

The health of puriri (*Vitex lucens*)

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Summary

An evaluation of 151 sites covering the core range of puriri shows that:

- The species is found throughout the northern half of the North Island but is locally rare, particularly in areas of intensive pastoral farming.
- The species shows most severe decline where it is represented by individual trees on intensively farmed river flats.
- Puriri is most healthy, and very common, in residual hill slope forest areas throughout its range, and also in pastoral farmland where it has been fenced to exclude stock.
- Decline is characterised by crown contraction involving the death of the outer canopy and re-establishment of lower crown or core crown foliage through epicormic growth.
- Crown contraction is associated with root damage, ground pugging, and lower stem bark damage, most commonly caused by cattle or horses.
- There is no evidence to suggest insects or disease are in any way responsible for decline, although the role of possums remains unclear.
- A number of unique and nationally significant stands in the historic Waimate North area are under serious threat and require urgent action.

1. Introduction

This report was commissioned by the Department of Conservation following expressions of concern at the health of puriri by their own staff and members of the public. It was not intended to be a comprehensive description and evaluation of the health of the species on all sites where it is found, but rather an expert opinion of its status and main health impacts based on an evaluation of representative sites. The key questions asked of the investigator were:

1. What are the physical characteristics of puriri dieback and their impact on the health of puriri trees?
2. What is the extent of puriri dieback throughout the range of the species?
3. Are there any ecological or pathological circumstances which suggest a cause?

4. Is the dieback significant from a conservation point of view, and are there any management implications?

This report outlines the survey and its findings and specifically responds to these questions in its conclusions. Summary data on which the report is based is presented for individual sites along with brief regional notes in appendices 2 and 3. The field data sheets held by Hosking Forestry Ltd are available to the Department upon request.

No attempt is made in this report to review the literature on puriri, although a useful *entrée* can be found in Astrid Dijkgras's MSc Thesis, 'Propagation and Timber Plantation Potential of Puriri', University of Auckland 1994.

2. Scope of survey and methodology

The survey involved assessments throughout the three main areas where puriri is common (South Waikato-Kawhia, Coromandel and Auckland-Northland) and also included some sites in the Bay of Plenty. A total of 151 sites were assessed throughout these areas (Figure 1) and data collected on location, site characteristics, tree and stand characteristics, and tree health (Appendix 1). In addition, numerous comments and impressions were noted on the survey sheets. The sites were not selected at random but rather to represent the range of health and ecological conditions evident for the species in any area. However, most major stands and significant trees were included. The survey was carried out between October and December 1998.

All sites were located using GPS-generated coordinates, and a large number were photographed, representatives of which are used in the report. Tree diameters and crown spread are approximate only, owing to the form of the tree stem and the inclusion of estimates where trees were not easily accessed because of topography or property rights.

As the survey progressed, certain data categories specified on the survey form were found to be more relevant than others, for example aspect for many sites on river flats was not appropriate, and site moisture was highly subjective. Fruit was added to the flowering category, as few trees showed significant flowering but many were heavy with fruit. No attempt has been made to statistically analyse the data collected, since the lack of randomness in site selection would generate spurious results. However, observations on tree size, crown spread, habitat, etc. are clearly based on the data collected.

3. Survey findings

3.1 DISTRIBUTION

Although puriri was found throughout the northern half of the North Island, its distribution was locally patchy. In many instances areas of plentiful trees and stands would be separated by 10 or 20 kilometres where hardly a tree could be found. Much of this discontinuity appeared related to historical and present land use. As a general rule the more intensive the land use the more rare puriri. While this might well be expected in areas of intensive horticulture, it also held true for pastoral farming. In particular, intensive pastoral farming of river flats, for example the eastern Coromandel from Coroglen to Whangamata, contains virtually no puriri, while the tree survives on similar sites less intensively farmed, for example eastern Coromandel from Waikauau Bay South to Te Rerenga.

Puriri is a key element in many residual areas of hill slope forest such as along the south-eastern edge of the Kaipara Harbour but only in mature stands. Even advanced regenerating forest generally lacks puriri. The most extensive stands of puriri were seen in the Waimate North - Ohaeawai - Puketona area south of the Waitangi River. These stands, often covering several hectares in a pastoral farming landscape, were almost pure very old puriri or puriri/tarairi mixtures, and will be discussed later in the report. The most common associate of puriri, particularly in Northland, was totara, often in mixed stands. Although commonly found on river flats, puriri was seldom in association with kahikatea, the main exception being seen at Waipu, south of Whangarei. The species is clearly most common in lowland coastal forests, although it was found throughout Northland and seen up to 400 m.

The present local distribution of the species no doubt reflects both the historical use of the timber for fence posts, railway sleepers and house blocks. However, land management, particularly burning of forests and intensive pastoral farming, has also been important.

3.2 SITE CHARACTERISTICS

Trees on river flats were most common as individuals or small open groves. They had the appearance of residual stands, were often along the edge of rivers and sometimes preserved around house sites. Such stands were invariably grazed, usually by cattle (Figure 2), and only rarely had enlightened property owners fenced to exclude stock (Figure 3). These sites, except where fenced, were devoid of regeneration of any species, almost exclusively contained old trees, and commonly showed damage to the lower stem and major roots through loss of bark (Figures 4 and 5). Typical sites can be seen on the river flats of north eastern Coromandel Peninsula, on Northland's west coast between Waipoua Forest and the Hokianga, and between Ohaeawai and Mangamuka.

Trees were also scattered across hill country under pastoral farming as individuals but also as an important component of residual forest areas in gullies. But once again such areas were rarely fenced, and grazing excluded regeneration and caused similar damage to trees as that seen on river flats. Typical areas include the northern part of the Coromandel Peninsula, north-eastern Northland and along the south-eastern edge of the Kaipara Harbour.

The primary refuge for puriri appears to be residual blocks of mature forest, often on quite steep hill slopes. These areas vary from a few hectares to several hundred hectares and, although often adjoining pasture, tend to be grazed only along a narrow interface. Puriri often forms a significant part of the canopy of these forests, usually as large individual trees. Typical examples are the Whiritoa Valley on the southern Coromandel Peninsula, north of Kaukapakapa on the Kaipara Harbour, on the hills east of the Ruawai - Dargaville flats, the Waima Range south of the Holianga and the southern slopes of the Maungataniwha Range.

Special mention must be made of the stands on the broad volcanic ridges of Waimate North-west of Kerikeri. These are undoubtedly the most notable stands seen in the course of the survey. The stands of very large puriri (figures 6,7 and 8) varied between one and perhaps five hectares, often pure, but also with totara and tarairi and in a pastoral farming landscape. With one or two notable exceptions, due to the foresight of individual land owners, stands are open to cattle and other stock, totally lack regeneration of any species, and suffer extensive root and lower stem damage. These stands are unquestionably of national significance from a botanical point of view, are also a major feature of this historically significant area adjoining the Mission House and other Historic Places trust buildings, and are key landscape features. The local community clearly recognises these values through the incorporation of the Waimate North Landcare Trust, but lacks the resources to take effective action. If the sole outcome of this report was to generate the enthusiasm within DOC and the public to effectively protect some of these stands it would have been a very good investment.

3.3 TREE HEALTH AND SITE

The health of trees, as measured by crown thinning and crown contraction, was poorest on individual trees on river flats (Figure 2), followed by individual trees on hill country. Tree condition was best for trees in larger forest remnants on hill slopes, or on land which excluded domestic stock (Figures 3 and 5). Although there were exceptions to these rules they overwhelmingly held true.

Trees forming a continuous canopy, either in extensive forest or quite small stands, were almost invariably in better condition than individual trees, except those protected from stock. Crown characteristics used as a measure of tree health are discussed in detail under crown contraction, but increasing twig death and contraction of the foliated crown, or overall crown thinning, were found to be good indicators of tree condition. Trees in intensively grazed pasture were generally in poorer condition than those in rough occasionally

grazed pasture, particularly on river flats. The evidence is clear cut of the link between tree health and land use. Furthermore, pastoral farming completely eliminates the possibility of regeneration of the species, with almost all trees in this environment being mature or overmature.

There is evidence that, although a tree of river flats and lowland forest, puriri is susceptible to root damage and does not like the wet sites suited to kahikatea. It is probably a combination of animal caused root damage, winter pugging of the root area, and bark damage to the lower stem, that is responsible for the decline observed on river flats. In many cases declining trees are likely to be a remnant of stands depleted by post and sleeper extraction and past tree death. It appears likely the species is destined to disappear from these sites. Similar although less severe impacts probably occur to scattered trees on hill country and also to stands and forest edges open to domestic stock.

3.4 CROWN CONTRACTION ECOLOGY

Crown contraction is very characteristic of mature and overmature puriri. Crown foliage on healthy trees is carried on the outer surface as one year's foliage at the extremity of robust twigs. The tree has the ability to generate strong epicormic growth from just about any branch or branchlet and the main stem (Figure 9). Periodically extensive dieback appears to occur in the outer canopy and the active crown either retrenches downward creating the typical two-tiered crown effect (Figure 10), or inward to the crown core. This dieback is a slow process and does not involve foliage death but rather the lack of replacement as old foliage is shed. This retrenchment strategy is not unique to puriri and can be seen in species as diverse as pohutukawa and cabbage trees. It has been suggested it is a strategy to increase the ratio of foliage to the wood it must support, which is particularly relevant to old trees at times of environmental stress. Puriri showing extensive upper and outer crown contraction usually support a vigorous and healthy retrenched crown (Figure 11). In the case of fallen trees or branches, regrowth takes on the characteristics of vigorous juvenile trees.

The survey suggests a natural strategy of crown contraction leading to a redistribution of resources is being triggered by the stresses imposed by the impact of pastoral farming, which in extreme cases leads to tree death. This latter stage is evident in the Waihou valley and around Waipu in Northland.

3.5 INSECT AND DISEASE IMPACTS

No evidence was found that insects or diseases were implicated in the decline of puriri. Recent statements by researchers that a phytoplasma might be responsible for puriri decline remain unsubstantiated.

A total of 50 records of insects or disease samples from puriri are contained in the Forest Health database at *Forest Research*, dating back over 20 years. While samples include a range of scales, mites and leaf spot fungi as well as puriri moth and wood-rotting fungi, none is considered of significance to the health of the tree and all, except one introduced scolytid, were native to New Zealand. While scale insects, mites and leaf spots were recorded during the survey, they most commonly affected old foliage and in no instance were considered significant to tree health.

3.6 VERTEBRATE IMPACTS

The role of possums in puriri decline is problematical and, although some very skilled forest health specialists maintain they harvest foliage, observations by the author do not suggest it is high on the list of preferred food. At a pohutukawa study area at Homunga Bay, puriri contiguous with the crowns of severely browsed pohutukawa showed no damage, and the Waima Range where extreme possum damage has occurred over the past 15 years supports extensive puriri in apparently good health.

It has been suggested that possums take the complete leaf group of epicormic flush, which would be consistent with the lack of visible leaf damage. Possums are also recorded as harvesting puriri flowers.

The role of the native pigeon, kereru, appears central to the dispersal of puriri, and the lack of regeneration away from seed sources may be related to lack of kereru. Kereru have also been observed consuming the newly flushed foliage of puriri, but such impact is unlikely to be significant to tree health.

3.7 REGENERATION

The survey found an almost complete absence of regeneration of puriri except in stands from which domestic stock had been excluded. Juvenile trees and saplings were also rare, although these are likely to be more common in larger intact forest areas such as the Whiritoa Valley on the Coromandel Peninsula. Saplings were common at two sites, advanced regenerating shrubland south of Coromandel township and in the hills above Kawhia Harbour. Dense regeneration was evident in two stands from which stock were excluded in Waimate North. The survey suggests domestic stock are the main impediment to regeneration of the species.

4. Conclusions

It is possible to draw a number of well supported conclusions concerning the current ecological status and health of puriri from the survey data. Key findings are:

1. The primary impact on the present distribution, health and regeneration of puriri is human impacts associated with past and present land use, in particular pastoral farming.
2. While puriri is found throughout the northern half of the North Island, it is locally rare in intensively farmed landscapes and regenerating shrublands.
3. A slow deterioration affects most individual puriri in pastoral landscapes and is characterised by crown contraction and associated stem and root damage.
4. Puriri decline is most severe on intensively farmed river flats and affects individual trees more than groves and small forest remnants.
5. Puriri is healthy in most areas of residual hill slope forest and on sites from which domestic stock has been excluded.
6. There is no evidence that insects or disease are in any way implicated in puriri decline.
7. While there is good evidence that possums have some impact on puriri, their exact role is unclear, but it does not appear to be critical to tree health unlike their impact on pohutukawa.
8. While regeneration might be expected in larger forest areas, it is totally lacking from stands open to domestic stock.
9. Stands of puriri of national significance are under serious threat unless the resources are found to support community groups in their management and preservation.

The summary answers to the questions asked of this study are:

- Puriri dieback is better considered a slow decline characterised by crown contraction which leaves the outer or upper crown dead and a much reduced area of healthy foliage. The process ultimately leads to tree death, but this is a slow process which appears easily reversed.
- Puriri decline is evident throughout the range of the species, although trees near death were confined to localised areas in Northland and the Coromandel.
- Puriri decline is almost certainly associated with stresses induced by pastoral farming, in particular root damage, ground pugging, and stem damage.
- Puriri is not under threat as a species, but is likely to disappear from intensively farmed river flats where it was once plentiful and be reduced in abundance on grazed hill country. The aging population and lack of regeneration in these environments suggest the inevitable loss of the species where trees or stands are unprotected.

5. Management implications

There are a number of actions which could be taken to enhance the health of puriri both in a forest and pastoral environment. All these actions relate to the exclusion of domestic stock and the re-establishment of the forest edge. For a modest investment of resources, the future of a few nationally significant stands could be secured. Specifically:

- An initiative, in collaboration with the local Landcare Trust, is urgently needed to secure the future of the country's most significant stands of puriri at Waimate North. In particular the 4 hectare stand adjacent to the showgrounds and close to the Mission House should be a focus of attention.
- Landowners should be encouraged to fence individual trees and retire groves from grazing as part of an overall strategy for retention of the species in pastoral landscapes.
- The re-establishment of the forest edge through the planting of both native and exotic species should be encouraged to enhance residual forest stands and groves of trees and re-establish the moist subcanopy environment.

6. Acknowledgement

I would like to thank Dave Bartram and Geoff Weightman for their time and local knowledge of the Waimate North stands. Also thanks to *Forest Research* for access to the Forest Health Database.

APPENDIX 1: PURIRI HEALTH SURVEY - SITE DESCRIPTION FORM

Date: _____ Location: _____ Photo: Y/N
 Site No.: _____ Latitude: _____ Sample: Y/N
 Longitude: _____

<p>Site</p> <p>Pasture (grazed) River flat Grassland (ungrazed) Valley Shrubland Hill slope Forest Ridge</p> <p>Dry Aspect: N, S, E, W Moist Altitude: Swamp</p>	<p>Health:</p> <p>Crown Condition:</p> <p>Full: Healthy Thinning Upper: Healthy Thinning Lower: Healthy Thinning</p> <p>Crown Contraction:</p> <p>No contraction Upper crown contraction Whole crown contraction</p>
<p>Tree:</p> <p>DBH cm Crown spread m Life stage: Seedling Sapling Juvenile Mature Senescent</p> <p>Single tree Tree in forest canopy Grove of trees</p>	<p>Insect/Disease Possum Flowering Other damage:</p> <hr/> <p>Comments:</p>

APPENDIX 2: REGIONAL NOTES ON PURIM ABUNDANCE AND CONDITION

1. Kawhia. Trees scattered through remnant forest on hills above Kawhia are healthy and regeneration is present. Trees close to the harbour show some decline but exotic forest planting will probably ensure their health and survival.
2. Thames Coast. Trees along coast probably number less than 100 mostly old trees and despite some crown layering are all in good health.
3. West Coromandel Hill Country. Puriri scattered across pastoral hill country and in residual gully stands. The later are generally healthy while open country trees range from healthy to severe crown contraction. Puriri are an important element in the landscape.
4. West Coromandel Regenerating Shrubland. A major component of regenerating puriri is present in this ungrazed shrubland - young forest.
5. Coromandel Rough-grazed River Flats. Puriri common with scattered large trees and small groves in moderate health. Contrast with ungrazed stands in DOC reserves which are in exceptional health.
6. South Eastern Coromandel. Intensively farmed areas with almost total lack of puriri. Outstanding trees reappear in Homunga Bay in fenced Orokawa Bay Reserve.
7. South Eastern Kaipara Harbour. Extensive areas of puriri in residual hill forests in good condition while pastoral landscape trees are uncommon but still in moderate health.
8. North Eastern Kaipara Harbour. Puriri almost absent from Ruawai - Dargarville flats but common and healthy in remnant forests of hill slopes behind.
9. Waipoua Forest, Hokianga. Puriri uncommon in forest but some regeneration seen. North of forest to Hokianga major river flat population mostly healthy in rough pasture. Also a major component of Waima Range forest and apparently healthy.

10. Kaikohe. Magnificent fenced totara-puriri stand just out of town on Kawakawa road.
11. Kawakawa - Bay of Islands Region. Trees uncommon in pasture but present and healthy in steep gully forest remnants. Absent from much of regrowth shrubland west of Bay of Islands.
12. Waimate North. The most outstanding area for puriri seen, with extensive and dense puriri dominant stands on broad volcanic ridges. Most stands are open to cattle and lack any understorey. Some stands of several hectares in area within in region of perhaps 5000 ha.
13. Waihou Valley. Severely debilitated and dead trees scattered across an intensively farmed river flat also subject to flooding according to local information.
14. Maungataniwha Range. Puriri, a prominent component of the mature forest on the southern slopes is healthy, but the species is largely absent from regeneration on burnt over northern slopes.
15. North Eastern Northland. Puriri uncommon in area but individual trees on river flats are generally in poor health. Residual forest on hill slope south of kawakawa has significant healthy puriri component.
16. Whangarei to Wellesford. Waipu flats have interesting kahikatea - puriri component and scattered severely debilitated trees. Brynderwyn hills contain forest remnants containing significant healthy puriri.

APPENDIX 3: KEY TO SITE DATA/SUMMARY SITE DATA

Site Type

- Topography - River Flat (R)
 - Valley (V)
 - Hill slope (H)
 - Ridge (RI)

- Landcover - Pasture (grazed) (P)
 - Grassland (ungrazed) (G)
 - Shrubland (S)
 - Forest (F)
 - Urban (U)

- Moisture - Dry (D)
 - Moist (M)
 - Swamp (S)

Tree Characteristics

- Life Stage - Seedling (S)
 - Sapling (SA)
 - Juvenile (J)
 - Mature (M)
 - Senescent (SC)

- Association - Single Tree (S)
 - Tree in Forest Canopy (F)
 - Grove of Trees (G)

- Crown Health - Healthy (H)
 - Thinning (T)

- Crown Contraction - None (N)
 - Upper (U)
 - Whole (W)

APPENDIX 3: Individual Site Data

Site Number	01	02	03	04	05	06	07	08
Location	Te Puke	Te Puke	Te Puke	Kawhia	Kawhia	Kawhia	Kawhia	Kawhia
Latitude	37-47-00	37-47-00	37-47-00	38-04-93	38-04-87	38-04-87	38-04-87	38-04-87
Longitude	176-19-496	176-19-49	176-19-49	174-54-07	164-58-94	174-58-94	174-58-94	174-58-94
Altitude (m)	22	22	22	221	289	270	270	260
Site Type								
Topography	R	R	R	H	H	H	H	H
Landcover	U	U	U	F	S	S	S	S
Moisture	M	M	M	M	M	M	M	M
Tree Characteristics								
DBH (cm)	95	63	110	84	14, 24, 29	25	Large	45, 47, 78
Crown spread (m)	16	16	24	15	12	4	15	15
Life Stage	M	M	M	M	M, S	M	M	M, S, SA
Association	S	S	S	F	F	S	S	S
Crown Health								
Whole	H	T	H	H	H	H	H	H
Upper								
Lower								
Crown Contraction	N	W	N	N	N	N	N	N

Appendix 3: Individual Site Data (contd)

Site Number	17	18	19	20	21	22	23	24
Location	Kawhia	Thames	Thames	Thames	Thames	Thames	Ngarimu	Waiomu
Latitude	38-02-66	37-07-98	37-07-98	37-07-98	37-07-98	37-07-98	37-04-41	37-01-70
Longitude	174-53-47	175-32-37	175-32-37	175-32-37	175-32-37	175-32-37	175-31-15	1750-30-96
Altitude (m)	40	13	13	13	13	13	2	3
Site Type								
Topography	H	R	R	R	R	R	R	R
Landcover	P	U	U	U	U	U	P	U
Moisture	D	M	M	M	M	M	M	M
Tree Characteristics								
DBH (cm)	118	89	74	77	80	86	104	171
Crown spread (m)	20	10	9	8	10	14	10	18
Life Stage	M	M	M	M	M	M	M	M
Association	S	G	G	G	G	G	S	S
Crown Health								
Whole	T	H	H	H	H	H	H	
Upper								T
Lower								H
Crown Contraction	W	N	N	N	N	N	N	U

Appendix 3: Individual Site Data (contd)

Site Number	25	26	27	28	29	30	31	32
Location	Te Mata	Waikawau	Wilsons	Wilsons	Wilsons	Wilsons	Wilsons	Omaru
Latitude	36-57-57	36-56-84	36-52-89	36-52-89	36-51-87	36-51-87	36-51-67	36-43-64
Longitude	175-29-23	175-28-52	175-25-63	175-25-63	175-26-19	175-26-19	175-26-46	175-27-96
Altitude (m)	4	8	180	180	200	200	156	20
Site Type								
Topography	H	H	H	H	H	H	H	H
Landcover	G	P	P	P	P	P	P	P
Moisture	D	M	M	M	M	M	M	M
Tree Characteristics								
DBH (cm)	86, 40	120, 39	110	97	76	84, 56, 52	184	93
Crown spread (m)	16	11	14	14	10	10	26	13
Life Stage	M	M-SC	M	M	M	M	M-SC	M
Association	S	S	S	S	S	S	S	S
Crown Health								
Whole	H			H	T	T	T	
Upper		T	T					T
Lower		H	H					H
Crown Contraction	N	U	U	N	W	W	W	U

Appendix 3: Individual Site Data (contd)

Site Number	33	34	35	36	37	38	39	40
Location	Paparoha	Paparoha	Paparoha	Paparoha	Amodea	Waikawau	Waikawau	Waikawau
Latitude	36-42-49	36-42-49	36-42-49	36-42-32	36-40-52	36-34-76	326-35-02	36-36-43
Longitude	175-26-55	175-26-55	175-26-55	175-26-36	175-26-46	175-29-43	175-29-96	175-32-32
Altitude (m)	50	50	50	40	60	30	30	30
Site Type								
Topography	R	R	R	R	H	R	R	R
Landcover	P	F	F	G	G	P	P	G
Moisture	M	M	M	M	M	M	M	M
Tree Characteristics								
DBH (cm)	147	98, 120	163	134	84	126	139	113, 80
Crown spread (m)	20	24	29	19	13	19	23	24
Life Stage	M-SC	M	M	M	M	M	M-SC	M
Association	S	F	F	S	S	S	G	G
Crown Health								
Whole	H		H	H			T	H
Upper		T			T	T		
Lower		H			H	H		
Crown Contraction	N	U	N	N	U	U	W	N

Appendix 3: Individual Site Data (contd)

Site Number	41	42	43	44	45	46	47	48
Location	Waikawau	Waikawau	Tuataewa	Tuataewa	Kennedy	Kennedy	Kennedy	Kennedy
Latitude	36-36-43	36-36-43	36-37-29	36-38-33	36-39-41	36-41-45	36-41-45	36-41-44
Longitude	175-32-32	175-32-32	175-33-48	175-34-35	175-32-97	175-32-36	175-32-36	175-32-31
Altitude (m)	30	30	207	50	32	40	40	11
Site Type								
Topography	R	R	H	H	R	R	R	R
Landcover	G	G	S	G	P	P	P	P
Moisture	M	M	M	M	M	M	M	M
Tree Characteristics								
DBH (cm)	204	110	23, 18	48	88	166	14, 16, 20	119
Crown spread (m)	22	15	6	10	8	18	5	18
Life Stage	M	M	J	M	M	M	SA	M
Association	S	G	F	F	S	S	S	S
Crown Health								
Whole	H	H	H	H	T		H	H
Upper						T		
Lower						H		
Crown Contraction	N	N	N	N	W	U	N	N

Appendix 3: Individual Site Data (contd)

Site Number	49	50	51	52	53	54	55	56
Location	Kennedy	Waipoua	Kuaotuna	Kuaotuna	Kuaotuna	Kuaotuna	Whitianga	Tairua
Latitude	36-41-44	36-41-11	36-43-87	36-43-52	36-43-52	36-45-12	36-50-65	36-58-55
Longitude	175-32-31	175-36-73	175-42-47	175-43-75	175-43-75	175-43-68	175-39-82	175-50-58
Altitude (m)	11	35	40	70	70	40	40	130
Site Type								
Topography	R	H	R	H	H	H	R	H
Landcover	P	S	P	P	P	S	P	F
Moisture	M	M	M	D	D	M	M	M
Tree Characteristics								
DBH (cm)	46	120	67	105	119	35	108	98
Crown spread (m)	12	15	11	15	18	10	14	18
Life Stage	SC	M-SC	M	M	M	J	M	M
Association	S	S	S	G	G	F	G	F
Crown Health								
Whole		T	T		T	H		H
Upper	T			T			T	
Lower	H			H			H	
Crown Contraction	U	W	W	U	W	N	U	N

Appendix 3: Individual Site Data (contd)

Site Number	57	58	59	60	61	62	63	64
Location	Tairua	RamaRama						
Latitude	36-58-55	37-16-95	37-16-95	37-16-95	37-16-95	37-17-01	37-17-49	37-17-49
Longitude	175-50-58	175-53-24	175-53-24	175-53-24	175-53-24	175-53-47	175-54-04	175-54-04
Altitude (m)	130	18	18		18	25	50	50
Site Type								
Topography	H	R	R	R	H	H	R	R
Landcover	F	P	P	P	G	G	S	G
Moisture	M	M	M	M	M	M	M	M
Tree Characteristics								
DBH (cm)	94	129	104, 86	123	65	64	122	80, 75
Crown spread (m)	15	16	18	14	10	12	17	10
Life Stage	M	M	M-SC	M	M	M	SC	M
Association	F	G	G	G	S	S	S	S
Crown Health								
Whole	H		T	H	H	H	T	
Upper		T						T
Lower		H						H
Crown Contraction	M	U	W	M	N	N	W	U

Appendix 3: Individual Site Data (contd)

Site Number	65	66	67	68	69	70	71	72
Location	Homunga							
Latitude	37-21-79	37-21-56	37-21-56	37-21-56	37-21-56	37-21-56	37-21-56	37-21-83
Longitude	175-56-16	175-56-23	175-56-23	175-56-23	175-56-23	175-56-23	175-56-23	175-55-72
Altitude (m)	100	50	50	50	50	50	50	200
Site Type								
Topography	H	H	H	R	R	R	R	H
Landcover	F	G	G	G	G	G	G	P
Moisture	M	M	M	M	M	M	M	D
Tree Characteristics								
DBH (cm)	98	36	52	120	105	51	77	Large
Crown spread (m)	14	10	10	16	12	10	12	24
Life Stage	M	M	M	M	M	M	M	M-SC
Association	F	S	S	G	G	G	G	S
Crown Health								
Whole	H	H	H			H	H	T
Upper				T	T			
Lower				H	H			
Crown Contraction	N	N	N	U	U	N	N	W

Appendix 3: Individual Site Data (contd)

Site Number	73	74	75	76	77	78	79	80
Location	Matakohe	Ruawai	Ruawai	Ruawai	Ruawai	Tokatoka	Kaihu	Aranga
Latitude	36-07-77	36-07-24	36-06-99	36-06-99	36-07-24	36-02-61	35-47-88	35-43-75
Longitude	174-08-64	174-06-34	173-59-01	173-54-01	174-06-34	173-57-44	173-43-64	173-36-01
Altitude (m)	115	45	30	30	80	7	70	262
Site Type								
Topography	V	R	R	R	H	H	R	H
Landcover	P	P	G	P	P	P	P	S
Moisture	M	M	M	M	D	M	M	D
Tree Characteristics								
DBH (cm)	98	107	85	45, 26	Large	97	95	120
Crown spread (m)	15	9	10	9	Large	12	9	15
Life Stage	M	M	M	M	M	M	M	M
Association	F	S	S	S	F	G	S	F
Crown Health								
Whole		T		T	H			H
Upper	T		T			T	T	
Lower	H		H			H	H	
Crown Contraction	U	W	U	W	N	U	U	N

Appendix 3: Individual Site Data (contd)

Site Number	81	82	83	84	85	86	87	88
Location	Katui	Waipoua	Waipoua	Waipoua	Waipoua	Waipoua	Waipoua	Waimamaku
Latitude	35-41-28	35-39-80	35-39-80	35-39-15	35-59-15	35-38-29	35-35-15	35-33-72
Longitude	173-34-43	173-34-41	173-34-41	173-33-33	173-33-33	173-33-56	173-30-76	173-29-34
Altitude (m)	306	133	133	70	70	270	295	150
Site Type								
Topography	H	H	H	R	R	H	H	R
Landcover	P	S	S	G	G	S	P	G
Moisture	M	M	M	M	M	M	M	M
Tree Characteristics								
DBH (cm)	125	18, 12, 11	26	69	81	55	Several	72
Crown spread (m)	16	4	7	9	10	7	20	10
Life Stage	M	SA	J	M	M	M	M	M
Association	S	F	F	S	S	S	G	S
Crown Health								
Whole		H	H	T	T	H		T
Upper	T						T	
Lower	H						H	
Crown Contraction	U	N	N	W	W	N	U	W

Appendix 3: Individual Site Data (contd)

Site Number	89	90	91	92	93	94	95	96
Location	Waimamaku	Waimamaku	Waimamaku	Omapere	Motoua	Motoua	Whirinaki	Whirinaki
Latitude	35-33-72	35-33-72	35-33-43	35-32-11	35-28-97	35-28-97	35-27-43	35-27-43
Longitude	173-29-34	173-29-34	173-24-47	173-23-19	173-26-90	173-26-90	173-28-22	173-28-22
Altitude (m)	150	150	109	4	68	68	82	82
Site Type								
Topography	R	R	H	R	H	H	H	H
Landcover	P	P	F	G	P	P	P	P
Moisture	M	M	M	M	D	M	M	M
Tree Characteristics								
DBH (cm)	282	Regrowth	Large	51	102	64	59	80
Crown spread (m)	23	6	Large	8	12	10	11	13
Life Stage	M	M-J	M	M	M	M	M	M
Association	G	S	F	S	G	G	S	S
Crown Health								
Whole	H	H	H	H	H	H	H	T
Upper								
Lower								
Crown Contraction	N	N	N	N	N	M	N	W

Appendix 3: Individual Site Data (contd)

Site Number	97	98	99	100	101	102	103	104
Location	Waima	Taheke	Kaikohe	Kaikohe	Kaikohe	Kaikohe	Kaikohe	Ngawha
Latitude	35-29-13	35-28-95	35-25-74	35-25-74	35-25-74	35-23-71	35-23-71	35-22-51
Longitude	173-34-18	173-37-34	173-46-49	173-46-49	173-46-49	173-50-14	173-50-14	173-51-88
Altitude (m)	150	140	192	192	192	202	202	300
Site Type								
Topography	H	R	R	R	R	R	R	RI
Landcover	F	P	P	P	G	G	G	P
Moisture	M	M	M	M	M	M	M	M
Tree Characteristics								
DBH (cm)	Large	107	146	126	Large	127	98	Large
Crown spread (m)	Large	19	21	16	Large	18	15	16
Life Stage	M	M	M	M	M	M	M	M-SC
Association	F	S	S	S	G	F	F	S
Crown Health								
Whole	H	H	T		H	H	H	H
Upper				T				
Lower				H				
Crown Contraction	N	N	W	U	N	N	N	Ngawha

Appendix 3: Individual Site Data (contd)

Site Number	105	106	107	108	109	110	111	112
Location	Kawakawa	Kawakawa	Kawakawa	Kawakawa	Pahia	Pahia	Pahia	Waimate
Latitude	35-23-07	35-23-07	35-21-04	35-21-04	35-18-77	35-17-60	35-17-90	35-18-77
Longitude	173-59-34	173-59-34	174-05-18	174-05-18	174-06-22	173-59-06	173-57-16	173-54-37
Altitude (m)	177	195	145	145	46	85	120	120
Site Type								
Topography	V	H	H	H	V	R	R	H
Landcover	P	F	F	F	G	F	G	F
Moisture	M	M	M	M	M	M	M	D
Tree Characteristics								
DBH (cm)	87	97	30	58	115	Large	123	Large
Crown spread (m)	12	12	6	9	15	Large	16	Large
Life Stage	M	M	M	M	M	M	M	M
Association	S	F	F	F	S	F	S	F
Crown Health								
Whole	H	H	H	H	T	H	H	H
Upper								
Lower								
Crown Contraction	N	N	N	N	W	N	N	N

Appendix 3: Individual Site Data (contd)

Site Number	113	114	115	116	117	118	119	120
Location	Waimate	Waimate	Waimate	Waimate	Waimate	Waimate	Waimate	Waimate
Latitude	35-19-36	35-19-36	35-19-36	35-19-36	35-19-36	35-19-36	35-19-36	35-20-02
Longitude	173-53-25	173-53-25	173-53-25	173-53-25	173-53-25	173-53-25	173-53-25	173-51-29
Altitude (m)	269	269	269	269	269	270	270	162
Site Type								
Topography	RI	RI	RI	RI	RI	RI	RI	R
Landcover	P	P	G	P	G	P	P	P
Moisture	D	D	D	D	M	D	D	M
Tree Characteristics								
DBH (cm)	207	195	75, 37, 137	200	104	220	126	122
Crown spread (m)	18	25	23	20	16	18	12	10
Life Stage	M	M	M	M	M	M-SC	M-SC	M
Association	G	G	G	G	G	S	S	G
Crown Health								
Whole	H	H	H		H	T	T	
Upper				T				T
Lower				H				H
Crown Contraction	N	N	N	U	N	W	W	U

Appendix 3: Individual Site Data (contd)

Site Number	121	122	123	124	125	126	127	128
Location	Te Ahuahu	Waihou	Waihou	Mangamuka	Mangamuka	Maungataniwha	Victoria	Kaitaia
Latitude	35-20-18	35-17-56	35-17-56	35-14-44	35-12-93	35-11-37	35-09-33	35-06-43
Longitude	173-49-29	173-40-76	173-40-76	173-32-69	173-32-58	173-27-35	173-25-10	173-15-50
Altitude (m)	270	81	81	120	120	383	85	50
Site Type								
Topography	RI	R	R	R	R	RI	R	R
Landcover	P	P	P	P	P	F	P	U
Moisture	D	M	M	M	M	D	M	M
Tree Characteristics								
DBH (cm)	Large	85	76	35, 50	84	?	134	72
Crown spread (m)	Large	15	6	5, 8	5	10	18	14
Life Stage	M	M	M-SC	M-J	M-SC	M	M	M
Association	G	G	S	S	S	F	G	S
Crown Health								
Whole	H	T	T	H	T	H	H	H
Upper								
Lower								
Crown Contraction	N	W	W	N	W	M	N	N

Appendix 3: Individual Site Data (contd)

Site Number	129	130	131	132	133	134	135	136
Location	Awanui	Awanui	Aurere	Taipa	Kahoe	Kahoe	Kahoe	Kahoe
Latitude	35-02-68	35-02-68	34-59-44	34-59-58	35-03-08	35-03-08	35-06-04	35-06-04
Longitude	173-16-74	173-16-74	173-25-24	173-27-36	173-40-41	173-40-41	173-47-48	173-47-48
Altitude (m)	45	45	30	30	120	122	20	30
Site Type								
Topography	R	R	R	R	H	H	H	H
Landcover	G	G	G	P	P	P	P	G
Moisture	M	M	M	M	D	D	D	M
Tree Characteristics								
DBH (cm)	35	87	74	Large	106	Large	115	87
Crown spread (m)	8	14	14	15	12	16	17	12
Life Stage	M	M	M	M	M	M	M	M
Association	S	S	G	F	G	S	S	S
Crown Health								
Whole	H	H	H		T			H
Upper				T		T	T	
Lower				H		H	H	
Crown Contraction	N	N	N	U	W	U	U	N

Appendix 3: Individual Site Data (contd)

Site Number	137	138	139	140	141	142	143	144
Location	Kerikeri	Ohinewai	Moerewa	Moromaku	Whangarei	Mata	Waipu	Brynderwgn
Latitude	35-12-47	35-20-78	35-23-01	35-26-81	35-43-17	35-51-66	35-58-77	36-05-42
Longitude	173-56-06	173-53-66	173-59-30	174-05-04	174-19-28	174-23-51	174-26-08	174-25-82
Altitude (m)	118	109	92	144	50	20	20	210
Site Type								
Topography	RI	H	H	R	V	H	R	H
Landcover	F	P	P	P	U	F	P	F
Moisture	M	D	M	M	M	M	M	D
Tree Characteristics								
DBH (cm)	Large	Large	95	124	80	Large	96	Large
Crown spread (m)	15	Large	18	17	16	Large	12	Large
Life Stage	M	M	M	M	M	M	M-SC	M
Association	F	F	S	S	S	F	S	F
Crown Health								
Whole	H	H	H	T	H	H	T	H
Upper								
Lower								
Crown Contraction	N	N	M	W	M	M	W	M

Appendix 3: Individual Site Data (contd)

Site Number	145	146	147	148	149	150	151
Location	Brynderwyn	Wellesford	Kaipara	Kaipara	Kaipara	Kaukapakapa	Kaukapakapa
Latitude	36-05-42	36-18-02	36-21-06	36-23-98	36-27-88	36-36-39	36-38-73
Longitude	174-25-82	174-30-19	174-28-31	174-26-80	174-26-83	174-29-35	174-27-23
Altitude (m)	210	161	248	115	150	96	20
Site Type							
Topography	H	H	V	H	H	H	H
Landcover	P	P	P	P	F	F	F
Moisture	D	D	M	D	D	D	M
Tree Characteristics							
DBH (cm)	Large	75	80	38	Large	Large	Large
Crown spread (m)	Large	8	14	8	Large	Large	Large
Life Stage	M	M-SC	M	M	M	M	M
Association	G	S	S	G	F	F	F
Crown Health							
Whole	T	T			H	H	H
Upper			T	T			
Lower			H	H			
Crown Contraction	W	W	U	U	N	N	N

