

A man wearing a wide-brimmed hat and a light blue button-down shirt is smiling. He is standing next to a Tōtara tree, with his hand near its branches. The background is a bright, sunny outdoor setting.

PLANTING AND ESTABLISHING TŌTARA

A Practical Guide to Managing
Tōtara on Private Land

By Paul Quinlan, July, 2022.

Contents

1	Why plant tōtara for timber?	4
	Iconic status and potential role in establishing native forestry	
2	Working with natural regeneration	6
	Ability to regenerate naturally	
	Patterns of establishment	
	Scope to manage natural regeneration	
	Advantages and disadvantages	
3	Planning a tōtara forest	14
	Site suitability	
	Tracks, tracks, tracks	
	Seed source and nursery orders	
	Planting season, maramataka	
	The Forests Act and legal matters	
	Certifying 'Planted Indigenous Forests'	
4	Planting regimes for tōtara	17
	Role and choices of nurse species	
	Target stocking rates at harvest diameter	
	Spacings and set out	
	High, medium, and low-density planting options	
5	Planting specifications	26
	Pre-plant site preparation	
	Plant size/grade	
	Planting season	
	Monitoring and maintenance	
	Maramataka	
6	Releasing – weed control	28
	Herbicide resistance	
	Indications of resistance to certain herbicides useful for releasing	
	Grazing as a release method	
7	Cost of establishment	33
	Comparative costs between four planting options	
8	Conclusions	34

Acknowledgements

This work is part of a Tāne's Tree Trust project: *A Practical Guide to Managing Tōtara on Private Land*. It was funded by Te Uru Rākau (1BT 01449) and The Tindall Foundation.

Many thanks to David and Michael Bergin and Ian Brennan, for technical guidance and review. And Gordon Williams at Pāmu (Landcorp farming Ltd.) for support with establishment trials. Helen Moodie is also acknowledged for starting the Northland Tōtara Working Group in 2006, as part of the NZ Landcare Trust.

Design and layout by Abby Davidson Design

Disclaimer:

In producing this report, reasonable care has been taken regarding the accuracy of the information presented. However, no guarantee as to the truth, accuracy, or validity of any of the comments, implications, recommendations, findings, or conclusions are made by the author, the Northland Totara Working Group, Tāne's Tree Trust, or any other party. Therefore, neither the author, nor any of the supporting organisations, including the Ministry for Primary Industries/ Te Uru Rākau, shall be liable for, or accept any responsibility for any loss, damage or liability incurred because of direct or indirect result of any reliance by any person upon information or opinions or recommendations expressed in this work. Users of any of this information, whether contained or inferred, in or arising from this report do so at their own risk. This does not constitute advice from a Registered Forestry Consultant.



“Tōtara has excellent potential to be managed as a high-value native timber species.”

Dr. David Bergin

The preeminent forestry scientist David Bergin did his PHD thesis on the growth and management of planted and naturally-regenerating stands of *Podocarpus totara* D. Don.

1. Why plant tōtara for timber?

Rākau Rangatira

Tōtara is revered in Aotearoa, New Zealand. For Māori it is the leading Rākau Rangatira, the first big tree created by Tāne. It is a species that grows throughout the country and has iconic status based largely on respect for the attributes of its timber and the cultural heritages associated with its use – and its abuse.

These days it is one of the most widely planted native canopy-tree species. This probably reflects the ease of seed collection, propagation, and that it generally has good survival rates and reasonable growth across a range of site conditions. It is also one of our few native pioneer tree species, tolerating more open light conditions and fresh mineral soils. These are natural advantages that make it suitable for early inclusion in reforestation projects. And, when people are thinking about possible future native timber options, natural durability is often a priority attribute – and in that respect, tōtara is one of the kings.

“Tōtara is an iconic native tree species. It is revered for its timber attributes and cultural heritage values.”

A popular choice

In recent years, native reforestation has been encouraged through schemes such as the One Billion Trees programme. This recognises that native forests can be an elegant way to address some of the most pressing issues of our times – the biodiversity, freshwater, and climate-change crises, as well as providing an array of other environmental services along with natural landscape and cultural values. However, for many people, adding some potential productive timber value to this suite of benefits makes perfect sense. Diversifying our country's production forests in terms of forest type and species is considered one way to weave environmental resilience into our working landscapes – particularly with native forest.

Work by the Northland Tōtara Working Group and others has demonstrated that tōtara has excellent potential to be managed for timber production. It responds well to silvicultural treatments, such as pruning and thinning, and the timber, even from relatively young trees, is an excellent softwood timber suitable for many interior applications and uses.

Tōtara is considered one of the most promising native tree species for timber production purposes. New tōtara forests can be planted and managed as even-aged plantations, or as continuous cover forests for selective harvesting, or as part of a more natural mix of native forest species.

Resource scale and future timber demand

Scale is another reason to plant tōtara. A significant resource of naturally regenerated tōtara already exists on private land in Northland and other regions. This natural resource has commercial scale and could provide the potential continuity of supply that is essential to develop markets for a sustainable tōtara timber industry. Planted tōtara forests should benefit from this confidence and be a complement to the extensive existing regenerating forest resource. Few other alternative timber species have this advantage of commercial scale and continuity. The more people that plant and create tōtara forests, the better the chances that a strong tōtara timber market and industry will develop.

“Tōtara is one of the most popular choices for native tree planting – and the more that are planted, the better the chances that a strong market for the timber develops.”

Monocultures and mixed species

For many reasons it appears that tōtara has been considered one of the safer bets when planting with long-term native timber production in mind. While there are some advantages with single-species plantations, diversity is a sound strategy for spreading risk. Moreover, non-timber values, such as biodiversity and natural character, are likely to be much higher in diverse, mixed-species native forests, rather than mono-cultural native plantations. Planting also brings the opportunity to create and support the many non-timber values also associated with mixed native forests.

Nevertheless, the forest of the early establishment phase will not be the same as the enduring forest after 80 years or more. Ferns and other native plants will likely establish themselves naturally as conditions change under the canopy and will increasingly support shade-tolerant and exposure-sensitive plants that wouldn't have survived if they had been planted out in the open from the start.

Role in establishing native forestry

Tōtara, as a pioneer tree species might be useful, in places, to help create the first emergent forest canopy within which a more diverse native forest will inevitably develop or can be supplemented by under-planting later. Some low-impact selective harvesting could even be a way of helping to transition a tōtara dominant forest into a more diverse native forest - within a couple of centuries.

Native forest establishment involves very long timeframes and processes of species succession. On many sites, tōtara is a species well-suited for inclusion and strong representation in the mix of early canopy tree species. Given its attributes and its mana, it is only natural for tōtara to take a leading role in native afforestation. Perhaps this echoes Maori creation stories where tōtara provides the space for other life to thrive.

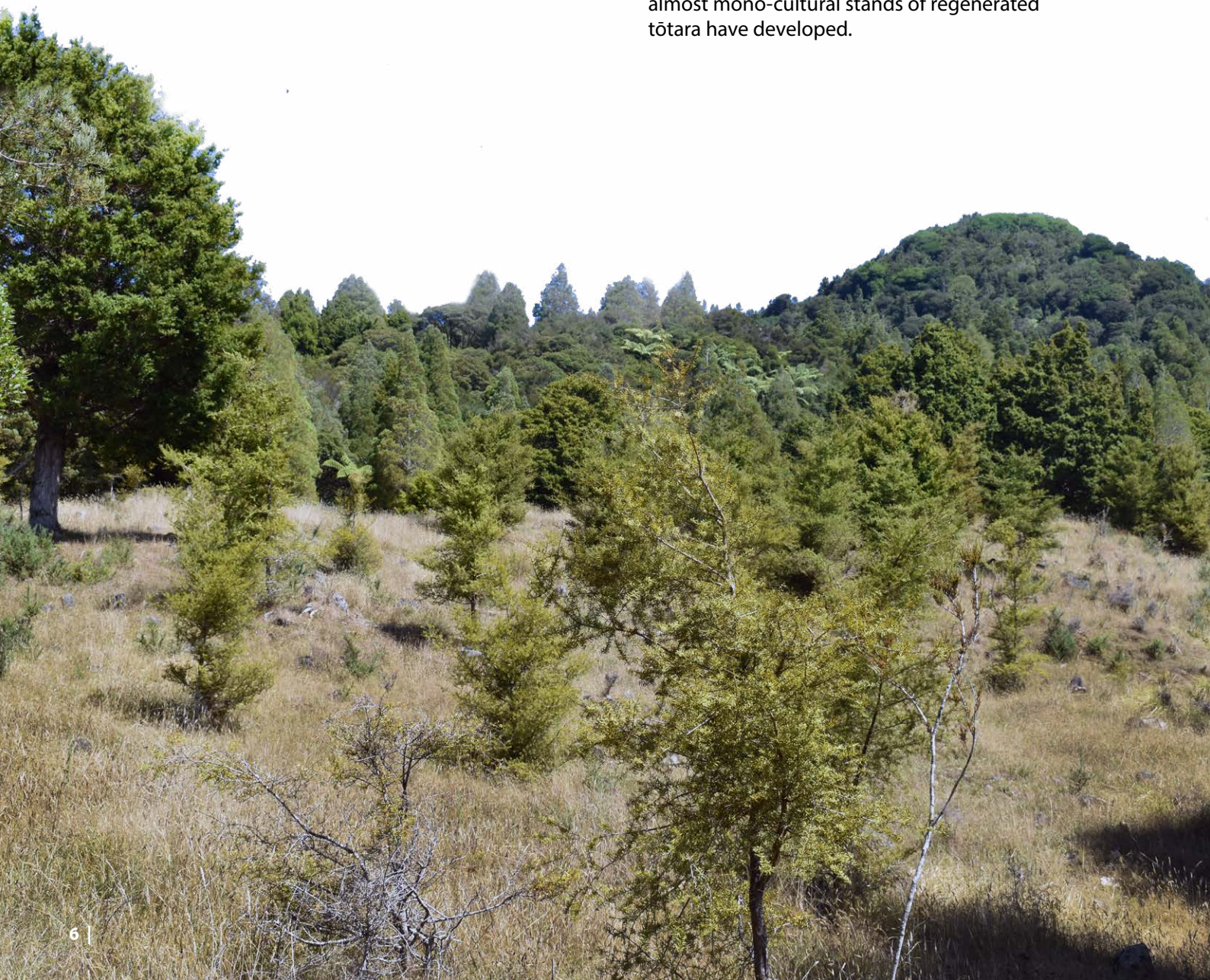
“Given its attributes and mana, it is only natural for tōtara to take a leading role in native afforestation.”

2. Working with natural regeneration

The ability of tōtara to naturally regenerate is one of the most remarkable features of the species today. In some regions, such as Northland, regeneration of the species is especially prolific. Clearly planting is not the only way to establish a tōtara forest. Indeed, in respect to large-scale native reforestation, and particularly tōtara forests, I suggest that natural regeneration is the much 'bigger fish'. The key role of planting is to complement it by adding more forest area.

"Natural regeneration is the 'big fish' of large-scale native forestry."

Ecologically, tōtara is a pioneer tree species. It is well suited to colonising disturbed environments, such as what we have created through bush clearances and farming. It sets seed from a young age and the seeds are widely spread by birds and germinate easily. Moreover, it seems to be enjoying the warming climate. But perhaps its greatest advantage is its relative resistance to grazing by livestock. Tōtara is often the dominant native canopy tree species in areas of second-growth forest and scrub regrowth on farms. This reflects the influence of livestock browsing which modifies the species composition of regenerating vegetation. It has become one of our most prolific native tree species in highly modified pastoral landscapes nationwide. In some pastoral areas, almost mono-cultural stands of regenerated tōtara have developed.





Just like gorse and tea-tree, tōtara can naturally regenerate within a pastoral environment, especially on rough pastoral hill country. Birds spread the seeds across the landscape and grazing helps release the tōtara from competing vegetation. Kahikatea is often also present, but to a much lesser extent.



Grazing can even help naturally regenerating seedlings to establish.



Tōtara are well suited for integration into the pastoral environment. They tend to colonise steep slopes with poor pasture – arguably the areas that should be in trees anyway.



At low stocking rates, the first trees to establish will be heavily branched and with no merchantable timber bole. Such trees provide livestock shelter and amenity value but have no timber value. Photo: Helen Moodie

Scope to manage natural regeneration

Given the demonstrable ability of the species to regenerate, the critical question is whether we can deliberately encourage and manage this natural process to establish new tōtara forests suitable for timber production – without planting? Certainly, the work of Dr David Bergin and the Northland Tōtara Working Group, shows the scope to apply silviculture (pruning and thinning) to the areas of dense tōtara saplings and pole-sized trees. But those dense pole-stands and trees, with boles suitable for timber production, are only a small proportion of the natural population. The bulk of the naturally regenerated resource is dominated by branchy trees with little or no merchantable timber volume.

Establishment pattern in open areas

A typical pattern of establishment in open areas is that the older trees, the first to colonise, develop a coarse branchy growth habit, often with multiple leaders, and no merchantable timber volume. However, these provide the seed source and bird-perches, for consequential waves of colonisation that start to infill the areas immediately around and in between these parent trees. As the stocking rate increases, so too does the effect of side-shade and competition, which produces young saplings and poles with increasingly better form for timber production purposes. This infilling continues until a dense and closed canopy is formed and there is insufficient light reaching the ground for further regeneration of tōtara.

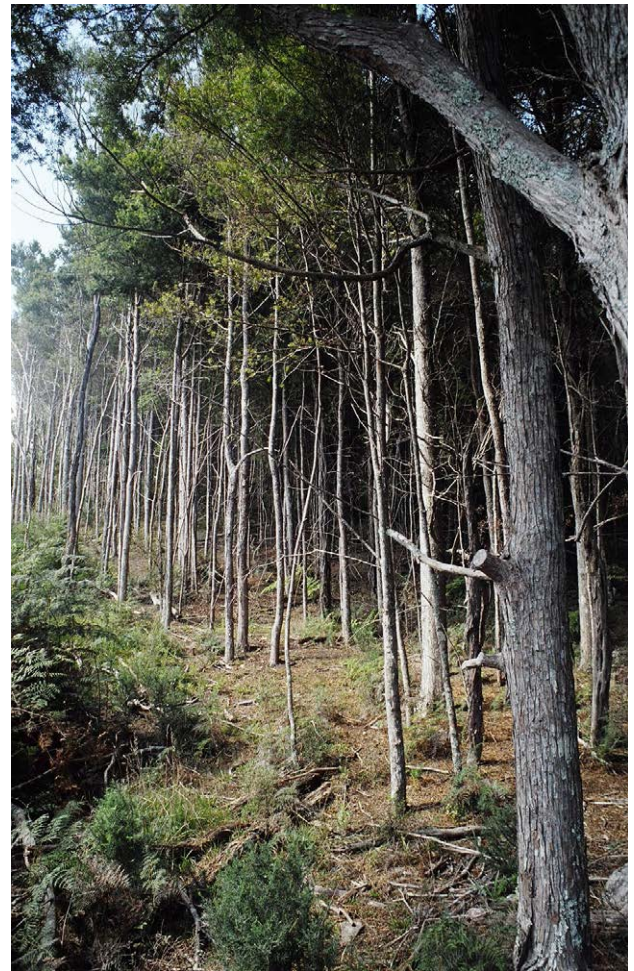
Ultimately, natural regeneration tends to result in a fully stocked forest comprising trees with a range of ages and highly variable form. The poorest-formed trees are usually the oldest and biggest and dominate the stands. Dense stands will progressively self-thin, but unfortunately the better-formed trees will often be suppressed by the poorer-formed ones with the bigger crowns. Of course, there is scope to intervene and manipulate this structure through thinning and pruning – to direct the growth onto the better-formed trees so they become the dominant trees (see the chapters on pruning and thinning).



Open pastoral areas between scattered trees can infill with dense stands of saplings – up to 60,000 stems/ha

Establishment in scrub and bush

Tōtara regenerating amongst scrub and bush will tend to have much better form for timber production. However, shade and competition from ferns and shrub hardwoods will often significantly inhibit levels of tōtara regeneration. Even where seed sources are present, areas of second-growth native forest may have a relatively low stocking of tōtara, especially if there is no history of livestock influence. In contrast, tōtara abundance does seem to have a relationship with a history of farming. Presumably where cattle have had access and kept the ferns, shrubs, and herbaceous weeds in check, tōtara and other podocarps have had enough light and freedom from competition to become established. Without grazing, a mixed-species native forest develops.



Severe competition between stems in dense thickets or stands of tōtara saplings will encourage the development of tall straight stems, but significantly slows the growth rate.

Even without any silvicultural management, naturally regenerated pole-stands can develop into tōtara forests that are well-stocked with well-formed trees and high volumes of merchantable timber. However, growth rates could be significantly improved with some active management (see chapters on pruning and thinning).

Encouraging natural regeneration

In areas where a seed source is present and natural regeneration is evident, there may be opportunities to establish areas of tōtara forest without actively planting. However, this is likely to be a slow process over a couple of decades or more. Conducive land management practices may include:

- Allow natural reversion with gorse, and kanuka.
- Refrain from slashing or burning the area.
- Continue light periodic grazing (if that is an option) but avoid intensive mob-stocking or feeding-out, or standing-off, in that area.
- Spray to control thick gorse, bracken, blackberry, shrub hardwood and herbaceous weeds. (N.B. – see section on herbicide resistance).
- Manage the vegetation cover to ensure that it is not inhibiting successful colonisation and growth of tōtara seedlings through excessive shade and competition.
- Protect from fire.

“The advantage of natural regeneration is cost. No planting, no fencing, no releasing is needed to establish the trees”

Managing natural regeneration for timber production purposes

Unless dense thickets of tōtara develop (>6000 stems/ha), some form-pruning will be needed and later some thinning. See the video on form-pruning tōtara for timber production: <https://vimeo.com/580207222>

Images following show a small fringe of regenerating tōtara encroaching on a paddock on a dairy-farm runoff block. Gorse developing amongst it was killed off by herbicide spray, which also killed the black tree ferns (see section on herbicide resistance). This left a monoculture of tōtara on the rough pasture with a stocking rate equivalent to 2800 stems/ha. No planting, no releasing, and no fencing was necessary to establish this stand. Form-pruning and later thinning should see it develop as a woodlot with excellent timber production potential.

Frequent (3-5 yearly) form-pruning should be carried out to improve the form of saplings and poles (see chapter on form-pruning tōtara). Such silviculture will help maximise the productive potential of the developing stand.



These young tōtara naturally established amongst gorse and kanuka within a paddock. Herbicide applications killed off the gorse and kanuka and have left the tōtara. If the landowner refrains from clearing these trees, they could be managed to become a tōtara woodlot, but would need a lot of form-pruning.



Regenerating tōtara saplings and poles establishing at the edge of the paddock can be form-pruned and managed to ensure they develop sawlog potential in the future.



These regenerating tōtara have encroached into a paddock on a dairy-farm runoff block. Herbicide spraying has left a monoculture of tōtara at a stocking rate of 2800 stems/ha. No planting, no releasing, and no fencing was necessary to establish this stand. Continued form-pruning and later thinning should see it develop as a woodlot with excellent timber production potential.



“The disadvantages with natural regeneration are that it is slow, inconsistent, and legal restrictions in the Forests Act apply.”

Any native forest established by natural processes, such as described above, will be subject to the restrictions of Part 3A of the Forests Act. This is the case even for tōtara forests that have regenerated on previously cleared land, and as a result of conscious management decisions, such as encouraging and assisting natural reversion. The implications of this are set out and discussed further below in the next section.

Regenerating tōtara can often be integrated with other land uses such as pastoral farming or production forestry. Many small areas will cumulatively amount to a significantly-scaled resource.

Naturally regenerated tōtara on a farm in Northland.
Photo: Michael Bergin



3. Planning a tōtara forest

There are many excellent publications covering the importance of planning native plantings and the steps involved. In general, the same content and processes will be applicable to tōtara forests so it is not all replicated here. However, it is worth emphasising the following:

- **Site suitability:** Make sure you match species choice to the site. Tōtara do not like wet feet! And although tolerant of a range of soil types and conditions, on some sites, they simply won't thrive.
- **Work with natural regeneration as much as possible:** Planting is expensive. So use planting strategically to start-off the processes of natural regeneration where needed, and to work with and complement existing native vegetation where present. Plant close to existing bush and/or create corridors and linkages to existing remnants.
- **Local examples and advice:** Seek out local knowledge and experience and learn from local examples. Also, be aware of other local initiatives and projects such as pest control and plantings, that your plantings might link or contribute to (e.g., wildlife corridors/riparian connections).
- **Funding support:** Check with regional councils, Government agencies (e.g., Te Uru Rākau), and other organisations (such as Trees That Count) or local projects (e.g., Kaipara Moana Remediation project) for possible assistance with planning, technical advice, or funding to lessen the costs.
- **Staging:** Stage large planting projects and start with small-scale trial plantings to learn about any unique site conditions or issues, and to spread your risk (e.g., severe droughts after planting).
- **Pre-ordering:** Pre-order plant stocks from nurseries well in advance (1-2 years for manuka, 2-3 years for tōtara) – especially if eco-sourcing, and ensure plants are up to specifications at the time of planting. Pre-ordering should also get the best prices.
- **Tracks, Tracks, Tracks:** Accessibility is important for establishment and maintenance - but it is essential for harvesting! Experienced foresters stress the need for and value of tracks. These are best formed before planting and should be suitable for large 4WD tractors or skidders. Ian Barton's handbook on continuous cover forestry, states that an effective network of roads, tracks, and skid trails will occupy 6 - 8 % of the total forest area.

With present technology, helicopter-logging is probably too expensive for young tōtara plantations. Therefore, track lay out should facilitate practical ground-based harvesting. The effective reach of a tractor-mounted forestry winch is probably around 35 – 50m (max. 70m) depending on terrain and machinery used. Skidding tracks should aim to be no more than 70m apart – 100m maximum.

Ideally tracks should only have gentle gradients and follow along a contour. However, in steep country they might be restricted to ridges, spurs, and gully floors. Management objectives for inaccessible areas should be weighted towards conservation values.
- **Allow for mortality:** There will inevitably be some losses of planted totara in the first few years after planting – on average of up to 20%. So allow budget for blanking (replacement of failures).

Forest mapping

Mapping is an important tool in developing a forest management plan. Mapping your tōtara forests areas is likely to be useful for other purposes too (e.g., as integral parts of a Farm Environment Plan).

Furthermore, on many sites, planted tōtara may be complemented by areas of *naturally* regenerating tōtara – or native reversion. Differentiating planted tōtara forest from areas of naturally established native forest may be difficult to accurately map. However, the implications of the Forests Act, and potential maps and rules in District Plans (e.g., Significant Natural Areas (SNAs)), make it important to do so. Therefore, accurate mapping of the land and potential tōtara forest areas is recommended as part of the initial planning stage.



Tōtara forests provide habitat for many other native and exotic species - in this case the climbing white rata.
Photo: Michael Bergin

Ian Brennan and Trisha Wren established an excellent network of tracks ahead of planting areas of native forestry that will be managed under a continuous cover canopy system. Photo: Ian Brennan



The Forests Act

Planted vs natural forests

The Forests Act is relevant to those planting native forests in the following ways:

- It differentiates between areas of planted indigenous forest and naturally established indigenous forest. Different rules apply at the time of harvest.
- Planted indigenous forests can be certified as such, to exempt them from the sustainable management requirements that naturally established native forests are subject to.

Therefore, for most native forest planters, involvement with Part 3A of the Forests Act will only be the mapping and certifying of their planted forest areas, and then again with some record-keeping, at the time of harvest and milling. These are not onerous requirements, and Te Uru Rākau charge no fees to certify planted forests.

“Get your planted tōtara forests certified as ‘Planted Indigenous Forest’ by Te Uru Rākau – The New Zealand Forest Service.”

Planted native forests may be clear-felled

Essentially, as far as the Forests Act is concerned, planted indigenous forests may be treated like exotic woodlots, and could be clear-felled at the time of harvest, if the owner wishes. Retaining this freedom is strongly recommended – even if it is never utilised. Owners may still choose to manage their planted forests under a continuous cover forestry system instead – when harvest time comes.

This contrasts markedly with all naturally established forest areas. Part 3A of the Forests Act applies to the harvesting of native forests. And Sustainable Forest Management Permits or Plans dictate allowable harvest volumes and forest protection measures. There are also significant costs and lengthy processing times involved.

An issue for landowners planting native forest may be mapping out what is classed as already indigenous forest area. It is likely to include reverting scrub regrowth and regenerating native plants on land that has previously been cleared or is still in pastoral use. Advice from Te Uru Rākau forestry advisors will be necessary.

“Mapping out areas of existing indigenous forest – including scrub regrowth will be necessary.”

Contact Te Uru Rākau – The New Zealand Forest Service to register your planted indigenous forests: <https://www.mpi.govt.nz/dmsdocument/54-Planted-indigenous-forest-certificate-Application-form>

Other legal disincentives

Fear of legal impediments and not being allowed to harvest, has been a disincentive for many landowners contemplating planting native forest, and especially for allowing natural reversion. Getting planted indigenous forest areas certified by Te Uru Rākau will limit potential encumbrances from the Forests Act. However, other regulations such as District Plan rules relating to Significant Natural Areas (SNAs) may still apply. Certification will not guarantee total freedom or rights to harvest in the future. Nevertheless, it is a clear registration of an interest to do so, and strongly recommended.

Given the long timeframes involved between the planting and harvesting of native forests, let's hope that issues with the regulatory frameworks are well resolved when the time comes. In the meanwhile, don't let it put you off planting and managing native forests in all their forms.

“The trees still grow despite daft regulations – hopefully there is time to sort any silly rules between planting and harvest.”

4. Planting regimes for tōtara

Best practice for native forest establishment is set out in the Tane's Tree Trust Handbook: <https://www.tanestrees.org.nz/resources/publications/>

These follow the orthodox approach of interplanting canopy tree species, such as tōtara, within and amongst a protective 'nurse cover' of native plants and shrub hardwoods. In sheltered and mild Northland sites, tōtara are often planted out at the same time as the nurse species. But on harsher sites, such as exposed coastal areas, or in colder regions, the interplanting of the canopy trees is often delayed a year or more until the nurse is established enough to provide some protective shelter.

The nurse species

For most sites and situations, it is recommended that tōtara are interplanted within a 'nurse cover' of native shrub and small-tree species to provide surrounding shelter from the elements and to help suppress grass and weed competition, enhance biodiversity, attract birds, and feed bees etc., and for natural aesthetic character.

Function of a nurse for timber crops

For timber production purposes, the nurse cover also needs to draw the tōtara stems up tall and straight, by providing some lateral shade and competition to discourage the tōtara from developing heavy side branches. Ideally the nurse cover should provide some light overhead canopy competition to reduce the tendency of the tōtara stems to fork and develop more than one single leader or tip.

A trial at Tapapakanga Regional Park in South Auckland planted tōtara at the medium-high stocking rate of 2.0 x 2.0m spacings (i.e., 2500 stems/ha) but without a nurse. Evaluations more than 30 years later show that it did not result in a stand of well-formed trees for timber production purposes.

An effective nurse cover will improve the form of the tōtara and reduce the need and cost of pruning – which is expensive. It should also increase the height of the tree's bole – which ultimately is the length of usable log. However, if the nurse cover is too dominant and over-tops the tōtara with heavy shade, then the growth of the tōtara will be significantly slowed – possibly for decades. Naturally, a fine balance between enough competition and too much is what is wanted but that is certainly not easy to achieve. An ineffective nurse is an unnecessary expense.

The choice of nurse species is an important decision.

"The nurse cover has a critical role in improving the form of the tōtara."

Manuka as a nurse species

In recent years manuka has been a popular choice. It is usually one of the cheapest native plants, quick-growing and quick to plant, tough, and tolerant of a wide range of site conditions, and at little risk from accidental livestock browse, or pests. Many people have planted manuka with the hope of some income from the manuka honey industry but have still interplanted tōtara for the option of some timber value in the longer-term and for when the manuka is succeeded by taller vegetation.

Other features of manuka as a nurse are that it doesn't grow too tall or persist and live too long. Once above the height of a manuka canopy, typically 3-5metres, tōtara will quickly dominate and suppress the nurse.

However, at that stage, the adjacent planted tōtara will provide the only competition between the tōtara crowns. The big question is whether that will be sufficient competition to encourage them to form good quality top-logs, and limit forking and the development of heavily branched crowns? If not, the result will be a forest of relatively short-boled tōtara trees with large, unusable crowns. But in such instances, at least the short butt logs should fatten quickly, reducing the time to first harvest opportunities.

If using manuka as the nurse cover species, interplanting the tōtara at a medium stocking rate (>1250 stems/ha) is probably the best bet to influence the length of merchantable log (i.e., encourage the formation of usable top logs). And hopefully, provide enough choices for effective thinning.

Kanuka

In contrast to manuka, kanuka can grow relatively tall (12-18m) and persist in the secondary forest for a century or more.

It has not been as popular as manuka for use as nurse species. This probably reflects factors such as availability, price, and that kanuka is less tolerant of some site conditions. It also has the potential to develop a taller nurse canopy cover and dominate and compete with the emergent tōtara for a much longer time. This overtopping and prolonged competition is likely to significantly slow the growth rates of tōtara seedlings, saplings, and small poles. Furthermore, branches and stems from competing kanuka may damage or deform the stems of the developing tōtara if they rub against them or cause them to lean. Nevertheless, some of the best-formed young tōtara trees and forests have regenerated naturally through a predominantly kanuka nurse cover.

Indeed, tōtara is naturally more commonly associated with kanuka than with manuka. This begs the question whether we should be following nature's examples and be using kanuka as the natural nurse for tōtara? Unfortunately, there is little research to guide us on this matter. Observations and experience with naturally regenerated tōtara forests confirm that tall-boled and lightly branched tōtara poles and trees often develop through a kanuka dominated cover. However, the growth rates of tōtara within natural stands are usually significantly slowed by the competition and overhead shading.

Nevertheless, using kanuka as a nurse cover may suit situations where little or no pruning is intended and minimising the growing time to reach a harvestable diameter is not priority. Also, fewer nurse plants per hectare may be needed. Unfortunately, we are not aware of trials comparing the long-term differences between using manuka or kanuka as a nurse for tōtara intended for timber production, nor the optimal stocking rates and spacings for planting. It would be good to have research guidance on these matters.

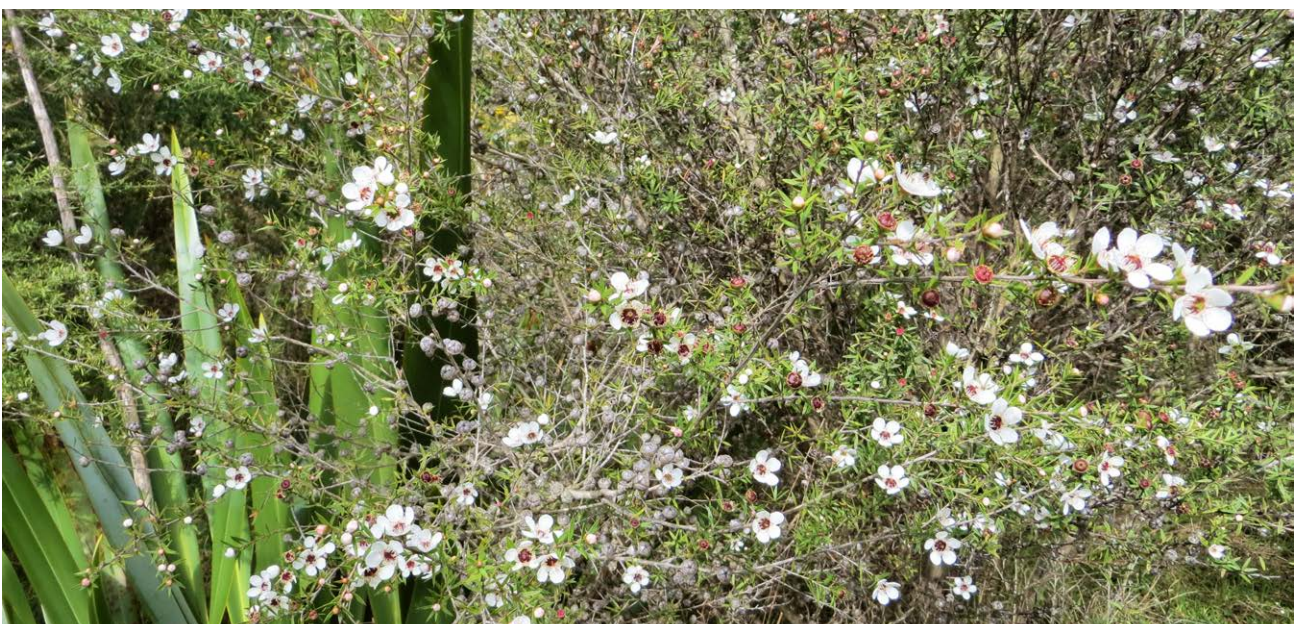
Kanuka may be a good option for those wanting a low-cost regime, and intending on minimal management, but still hoping to ultimately produce some trees with excellent form for high-value timber in the long-term – and don't care if it takes a long time.

Mixed native species nurse

For greater biodiversity and more natural aesthetic values, the option of using a mix of locally appropriate native colonising species as a nurse is recommended. Pick a range of plants naturally found in similar habitats in the local area and known to have good survival rates when planted in open and exposed conditions.

Try to match the nurse plant species to suit micro-site conditions, hopefully improving survival rates and the resilience of the plantings to extreme weather events and conditions.

While a mixed-species nurse has many benefits, it can involve greater unit costs per plant compared to manuka.



How many to plant and at what spacing?

Tōtara plantations are notorious for developing trees with poor form for timber production. However, as many natural stands attest, the species is very capable of producing tall, high-volume, high-value timber trees. We just need to learn how to achieve the same.

Most tōtara plantations do not produce well-formed timber trees. Planted tōtara often have forked stems, spike-branches, multiple leaders, heavy branching, low stature, and short boles. Frustratingly, even planting tōtara at medium-high densities (e.g., 2.0 – 3.0m spacings) will not ensure well-formed trees result. Some form-pruning is likely to be necessary to enhance potential timber values. Medium-high density plantings will also need thinning at some point but have better chances of achieving a well-stocked stand of good quality trees. The more trees to choose from the better.

Unfortunately, there is no one single planting prescription. Essentially, there are trade-off decisions to make. Some of the pros and cons are discussed here.

Trade-offs

Planting at lower initial stocking rates (numbers of plants per hectare – expressed as stems/ha), means less outlay costs for plants, and less cost for planting, but it is likely to mean a longer maintenance period before canopy closure (when the crowns of the plants join and shade out the grass and many weeds in the understory). This may mean an extra couple of years of releasing from weeds during establishment.

Low density planting may initially be cheaper, but then require more pruning which is expensive, and will likely result in a stand that is under-stocked with merchantable trees and/or quality timber volume.

Thinning is a much more cost-effective silvicultural intervention than pruning. But relying on thinning requires having sufficient good trees to choose from. The more the better.

Higher stocking rates have more silvicultural management options to maximise timber yield and quality. However, sometimes high stocking rates of nurse plants, while initially helping displace weeds, can in themselves start to require some controlling if they overly dominate the tōtara. This would involve thinning or cutting of branches to create or maintain light wells for the tōtara. For example, Ian Brennan at Te Miro in the Waikato, finds that tarata, (lemonwood, *Pittosporum eugenoides*), is too vigorous and produces dense shade, which often deforms or suppresses tōtara when planted in a 2500 stems/ha regime.

Matching site conditions with your capacity and objectives

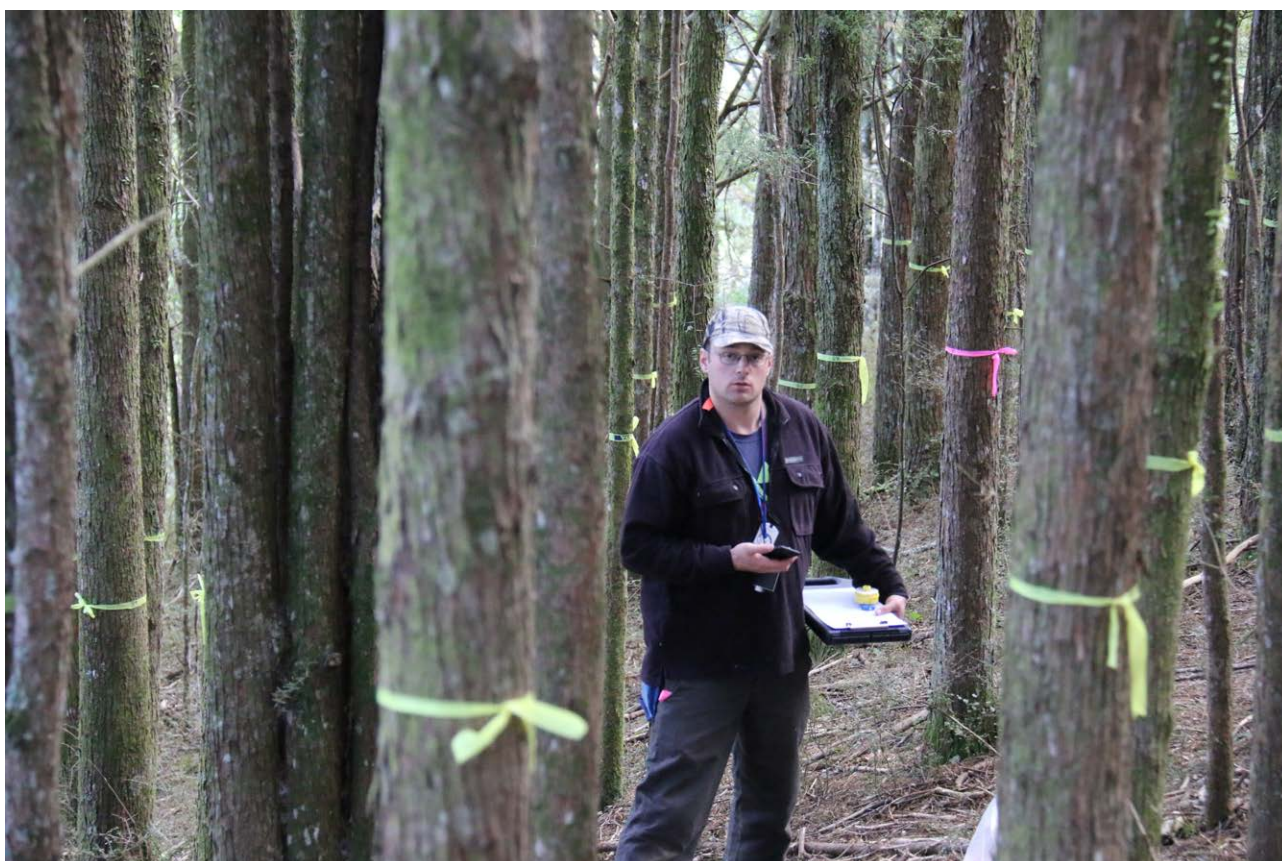
Growing conditions, weeds, and species performance will vary from site to site and region to region. Local knowledge and examples can be invaluable assistance when deciding on a planting prescription. Native afforestation is a costly long-term commitment, so it is worth trying to match the planting plan to your funds, capacity, and enthusiasm for silvicultural work.

“Most tōtara plantations do not produce well-formed timber trees – even when planted at medium densities.”

More detailed information is set out in the Tane’s Tree Trust Handbook, particularly chapter 8.2, and free to view and download here: https://www.tanestrees.org.nz/site/assets/files/1069/8_2_planting_patterns_and_density_for_natives_on_open_sites.pdf

Target stocking rates at harvest time

Analysis work by Mark Kimberley based on Stand Density Index, suggests aiming for a stocking of 400 pruned crop-trees per hectare of tōtara when their mean diameter at breast height is 40cm. However, this target stocking rate progressively reduces as the mean diameter increases – as set out in the table below.



Dense stands of naturally regenerated tōtara often have stocking rates exceeding 3000 stems/ha. Many trees have excellent form, and the stands can be heavily thinned so that they are fully-stocked with only the well-formed trees. In comparison, many planted stands may struggle to achieve a full stocking of premium quality trees.

Table: 1 – Target stocking rate in relation to mean diameter and/or at target harvest diameter:

Mean DBH* and/or target harvest diameter (cm)	Target stocking rate (stems/ha)	Approx. mean spacing** (m)
25	550	4.2
40	400	5.0
50	275	6.0
60	120-200	7.0- 9.0

* Quadratic mean DBH

** N.B. – Mean tree spacing is a guide only and does not need to be rigidly applied. Overall stocking per hectare is more important than even distances between trees.

However, attaining full stockings of good-quality timber trees may be difficult. Therefore, planting many times the numbers required and then selective and progressive thinning/harvests to attain the target stocking rates is recommended. Having plenty of trees to choose from is essential.

Recommended planting regimes for totara

Medium density regimes aim to strike a balance between the trade-offs discussed above. A medium density regime is set out below. It has plant spacings that are conducive to systematic thinning, silviculture, and selective harvests, while aiming to attain a full stocking of merchantable stems in the developing forest for timber production.

Note – the distances between trees and rows are horizontal distances – i.e., as if in plan view, rather than angled to follow the slope of the land.

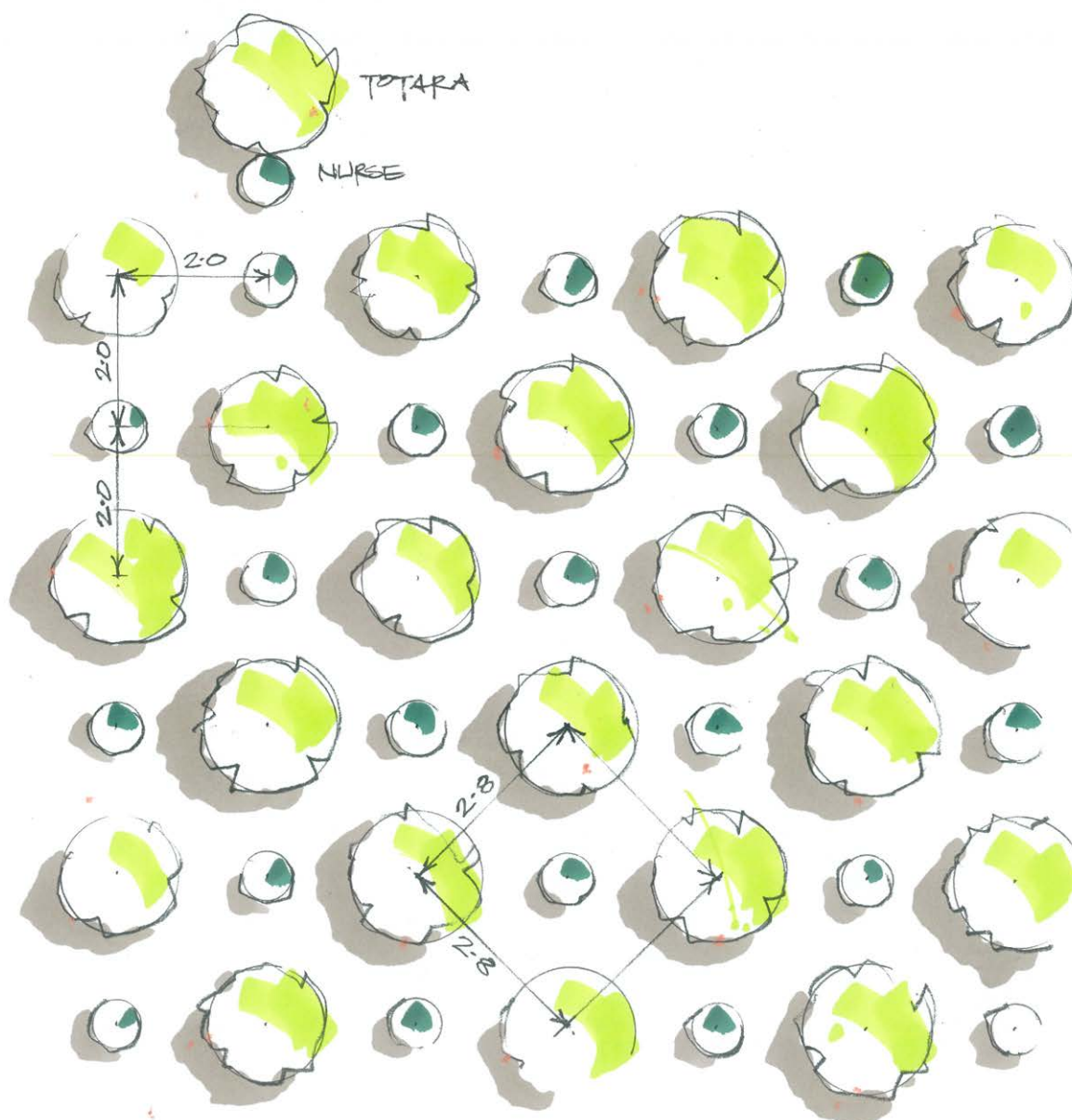
Medium density planting at 2500 stems/ha

Total stocking:	2500 stems/ha (50% tōtara/50% nurse)
Number of tōtara:	1250/ha
Number of nurse:	1250/ha
Distance between rows:	2.0m alternating nurse/tōtara along each row and staggered rows.
Distance between trees along each row:	2.0m
Set out tips:	Plant the nurse species in a 2.8m grid pattern and then interplant the tōtara in the centres of each grid (also at 2.8m centres between the tōtara).

This medium density plantation regime suits those aiming for good timber production potential and multiple management options. Thinning will be necessary as the stand develops (aiming for 400 premium, pruned trees, per hectare, by the time the mean diameter at breast height is 40cm).

Planting the nurse a couple of years before the tōtara should be considered for exposed or tough sites where the nurse needs to provide early shelter.

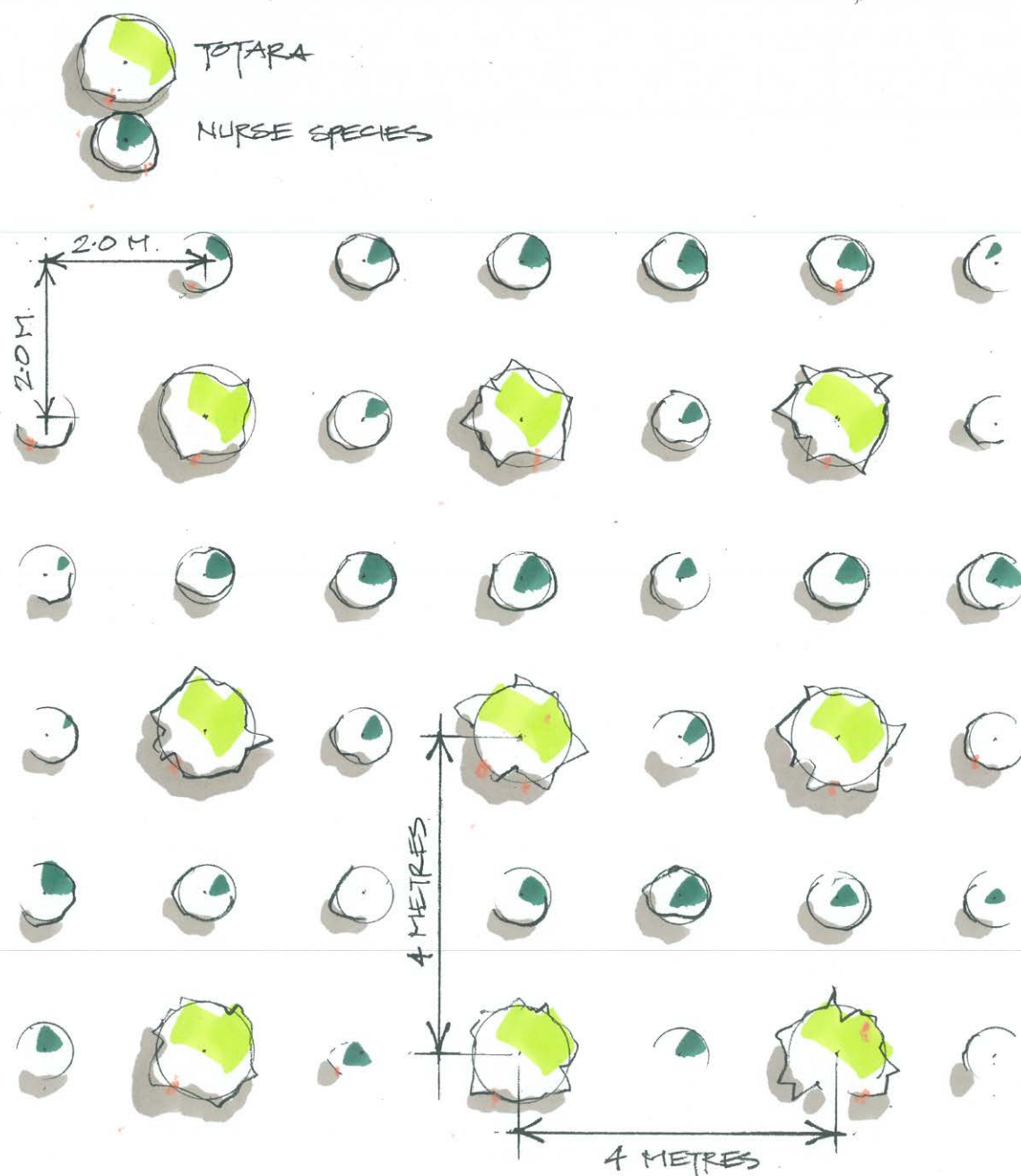
Form-pruning will still be needed to improve the quality and volume of merchantable tōtara timber. And it is still unknown whether this regime, with manuka as a nurse, will produce high quality top-logs.



Medium-low density at 2500 stems/ha

Total stocking:	2500 stems/ha (25% tōtara/75% nurse)
Number of tōtara:	625/ha
Number of nurse:	1875/ha
Distance between rows:	2.0m
Distance between trees along each row:	2.0m
Set out tips:	Plant the totara in a 4.0m grid pattern and then interplant the nurse species to complete a 2.0m x 2.0m fully planted grid pattern.

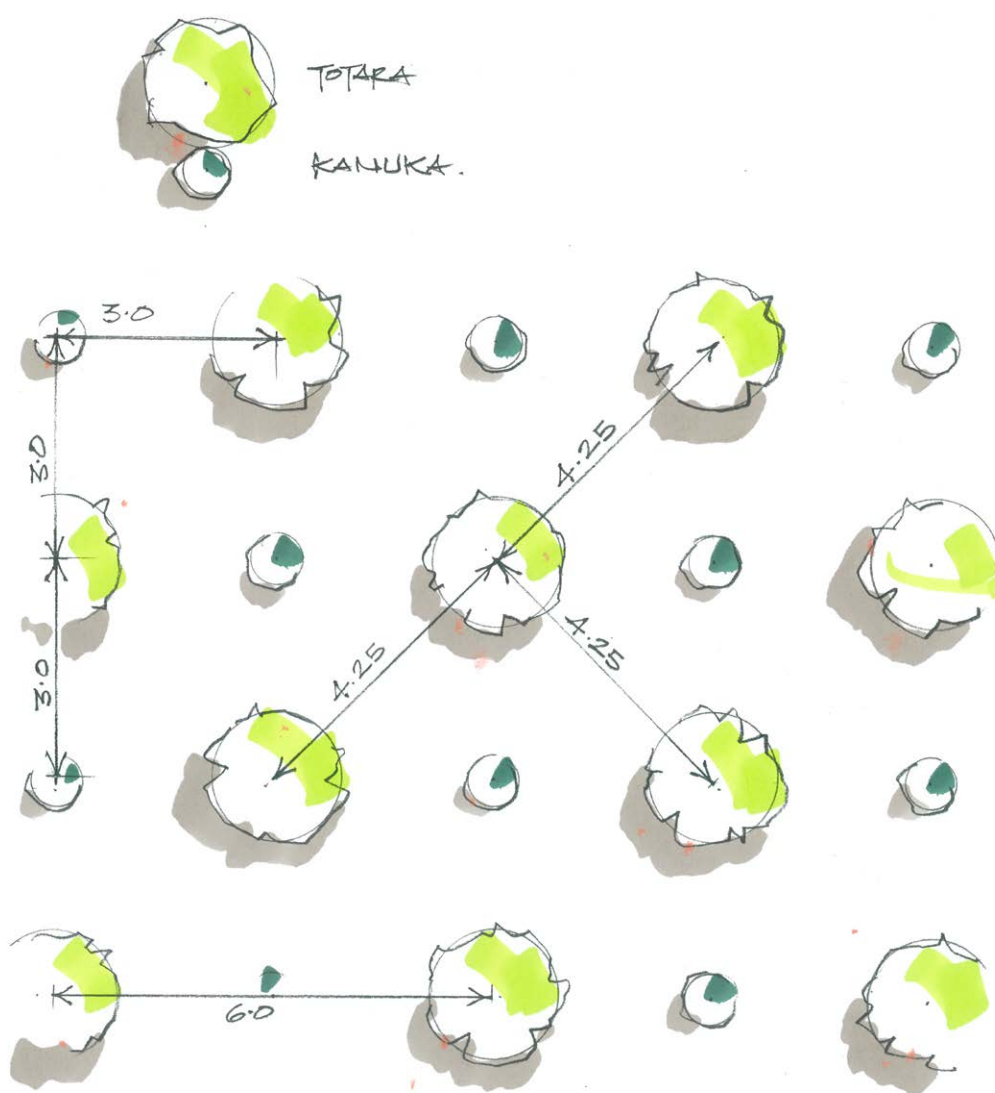
This regime suits mixed-species native forest plantings and tougher sites where establishing a thick protective nurse cover is important, and where expensive large-grade tōtara are used. However, with such a low stocking of tōtara, form-pruning will be needed, and there will be fewer choices for thinning operations. The resultant stand may not be fully stocked with well-formed timber trees.



Low-density at 1110 stems/ha

Total stocking:	1110 stems/ha (50% tōtara/50% Kanuka)
Number of tōtara:	555/ha
Number of Kanuka:	555/ha
Distance between rows:	3.0m
Distance between trees along each row:	Distance between plants along each row: 3.0m (alternating species: kanuka, tōtara, kanuka...)
Set out tips:	Plant the Kanuka in a 4.25m grid pattern and then interplant the tōtara in an offset grid pattern also at 4.25m centres.

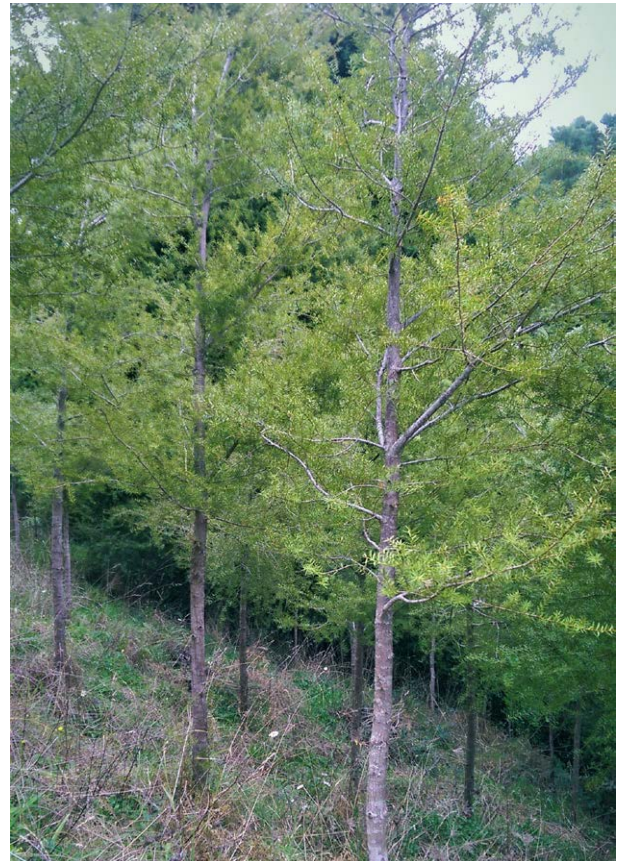
This regime is untested. It is inspired by observations of a common natural forest succession – i.e., tōtara under a tall nurse canopy of kanuka. It might suit those seeking to minimise establishment and management costs, and where slow growth of tōtara is acceptable. Potentially well-formed tōtara trees could form amongst the kanuka, but at such a low planting density, the stand is unlikely to be fully stocked with quality timber trees when poorly-formed trees are thinned out. However, some minimum-input European forestry systems consider producing as few as 20-40 tall, large-diameter, premium-quality trees per hectare, to be a success. And the trees may be 180–240 years old.



High density plantings at 4,444+ stems/ha

Dense natural stands of tōtara can produce many trees with excellent form for timber production. However, these have typically developed as thickets with extremely high stocking rates. Planting at a minimum of 4,444 stems/ha (i.e., a maximum of 1.5m spacings) would be needed to try to replicate that effect – and 1.0m spacings, or less (i.e., 10,000+ stems/ha), would be better. Of course, planting at such densities is extremely expensive and likely to be cost prohibitive for most situations.

In some parts of Northland, tōtara can be planted at high density without an accompanying nurse species. However, presently the high cost of tōtara seedlings that are large enough to plant out, precludes this from being a viable establishment option at any significant scale. While pruning costs could be minimised, or maybe even avoided, several thinning operations would still be required for effective timber production.



Medium-high density tōtara plantation at 1.5 -1.8m spacings without an accompanying 'nurse'. Even at this stocking rate form-pruning will be needed in order to have enough well-formed and vigorous trees to be optimally stocked after thinning.



Tōtara planted in Northland at around 4,000 stems/ha without an accompanying nurse species. All trees are looking healthy, but some form-pruning will still be required to maximise crop-tree stocking options.

Interplanting tōtara within an existing nurse

Interplanting tōtara within an existing cover of scrub, such as kanuka, may be an option on some sites.

However, site conditions may not be conducive to underplanting tōtara at medium or high stocking rates or in a regular grid layout pattern. Opportunities may be patchy rather than uniform. In such instances, planting along lines cut through the scrub, within gaps in the canopy, or creating some light-wells in taller vegetation may be necessary to get good growth rates. This is a lot of work. And maintenance of over-head canopy gaps may be needed to ensure survival and/or reasonable growth performance. Tōtara will not grow well in heavy shade.

If planting within larger canopy gaps, consider planting tōtara in groups at high density and expect to thin them later to select the best trees.



Planting into existing native vegetation

Note – If planting within a native scrub cover, the area will be classed as *indigenous* forest, and any harvesting will be subject to the provisions of the Forests Act (i.e., Part 3a) – if it is still relevant come harvest time!

That would effectively prohibit clear-fell harvesting but allow for low-impact selective harvests and close to nature forest management. Considering the long timeframes involved, the future legal situation is a gamble. Other regulation such as Significant Natural Areas (SNAs) may also apply. Checking with the regional and district plan maps is recommended. And well-documenting any supplementary planting within existing native cover is advised.



5. Planting specifications

The following sets out a basic specification. This may be used as part of a contract agreement with nurseries and contract planters, or as a guide for landowners doing the planting themselves.

Pre-plant site preparation

For sites that are being retired from grazing and are dominated by pasture, there are two options:

- Either
 - a) **Herbicide spray option** - A herbicide spray application (blanket sprayed over problem weeds, or as spot-sprayed 1metre squares in clean pasture areas – N.B., use spray marker dye to ensure coverage and assist with consistent spacing). N.B. - If herbicide is used, ensure it is applied sufficiently well in advance of planting, so that the target vegetation is brown and dying, to avoid problems with any residues in the soil affecting planted seedlings. Or
 - b) **Non-spray option** - Graze as hard as possible with livestock immediately before the planting date if that is an option. Otherwise, mulch the site, or chip weeds with a spade to clear around each plant spot.

Planting season

- Plant in the winter season only, no earlier than mid-May and no later than 20th August, unless unique site conditions dictate otherwise. Delay planting during dry periods until it has rained and the ground is moist.

Planting stock

- All plants are to be top-quality nursery stock, true to type and form (e.g., not cultivars), free of pests and diseases, and hardened-off well to cope with exposed open site conditions. The root-ball must be developed enough to hold the potting mix together when removed from the containers. **Inferior, root-bound, or otherwise ill-thrifty stock should be rejected and not planted.** Plants shall meet or exceed the specified grades. N.B. - It is best to check quality, seedling size and grade of stock at the nursery before delivery, and modify orders to reject any lines that do not meet planting specifications.

Grade and size of plants

- Best practice recommendations are that tōtara plant stock should be at least 2 years-old, a minimum of 50cm high above the potted soil level and have a minimum stem diameter of 4mm at 3-5cm above the root collar (N.B.- most plants will need to be in a PB 2 sized planter bag, or equivalent, to achieve these specifications, although sometimes attained in large volume trays).

N.B. – using smaller grade and younger planting stock is subject to higher risk of failures and a longer maintenance period.

- Manuka and kanuka plant stock may be less than two years old and in 5-7cm pots or trays with individual cell dimensions not less than 50mm x 50mm x 100mm deep. (N.B.- stock in Hillson root-trainers are not recommended). Manuka plants must have been trimmed in the nursery, so they are not tall and leggy, but instead have stiff upright stems, and plenty of green bushy foliage. Plant heights above potted soil level should be between 30-55cm. Tall leggy seedlings with foliage restricted to only the top third of the plant height are to be rejected.
- Size and grades of nurse plant species other than manuka and kanuka, will vary according to species. But generally, most shrub hardwoods will need to be in PB 1.5, 2, or 3 grades (i.e., 1.0 - 1.8 litre bags or equivalent).

Transport, delivery, and storage of plants

- Ideally plant material will be planted on the day of delivery. If this is not possible, the Contractor/Owner must protect the unplanted plants from sun or drying winds. Plants that cannot be planted on delivery need to be kept in a sheltered and shady location, and well-watered.

Set out of plants

- Plants are to be accurately laid out and planted according to the spacings and patterns in the selected planting prescription/ regime to meet the specified number of plants per hectare. However, where obstacles, such as rocks, watercourses, roots, or stumps, make that impractical, then a suitable location close nearby should be used instead.

Planting method

- Professional planting tools and methods shall be used. See video: How to plant native seedlings at scale: <https://www.tanestrees.org.nz/resources/videos/>
- Plant holes are to be well cultivated and at least 100mm larger in all directions than required to accommodate the root-ball of the plants, and the surrounding soil structure well fractured by levering actions of the planting spade to a minimum depth of 350mm.
- Plants seedlings so the base of the stem (top of the root ball) is at 3-5cm below level of surrounding ground to reduce loss of moisture from exposed potting mix and to ensure plants have sufficient anchorage to reduce socketing in high winds after planting. The backfilled soil shall be firmed by foot so that the plant is stable and wind firm, and large air pockets are removed, but avoiding excessive compaction.
- Plant protectors, weed mats, spray-guards, and fertilisers are considered unnecessary on most sites except dryland areas and where rabbits are a problem.

Healthy 1-year-old tōtara seedlings produced by the Te Kotahitanga e Mahi Kaha Trust in Kaikohe.



Locator stakes

- All tōtara should have a bamboo marker stake (1.5m long 14mm diameter). The purpose is not to stake the tree, but to help with visually finding the seedling for subsequent releasing and maintenance if overtopped or hidden by weeds. Consistent location of the stake, placed within 100mm on the uphill side of the seedlings, is recommended.

Monitoring

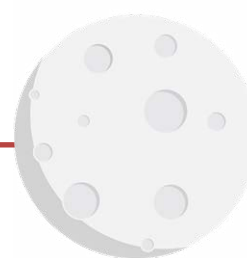
- Monitor the plantings within the first week of planting. Then schedule regular 3-4 monthly monitoring visits - at least in early spring, mid-summer, and early autumn for the first 3 years. Then at least each spring thereafter.

Maintenance

- Release seedlings by spraying/ chipping/ hand weeding, or trampling around them as necessary. Expect 2-3 release sprays, or 3-4 hand-releases each year for 3 years, or up to 5 years or more on particularly weedy sites. In addition to releasing, spray out any woody weeds annually for 4-5 years and then as required until canopy closure.

Blanking

- Replace all failures in the following planting season.



Maramataka

Based on the *maramataka* of Ngāti Miro in the Whangaroa area, rongoā practitioner Thomas Hawtin, suggests the best time to plant tōtara trees is Hoata (2 days after the new moon), and for the following three days to *Tamatea a Ngana*. However, planting could still be carried out for up to seven days if need be, up to *Tamawharu*, which is two nights before the full moon (*ōturu*).

6. Releasing – weed control

Herbicides

Anecdotal evidence suggests tōtara has some resistance to a range of herbicides commonly used in agriculture and forestry. These include Metsulfuron-methyl, Terbutylazine, and Triclopyr for gorse and brush weeds, and Haloxyfop for grasses. In Northland, tōtara surviving the aerial spraying of gorse has frequently been observed. And small preliminary trial results suggest that the apparent herbicide tolerance of the species certainly warrants further exploration. Understanding and utilising this herbicide resistance could make establishing tōtara less costly and more successful in the future.



In Northland, naturally regenerated tōtara is often seen surviving aerial applications of herbicide over gorse and scrub.



Tōtara seedlings needed releasing from gorse one year following planting. A small sample of tōtara were spot-sprayed with Metsulfuron-methyl at label-rates for gorse (and with penetrant) using a knapsack sprayer. The gorse died, and most of the tōtara showed some visible signs of ill-health, but nine months following the treatment, all tōtara were still alive.



Six months after an aerial spray application of Metsulfuron-methyl, the gorse and kanuka and black tree ferns (tall trunks) have died, but the naturally regenerated tōtara appears to be surviving, although with some 'burnt tips'.



A spray trial of Metsulfuron-methyl over 1 year old potted tōtara seedlings, tested a full label-rate, a half label-rate, and an unsprayed control group for comparison. Ill-health was observed amongst the seedlings subjected to the full label-rate spray dose and their height growth was also affected. However, 14 months following the treatment, the survival rate was still 100%.

Presently, there are insufficient trial results to be recommending the spraying of release herbicides directly over tōtara seedlings (other than perhaps Haloxypol for the control of grasses). Nevertheless, the indications to date should give confidence that with careful knapsack application of the chemicals mentioned above, that tries to avoid directly spraying the tōtara seedlings, there may be relatively little risk of killing them by minor accidental contact such as from wind-drift etc.

Furthermore, herbicide releasing of tōtara in areas afflicted with problem weed species such as Kahili Ginger (*Hedychium gardnerianum*), that can only be controlled with Metsulfuron-methyl, may be possible.

However, at this stage, only very careful use of the above-mentioned herbicides is advised. Mixes at lower than recommended label-rates may still provide an effective release from weed competition while reducing the chances of tōtara suffering adverse health effects. It is not known if observed damage - the browning-off of the growing tips - will

increase the likelihood of tōtara developing heavy branching and multiple-leaders. And the effect on seedling health from repetitive applications has not been tested.

“Keep a look out for results from further trials exploring herbicide release options for tōtara seedlings.”

WARNING / DISCLAIMER

Technical advice should be sought on selection, rates, and use of herbicides. It is recommended that users of herbicides follow manufacturer's instructions at all times.

Neither the authors nor Tāne's Tree Trust will be liable for any loss, claim, liability or expense arising from or due to any errors, omissions or advice provided or inferred within this publication, or from the use of herbicides or consequences arising from the use of herbicides.

Grazing as a releasing method

As discussed in Section 2, in many situations tōtara demonstrates high resistance to livestock browsing. This remarkable attribute opens the possibility of utilising controlled-grazing as a method of releasing tōtara from competing pasture grasses and other palatable vegetation. However, anecdotal experiences reveal mixed success.

David Bergin relates how sheep on a lifestyle block in Rotorua quickly ate and killed freshly planted nursery raised tōtara seedlings. And even in Northland, where tōtara often regenerate freely in paddocks grazed by sheep, beef, dairy cows, horses, even where feral goats are present, damage from browsing, rubbing, and trampling is usually observed on some of the tōtara seedlings and saplings.

In contrast, there are also instances where livestock have either had deliberate or unintentional access to young tōtara plantations without a net deleterious effect. In some cases, the loss and/or damage to a small proportion of the seedlings caused by the livestock, has arguably been balanced by the benefit of releasing the other seedlings. For example, a one-off release-grazing in a 5ha plantation of 3-year-old planted totara seedlings was tested on a Northland farm. The seedlings were in danger of being smothered by rank kikuyu grass. 600 ewes spent 4 days on one half of the block, and 85 angus cows on the other. The sheep made little impact on the kikuyu grass and so were followed by the cattle for another 3 days. Around 40% of the seedlings around the livestock camps showed signs of browse. However, no damage was observed on tōtara seedlings further away from the obvious stock camping areas.



Grazing as a desperate method of releasing to salvage a 5-ha plantation of 3-year-old planted tōtara seedlings from the smothering effects of kikuyu grass on a Northland farm was tested. Only the seedlings around the livestock camp areas were browsed (top), but those further away from the camps were not (above). Photos 3-weeks after stock removed.

So, what are the critical factors involved with release grazing? Unfortunately, there is no research guidance, but the following observations have been made:

- Fresh nursery-raised seedlings are likely to be palatable to livestock and may be completely killed by grazing.
- Hardened-off seedlings (e.g., 1 year or more after planting out) have a better chance of surviving grazing, although the fresh growing tips are still likely to be browsed.
- Livestock that are familiar with naturally regenerating tōtara, are less likely to browse tōtara.
- Younger livestock and pets are a greater risk to tōtara seedlings (possibly out of curiosity).
- Seedlings protected from trampling (e.g., next to fences, rocks, and other vegetation) are more likely to survive.
- Damage to seedlings is concentrated around livestock camp areas.
- As seedlings become saplings (i.e., taller than 1.4m) the risk of damage from browsing and trampling reduces.
- Sheep, cattle, horses, and goats do not appear to ring-bark established tōtara trees. Although some trees are targeted for rubbing against.
- Palatable plants amongst the tōtara will be at risk with any grazing.
- Manuka and kanuka as a nurse species are generally more stock resistant than tōtara.

Suggestions

If trialing the use of livestock as a release method the following suggestions are offered:

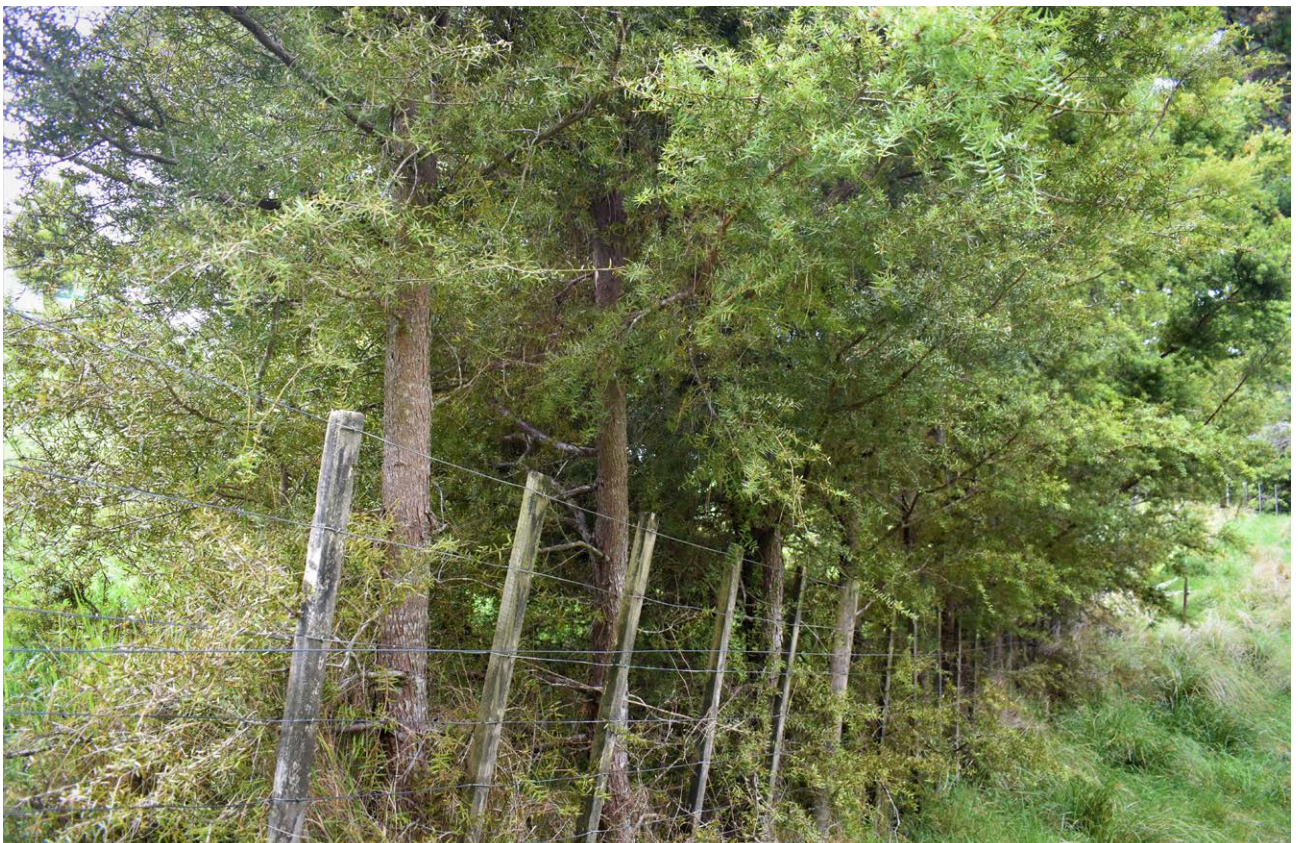
1. Use manuka or kanuka as an accompanying nurse species.
2. Avoid grazing in the early years of seedling establishment.
3. Use older livestock and preferably stock that are already familiar with tōtara.
4. Carefully monitor the behaviour of the livestock and remove them as soon as they have eaten their fill and camp - before they get bored and curious.
5. Trial frequent, short-duration grazing intervals to start with.



This 2-year-old tōtara seedling was planted into pasture behind a single hot-wire, but still well within reach of livestock (horses, cows and calves). One year after planting, it has survived unscathed and without any releasing.



A successful tall screen hedge of tōtara (approx. 12 years old) resulted from 25-35cm seedlings being densely planted directly into a paddock grazed by horses, cows, and calves without any protection. Proximity to an existing fence prevented trampling, but otherwise, no fencing, no livestock exclusion and no spray-releasing or any other post-planting maintenance occurred. This suggests scope to explore unconventional options for establishing native forest on farms in Northland.



Seedlings were planted close to the fence to prevent trampling, but otherwise not protected from grazing. However, the livestock were familiar with naturally regenerating tōtara in their paddocks.

7. Cost of establishment

Planting will usually be the quickest way to establish a tōtara forest, and in areas without natural regeneration, it is the only way. However, the high cost of establishing native forests is a significant disincentive and limiting factor. Good information on the costs of various options is essential in the decision-making and planning process. Indicative cost estimates for the four planting prescriptions/options outlined in section 4 are set out below. However, these figures should only be used as a guide for average site conditions and costs in 2022. Actual prices, costs and site requirements may vary significantly.

Table: 2 includes the following assumptions/unit costs:

- \$ 450/ha pre-plant site preparation (herbicide spray).
- The lower figures given in the cost estimate range relate to using 1 year old seedling stock at the price of \$1.85 + GST from the nursery. The higher figures of each range relate to 2-year-old tōtara seedlings in PB 2 or equivalent grades at the price of \$6.00 + GST each, at the nursery.
(N.B. - best practice recommendations are still to use top-quality PB 2 plant stock).
- Plant costs of manuka is \$1.50 and \$2.00 for kanuka.
- Set out and planting costs of \$2 per plant for PB2 grades, and \$1.50 for smaller tōtara grades, and manuka and kanuka.
- A bamboo marker stake is used beside each tōtara at a cost of 30 cents including stake.
- Tōtara are released three times per annum, and manuka and kanuka twice, for the first two years and then tōtara are released twice in the third year, but manuka only once. Release spot-sprays are costed at \$0.25 each unit.

Exclusions: No costs for the following items are included in the above figures: fencing, plant delivery from the nursery, blanking (replacement of failures), fertiliser or plant protectors, mulch mats or other products, or ongoing woody weed control in addition to spray release around the seedlings, nor ongoing maintenance beyond year three.

Table: 2 – Indicative estimates of comparative costs (per hectare) to plant and establish tōtara using 4 different planting regimes, in 2022.

Prescription /option (Stems/ha)	Number of tōtara (stems/ha)	Number of nurse & species (stems/ha)	Total cost including 3 years releasing*
Medium (2500)	1250	1250 (manuka)	\$12,500 – 19,000
Medium-low (2500)	625	1875 (manuka)	\$11,500 – 14,900
Low density (1110)	555	555 (kanuka)	\$6,250 – 8,800
High density (4444+)	4444+	0	\$25,600 – 45,700+

*Lower figures of each range relate to 1-year-old tōtara seedling stock at the price of \$1.85 + GST from the nursery. The higher figures relate to 2-year-old tōtara seedlings in PB 2 grades, or equivalent, at the price of \$6.00 + GST each, at the nursery.

Small vs large grades of tōtara

Research to date confirms that survival rates are usually higher if larger grade tōtara plants are used. However, the rising costs of PB 2 plants and the higher cost of planting, make the option of cheaper but smaller and younger seedlings attractive to some landowners. There are anecdotes of successful plantings that have used smaller grade tōtara (e.g., in T-28 and even TS-48 tray sizes), and more recently, nurseries that have managed to grow tōtara seedlings to a height of 30-50cm in a single year. Pressure to perfect the production and planting of smaller, younger, and cheaper seedlings is expected to continue.

Using smaller grade tōtara seedlings may be a lower-cost establishment option on some sites. However, it is associated with higher risk of failure and mortality due to factors such as unseasonal droughts, poor releasing and weed control, damage by animals, and severe frost or wind exposure. Moreover, smaller plant stocks will require a longer period of post-planting releasing and care. Therefore, small seedlings are not recommended for difficult or harsh sites and conditions. If in doubt, try a small-scale trial first.

8. Conclusions

Tōtara is an iconic native timber species well suited to silviculture and sustainable management for multiple values, including timber production. Tōtara has remarkable natural attributes. These include easy seed collection and germination, tolerance of a wide range of sites and drought conditions, high survival rates, quick growth and the ability to naturally regenerate, even apparent resistance to some herbicides and livestock grazing. It is no wonder that it is starting to be viewed as something of a wonder-species with a significant role to play in our indigenous forestry aspirations.

Tōtara is also one of the most popular choices for planted native timber trees in new forests.

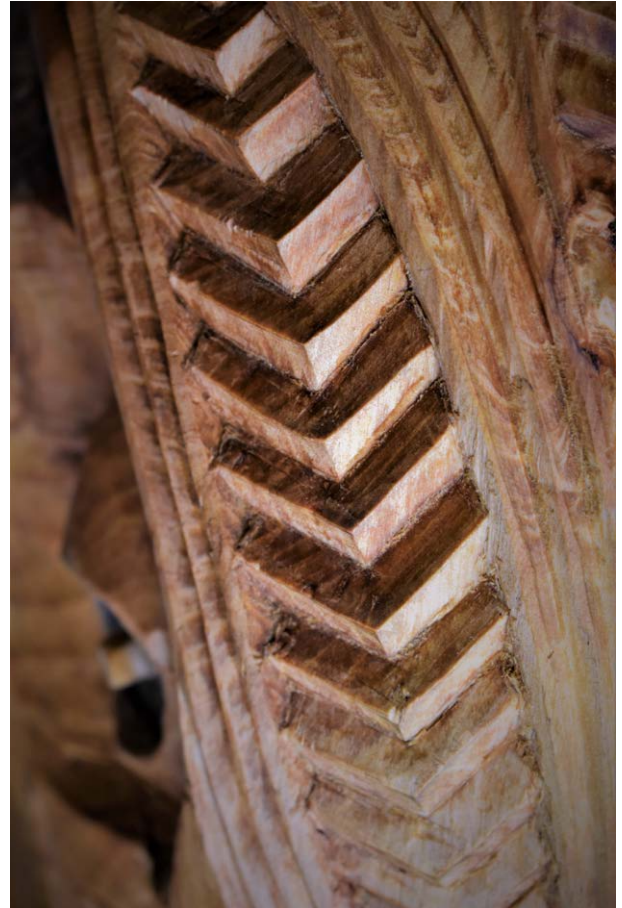
Planted tōtara forests will complement a significant resource of naturally regenerating tōtara forests developing on private land in several regions of the country. The cumulative scale and potential supply continuity of the combined natural and planted tōtara resource should encourage the development of a sustainable industry and a strong market for totara timber. The more planted the better – as far as timber value is concerned.

But planting a native forest is never just about timber, or any single value. It is always aspirational and regenerative. Tōtara has an important role to play in creating new native forests that provide the space for other life and values to grow and thrive.

And enjoyment can be part of that too. Enjoy creating a vision, enjoy the planning, and enjoy watching it grow.

Separate chapters covering details on pruning, thinning, and harvesting can be found [HERE](#).

<https://www.tanestrees.org.nz/about-us/northland-totara-working-group-ntwg/ntwg-publications-resources/>



Whakairo rākau tōtara - a work in progress by Mark Howard, Kaeo.

References:

Bergin, D. 2003: **Totara: Establishment, growth, and management.** New Zealand Indigenous Tree Bulletin No. 1. New Zealand Forest Research Institute, Rotorua. 40p

Bergin, D., Gea, L. 2007: **Native Trees: Planting and early management for wood production.** New Zealand Indigenous Tree Bulletin No. 3. Revised edition. New Zealand Forest Research Institute. 44p.

Bergin, D. O.; Kimberley, M. O. 2014: **Factors influencing natural regeneration of tōtara (*Podocarpus totara* D.Don) on grazed hill country grassland in Northland, New Zealand.** New Zealand Journal Forestry Science 44 (13).
<http://www.nzjforestryscience.com/content/44/1/13>.

Nairn, J. (et al.) 2020. **A literature review of the current knowledge on phytotoxicity of herbicides to indigenous tree species of New Zealand.** Scion Research. p.19

Nairn, J. (et al.) 2020: **Towards tree establishment success: Screening herbicides for indigenous tree tolerance at rates required for effective weed control.** Publ. Scion Research. p.26

Satchell, D. 2021: **Land use options and economic returns for marginal hill country in Northland.** Northland Regional Council report.19p.

TTT Technical Handbook: Planting & Managing Native Trees. By Tāne's Tree Trust
<https://www.tanestrees.org.nz/resources/publications/>

For more information on managing tōtara, see the Northland Tōtara Working Group pages on the Tane's Tree Trust website:

<https://www.tanestrees.org.nz/about-us/northland-totara-working-group-ntwg/>

To join the Northland Tōtara Working Group (NTWG) visit (membership is free):

<https://www.tanestrees.org.nz/about-us/northland-totara-working-group-ntwg/join-ntwg/>