



## Nationwide Survey of Planted Native Trees

*A 65-year-old kauri plantation, Glenbervie Forest, Northland.*

### INTRODUCTION

Contrary to popular belief, large numbers of native tree and shrubs have been planted throughout New Zealand for well over a century. The Lands and Survey Department began planting native tree species prior to 1900 with hundreds of thousands of seedlings raised in nurseries and planted out. Planting of native trees was continued with various levels of intensity by the New Zealand Forest Service up to the early 1980s.

The last decade has seen a resurgence of interest in ecological restoration and the planting of native trees. This includes shrub species and a number of major timber tree species. A conservative estimate is that at least 10 million native plants, both trees and shrubs, are currently planted in New Zealand per year (Bergin and Gea 2007).

A survey covering some of the native tree plantations was undertaken by the Forest Research Institute (FRI) in the mid-1980s (Pardy et al. 1992). Nearly 30 years on, Tāne's Tree Trust (TTT) has completed a new nationwide survey of significant plantings including re-measurement of some of those covered by the earlier FRI survey. The project was jointly funded by the Ministry of Agriculture and Forestry's Sustainable Farming Fund and TTT with complementary funding from Scion as part of the Future Forests Research (FFR) Diversified Species Programme.



# TĀNE'S TREE TRUST SURVEY

## Purpose of survey

The survey involved both the re-measurement of plots from key plantations included in the earlier survey, and the location and measurement of additional suitable plantations of native trees. The survey also included a selection of revegetation sites planted with native shrub species. The aim was to obtain growth data and stand management information for developing and refining growth and carbon models for native trees and shrubs.

## Location and assessment of stands

To locate suitable plantations, a questionnaire was circulated to forestry and farming networks nationwide, requesting information on the location and history of significant plantings of natives and requesting access for measurement. Based on this questionnaire, promising stands were then inspected and measured if found suitable. The more important stands from the earlier survey were also visited and re-measured.

In larger stands of planted trees, Permanent Sample Plots (PSPs) were established within representative areas of known age and management history. PSPs were established following the methods of Ellis and Hayes (1997) using circular or square plots of up to 400 m<sup>2</sup> in area. From 1-6 plots were established at each site depending on the range of species and ages and extent of the stand. In smaller stands of trees and where areas were planted with shrubs or small trees, non-bounded inventory growth plots were used.

Age of stands since planting was determined from stand records and landowners. Stand stocking was calculated based on the number of trees within bounded plots or estimated in inventory plots using a sample of intra-tree distances.

DBH (diameter at breast height - measured 1.4 m above ground level) was measured for tree species and heights measured for a sample of trees using a Vertex Hypsometer. Due to multiple leaders and heavy branching from near ground level, root collar diameter (RCD - diameter measured 10 cm above ground level) measurements were usually taken for shrub and small tree species. However, DBH was measured in some older stands of small tree species.

For the PSPs, diameters of all stems within plots were measured. For inventory plots used in most mixed species plantings of shrubs and small trees, diameters were



*Rimu planted 48 years ago, Holts Forest Trust, Hawkes Bay.*

measured for a representative sample of up to 30 plants of each of the major species. Height was measured for all trees and shrubs in young stands sampled for diameters, and for a representative sample of individuals in older and taller stands.

## Site factors and stand management

Characteristics of each site including location, elevation, topography, soil type and climate, status of understorey vegetation, and presence of browsing animals known to significantly influence performance of the stand were recorded. The history of site and stand management was collated from owners and managers, including original objectives for planting, site preparation, weed and pest animal control, and any silviculture undertaken.

### Tāne's Tree Trust Indigenous Plantation Database

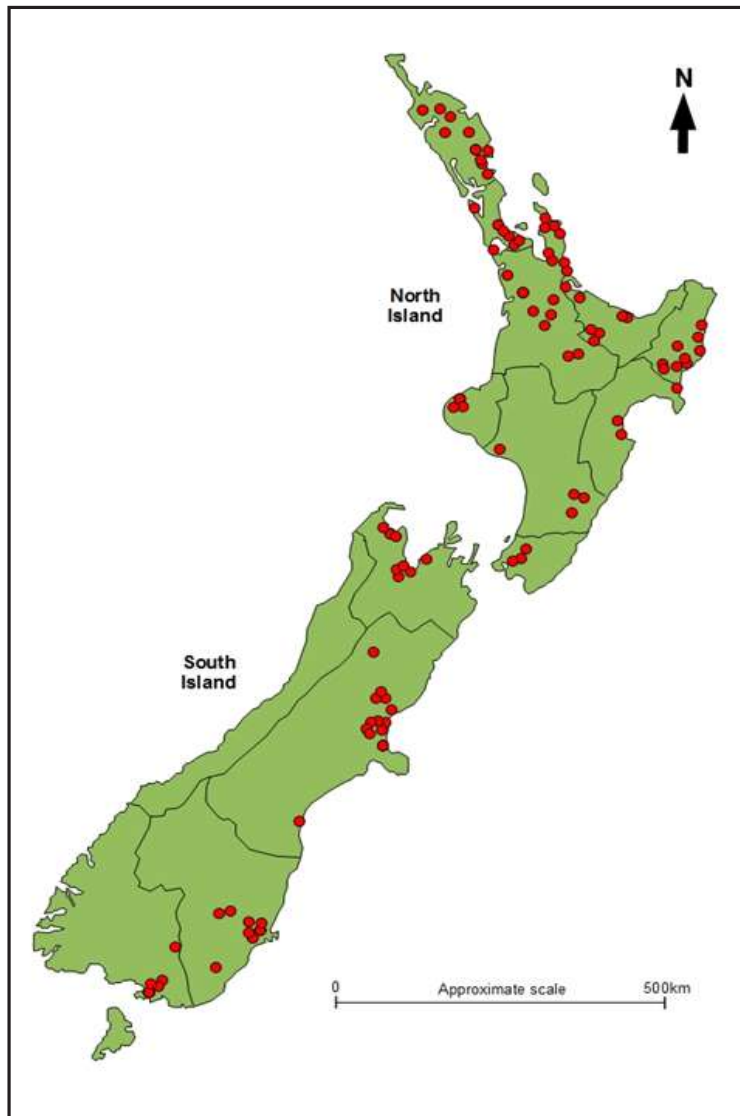
Data from the new survey was combined with data from both the earlier plantation survey to form a comprehensive native tree and shrub database known as the Tāne's Tree Trust Indigenous Plantation Database (refer side panel on page 7 for details).

## SURVEY FINDINGS

### Location of stands

Over 120 planted stands of native trees and shrubs were inspected nationwide and assessed for growth (Figure 1). Although predominantly in the North Island, stands were located in nearly all regions of New Zealand. They ranged from lowland coastal sites to inland sites over 500 m above sea level. While most tree plantations were single species, virtually all shrub and small tree plantings comprised a mixture of species.

Almost 10,000 planted trees and shrubs were measured during the survey with an age range of 3-110 years. Most stands assessed were less than 50 years of age. Stand density averaged 1900 stems/ha for trees and 3500 stems/ha for shrubs and small trees reflecting the high proportion of relatively young plantations in the survey.



**Figure 1:** Location of planted stands of native trees and shrubs assessed nationwide by Tāne's Tree Trust.

**Tāne's Tree Trust**  
**Tāne's Tree Trust Native Tree Plantation Survey**  
 Questionnaire for landowners with stands of planted native trees

1. What is the age of your planted native trees (approximate year of planting or stand age)?

2. Have the native trees been planted in stands or groves as:

- ☐ a. single species, or
- ☐ b. robust trees within a existing scrub cover, or
- ☐ c. planted trees within a existing scrub cover, or
- ☐ d. other (please specify)

3. Indicate approximate number of trees planted or area planted by species or as mixed species

SPECIES	No. trees planted	Know	Ratio	Totals	Other	Other	Mixed spp.
<10 trees							
10-50 trees							
51-100 trees							
101-500 trees							
>500 trees							
Or approx. area planted							

4. Location of the planted native stands and access (provide region or general location if you prefer to keep exact location confidential)

5. Have you any data on establishment, management and growth that you would be willing to let Tāne's Tree Trust have access to? ☐ Yes ☐ No

6. Do you know of any other significant plantings of native trees in your area that could be included in this survey? If so, provide any details on the stands, location and owner. ☐ Yes ☐ No

7. Can Tāne's Tree Trust contact you to assess the performance of your stands?

8. Name and contact details

Name: \_\_\_\_\_ Email: \_\_\_\_\_

Address: \_\_\_\_\_

Phone: \_\_\_\_\_

9. Please add further comments or other information

10. Please return this questionnaire by post or email to:

Dr David Bergin  
 Tāne's Tree Trust  
 Private Bag 2020,  
 Mairangi  
 david.bergin@tane.org.nz

For more information on Tāne's Tree Trust, please check out our website [www.tanestree.org.nz](http://www.tanestree.org.nz)



A Vertex Hypsometer is used to accurately establish Permanent Sample Plots and to measure tree heights.



## Reasons for planting

As found in the earlier survey (Pardy et al. 1992), objectives for planting natives were often for amenity and aesthetic reasons. There has also been increased interest in establishing and managing native timber trees as a long-term resource for wood production, especially for conifers and beeches. Very few plantations had been pruned or thinned, with the most common treatment a low pruning for improved access.

Shrub hardwood species were planted primarily along riparian areas and on steep hill country recently retired from grazing aimed at improving land use and water quality in pastoral landscapes. While many owners recognised the need to provide a nurse of hardy shrub hardwoods for later planting of native trees, there were few instances of this next step having been undertaken.

## Species planted

Over 60 different native tree and shrub species were encountered during the survey. Species were classified into one of four species groups – conifer trees; beeches; other hardwood trees; and shrubs and small trees. Of the more than 10,000 trees and shrubs assessed during the survey, 6600 were conifers, 800 beeches, 900 other hardwood trees, and 2200 shrubs and small trees.

*Trees* – The 16 most commonly encountered native tree species are summarised in Table 1. The major conifers planted are totara, rimu, kauri and kahikatea, and of the beeches, red beech and black beech were most common. Of the remaining hardwood trees, there are relatively high numbers of puriri followed by karaka on a limited number of sites (Table 1). Mean stand ages across all plots for the trees species ranged from under 30 years to over 50 years, with a maximum age of over 100 years for some species.

**Table 1:** Summary of the more common native tree species in Tāne's Tree Trust Indigenous Plantation Database. Listed are the number of plots established and the number of trees measured for height and DBH. Mean age and age range is given for each species. Stands aged less than 5 years are excluded from this summary.

Species group	Species name	Botanical name	No. plots	No. trees measured for each parameter		Age (years)		
				Height	DBH	Mean	Min	Max
Conifers	Kauri	<i>Agathis australis</i>	112	2200	1594	24	1	84
	Rimu	<i>Dacrydium cupressinum</i>	46	440	530	38	5	84
	Kahikatea	<i>Dacrycarpus dacrydioides</i>	44	463	664	29	6	84
	Kawaka	<i>Libocedrus plumosa</i>	12	34	51	24	9	50
	Tanekaha	<i>Phyllocladus trichomanoides</i>	18	76	61	32	1	69
	Totara	<i>Podocarpus totara</i>	111	1248	2031	43	0	106
	Miro	<i>Prumnopitys ferruginea</i>	11	25	33	29	1	55
	Matai	<i>Prumnopitys taxifolia</i>	15	38	16	29	1	55
Beeches	Red beech	<i>Nothofagus fusca</i>	33	263	499	38	11	110
	Silver beech	<i>Nothofagus menziesii</i>	13	62	22	29	10	82
	Black beech	<i>Nothofagus solandri</i>	24	138	266	42	11	110
Other hardwoods	Taraire	<i>Beilschmiedia tarairi</i>	6	35	29	45	1	84
	Karaka	<i>Corynocarpus laevigatus</i>	14	82	89	45	11	84
	Kohekohe	<i>Dysoxylum spectabile</i>	8	45	6	50	1	84
	Rewarewa	<i>Knightia excelsa</i>	16	76	33	29	1	84
	Puriri	<i>Vitex lucens</i>	38	207	426	43	8	113



**Table 2:** Summary of the most common native shrub and small tree species in Tāne's Tree Trust Indigenous Plantation Database. Listed are the number of plots established and the number of trees per species for each of the assessment parameters height, RCD and DBH. Mean age and age range is given for each species. Stands aged less than 5 years are excluded from this summary.

Species name	Botanical name	No. plots	No. trees measured for each parameter			Age (years)		
			Height	RCD	DBH	Mean	Min	Max
Makomako	<i>Aristotelia serrata</i>	11	56	41	7	14	9	36
Karamu	<i>Coprosma robusta</i>	15	103	91	7	12	6	20
Ti kouka	<i>Cordyline australis</i>	26	217	49	194	17	6	50
Akeake	<i>Dodonea viscosa</i>	9	49	38	9	22	11	55
Broadleaf	<i>Griselinia littoralis</i>	14	84	73	2	17	9	36
Houhere	<i>Hoheria sexstylosa</i>	14	81	39	20	14	6	29
Kanuka	<i>Kunzea ericoides</i>	23	250	208	17	15	5	36
Manuka	<i>Leptospermum scoparium</i>	12	132	113	2	12	5	23
Mahoe	<i>Melicytus ramiflorus</i>	14	51	42	3	17	6	69
Mapou, red matipo	<i>Myrsine australis</i>	6	17	15	2	21	9	60
Akiraho	<i>Olearia paniculata</i>	6	38	40	0	14	14	14
Rautawhiri	<i>Pittosporum colensoi</i>	6	36	34	6	12	6	24
Tarata, lemonwood	<i>Pittosporum eugenoides</i>	27	213	161	18	18	6	59
Kohuhu	<i>Pittosporum tenuifolium</i>	28	313	237	7	16	6	59
Manatu	<i>Plagianthus regius</i>	5	46	34	5	12	9	24
Whauwhaupaku	<i>Pseudopanax arboreus</i>	11	107	43	43	20	6	46



Native shrub hardwood planting on steep hillside, Rotorua.



Mixed native hardwood shrubs planted in Victoria Park, Port Hills, Christchurch.

*Shrub and small trees* – Plant numbers and age of sixteen of the most commonly planted native shrub and small tree species established in revegetation programmes assessed in the survey are shown in Table 2. These include karamu, ti kouka, manuka, kanuka, houhere, kohuhu, tarata, manatu and whauwhaupaku. Mean age for stands of shrubs and small trees in the survey was less than 20 years.





## Growth performance of planted trees and shrubs

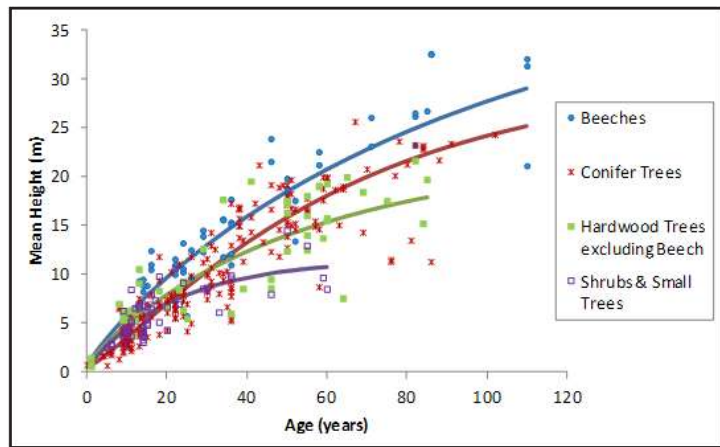
Height/age curves are presented in Figure 2 for the four species groups (beeches, conifer trees, hardwood trees other than beech, shrubs and small trees). Although there is considerable variation within each species group, it is clear that in general, beeches (predominantly red beech and black beech), show the fastest height growth followed by conifers.

While most of the major conifer species are known to have tree heights at maturity similar to or greater than beeches, Figure 2 indicates their growth rates are slower on average than

the major beech species. Furthermore, Figure 2 only include the four most commonly planted species (kauri, totara, rimu and kahikatea), and exclude the much slower growing matai and miro.

As a group, hardwood trees other than beech show similar or better height growth compared with conifers to age 50 years, after which they begin to fall behind. Many hardwood trees species have relatively low heights of around 20-25 m at maturity.

Shrub and small tree species have good height growth in early years, but slow considerably beyond age 30. Many of these shrub species are early successional species that in



**Figure 2:** Height/age modelled for the four species groups of planted native trees and shrubs assessed during the Tāne's Tree Trust plantation survey.

natural stands would eventually be out-competed by taller growing hardwood and conifer tree species. Variability between individual stands across all species is substantial due to the wide range of site and climatic factors that occur between stand locations, as well as differences in stand characteristics, particularly stocking.

More detailed species-specific models of height, diameter and volume growth, as well as carbon sequestration have been developed from the survey of planted native trees and shrubs and are provided in Section 10 of this handbook. These are conifers (Technical Article No. 10.2), native hardwood trees (No. 10.3), native shrubs (No. 10.4), and carbon sequestration by native trees and shrubs (No. 10.5).

*Most planted native tree stands assessed during the survey were less than 50 years old and planted native shrub species less than 20 years old.*



*Planted grove of kahikatea 30-years-old, Upper Hutt, Wellington*



*Planted beech stand, 16-years-old, Gore, Southland.*



*Native shrub species planted 6 years ago, Piopio, King Country.*

### **Tāne's Tree Trust Indigenous Forestry Plantation Database**

With only a handful of exceptions, the existence and locations of native tree plantings is poorly documented, and their growth performance is unknown. Information representing tens of millions of dollars worth of planting effort is therefore effectively lost or inaccessible to those interested in planting and managing native trees.

Tāne's Tree Trust has developed a nationwide register of significant plantings of native trees, both historical and recently established. This Indigenous Plantation Database will provide current and future generations with information about species choice and matching to appropriate sites, site preparation, establishment practice, monitoring, maintenance, stand management, and summaries of growth performance. An interactive web-based system will allow landowners to access this information at both a regional and nationwide level.

Growth data from the Tāne's Tree Trust native plantation survey has been included within the database and will be updated as further stands of native trees are planted and established plantations are found.

The project has been jointly funded by Forest Industries Development Agenda (FIDA) and Tāne's Tree Trust in collaboration with Scion and Future Forests Research's Diverse Species Programme. The Database complements the Permanent Sample Plot System at Scion.

The Indigenous Forestry Plantation Database is available via the Tāne's Tree Trust website [www.tanestrees.org.nz](http://www.tanestrees.org.nz).

## **CHALLENGES IN DEVELOPING GROWTH AND CARBON MODELS FOR PLANTED NATIVES**

---

While a substantial database on growth of native trees and shrubs has been gathered during this survey and in previous assessments of native plantations, most stands of native trees and shrubs are small and comprise trees established in groves sometimes at wide and variable spacing, or in shelterbelts on farms or as avenues of trees in urban parks. In addition, some stands of the major native timber trees are a mixture of two or more species or have been inter-planted within a nurse crop of planted or naturally regenerating shrubland. Native trees have occasionally been planted within or in close proximity to exotic trees. Furthermore, most shrub and small tree species assessed in the survey were mixtures of up to 10 species typical of the many native revegetation programmes underway nationwide such as those along riparian areas.

There are, therefore, only a handful of examples of the major native conifer and hardwood tree species established for more than a decade in single species stands established at a regular stem density that is standard practice for exotic forestry production. Even then, because many of these plantations are small, there can be significant edge effects where diameter growth of edge trees is significantly faster than that of within-stand trees.

Developing growth and carbon models based on a highly variable native plantation database therefore presents major challenges. Such models are reliant on accurate calculations of stand stocking of a representative sample of trees using bounded plots such as Permanent Sample Plots sited within stands to reduce any forest edge effects. Temporary non-bounded inventory plots used in the survey for estimating growth rate and stand density for many stands prove less reliable especially for calculations of volume and carbon.

Consequently, native trees that are established as small stands with a high proportion of edge trees, are established at wide spacing, or are planted as shelterbelts or as avenues in urban parks, were generally excluded from the growth data used to develop volume and carbon models. This has considerably reduced the sample size presented in subsequent articles in Section 10 of this Handbook. A degree of caution in interpretation of results is therefore prudent, especially for some of the less commonly planted native tree species.





There are major challenges in using growth and stand data from widely-spaced mixed-species stands of planted native trees in developing growth and carbon models. This 21-year-old stand of native trees planted at Opononi, Northland, is an example of the many stands measured during the survey for height and diameter where two or more tree species are planted at wide spacing such as the rimu and kauri (left), or are planted with or in the vicinity of exotic species such as these kauri planted under eucalypts (right).

## References:

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

Davis, M.; Douglas, G.; Ledger, N.; Palmer, D.; Bhubaneswar, D.; Paul, T.; Bergin, D.; Hock, B.; Barton, I. 2009: Establishing indigenous forest on erosion-prone grassland: land areas, establishment methods, costs and carbon credits. Scion Contract Report for the Ministry of Agriculture and Forestry No. MAF POL 0809-11192. (Unpubl.). 90p.

Ellis, J.; Hayes, J. 1997: *Field guide for sample plots in New Zealand forests*. New Zealand Forest Research Institute, Rotorua. FRI Bulletin No. 186. 84p.

Pardy, G. F.; Bergin, D. O.; Kimberley, M. O. 1992: *Survey of native tree plantations*. Forest Research Institute Bulletin No. 175. 24p.



The Ministry of Agriculture and Forestry does not necessarily endorse or support the content of the publication in any way.

Author: David Bergin and Mark Kimberley, Scion

Contact: Tāne's Tree Trust

Website: [www.tanestrees.org.nz](http://www.tanestrees.org.nz)



[www.tanestrees.org.nz](http://www.tanestrees.org.nz)

Tāne's Tree Trust promotes the successful planting and sustainable management of New Zealand native trees and shrubs for multiple uses.