Specialty Wood Products Research Partnership

MARLBOROUGH RESEARCH CENTRE
Te Rito Hiranga o Wairau

National forest owner survey and resource inventory of alternative species

Stage One of Hawke's Bay Region pilot project

Authors: Dr Vega Xu and Harriet Palmer

Research Providers: Marlborough Research Centre
University of Canterbury

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TE KAUNIHERA Ā-ROHE O TE MATAU-A-MĀUI

Leadership in forest and environmental management, innovation and research

Acknowledgement

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Objectives

The Stage One objective of this project is to identify a suitable methodology for a NZ-wide survey and inventory of alternative species forests and their owners by undertaking a pilot study in Hawke's Bay Region. This report presents the initial results of this pilot study.

On the culmination of this first stage a '**stop/go point'** will be reached, based on the estimated cost and funding required to continue with the objectives of two subsequent stages – (i) field work to better assess the quality, harvesting potential and owner objectives of the small-scale alternative species resource in the Hawke's Bay Region and (ii) modelling to determine high, medium and low regional scenarios for the potential log supply from Hawke's Bay existing alternative species forest resource.

Introduction

The National Exotic Forest Description (NEFD) is known to be inaccurate in its representation of small-scale forests, especially those comprising alternative (or 'specialty') species. In order to assess how these forests could contribute to regional economic development by supplying logs for small-scale domestic processing and markets, much more accurate information is needed on where these forests are, what species they comprise, the age and quality of the trees, their harvest potential, and their owners' plans for future management including harvest.

Stage One of this project comprises the first part of a pilot project designed to test a new methodology for inventory of alternative species forests. The project focused solely on Hawke's Bay Region.

In 2018 the University of Canterbury's School of Forestry (SoF) mapped all of the smaller exotic plantations (1 hectare minimum) in Hawke's Bay[1] from aerial photographs, although these forests were not differentiated by species in this exercise. Therefore, there was a good foundation for this project.

The region's five largest corporate forest owners were excluded from this earlier work, so the current project began with a survey of those owners and a small number of other corporate/large-scale private owners identified in Hawke's Bay. It was anticipated that these large-scale owners would be readily able to supply data (including shapefiles) of their alternative species resource, therefore enabling their forests to be mapped and eliminated from later work to identify all the remaining alternative species forests over 0.1ha, and their owners.

Method and outcomes

1. Obtaining data from corporate forest owners in Hawke's Bay

With the help of local forestry consultant, James Powrie, the following major corporate and large-scale forest owners/managers thought likely to have an alternative species resource in the Hawke's Bay region were identified:

- PanPac
- Juken NZ Ltd
- Rayonier-Matariki
- Ernslaw One
- Hawke's Bay Regional Council
- Pamū/Landcorp Farming Ltd
- PF Olsen

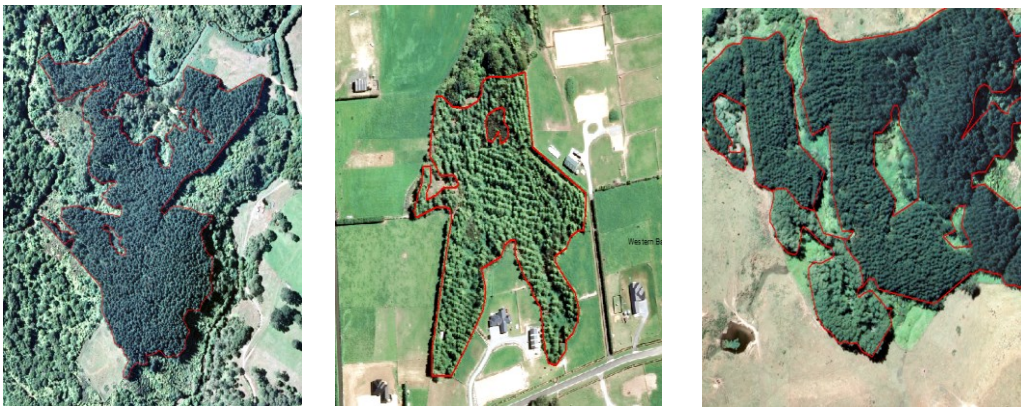
[1] Mapping was done using the Hawke's Bay Wood Supply region boundaries. These are Wairoa District, Hastings District, Napier City, and Central Hawke's Bay District.

These companies were all contacted and asked to provide information about their alternative species resource, including information on likely future management. Of the seven companies listed above, five who responded in full were also able to provide shapefiles detailing their alternative species resource. The sixth provided useful anecdotal information about their resource, while the seventh did not respond. Further investigation suggests this company is unlikely to have any significant alternative species resource.

Shapefiles received were processed by Dr Vega Xu at the School of Forestry as she began her work to identify and quantify the total small-scale alternative species resource in the Hawke's Bay Region.

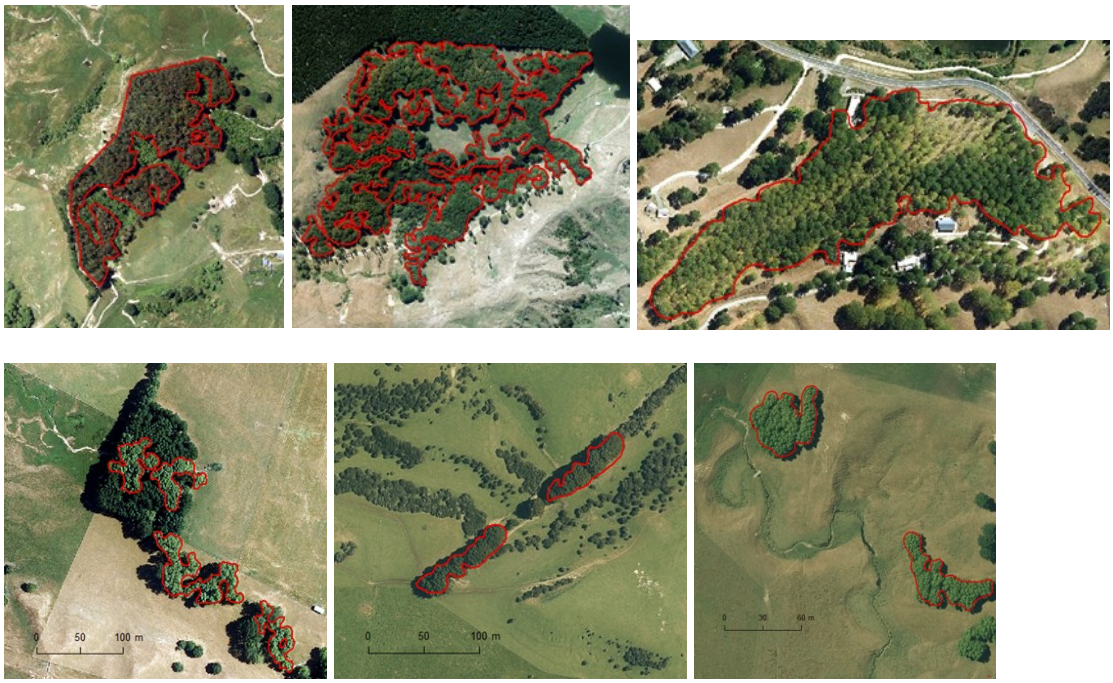
2. Identifying and quantifying the remaining small-scale alternative species resource

Using the existing 2018 small-scale forest map, each polygon (in total 2574 polygons) was assessed and a visual differentiation was made between radiata pine and other plantation species.



Following this, all tiles were assessed with the support of multispectral 2018-19 Sentinel imagery and Google Earth images to pick up any alternative species not mapped previously using aerial photos (in total 1656 aerial photo tiles).
The plantation forests mapped by Land Use and Carbon Analysis System (LUCAS) and Land Cover Database (LCDB) were also used as a reference from time to time to confirm plantation forests.

Further examples of alternative species mapping



Mapping results

In total 6590 polygons were mapped and 3792 ha were identified as the small-scale alternative species resource:

- 0.1- 1 ha 2045 ha
- 1- 10 ha 1387 ha
- > 10 ha 360 ha

Ownership identification

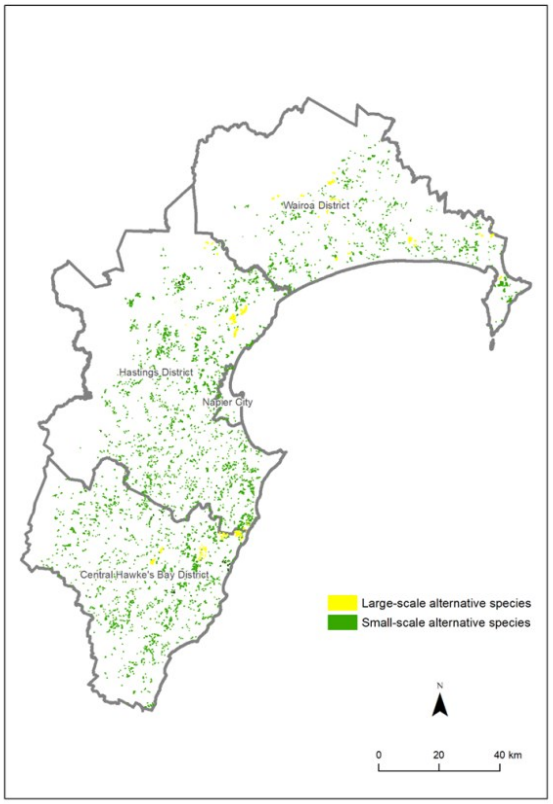
The next step was to overlay the LINZ cadastral property titles layer for the Hawke's Bay Region, which includes details of owners. Overlaying the property title information with ownership boundaries enabled removal of DOC land and public reserves and permitted identification of legal owners of 3566 hectares of alternative species.

Ownership was then clarified so that multiple polygons belonging to one owner were merged into one record, and polygons belong to multiple owners were split into multiple records.

Finally, the data was then checked to ensure no overlaps with the large-scale owners' resource.

Mapped distribution of alternative species in Hawke's Bay Region

The two datasets – small-scale and large-scale alternatives species were then demonstrated spatially at a regional scale. Map 1 below shows the distribution of all the alternative species resource in the Hawke's Bay Region and confirms that the forests are extremely scattered:



Map 1: Distribution of all alternative species forests over 0.1 ha in Hawke's Bay Region.

Analysis of area by ownership category

- **Small-scale owners**

The total small-scale owners' area mapped was 3566 ha.

The minimum area mapped was 0.1 hectare, and the results show the heavy weighting of ownership records towards areas of between 0.1 ha and 1.0 ha (1551 'counts' or records, or some 66.5% of the total number of ownership records).

The total area of the forests in the 0.1-1.0 ha range is around 613 ha, approximately 17% of the total mapped small-scale owners' area. 2780 ha (around 78% of the total resource) is in blocks of 10 ha or less.

Fig 1 and Table 1 provide more details of the small-scale owners' resource.

- **Large-scale/corporate owners**

The total corporate/large-scale owners' area mapped was 914 ha.

Again, there was some weighting in terms of the number of ownership records (equating to separate blocks of forest) towards areas of less than 1 hectare. In this case 226 records (around 58% of the total number of records) fell into this category. However, the total area of these small blocks was only 72 ha – less than 8% of the 914 ha recorded for all the records. Fig 2 shows the more even distribution of forest sizes between 0.1 ha and 45 ha compared with the small-scale owners' resource. In the case of corporate owners, 484 ha (around 53%) of the resource is in blocks of 10 ha or less.

Fig 2 and Table 2 provide more details of the corporate/large-scale owners' resource.

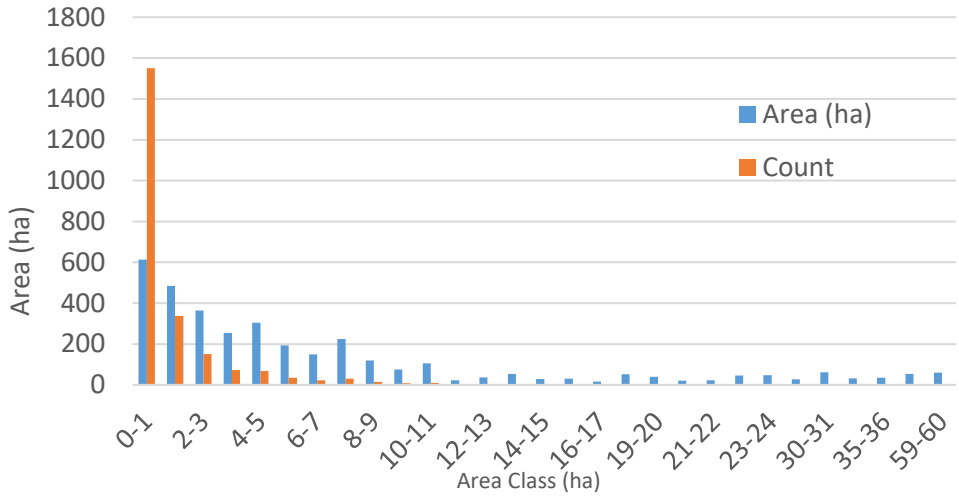


Fig 1 and Table 1: Distribution of small-scale owners' forest areas by number of ownership records

Area range (ha)	Total area (ha)	Count – ownership records
0-1	613	1551
1-2	484	337
2-3	364	151
3-4	254	73
4-5	304	68
5-6	194	35
6-7	149	23
7-8	224	30
8-9	119	14
9-10	76	8
10-11	105	10
11-12	23	2
12-13	36	3
13-14	54	4
14-15	29	2
15-16	31	2
16-17	16	1
17-18	52	3
19-20	39	2
20-21	21	1
21-22	22	1
22-23	45	2
23-24	47	2
26-27	26	1
30-31	61	2
31-32	31	1
35-36	35	1
53-54	53	1
59-60	59	1
Totals	**3566**	**2332**

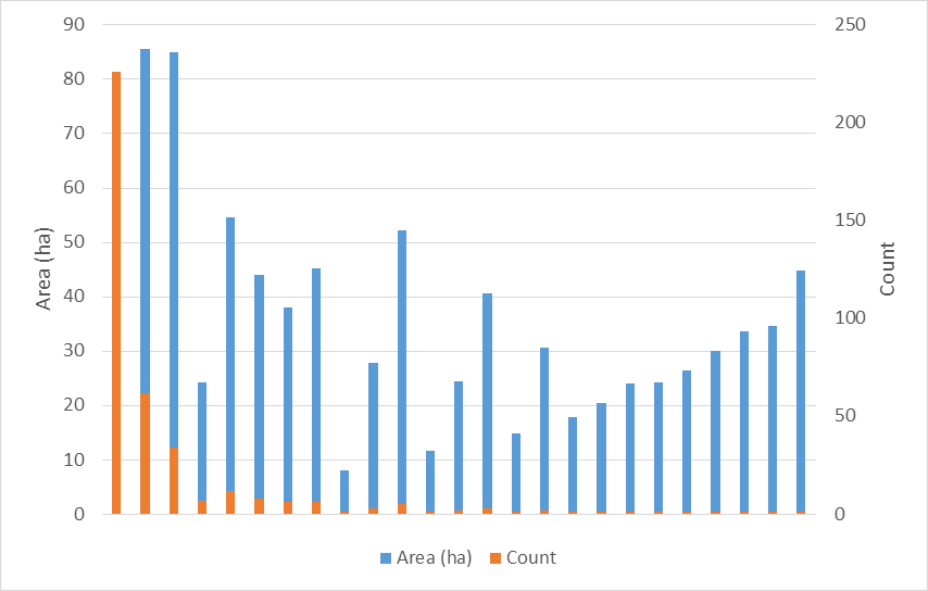


Fig 2 and Table 2: Distribution of corporate/large-scale owners' forest areas by number of ownership records

Area range (ha)	Total Area (ha)	Ownership records count
0-1	72	226
1-2	86	62
2-3	85	34
3-4	24	7
4-5	55	12
5-6	44	8
6-7	38	6
7-8	45	6
8-9	8	1
9-10	28	3
10-11	52	5
11-12	12	1
12-13	24	2
13-14	41	3
14-15	15	1
15-16	31	2
17-18	18	1
20-21	20	1
23-24	24	1
24-25	24	1
26-27	26	1
30-31	30	1
33-34	34	1
34-35	35	1
44-45	45	1
Total	**914**	**388**

Comparing School of Forestry results with NEFD data for alternative species in Hawke's Bay

The 2019 National Exotic Forest Description (NEFD) data for Hawke's Bay records a total of 3190 hectares of alternative species (Table 3).

Table 3: NEFD (2019) alternative species data for Hawke's Bay Region.

Species	Age class (years)				Total area by species (ha)
	1-10	11-20	21-30	30+	
Douglas-fir	63	65	163	154	**445**
Cypress	20	289	38	21	**368**
Other Softwoods	312	186	172	247	**917**
Eucalypt	690	151	9	111	**961**
Other Hardwoods	172	65	91	171	**499**
Total area by age class (ha)	**1,257**	**756**	**473**	**704**	**3,190**

Our initial pilot mapping exercise confirms that this is a significant underestimate. The total area recorded by our mapping exercise is (3,566ha small-scale + 914ha corporate/large-scale) = 4,480ha, so a difference of 1,290ha or around a 40% increase in forest area from the original NEFD figure.

However, NEFD data only records forests of over 1 ha, so the comparison with the total area mapped (which included forests down to 0.1ha) does not compare 'like with like'.

Table 4 provides a like-with-like comparison of the data for forests over 1 ha and shows the SoF mapping identified an additional 604 ha of alternative species forests not accounted for by the NEFD (a 19% differential).

Table 4: Comparison NEFD and SoF data for forests over 1ha.

A. NEFD data – all alternative species forests over 1ha	**3,190ha**
SoF data – small-scale owners' forests over 1 ha	2,952 ha
SoF data - corporate/large-scale owners' forests over 1ha	842 ha
B. SoF data – total forests over 1 ha	**3,794 ha**
Difference between NEFD and SOF data - forests over 1ha (B-A)	**604 ha**

Species breakdown – corporate/large-scale resource

At this stage, while the corporate owners provided details of which alternative species and the ages of trees, the SoF survey of small-scale owners has only been able to map the resource but cannot differentiate species or the ages of the trees.

Analysis of the corporate owners' species (Table 5) suggests there is a high proportion of species with economic potential.

Table 5: Corporate/large-scale owners species breakdown

Species group	Area (ha)
Eucalypts	598
Poplars	47
Cypresses	74
Redwoods	57
Native spps	30
Pinus nigra	26
Larch	23
Others*	85
Total	**914 ha**

* Others include 'mixed species' (19ha), *Acacia melanoxylon* (6ha), *Cedrus deodar* (8ha), Douglas-fir (3ha), and a range of minor/ornamental species. Almost all native species plantings are under 1ha (native species are not included in NEFD data).

Conclusion: Stage 1

The outcomes of this initial stage of the project demonstrate there is a significant opportunity to continue developing an alternative inventory methodology for mapping the alternative species resource in New Zealand.

The new methodology should be capable of capturing the alternative species belonging to both corporate/large-scale owners and small-scale owners, as the Hawke's Bay pilot shows both groups of owners are important.

The new methodology should also be capable of mapping and identifying areas of alternative species which are smaller than 1 hectare, because these small areas make a significant contribution to the total resource.

Next steps

The original work plan for this project identified two further potential stages once the Stage 1 pilot mapping and survey was complete. These were (i) **Stage 2** - follow up the Hawke's Bay mapping work with a ground-based survey of small-scale alternative species (and their owners) to gather more information about the resource and the owners' management intentions so as to further refine the resource map and alternative species records, and (ii) **Stage 3** - Scion to undertake to determine high, medium and low regional scenarios for the potential log supply from Hawke's Bay existing alternative species forest resource.

However, the experience gained during the Stage 1 mapping work indicates that it should be possible to use the known species and age classes from the corporate/large-scale forest owners' data as 'training' data to start the process of 'training' a mapping algorithm. This algorithm will be capable of recognising different tree species from aerial imagery (i.e. use artificial intelligence),

enabling a much more accurate identification of the areas of different alternative species which comprise the small-scale growers' resource.

The primary aim of this project is '*to identify a suitable methodology for a New Zealand-wide survey and inventory of alternative species forests and their owners'*, with the objective of providing accurate information about the national alternative species resource and the management intentions of owners. This will give greater confidence to industry and government to invest in supporting expansion of small-scale processing and strengthening the alternative timbers value chain.

Stage 2: Surveying small-scale owners and developing the School of Forestry mapping algorithm

Our recommendations for Stage 2 of this project are now as follows:

Stage 2a: A selected group of Hawke's Bay's smaller-scale owners whose alternative species areas and locations have already been captured in Stage 1 work, and whose holding details we have from the LINZ cadastral records, will be identified with the help of the local branch of the Farm Forestry Association. We will target owners of the (relatively) larger areas of alternative species (e.g. 2-3 hectares and above). It is anticipated that most of these owners will have some records and knowledge of their resource (e.g. maps and details of species and planting dates etc). These owners will be contacted by email and asked to complete an on-line survey, providing details of their resource and future management plans, including plans for harvest.

The survey data will have two benefits: (i) it will provide information on the resource and owner intentions which will be useful in further analysis of the potential for developing the small-scale sawmilling industry in Hawke's Bay, and (ii) it should be possible to use the information to assist with work in Stage 2b, as records will be able to be linked with aerial mapping data already obtained in Stage 1 and used for training the computer algorithm.

Stage 2b: work will continue at the School of Forestry to develop the envisaged mapping algorithm – a potentially highly valuable tool. The work, which we believe is a 'first' in New Zealand, has merit both as novel research as well as in terms of its future practical application.

To train a computer algorithm, multiple GIS records of specified alternative species at known multiple ages are needed. Corporate forest owners in Hawke's Bay were readily able to provide good resource data, including planting dates and shapefiles, for their alternative species resource. Large-scale forest owners generally have this data in digital formats for management purposes, whereas smaller-scale owners rarely have such good digital records.

Therefore we suggest that in addition to obtaining records by identifying and contacting a selection of the small-scale Hawke's Bay owners (say 200 owners of the larger small-scale woodlots), more good data could be obtained to progress training the mapping algorithm by approaching the corporate forest sector again and requesting their data, including shapefiles, for alternative species plantings in regions other than Hawke's Bay.

Dr Vega Xu can then begin work using a machine learning (ML) classification such as Random Forest (RF) to develop the computer algorithm.

Appendix 1: Species abbreviations used in the large-scale owners dataset, and species list

Abbreviation in record	Botanic name	Common name
AAMEL	*Acacia melanoxylon*	Blackwood
Ac.del	*Acacia dealbata*	Silver wattle
C.deo	*Cedrus deodara*	Deodar cedar
C.lus	*Cupressus lusitanica*	Lusitanica
C.tor	*Cupressus torulosa*	Macrocarpa
Ced.spp	*Cedars*	
CHLAW	*Ch. lawsoniana*	Lawsons cypress
CULUS	*Cupressus lusitanica*	
CUMAC	*Cupressus macrocarpa*	
CUMIX	*Mixed cypresses*	
CUSPP	*Mixed cypresses*	
D.dac	*Dacrycarpus dacrydiodes*	Kahikatea
E.fas	*Eucalyptus fastigata*	
E.glo	*E. globoidea*	
E.glo,E.obl,E.ova,E.qua	*Mixed eucs*	
E.maid	*E. maidenii*	
E.mue	*E. muelleriana*	
E.obl,E.glo,E.mue,E.ova	*Mixed eucs*	
E.reg	*E. regnans*	
E.sal	*E. saligna*	
EUBOS	*E. bosistoana*	
EUBSA	*E. bosistoana?*	
Euc.mix	*Mixed eucs*	
EUCAM	*E. cameldulensis*	
EUCLA	*E. cladocalyx*	
EUGLO	*E. globoidea*	
EULAE	*E. laevopineae*	
EULEU	*E. leucoxylon*	
EUMAC	*E. macroryhncha*	
EUMIX	*Mixed eucs*	
EUMUL	*E. muelleriana*	
EUPIL	*E. pilularis*	
EUQUA	*E. quadrangulata*	
EUQUD	*E. quadrangulata*	
EUSAL	*E. saligna*	
EUSPP	*Mixed eucs*	
JUNIG	*Juglans nigra*	Black walnut
L.DEC	*Larix decidua*	European larch
L.Flaxae	??	
L.KAE	*Larix kaempferi*	Japanese larch
Matai	*Matai*	
MXSPP	*Mixed species*	
N.Solan	*Nothofagus solandrii*	Black beech
Nat.spp	Native species	

Nat.spp,C.palm	Native species, *Chamaecytisus palmensis*	Tagaste/tree lucerne
Orn.sps	Ornamental species	
P.mur	*Pinus muricana*	
P.NIG	*Pinus nigra*	
P.pin	*Pinus pinaster/pinea*	
PCTOT*	*Podocarpus totara*	Totara
Pod.tot	*Podocarpus totara*	
POMIX	Poplars - mixed	
POSPP	Poplars - mixed	
Ps.menz	*Pseudotsuga menziesii*	Douglas-fir
PSMEN	*Pseudotsuga menziesii*	
Puriri	Puriri	
Rimu,Matai	Rimu, Matai	
Sq.sem	*Sequioa sempervirens*	Californian redwood
SQSEM	*Sequioa sempervirens*	
SXSPP	Salix species	Willows
THPLI	*Thuja plicata*	Western red cedar

Appendix 2: Full break down of species and areas – corporate resource

Species	Area (ha)	No. of stands	Establish Yr from	Establish Yr to
E. bosistoana	145.8	27	2013	2019
E. cameldulensis	10.9	2	2017	2017
E. cladocalyx	8.3	8	1970	2019
E. fastigata	95.8	7	2003	2012
E. globoidea	108.8	49	2013	2019
E. laevopineae	0.0	1	2017	2017
E. leucoxylon	0.2	3	2017	2017
E. macroryhncha	21.8	8	2017	2019
E. maidenii	8.4	2	2010	2010
E. muelleriana	9.1	5	2008	2019
E. pilularis	0.2	2	2017	2017
E. quadrangulata	34.5	3	2016	2016
E. regnans	88.0	6	2009	2011
E. saligna	4.2	2	2007	2019
Mixed eucs	62.1	38	1982	2019
Eucalypts total	**598.3**			
Cupressus lusitanica	60.6	26	1968	2013
Cupressus macrocarpa	4.1	8	1982	2003
Cupressus torulosa	8.4	6	2008	2013
Ch. lawsoniana	0.5	2	1959	1959
Mixed cypresses	0.9	2	2019	2019
Cypresses total	**74.5**			
Cedrus deodara	7.8	8	2008	2012
Cedars	5.9	1	2010	2010
Acacia dealbata	1.0	1	2008	2008
Acacia melanoxylon	5.9	6	1978	2019
Juglans nigra	1.0	1	1982	1982
Larix decidua	8.0	1	1957	1957
Larix kaempferi	15.4	12	1977	1978
Poplars - mixed	46.8	44	1985	2019
Pinus muricana	1.0	1	2008	2008
Pinus pinaster/pinea	2.2	1	2008	2008
Pinus nigra	26.3	11	1958	1966
Pseudotsuga menziesii	3.4	3	1980	2012
Douglas-fir total	**3.4**			

Salix species	7.9	4	1985	1985
Sequioa sempervirens	57.3	32	1929	2019
Redwoods total	**57.3**			
Thuja plicata	0.3	1	1968	1968
Native species, *Chamaecytisus palmensis*	17.3	2	1992	1999
Matai	0.5	1	2012	2012
Native species	1.7	5	2010	2012
Dacrycarpus dacrydiodes	0.6	1	2012	2012
Nothofagus solandrii	2.1	1	2012	2012
Puriri	1.0	1	2008	2008
Rimu, Matai	1.8	1	2012	2012
Podocarpus totara	6.1	3	2008	2019
Ornamental species	0.3	1	2012	2012
Mixed species	19.3	37	1985	2013
Total	**913.6**	**387**	**1929**	**2019**