceptible to damage and disease. Organic mulch such as fine bark chips and straw can be placed around the root zone to help improve root health.

Wherever possible, leave any fallen leaves and branches where they fall, as this mirrors what occurs naturally in the forest. If you find this unsightly, you may wish to mulch this material and place it around the base of the tree, which will still help keep the Kauri healthy.

If adding any type of mulch, it should not be placed up against the base of the tree and must be relatively dry when applied.

For established trees in urban situations, adding a 10 cm deep layer of fine mulch (in a diameter up to two metres around mature trees) is ideal. Only source mulch and/or fine bark chips from a supplier who is NZPPI accredited or who has developed a PA Risk Management Plan or has sound biosecurity practices. See nzppi.co.nz

Synthetic weed mats are not a good option around Kauri – although they prevent weed growth, they do not decompose, and they prevent the feeder roots growing up into the rich organic layer of mulch.

NB: Mulch should not be added around Kauri in wet areas as this can cause further water logging of the soil and may promote root and core diseases.

Soil nutrients

In natural conditions, Kauri trees diminish soil nutrient levels and increase soil acidity. Kauri are tolerant of low levels of soil nutrients, but growth and health can be enhanced by ensuring nutrients are plentiful and competition is minimised.

Research has found that growth of Kauri occurs best in soils with a pH between 4.8 and 6. Lime is not required unless the soil acidity is below pH 4.5. A simple soil acidity test kit can be bought from plant shops if there is concern that soil acidity may be affecting growth.

Water

Seedlings and young Kauri trees with developing root systems are susceptible to drought. Mature trees (while being well-known for being more drought tolerant than many other native plants) will also suffer during long dry periods. To minimise drought stress, ensuring a solid water once a week is beneficial, especially for young trees.

NB: The water requirements of Kauri will depend on the site and soil conditions. Care must be taken to prevent over-watering, especially in areas with compacted or clay soils. Root diseases are more likely to infect trees in waterlogged soils and cause early death.

Provide some company...

Kauri don't like being alone or on the edge of bush – they like to have some company around them. Even in natural stands of bush, Kauri trees on the edge will suffer from a loss of health, and occasionally death, from being exposed to the elements (also known as the “edge effect”).

A range of native species are commonly found growing in association with Kauri and can be planted to provide shelter for trees growing in open areas. Suitable companion plants include kānuka and mānuka, which are useful pioneer or nurse crop plants that rapidly provide shelter for young Kauri while still allowing access to light. Other suitable companion plants include akepiro (*Olearia furfuracea*), māpou (*Myrsine australis*), mingimingi (*Leucopogon fasciculatus*) and shining karamū (*Coprosma lucida*).

Shade cloth can be used as a temporary wind break option. Suppressing weeds to allow for natural regeneration of companion plants will also help Kauri to establish within existing bush areas.

... but don't crowd.

Care should be taken to minimise competition for sunlight and soil nutrients. If planting other large tree species (for example, pūriri, pōhutukawa or kahikatea) nearby, ensure there is adequate space for future growth. Allow at least 3–10m between these species and Kauri trees.

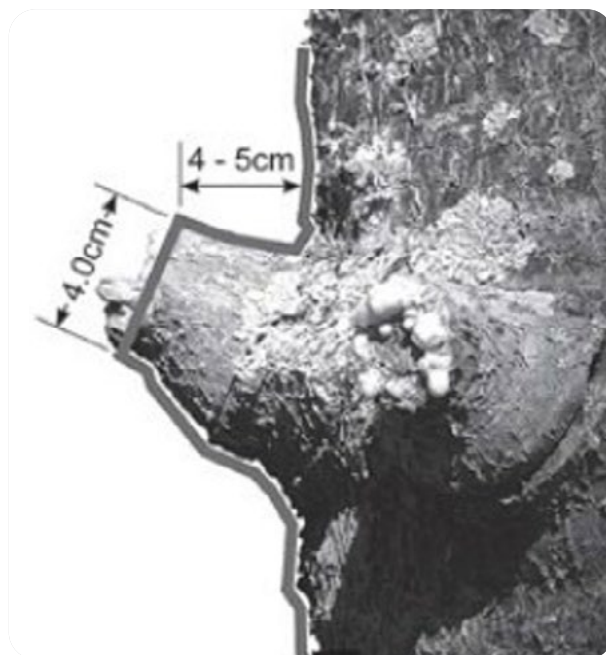
As a slow growing plant, young Kauri can easily become suppressed by a dense canopy of faster growing plants. Access to overhead light is essential for growth of young trees.

Pruning

Kauri naturally drop their lower branches as they grow toward the forest canopy. However, in open areas the lower branches may be retained.

If a small branch dies on a Kauri tree, or if live branches need to be removed, a 4–5cm stub should be left on the tree when cut. This measure encourages the tree to drop the stub naturally (it simulates the loss of energy, similar to that experienced if it became shaded in the forest) without leaving a scar or bleeding wound on the trunk. This method should only be used for branches less than 4cm in diameter. Larger branches should be sawn off close to the trunk.

Wind stress can often cause cracking/damage at the joint of trees with double leader shoots. Young trees with multiple leader shoots can be pruned back to one main trunk to avoid this. Consult your local nursery or garden centre for instructions regarding the pruning of Kauri.



More tips on general care

Herbicides: Take care when spraying around the root zone. Avoid using residual herbicides around Kauri.

Weeds: Weeds such as kikuyu grass can smother young trees and compete for nutrients. Mulching around the base of Kauri will minimise weed growth. However, removal of some weeds may be necessary.

Physical injuries:

- The natural bleeding of gum is sufficient to cover and heal small wounds. However, large physical injuries may need application of anti-fungal sealants to prevent entry of water and bacteria.
- Be wary of large lateral Kauri roots if mowing lawns within the root-zone. Mulch can help prevent accidental mower damage.
- Avoid securing wire or nails in the trunks of Kauri. These activities cause damage over time.

How to grow Kauri

Growing Kauri from seed can be achieved at home with care and planning. Moving young Kauri plants, Kauri seeds and associated soil carries a high risk of spreading the PA pathogen. **Rule 3** of the National Pest Management Plan helps ensure that this high-risk activity is undertaken only by individuals and organisations that have practices in place to prevent the spread of the PA pathogen.

Gathering seed

Strict protocols for the growing and production of Kauri are an important part of protecting Kauri from PA. The National Plan for Kauri includes rules for anyone growing Kauri in Aotearoa New Zealand.

Depending on area of land tenure, seed collection permits may be required prior to collection. They will be required for Department of Conservation or council administered lands.

Cones can be collected when scales first start to appear on the forest floor (February– March). **Do not collect seed from the forest floor** as there is a risk of introducing PA and other soilborne pathogens.

You can instead collect mature cones directly from the tree or onto a sheet. This can be achieved by placing a raised plastic sheet below the canopy to catch the seeds as they fall. Alternatively, if there are two people available, a pair of long-handled loppers can be used to cut the cones from the tree with another person ready to catch the cones in a small net (e.g, swimming pool net). Be sure to obtain permission before collecting seeds. Please see the Principles of Hygiene guide.

www.kauriprotection.co.nz/resources/best-practice-guides/protecting-kauri-principles-of-hygiene

Cones placed in a dry room will naturally open and release seeds within 5–10 days. Viable seed needs to be separated out. Only seeds that are swollen at the base are viable (you should be able to feel a bump when squeezing the seed between thumb and forefinger).

There are four possible scenarios for collecting seeds and growing Kauri. **Rule 3** of the National Pest Management Plan applies to some of these.

Key points are as follows:

- if the Kauri are going to be planted **anywhere other than where they are being grown**, a Kauri Plant Production Plan needs to be prepared and followed (**Rule 3**).
- collecting seeds and cones from another property, as well as planting Kauri on another property, needs permission from the landowner.
- seeds and cones should be collected from healthy sites and removed of all soil and organic matter.
- The growing medium shouldn't originate from Kauri forests or be reused.

Germination

Kauri seeds quickly lose viability over time, so should be planted as soon as possible after collection. Two seeds can be placed (wing up) in pots or bags of soil (5cm² x 8cm deep) and covered with a very thin layer of potting mix (just enough to cover the seeds). This provides enough space for one year of growth. If both seeds germinate, the weaker plant should be removed.

A warm environment (such as a glasshouse) and moist soil will enable seeds to germinate within two to three weeks. Around one month after germination, a two-leaved cotyledon (embryonic leaf) should have emerged. Once this has reached about 5cm high, seedlings can be placed in a shade house or sheltered area outdoors to harden off.

At one year, seedlings will be 15–30cm in height and should be re-potted into a final container (PB3 bags should be adequate) to allow for growth of the developing root system. Care needs to be taken to prevent seedlings from becoming root bound. Roots growing through holes in the bottom of the bag indicate the seedling will need re-potting. Do not cut the roots as you will introduce injury points which could result in a pathway for infection. From two to four years old (about 40–60cm), seedlings can be successfully planted out (don't plant out if the seedling is less than 30cm in height).

Propagation

It is essential that what you are growing Kauri in is pathogen-free and free draining but still has a good moisture holding capacity. Using commercially supplied potting mix from trusted suppliers is advised. Recycling or reusing media is not advised. Different batches should be stored separately to avoid cross contamination.

Growing areas should be raised off the ground to prevent contamination from soil and water flow. Kauri seedlings should be kept separate and in a separate location from other plants.

It is recommended to use municipal reticulated, bore, spring or rainwater as they do not usually require treatment. Water sourced from dams, creeks or bores would need to be treated before use. The use of chlorine can be used to disinfect water.

New pots and containers should be used where possible, otherwise clean and disinfect used containers before re-use. Contamination can easily occur from dirty equipment, tools, containers and preparation surfaces. These items should be cleaned and disinfected regularly and thoroughly, between batches of growing media and plants to reduce this risk. Remove dirt from equipment, tools and pots well away from the propagation and nursery area. Items can be disinfected using recognised disinfectants such as Virkon® S, Janola®, and Sterigene or methylated spirits mix.

Do not plant or give away plants with ill health as they may be infected. Do not use fungicides, biological control products or phosphite in any of the propagation step as these products may conceal the presence of PA making it difficult to detect.

If you are propagating and selling plants as a business or commercial operation, please read the Nurseries Guide. www.kauriprotection.co.nz/resources/best-practice-guides/nurseries

Planting out and site preparation

For optimal growth, seedlings should be planted out in autumn (late March–April) while the soil temperature is still warm. Site selection is critical when planting Kauri. Think carefully about how large a Kauri tree can grow before planting one in an urban environment. It could become a nuisance on a small suburban section if planted too close to a building or beneath an overhead obstruction like a power cable. Where trees have died due to PA infection, don't plant new Kauri in or near the same area. Instead replant with other native species. Strict hygiene must be followed when working around PA infected Kauri for replanting or removing dead trees.

When planting out, place mulch (from a reputable source) or leaf litter at the base of the hole and position the seedlings so that one-quarter to one-third of the root ball is above ground level. Fill the hole and mound up with soil, mulch, and/or leaf litter around the remaining root ball. This procedure provides soft fertile material for the fine feeder roots to grow into. Please note that fertiliser should not be added into the hole before planting out as this can burn the roots.

Careful site selection and preparation is essential. The best results will be achieved by planting seedlings in moderately fertile, free-draining soil in sheltered sites with adequate space to grow.

With some work, seedlings can also grow well in less suitable conditions. Pre-pitting is a useful step in preparation of all soil types, especially for compacted or clay soil.

Pre-pitting involves digging a 30cm² pit one to three months before planting and placing the removed soil beside the hole to allow weathering. This process should develop a looser, lighter textured soil to place around the root ball. Mulch and well decomposed compost can be added to the soil at this stage.

In areas with very hard soils (which prevent tap root development) or with waterlogged soils (which can lead to root rot), Kauri can be planted on hand-made mounds of soil/mulch (1–1.5m in diameter and 0.5–1m high). Planting in mounds allows the root system to develop before encountering the harsher soil conditions below.

Kauri grow best in sheltered areas. If planted in areas that are susceptible to wind gusts, the root systems can be easily damaged. Wind damage can be minimised by securing young trees to stakes with cloth ties or pantyhose material – noting that wire and rope ties can cause injury. Preferably provide shelter in windy areas by planting Kauri seedlings under established nursery crops (such as mānuka and kānuka).

For the first 5–10 years after planting, seedlings should be monitored regularly to ensure they are not smothered by weeds or suppressed by other trees in the overhead canopy. Like any native forest plant, individual Kauri are part of a larger ecosystem. All members of the community are interconnected and are affected by one another. Care for Kauri should first be based on care for the entire ecosystem/ community in which it lives. Eradication of weeds and pest animal species will increase the health of the ecosystem, improving better conditions for all native species.

To protect Kauri when planting and for the future:

- Plant Kauri away from walking and vehicle tracks and other infrastructure like power lines, buildings and fences.
- Undertake planting in dry weather wherever possible to reduce contamination on footwear and equipment and to make decontamination operations easier.
- Fence off planted areas to exclude animals like livestock and pigs.
- Sites should be monitored for establishment success of plants.
- Hygiene must be carried out on footwear, tools and equipment prior to accessing planted areas containing Kauri.
- Avoid planting Kauri in close proximity to existing Kauri forest and seed sources.
- At a minimum, Kauri should not be planted within three times the dripline (Kauri Hygiene Zone) of existing Kauri.
- Consider spacing Kauri to allow for future growth.

Glossary

Araucariaceae	A family of conifer species.
Bleeding	Deliberately injuring the trunks of Kauri to cause gum production.
Conifer	Cone-bearing plant.
Cotyledon	The first leaf of the embryo of a seed plant.
Damping off	Root rot disease that can cause death of Kauri seedlings.
Drip zone	The area of ground below the canopy of an individual tree.
Epicormic shoots	Small shoots that grow from the lower trunk in response to sudden increase in light levels or stress.
Germinate	Begin to sprout or grow.
Gummosis	Gum production.
Moko	Facial tattoo.
Mycorrhizal fungi	Fungi that have a beneficial relationship in and on the roots of host plants.
Nursery crop	Plants that help establishment of Kauri seedlings. For example, mānuka and kānuka provide shelter for seedlings while allowing access to overhead light.
pH	A measure of acidity or alkalinity, on a scale from 0 (very acidic) to 14 (very alkaline). Neutral pH = 7.
Phytophthora	The phytophthora genus is a group of destructive plant pathogens. From Greek phyton, (plant) and phthora (destruction); “the plant destroyer”.
Pre-pitting	Weathering soil from planting hole prior to planting.
Rangatira	Māori chief or of noble birth.
Root zone	Area where roots grow horizontally. At least the area of the drip zone.
Rickers	The term “ricker” is a reference to either the sticks used to make a hayrick; or as a corruption of “Riga” the Baltic port that had been a primary source of timber for British ship spars prior to development of the Kauri timber industry.



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For more information about protecting Kauri, visit www.kauriprotection.co.nz