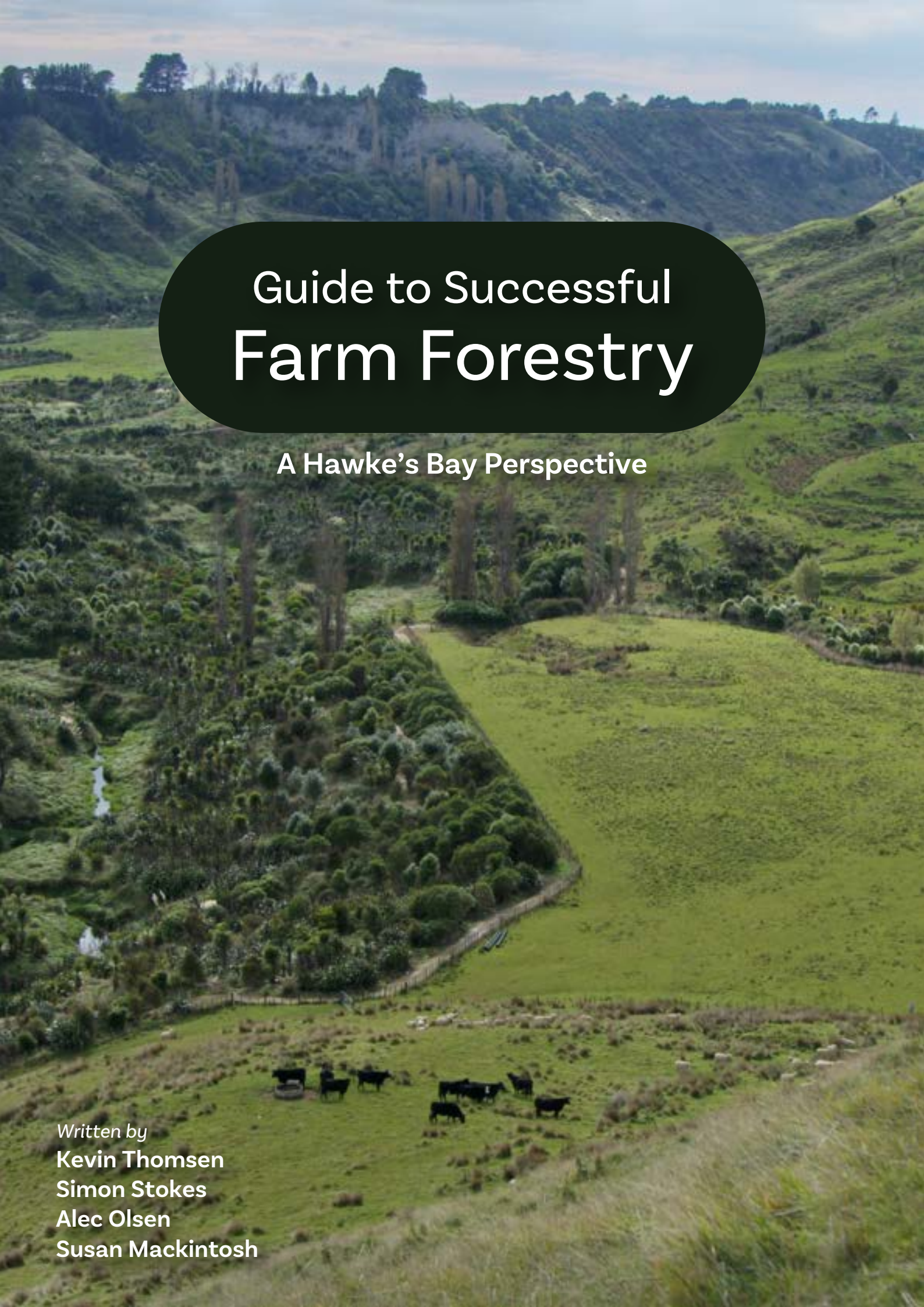

Guide to Successful Farm Forestry

A Hawke's Bay Perspective

Written by
Kevin Thomsen
Simon Stokes
Alec Olsen
Susan Mackintosh

This book is dedicated to

Chris McGillivray
Garry Glazebrook
Jack Nicholas

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Foreword

The Honourable Sir Rodney Gallen KNZ

My grandfather travelled on the first passenger train from Napier to Dannevirke, and remembered that the train passed through native bush for almost the whole journey. That bush stretched well into the Wairarapa and was be believed to be inexhaustible. By the time I was a schoolboy in Central Hawke's Bay it would have been hard to find more than traces of it, either from the railway, or the road.

Making a living for the early settlers from Europe meant disposing of the bush which had, for them, little value in itself, interfered with farming, and presented an ever present threat. Very efficiently, they turned it into grassland.

By the middle of last century, many farmers took the view that a tree or trees in a paddock meant less sheep feeding. Because animals camped in their shade, they were said to encourage the spread of disease. For these reasons remnants of bush, and even exotic trees planted by homesick settlers, were removed from farms, and survived if at all, in many places, only in the vicinity of homesteads.

Times and attitudes have changed. Trees are coming back. There are good economic reasons for this, survival depends on the best and most efficient use of the land, and the planting of trees for forestry purposes is now seen as a valuable longer term use. The Farm Forestry Association and the publicity and encouragement it has given to the planting of trees is at least partly responsible for this, but there are other reasons as well.

Successful farmers have a close, and in most cases, long term relationship with the land. Its well-being is a constant concern for those who care about where they live and farm. Problems of erosion, land preservation, river and stream management, and the avoidance of pollution have become important in a world which is shrinking and where the thoughtless actions of some can have great effects on others.

Just as importantly aesthetics and amenities have become important. A pleasant, wooded landscape is a better place to live and work. Many farmers hope to leave the land with which they have a relationship better than they found it.

Ecological balance has also become important, and there is now a knowledge of the effect that every part of the environment has on every other. We are a part of that ecological balance and have an obligation not only to understand it, but to preserve it. If we do not there will be little for others to inherit.

Trees play a significant part in all these objectives and their return to the landscape will only occur in a successful way if we assume the responsibility to bring them back. For this we need skill and understanding in selection, planting, and care of the trees we introduce.

The Farm Forestry Association has been in the forefront of the accumulation and passing on of this knowledge. The Hawke's Bay Regional Council, The Landcare Foundation, Ministry of Agriculture and Forestry (Sustainable Farming Fund), New Zealand Landcare Trust and Pan Pac are to be congratulated for supporting this publication.

I expect most people like me will look first at that section which includes the land in which they are interested, but will then look on to other areas to make comparisons.

The availability of this book will help all those of us who want to restore trees to their essential place in our province, and help too to avoid those often costly mistakes which come from moving forward with an inadequate knowledge of what is best for our own particular area. As one who has made mistakes I welcome this book, but it is interesting in itself and will I hope lead on to the return and increase of trees in our environment.

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Eileen von Dadelszen

Hawke's Bay Regional Council Chairman.

On reading this Guide to Successful Farm Forestry: A Hawke's Bay Perspective I was reminded of Albert Schweitzer's saying: "Example is not the main thing in influencing others. It is the only thing."

For throughout this publication shines through not only knowledge from scientific study but also the experience of many individuals over years in implementing the practice of farm forestry in the Hawke's Bay region. These experiences act as excellent examples to everyone (dedicated professional or interested amateur) on how to go about the business of planting trees in our region. From the useful opening "How To Use this Guide" through the chapters dealing with identification of zones, tree information, establishment and management techniques and practical appendices, glossary and bibliography, plus copious photographs and illustrations, this Guide will leave little unsaid about tree planting in Hawke's Bay.

I am delighted that the Regional Council with its responsibilities has been able to be associated with this publication. The examples displayed in this Guide will encourage others to plant (with knowledge) more trees leading to sustainable improvements to land, enhancement to the water quality of rivers and streams as well as an increase in biodiversity and subsequent numbers of our native birds.

Congratulations to all involved!

Nick Seymour

New Zealand Farm Forestry President.

When I first heard that this book was being contemplated by the Hawke's Bay Branch of Farm Foresters and who was involved I knew that it would be good. On reading the final draft, it is exceptional, very thorough, providing useful and practical information on commercial forestry, woodlot species, soil conservation, gully erosion and shelter belt species that grow well on the numerous soil types and managed riparian areas of Hawke's Bay.

The book is a comprehensive guide to allow tree planters to make informed decisions with references and comments from Hawke's Bay's many experienced farm forestry practitioners. Soil types have been identified with detailed rainfall maps and tables of trees suited to those specific environments.

This is a unique and timely reference guide and work book. It includes photographs of tree planted landscapes and tree species that should inspire many new 'tree planters.'

I commend the writers for all their research, time and effort that has gone into producing such a practical and useful book, also the sponsors too that have contributed to its successful publication.

The vision of the Hawke's Bay branch committee has always been of a landscape enriched with trees. This book makes a significant contribution to assist all landowners to reach that goal.

Acknowledgments

The writers wish to acknowledge the significant contributions and assistance from the many whose love of trees and passion for wise land use is reflected in the following pages.

John Aitken
Peter Arthur (Touchwood Books)
Ashley Cunningham
John & Heather Dean
Joe Devonport (H.B.R.C. Napier)
Mike & Helen Halliday
Tom & Dora Hartree
Robin Hilson
Kip & Esther Holt
Bill Lawrence (Paddockwood Nursery)
David Manktelow (Hort Research)
Peter Manson (H.B.R.C. Wairoa)
Tim Parker
Geoff Prickett
Quentin Roberts
Ed Saathof (Pan Pac)
Marie Taylor (QEII National Trust)
Gavin Wright (Pan Pac)
Hawke's Bay Farm Forestry Association Branch Committees 2002/2003/2004

The research, writing and publishing of this book would not have been possible without the generous financial assistance provided by the following organisations:

Hawke's Bay Regional Council
Hawke's Bay Branch NZFFA
M.A.F. Sustainable Farming Fund
Landcare Foundation (Hawke's Bay)
Pan Pac
New Zealand Landcare Trust

Tree Species Survey Respondents:
Peter & Diane Arthur
David Bryant
John & Heather Dean
Joe Devonport
Garry Glazebrook
Ross & Margaret Haliburton
Mike & Helen Halliday
Tom & Dora Hartree
Robin Hilson
Philip & Robyn Holt
Michael & Carola Hudson
Graham & Susan Mackintosh
Hugh McBain
Chris McGillivray
Ewen McGregor
Peter Manson
Vin Merwood
Jack & Agnes Nicholas
Malcolm & Rohan O'Dwyer
Alec Olsen
Peter & Elizabeth Ormond
Willie Peacock
Geoff Prickett
David Rumball
John Russell
Helen Swinburn
Kevin & Bev Thomsen
Hans & Jenny Weichbrodt
Bill Whittle
Steve Wyn Harris

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Introduction

Imagine a hillside covered with trees providing shade and shelter for the adjacent pasture and animals, and also preventing erosion and improving the water quality. It provides a habitat for birds and food for bee and beast (including us!). In time, there will be trees to harvest providing cashflow and security. What price the beauty? A salve for the soul of a passing farmer with worries on his mind. This is farm forestry at its best, not just "killing two birds with one stone", but ten.

Farm forestry developed from farmers' natural conservation instincts, and for the sheer love of living with trees. Neil Barr, a farmer from Kaukapakapa, formalised this concept in 1950, when he and some like-minded friends formed the Farm Forestry Association. The Hawke's Bay Branch came into being on 23rd April, 1956, under the leadership of Meyric Williams, Alec Rainbow and Maurice Chambers, and today has about 230 members. Nationally, the Association has 28 branches and more than 3000 members.

It is no accident that Pinus radiata is the main species planted in Hawke's Bay as it performs reliably in most situations. However, it is the want and wisdom of farm foresters to plant a diverse range of species, most of which are more challenging in their requirements. The knowledge to successfully match needs, species and site usually takes many years to gain. Unfortunately, years are wasted making mistakes, and either getting out the chainsaw and starting again or living with trees that are handicapped by site or disease. As novice tree planters we are powered by enthusiasm and dreams, but how we longed for a simple short-list of reliable species choices for our special situation, in our special part of Hawke's Bay. This book provides those lists!

Garth Eyles, leader of Hawke's Bay Regional Council Land Management team, had been concerned for some time that the collective wisdom and experience of our region's senior farm foresters was not readily accessible to prospective tree planters. So, we agreed to research and write this book. Its aim is to provide lists of the most reliable species for the different planting situations on farms within each of the fourteen zones (based on soil and climate variances) that make up Hawke's Bay farmland. Application of these options should minimise planting disasters and the consequent waste of money, years and enthusiasm. These lists should also lead planters to select a range of species that they might not otherwise have considered. For experienced farm foresters, this book still has much to offer, especially the detailed information on Hawke's Bay's soils, and regionally specific details on the various species.

While the essence of this book is to promote successful establishment of trees for new planters, the exclusion of certain species doesn't necessarily mean that they would always fail, as it is impossible to cover all the isolated microclimates, plus the one-off varieties from unique seed sources. For example; Thuja plicata and Cupressus macrocarpa have a poor track record in Hawke's Bay and we don't recommend these species. However, in special circumstances, skilled planters do make them grow and thrive.

This book is the captured wisdom and experience that gave us the confidence to create definitive lists of species, and we thank the contributors most sincerely for their efforts. Especially treasured are the comments from Chris McGillivray, Garry Glazebrook and Jack Nicholas who passed away before the book was published.

Hawke's Bay Farm Foresters - this is your book, written from knowledge created by your efforts and observations in the field. We are also indebted to the Hawke's Bay Regional Council for their financial and moral support, and the in-house technical expertise that made such a difference to the finished publication. Our thanks to those sponsors who have supported this project with generous donations.

To the new tree planters who use this book, we wish you great success.

Kevin Thomsen, Simon Stokes, Alec Olsen, & Susan Mackintosh

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How to use this guide

To gain maximum benefit from the information in this publication, the following step-by-step progress is recommended:

Step 1 : Identify Farm forestry zones:

Identify your property's zone from the regional map in Chapter 2. Go to the relevant section for that zone and read the information. It is not necessary to read the information in the other zones as each is individually complete.

Step 2 : Identify Appropriate Tree Species:

Select the recommended tree species for your purpose from the tables in your zone.

Step 3 :Examine the detailed information on your selected tree species:

This is found in Chapter 3.

Step 4 :Examine information on tree establishment and silvicultural practices:

This is contained in Chapter 4.

Chapter 1 has information of a general nature that is essential knowledge for any landowner who is considering planting trees.

Region-wide survey results

Appendix II is a list of the most popular tree species collated from a survey of experienced farm foresters within the Hawke's Bay region. Included are the property owners' names and localities. This information has been used as a guide to write this book, and it may also reinforce recommendations for particular areas or sites.

Further Information

For further information on the New Zealand Farm Forestry Association contact www.nzffa.org.nz . This will always provide contacts for the local branch committee and other extensive information. Obtain a copy of the NZFFA information leaflets to further your knowledge.

Farm Forestry

Since the very first Hawke's Bay Farm Forestry Association field day held at 'Tuna Nui', Sherenden, in 1956, farm foresters in Hawke's Bay have planted trees for many reasons. Many farms are now reaping the rewards from those initial plantings, including winning environmental awards for land use and sustainability. It is of no coincidence that the needs of farmers today are similar to those of farmers gone before, although the reasons for today's plantings may be more geared towards long-term sustainability. It is a learning process - planting trees - and you keep learning, as trees continue to require care and Figure 1: Hawke's Bay Region management throughout their lifetime.

This chapter discusses Hawke's Bay's resources and climate as they relate to farm forestry, and then looks at the current farm forestry practices, outlining their usefulness to the farmer. Finally, the chapter covers some of the broader issues, considering how they affect you, the farm forester. The aim is to provide you with sufficient knowledge so you can understand and benefit from the remaining chapters.

Figure 1: Hawke's Bay Region

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Hawke's Bay

Landforms

The unique physical attributes of the Bay can be both a blessing and a hindrance to the farm forester. It is a landscape developed from erosion and deposition, mostly from the rocks that formed the backbone of the North Island many millions of years ago, and volcanic influences. The Ruahine, Kaweka, and Huiarau Ranges frame the western fringe of our region. The Pacific Ocean runs along the eastern boundary. In between is a mix of marine sediments that range from massive depths of mudstone, interbedded layers of sand, silt and volcanic material, sometimes overlain with limestone from previous reef environments. In some places on your farm, you may find extremely soft sand where there was once a beach or river, or marine gravels that were eroded from the main ranges and redeposited in the sea or along the river margins. One of the farm forestry zones is based on argillite, a rock created by sediment being deposited into a marine environment at such depth that all the nutrients were stripped, leaving nothing but clay fractions. Though the underlying bedrock may appear to be the same throughout your farm, it is highly likely that there will be some subtle changes of which you need to be aware.

Another interesting aspect of our region is the effect of past and recent earth movements. Tectonic upheaval has shaped Hawke's Bay, folding and faulting the land and creating large block slides and structural collapse of the bedrock. Many lakes are a result of these failures, including Tutira, Waikaremoana, and the Putere lakes. There are also some famous slumps, such as Ponui Stream, the Rosewood and Waipoapoa slumps, and the Ngaroto Slump on the edge of the Tutaekuri River.

The most important thing for you to remember as a farm forester is that the differences in the landscape are extremely relevant to farm forestry needs.

Materials, such as wind-blown silts and volcanic tephra, have been deposited over the top of the land, adding to the interesting mix of landscapes. Over a large portion of Northern Hawke's Bay Farm Forestry Zone, there is such a depth of volcanic material that it overrides any influence the bedrock has on use and soils. Spectacular depths of water-sorted Taupo flow tephra hide in the terraces in the hinterland, only exposed by an errant blade or massive gully collapse caused by rainfall. However, where ash remains, it is usually on stable areas irrespective of slope, otherwise it would have been eroded in the past.

The Ngaruroro River winding its way through three farm forestry zones: the Mountainlands, Volcanic Foothills and Loess. Pigsty Swamp is in the foreground and Whana Whana terraces on the right. Source: ***James Lawson***

Significant influences

Most bedrock is tilted eastwards; very little is horizontal, and even less is tilted westwards. So altitude changes gradually from seashore to hinterland with some exceptions in between. Very little of Hawke's Bay is over 600m above sea level. Above this, the climatic changes are significant, making farm forestry in these areas very specific and restricted. Most of Hawke's Bay's mountainous areas are still clad with indigenous species. The climate and soils of Hawke's Bay are special in that they clearly define the growing environment. The two things needed for growing trees are rainfall and soil; limitations to either of these can seriously affect the growth of your trees.

Rainfall

Most of Hawke's Bay is notorious for its variable seasonal rainfall hence the wet/dry seasonal extremes. Within a very short distance, the annual rainfall can vary dramatically. For example, the Maraetotara area can often receive around 2000 mm per annum, whereasthe nearby inland Tuki Tuki valley may receive as little as 550 mm per annum. Some farmers keep excellent rainfall records that are a wonderful resource for your area. Contact them for a local guide on rainfall. In each Farm Forestry Zone, we provide a rainfall map showing the isobar lines with annual averages. The annual spread of rainfall is more relevant, but this data is not available.

It is generally accepted that the split between summer dry Hawke's Bay and summer moist, or sufficient annual rainfall, is at 1000-1200 mm. The band of country that receives sufficient rainfall runs roughly parallel with the ranges and is bounded in the east by a line between Nuhaka, Otamauri and Norsewood.

However, even this area is subject to severe dry periods at times. These severe dry periods occur roughly once every ten years and have a prolonged effect on the summer dry parts of Hawke's Bay. While many tree species grow extremely well in our climate, when drought occurs, some of these trees will not cope with the severe soil moisture deficits. For instance, the drought of 1998 killed some varieties of Eucalyptus aged around 12 years old. Therefore, it is important that you take drought, or more relevantly, soil moisture availability into consideration. Remember that on your farm, there will be times when you may want to plant a tree on a very tough site, regardless of annual rainfall or soil depth. It should also be remembered that drought periods can occur at the most inopportune times, such as from September to Christmas, just after trees have been planted.

Lake Waikapiro at Tutira in a storm event. Source: ***Blue McMillan***

The drought of 1998 on 'Marlow Hill', property of S & J Wyn Harris, Hatuma. Note how well the trees stand out during such an extreme climatic event. Source: ***Simon Stokes***

Frost

The results from the questionnaires sent to Farm Forestry members indicated that frost is a common problem, and is seen as an important limitation to growing trees. The risk of damage from frost is not influenced directly by altitude, and visual 'whiteness' is not necessarily an indicator of the coldness. The main factor for frost is the natural landform that influences air drainage and wind patterns. Research has established that a significant amount of damage from frost occurs when sunlight shines on the frozen foliage, resulting in photo-bleaching.

To determine where a frost will occur on your farm, think of cold air as water and consider where it will flow to and pond. Cold air is heavier than warm air, so it flows downhill. The valley bottoms, lower slopes, and flat land have the greatest risk, especially when naturally or artificially sheltered. This ponding effect is a serious contributor to plant damage.

The most common type of frost is known as a **groundfrost**. This occurs when the frozen air is restricted to close to the ground. A second type of frost is an airfrost. This occurs when an extremely cold air mass moves in to cover the ground. Trees on slopes usually safe from groundfrost can be damaged or killed by an airfrost. The frost prevention techniques of orchardists using wind machines and helicopters do not work. In fact, they can worsen the situation by blas-tfreezing plants with frozen air!

Frost can be one of the most damaging climatic events on some tree species. This photo shows young olive trees protected from a -8 OC frost by irrigation. Source: ***Kevin Thomsen***

There are a number of other factors influencing frost damage:

- A persistent wind can reduce the risk of frosts.

- The time of year is important as even a light out-of-season frost will be hard on most plants. The risk can be reduced by using container grown seedlings, as these may be planted after the greatest risk of frost has passed.
- The origin of the species is important as the genetic hardiness of the plant is affected by its home climate. Different seed sources (provenances) of the same variety can have quite different hardiness ratings.
- Finally, aspect and slope affect the severity of frost. Steep northerly slopes are generally the warmest and, therefore, more suitable for planting with high value trees that are intolerant of frost (as long as severe wind is not a limiting factor).

Frost is always a risk in Hawke's Bay because the region is exposed to the southern ocean climate influence. Cold southerly wind can blast-freeze and kill trees even in places where frost does not pond. Fortunately, this is rare with mature trees, but it can check or kill newly established trees.

A recently released assessment of frost risk in the grape growing areas of Hawke's Bay (NIWA, 2003) highlighted some interesting points. For instance, frost risk is highest in the El Niño climate phase, when more frequent, cooler south-westerly airflows predominate in spring. (The spread of risk also increases from September into October.) The La Niña springs reduce the risk of frost. At the sites analysed, it was significant that there was a large variability in frost incidence depending on the site. A frost may strike on one area of a farm, but be less damaging elsewhere.

Wind

In many areas of Hawke's Bay, wind is the greatest inhibitor to growing quality timber trees and different varieties of trees. It is such an important limitation that each Farm Forestry Zone (Chapter 2) has a section on wind sourced from information collected over the years. The dominant feature of Hawke's Bay wind is that it prevails from the west or northwest and is strong, particularly during the spring equinox. The soil moisture deficits are aggravated by accelerated evaporation on windy days,leading to drought-like conditions. Any steep, shallow soils on a north to northwest slope will quickly dry out, affecting the trees' performance. Potential rooting depth for trees is also an important issue on windy sites as deep roots provide stability for trees to resist wind-throw (toppling). In some planted areas, the windward trees are sacrificed to provide a buffer for the remaining trees. An example of how serious a problem wind can be is related to one of our toughest species. On steep, exposed sites, P. radiata can be marginal and experience shows that these trees should not be pruned, as the resulting timber quality will be poor due to stresses of constant wind. A tree may look reasonable, but the timber is likely to contain resin pockets and other invisible problems. A no pruning regime creates another series of issues that need to be considered.

Wind eroding soil at Maraekakaho in 1998. Source: ***Garth Eyles***

Salt spray

While most of Hawke's Bay has to deal with a prevailing west to northwest wind, the long stretch of coastline has its own problem – the effect of salt spray. In many areas, the effect does not intrude too far inland due to the topography. In areas regularly exposed to the salt wind, the tree species choices are limited. These species are listed in the relevant Farm Forestry Zones (Chapter 2). However, in the event of a storm coming from an easterly direction, the effects can be severe even in areas not normally affected. Tree foliage is burned by the salt wind and the leaves fall prematurely. Even normally hardy species can have the exposed side stripped. They will recover, although, over a number of exposures, they will have a lopsided shape. The blue strain (Glauca) variety of conifers seem to be more tolerant of salt wind exposure.

Salt-wind burn on the foliage of trees on George's Drive, Napier during late summer, 2003. Source: ***Kevin Thomsen***

Soils

The health of the soil is an important factor when growing trees. The following list covers the technical characteristics of the soil that should be part of a forester's examination of a potential forestry site. Many soil characteristics are interlinked; for example, a shallow rooting depth, in some cases, will mean low soil moisture reserves and a high drought potential. A grey colour may mean a high watertable, which results in shallow rooting depth due to wetness and low temperatures. So don't look at each soil characteristic in isolation.

Appendix I contains more specific information on each soil order found in Hawke's Bay. Significant soil characteristics include:

- physical characteristics, texture, structure, type and general location in the landscape
- drainage (linked to providing a soil water balance)
- moisture availability (linked to providing a soil water balance)
- potential rooting depth

The soil's **physical characteristics** affect its ability to grow plants. Soil texture influences the way plant nutrients behave in a soil, the development of the soil structure, and the ease with which a soil can be cultivated. Soil structure refers to how the soil is held together. Combined, these two provide some indication of soil porosity (pore space or air holes), bulk density (relates to soil compaction), and consistency (plasticity). Information on other characteristics such as soil temperature and aeration, and possibly chemical status, will help with making management decisions on issues such as trace element availability and nutrient deficiency. Remember, the soils will vary across your property.

A version of the Poporangi soil found throughout mid-Hawke's Bay, with gravels deposited over loess giving a false impression of a soil with good drainage ability, when, in fact, water will perch. Source: ***Simon Stokes***

Soil drainage is probably one of the most important soil characteristics to be aware of for trees and probably one of the easiest to understand. Basically, soil drainage refers to how quickly, and how much, water is removed from soil. It refers to the frequency and duration of periods when soil is not wet. Soil drainage is determined by four important factors:

- input into the soil from rainfall, irrigation, seepage, and run off
- the flow of water through the soil to exit points (permeability)
- outlet from the soil or field drains to receiving environments
- the level of cultivation or compaction that has occurred, possibly affecting drainage. Sometimes, soil colour is closely linked to drainage and is a good indicator of soil drainage patterns. For example, poorly drained soils are often grey in colour.

The Gisborne soil formed on volcanic layers found in the Wairoa area, in this case on Tukemokihi Station, with excellent physical capabilities. Source: ***Simon Stokes***

Soil moisture availability is complex. Put simply, within the soil there is a capacity to store water. Water is lost through transpiration from foliage, and evaporation from the soil (known as evapotranspiration), runoff and drainage. Water is gained by rainfall or artificial means through infiltration into the soil. The difference between the gain and loss is the soil water balance. Moisture availability is important if you live in areas prone to soil water deficits. Soil moisture availability is affected by soil type and depth, as well as climate (rainfall, wind, sun), slope and aspect. For example, on steeper slopes, soils are generally shallower and soil moisture levels lower, particularly if the slope is facing north or west. In Chapter 2, for each Farm Forestry Zone, the average annual rate of evapotranspiration is provided, along with the average annual rainfall. This gives you a reasonable picture of the soil water balance in your area and will help you determine the selection of tree species for your property.

The last soil characteristic is **potential rooting depth**, which is the available depth of soil for your trees to grow. This is important, as soil depth will have an effect on tree growth and survival and other soil physical characteristics. There will be sites with soils that are too shallow, such as some of the Recent Order slope soils on mudstone, siltstone, or sandstone, and this may cause problems like toppling or low soil moisture stress.

Pallic soil (Matapiro series) showing the duripan limiting rooting depth, on Nicholls Rd, south of Waipukurau. Source: ***Simon Stokes***

Farm forestry practices

The reasons for practicing farm forestry are many and vary from property to property. In the words of one of the authors, Alec Olsen: "the joy of farm forestry is that you can satisfy a number of objectives simultaneously". Farm forestry practices in Hawke's Bay haven't changed for many years.

Reasons for planting trees include:

- commercial forests and woodlots – for timber production
- soil conservation – erosion control of slopes and gullies
- shelterbelts providing stock and crop shelter and wind erosion control
- riparian management including wetland protection and enhancement
- shade for stock
- amenity planting
- indigenous forest preservation and enhancement

As the quote above testifies, each type of farm forestry listed may also provide other benefits, such as a source of fodder in times of drought, food for birds and bees, firewood,and on-farm timber use for yards, bridges and buildings. Trees also provide some solutions to current issues, such as protecting stock from storms and sun. They absorb carbon and other gases and ground based contaminants on your farms.

Farm forestry at its best, looking at gully planting, indigenous forest areas, woodlots and shelterbelts, on 'Falomai' R & M Thomsen, Hendley Rd, Patoka. Source: ***Jonathan Barran***

Planning

There is one aspect of farm forestry that is often overlooked - planning. We cannot overstate the importance of this and it is the foundation upon which we build this guide, as shown in Chapter 2.

Planning farm forestry will ensure that your farm gains maximum benefit. One of the best places to start is assessing the productive capability of the land for cropping, pastoral, forestry, retirement, and other uses. Many farmers understand this and, in most cases, the landscape will dictate use. However, sometimes there is a need to have that practical knowledge reinforced. One technique used is a Land Use Capability assessment that has provided the backbone to farm plans for many years in Hawke's Bay.

It looks at rock and soil type, slope, erosion potential, vegetation, climate, and current land use. Farmers use this technique, currently offered by the Hawke's Bay Regional Council and others, to make better decisions about the type of land use both short and long-term. It is an ideal way, for example, of locating potential commercial forestry and woodlot sites and estimating erosion control requirements. After you have completed this assessment or have looked at your own farm critically, you need to outline your farm forestry activity plan. This is important, because farm forestry has a cost and a long-term management requirement, such as shelterbelt trimming or a clearwood silviculture programme, for which you need to budget. The other benefit of farm forestry is its potential for long-term family succession planning.

This guide does not discuss in detail the access and harvest issues associated with commercial forestry and woodlots, as these are areas that require professional expertise, but they are both very important planning areas. If your objectives include growing timber for sale then make sure you discuss these issues with an advisor to give you some early indication of the benefits and problems of the selected sites. These issues are not just limited to forestry plantings either; some farms require helicopters to transport their erosion control trees to site due to poor access. And remember, planning is not just about the items listed above, as there are also peripheral issues. Will a shelterbelt shade the road? How much land is lost keeping the forest away from power lines? Can you afford fire insurance? You also need to check with your local authorities to ensure you know what their planning requirements are and what rules are applicable. (More details later in this chapter.)

Commercial forests and woodlots

Farm foresters establish commercial forests and woodlots to produce timber for sale, usually over a long time scale. Our distinction between a commercial forest and a woodlot is that the commercial forest is grown purely for sale while a woodlot refers to a block of trees that may serve more than one purpose, usually involving a variety of trees species. The term woodlot is also used to identify a small block of trees grown for timber sale, if it isn't large enough to be called a forest. The basis for establishing a forest option on your farm is a business one aimed at profit, usually in parallel with maximising productivity from land with marginal pastoral use. It is often used for providing another form of retirement income or establishing an income base for members of the family. In Hawke's Bay, the species currently used for commercial forestry is Pinus radiata. Other species have been planted, but mostly at woodlot scale, such as Eucalyptus, Douglas fir, and Cupressus species.

There is a strong foundation for investing in commercial forest or woodlots in Hawke's Bay as there is a port, a large processing plant, and an acknowledged, successful forest industry. The authors have also targeted some indigenous species for timber. While there is limited knowledge and experience on relatively large-scale plantings in the region, there is strong

potential for their use.

Be prepared to seek professional help for commercial growing, as there are many things you need to know. Get the species right, establish the trees well, manage for clearwood, ascertain access and harvest issues, insure, and record.

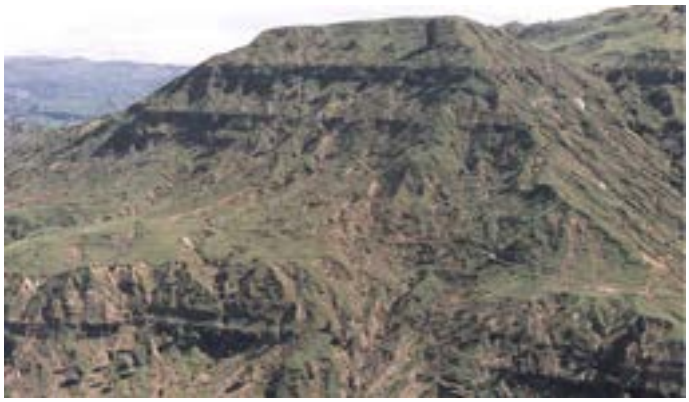
Pinus radiata near and far, pruned and growing well on volcanic soils in the Northern Hawke's Bay Farm Forestry Zone. Source: ***Jonathan Barran***

Flitching on site - rimu (Dacrydium cupressinum), with an 'Alaskan' technique. Source: ***Simon Stokes***

Soil conservation – erosion control

Historically, soil conservation has been an issue in Hawke's Bay. It was the 1938 Esk storm that forged the creation of the Soil Conservation and Rivers Control Act (1941), and focussed New Zealand on its erosion problems. Hawke's Bay farmers have long been involved in soil conservation, specifically erosion control of slopes and gullies, and preventing wind erosion. In each Farm Forestry Zone, we allocate a section to erosion control on slopes and in gullies, with wind erosion covered under "Shelterbelts".

Slope erosion is the movement of soil downslope, commonly as a soil slip, earth slip or earthflow. An extreme bedrock collapse is called a slump or large earthflow. Spaced planting of conservation trees or afforestation controls slope erosion. The tree species mostly used are poplar and willow because they can be grown in a nursery, then harvested as stakes or poles and planted in a paddock, often in such a way that grazing can continue. This is why 3 metre poles were developed (they are often termed 'cattle poles'). If stock grazing is not going to occur in the short term or at all, the range of tree species that can be grown increases and we list those options in Chapter 2.



An example of severe soil slip erosion in the Tangoio Farm

Gully erosion is the removal of soil or soft rock material by water. Erosion types associated with gully erosion are rill, tunnel gully and streambank. It is effectively controlled by planting; with trees planted in single file or paired along and across the gully floor, with afforestation of the entire gully, or by using other techniques such as debris dams and block plantings. To control active gully erosion, trees need to have a vigorous root-mass to bind soil and an ability to survive moist to very moist conditions, which is why we use the willow species. Less eroding gullies may be controlled by a variety of species (listed in Chapter 2). Sometimes the trees planted will not be harvestable due to the type of species or the difficulty of the terrain. Stock should be removed permanently from many gully planting sites, allowing an increase in the variety of species that can be planted. If the erosion level is extreme and the area large, then P. radiata may be the best, most cost-effective species to implement erosion control. A healthy pasture cover is important in protecting against gully erosion. Deciduous trees are the best choice or a variety that can be pruned to maximise light penetration.

An example of conservation tree planting to reduce gully erosion. Source: ***Sally Hobso***

Shelterbelts

Hawke's Bay farmers have planted many shelterbelts over the years. Strong wind and cold weather occur often, and some of our soils are extremely vulnerable to wind erosion. Shelterbelts provide an effective solution to wind erosion by reducing wind strength and flow. They shelter stock, crops, buildings, yards, and other tree plantings. They can also be a source of fodder during droughts. The use of conservation tillage techniques lowers the wind erosion risk, but shelterbelts are still needed to minimise other effects, such as moisture loss from plants and soil, and crop damage. They can act as a visual barrier, and reduce spray drift.

An example of the effect of wind erosion on Takapau soils, burying a fence at Mangleton. Source: ***Hawke's Bay Regional Council***

The most important aspect of shelterbelts is that they require management to provide long-term effective results and to ensure they do not become a nuisance when they are mature.

Shelterbelts are planted as single or multiple rows of trees and there are many different designs. The design selected will depend on the location and objective of the shelterbelt. For example, do you want the shelterbelt to form a barrier to strong winds or an east-west configuration of dense shelter to protect stock? These factors will influence species selection, width and length, and maintenance methods. Shelterbelts have also been seen as a means of growing timber trees in single or multiple rows. There have been many attempts at this in Hawke's Bay, sometimes as double and triple row systems. However, over the years, it has become clear that both tree growth and timber quality are compromised. Any attempt at growing timber in a shelterbelt needs to be well researched in relation to the site and species used.

Shows the different requirements for shelterbelts; an evergreen shelter running north to south to maximise wind protection, with a deciduous shelter running east to west, more open for light. Source: ***Trees on Farms Booklet. Environment Waikato***

An example of a well maintained, trimmed section, single row indigenous shelterbelt of Pittosporum eugenioides running north to south. Source: ***Simon Stokes***

Primary shelter is sited to reduce the effects of severe wind and needs to contain tree species that are able to tolerate the stresses

on stability, form, branch breakage and accelerated evapotranspiration. Primary shelterbelts generally will run north-south with subtle variation in Hawke's Bay reflecting the dominance of the west and northwest winds.

Secondary shelter is used when the winds are less severe due to topography or the prior establishment of primary shelter. More species are suitable for secondary than primary shelterbelts. However, stability will be important in areas occasionally subjected to strong, gusty winds. Secondary shelter will also run mostly north-south but can also be at right angles to the primary shelter, i.e. running east-west.
A general recommendation is to use deciduous species in an east-west shelterbelt and an evergreen mix in a north-south shelterbelt.
By doing this, adequate sunlight is allowed through, reducing the shading effect.
There are numerous methods for establishing effective shelter. The references Palmer et al (2003), Smail (1997) and Tombleson et al (1995) listed at the end of this chapter cover a selection of these methods.

An example of a north-south running shelterbelt of Eucalyptus delegatensis and Cedrus deodara.
Source: ***Jonathan Barran***

Riparian management

Riparian management covers areas that adjoin streams, rivers, wetlands and lakes. In Hawke's Bay there is a large variation of riparian types due to landscape, land use and vegetation, and each area needs its own management. Riparian vegetation shades and feeds these waterbodies, protects the banks from erosion, and filters surface and groundwater passing through or under them. Riparian vegetation is usually uniquely suited to the zone between aquatic and terrestrial ecosystems. It is important to remember that the composition and extent of replanted vegetation will influence how well your riparian area functions. In most cases, a revegetation programme is not only built around regenerating a former natural state but focuses on solving some of the issues associated with the riparian area and the adjacent paddocks.

Protection and planting of riparian areas can serve a number of useful functions. It will:

- create a 'buffer zone' that filters groundwater and surface flow contaminants, thus im
- proving water quality of the waterway provide shade to reduce the water temperature add debris to the waterway, creating habitat for stream insects and fish
- restrict stock access to the waterway
- add to the local biodiversity
- reduce the impacts of adjacent land use on the water quality
- provide shade and shelter to the stock, and shelter for crops in adjacent paddocks
- reduce the potential for liver fluke

Contaminants enter watercourses via two paths: surface or ground water:

- Rainfall can result in surface runoff or erosion, allowing soil particles to enter the watercourse. Attached to these particles may be fertiliser, nutrients or chemicals, and animal excrement that may contain bacteria such as *E. coli* and Campylobactor, and salmonella.
- Ground water movement can pick up and carry nutrients, chemicals and sediment below the surface and deposit the material into a receiving watercourse. Ground water movement is complex, being affected by many variables such as soil type and drainage patterns.

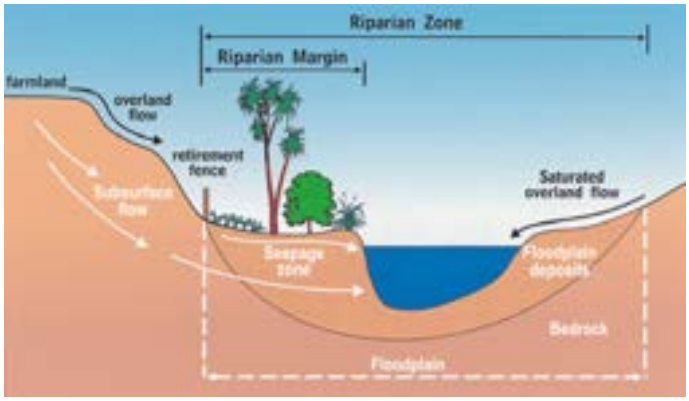


Diagram showing riparian zone and waterflow.
Source: ***Hawke's Bay Regional Council Environment Topic ET:LM:RM1 Sept 1999***

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Classic example of good riparian management.
Source: ***Hawke's Bay Regional Council Environment Topic ET:LM:RM1 Sept 1999***

Each of the Farm Forestry Zones (Chapter 2) providesa list of suitable tree species for riparian planting, mostly indigenous. However, there are some exotic options that provide solutions to particular problems. On most Hawke's Bay farms, there are small watercourses that become very wet during winter and spring but dry out in summer. Some farm foresters have been fencing these with one electric 'hot wire', sometimes temporarily, to keep cattle out. This still allows grazing to control pasture when and where it is suitable. In this case, the essential riparian management factors are grass cover and reduced stock access which reduce surface and groundwater problems.

An example of a recently established double 'hot-wire' fence along a stream – keeps cattle out, allows sheep to graze, and reduces the potential for costly flood damage.

It is important to assess your riparian areas carefully to ensure your management will achieve the end result you desire. It may merely be necessary to use a 'hot wire' to keep cattle out, as sheep will generally leave long, ungrazed pasture alone, especially if they have access to good quality pasture. However, if you intend to revegetate an area, either through planting or allowing natural regrowth, you will need to install a stock-proof fence. There is a very good guide listed at the end of this chapter, titled Managing Waterways on Farms: a guide to sustainable water and riparian management in rural New Zealand.

Wetland management is sometimes included in riparian management programmes on farms. However, wetland management can be quite specific and requires some quite different techniques. Sadly, a large proportion - more than 90% - of the original wetland areas of Hawke's Bay has been lost. Areas of shallow water and swamp provide excellent habitat for waterfowl, aquatic insects and fish. Owning and developing an asset like this adds a new dimension to the beauty of the property. Views that include water are enhanced. It is a rewarding challenge to source and establish a range of indigenous and exotic plants that suit wet areas, providing sustenance to birds and animals and improving the views. If you want to create, enhance, or protect a wetland on your farm, contact Hawke's Bay Fish and Game, Department of Conservation, Hawke's Bay Regional Council, or a local experienced farm forester.

A wetland containing indigenous remnants, fenced to exclude stock and enhanced with extra planting, makes an attractive view on 'Falomai' Hendley Road, Patoka.

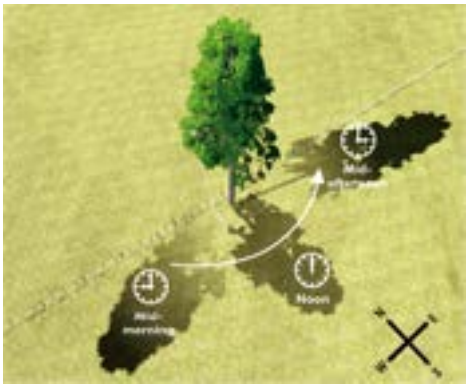
Amenity planting and shade trees

Each of the Farm Forestry Zones in Chapter 2 contains a list of species that will provide amenity features and/or shade. We have selected only those species that can withstand being planted individually in an open paddock in the conditions of the particular zone. On more favourable sites the choices will be much wider. However, all tree species will require adequate stock protection.

Amenity shade planting results in a very attractive scene in the autumn on Paterson's property Hendley Road, Patoka. Source: ***Kevin Thomsen***

Amenity plantings can provide a number of benefits such as shade for stock, shelter for buildings and stock, and enhancement of the landscape. When planting for amenity or visual effects, attempt to picture what your efforts will look like in 20 years' time. Some factors deserving consideration are:

- Spectaculargeological formations may be best left clear of trees.
- Where possible, do not plant long straight edges. This is not always practical, but with some thought, contour planting can be implemented without much extra cost, or edges can be softened with extensions of poplar orsimilar trees. Always complement the natural contours.
- The ideal mix is a mosaic of trees, pasture or crop which removes the effect of monoculture.
- Check with your local District Council on planning zone requirements for your area.



A tall tree with a pruned trunk keeps the shade further out into the paddock, reducing stock camping and encouraging grass growth under the tree. Source: ***Trees on Farms Booklet. Environment Waikato***

For most amenity planting situations, the main aim is to create effective shade and this involves maintaining a good pasture base around the tree to reduce bare ground problems. To achieve this, it may be necessary to prune the tree to a reasonable height as this encourages the stock to move with the pool of shade away from the tree rather than being concentrated at the base. Some of the suggested species will develop bark that is resistant to stock damage. However, stock must never be trusted, particularly horses and deer. Young animals are likely to cause bark damage, especially in the autumn and winter. Some tree species, such as the chestnut, are hardy except for the bark, which may require permanent protection from animals.

Over a 16-year period, Roger Alexander has developed a beautiful wetland from a swamp of overgrown willow and weeds. Near Puketapu village. Source: ***Kevin Thomsen***

Indigenous forest preservation and enhancement

The preservation and management of indigenous remnants and their enhancement is a farm forestry practice that is occurring with more regularity. Farm forestry activities have often coincided with the retention of remnant forest areas by the sheer nature of the farm's landscape. We encourage you to look at your property and see if there are any indigenous areas that you would like to see retained. Often, it is as simple as protecting these areas from grazing animals and allowing natural regrowth. This will allow the current species to continue and keep the site healthy. Of course, there are other management requirements, such as animal and plant pest control, that can require considerable cost and time. Over most of Hawke's Bay there is very little indigenous vegetation left. Native bush only remains fairly extensive in the Northern Hawke's Bay, Upland Pumice, and Volcanic Foothill Farm Forestry Zones.

Beech forest with undergrowth in Pohaturoa Station's Nga Whenua Rahui Whakapunake covenant, Te Reinga, Wairoa. Source: ***Simon Stokes***

The benefits of protecting or enhancing indigenous forest are many, and include: the retention of wildlife habitats, particularly for native birds, insects and animals found in our bush ecosystems; the maintenance of wildlife corridors or islands for species; the eradication of animal and plant pest species from the farm; and the retention of food resources for birds and bees and other native fauna. For example, the provision of winter nectar is beneficial to bee health and possibly even survival. If bees come into spring in good condition, they will have a greater potential through the summer. Landowners depend on bee activity for pasture and crop production.

Protection of your site can be achieved by fencing and on-farm management. However, many opt for covenant protection with an appropriate agency like Queen Elizabeth II National Trust or Nga Whenua Rahui. Some indigenous remnants are very important and may be areas listed as protected natural areas (PNA) or recommended areas for protection (RAP) by the Department of Conservation, or listed in a District Plan as significant for protection. You can find out by contacting the relevant agency. All indigenous remnants protected and enhanced are beneficial to the region.

An agency that will help you protect your bush is the Queen Elizabeth II National Trust. The local QE II Trust representative comments:

Kipper and Esther Holt at 'Maraetara' on Seafield Road, standing above the indigenous forest they have created from pasture over the last 50 years. Many of the trees are now seeding and regenerating. Source: ***Kevin Thomsen***

" Do you have a beautiful gully of bush or an amazing wetland on your farm?"

- If you do, the Queen Elizabeth National Trust may be able to help you protect it in perpetuity.
- The Trust uses a document called an Open Space Covenant, which is a legal agreement between the landowner and the Trust, and which is registered against the title of the land. So if your property is sold, the protection stays in place.
- As well, the Trust may help with fencing and survey costs associated with protecting the natural landscape.
- In Hawke's Bay, the Trust works with the Regional Council to share fencing costs in a three-way split between the landowner, Council and Trust.
- After the area is fenced, surveyed and registered, the Trust has an ongoing relationship to help look after the covenanted area. Trust staff visit every two years to check on the bush and ensure fences are in good condition, and to monitor pest and weed issues and the health of the area."

For more information about the QEII Trust and its work in Hawke's Bay, call (04) 472 6626 or visit the Trust website. www.openspace.org.nz

The Ministry of Forestry/NZ Farm Forestry Association (1998) publication listed at the end of this chapter contains comprehensive information to guide you with indigenous species establishment, management and harvesting expectations, plus the legal requirements for indigenous forest production.

Fodder trees

A large portion of Hawke's Bay is regularly subjected to drought and resulting animal food shortages. Fodder trees provide highly nutritious foliage that can be utilized during these times of stress. Several species of trees and shrubs can be used to feed livestock, usually as supplementary food in times of drought, but also as a dietary supplement to increase production. Willows and poplars are most commonly used because they are highly palatable and nutritious, they vigorously re-grow their foliage, and often simply because they're there! Current research indicates that sheep fed on willow achieve a higher reproductive rate than those fed solely on pasture (McWilliam et al, 2002). We should be seriously considering the potential of specialised fodder blocks on farms, grazed on an annual, biennial, or longer rotation basis.

Other fodder tree options include:

- Plane trees (Platanus species), which readily re-grow following pollarding or coppicing (for a description of this practice, see the Glossary) and have the added benefit of being high in zinc (which possibly mitigates the effects of facial eczema)
- Tagasaste, which thrive on dry areas
- Kurrajong (Brachychiton species), which is a drought-hardy Australian native that can be pruned for fodder.

Erosion control trees and shelterbelts often use species with fodder potential and this can provide a useful back up during a drought. Consider this potential use when you are planning your planting.

"Very popular Fast-Food outlet." Source: ***Alec Olsen***

Trees for birds and bees

One of the quickest and best rewards from planting trees is the increased birdlife. Attracting birds to your property can be achieved within one or two years. Fast growing indigenous and exotic plant species produce nectar, leaf, berries and seed for the birds to feed on throughout the year. The selection available is wide enough to provide a suitable choice for any purpose – indigenous enhancement, pond or wetland, shelter and shade or for amenity planting around buildings. There are good publications available with suggested species to benefit birds and bees – many are also good options for timber, firewood, fodder and shelter. (See Further Reading)

Tagasaste performs many beneficial tasks on a property within a very short time. A good choice for companion planting. Source: ***Kevin Thomsen***

Sustainability and Certification

The farm forestry practices mentioned previously are often interrelated and many objectives can be achieved at the same time. There has always been an ethic of sustainability of the land and water underlying these practices and this has put farm foresters in good stead in the current climate of resource management. If farm foresters' farms were to be environmentally audited then many would score highly based on the fact that the land and water issues are being well managed. Animal welfare, biodiversity, riparian management, and sustainable land use are all

resource issues requiring on-farm solutions that can be provided by trees and other vegetation.

Another issue to be aware of is having your commercial forest certified. This is also driven by the need for sustainable forest management. There is a growing demand for traceability of product within the forest industry and certification may be a process that you will need to go through to gain market access for some timber products. An increasing number of wood processors are themselves certified and are using a high proportion of logs from certified forests. This applies right through the range of timber products, including pulp. As the percentage of certified product increases within a processor's site, the difficulties and, therefore, the costs of keeping uncertified wood products separate become uneconomic. The processor is then likely to refuse acceptance of uncertified logs, or pay much less for them.

There are still considerable certification issues to be negotiated on a national scale before a clear direction emerges for the numerous private forest owners. There are a number of group certification schemes becoming available. Currently, there is probably no merit in committing to the costs of gaining certification, plus the ongoing monitoring requirements, unless you have trees near to harvest and can prove an advantage to being certified. This will change, possibly very quickly, in the future. References are provided to websites so readers can access up-to-date information.

To conclude, the current issue of greenhouse gases has resulted in a world wide environmental awareness that will have an effect on New Zealand's farms. It is difficult to predict how these issues will affect farm foresters but we can only guess that as there is a need to plant trees for carbon sinks, then it must follow that planting trees on farms will be beneficial both locally and globally.

To keep up to date with events regarding certification and greenhouse gases, visit the following websites:

- Pan Pac Forest Products Ltd
- NZ Farm Forestry Association
- United Nations Framework Convention on Climate Change
- PF Olsen and Co. Ltd.

Other issues to consider

Power lines

When planting, it is important to consider the proximity of electricity transmission lines. Everyone wants the luxury of electricity, but most landowners consider the presence of power lines to be a restriction on their choices of land use. However, these will exist into the future and must be considered. The relevant regulations and enforcement of these are much stricter than in the past. The full responsibility for private 'branch lines' falls on the landowner. Transpower (which operates the grid from power stations to substations and large industries) and distribution companies (which operate the lines from substations to domestic and business users) have minimum clearance rules, depending on the voltage of the transmission lines.

Landowners must have a responsible long-term view when planting trees:

- Consider the mature height and width of the tree being planted. A thirty-year-old pine may achieve 30 metres in height. Therefore, if blown over or felled, it has the potential to strike the wires if it is growing within that distance. A 60-metre corridor, especially on a smallholding, takes a big chunk of land out of potential forest. There are suitable options for utilising this strip: grazing, short-rotation trees (Christmas trees or firewood) or some variety of fruit/nut trees. Tree species such as oak or walnut can be planted closer to the wires than pines, as they are slower growing, do not reach the same height, and, eventually, provide a very valuable timber.
- When thinning or harvesting trees within 'striking distance' of transmission lines, only 'approved operators' with appropriate machinery to ensure the trees fall the right way are permitted. This may be an expensive exercise and could make the crop uneconomic. It is illegal for the landowner to fell trees within tree reach of the transmission lines.

It is essential that landowners have adequate Public Liability Insurance to cover any risks if they are planting near any electricity transmission or distribution lines (see notes on Insurance).

The rules and regulations regarding power lines are being revised and clarified. Check with

Federated Farmers on www.fedfarm.org.nz or NZ Farm Forestry Association on www.nzffa.org.nz for updates as they become available. In addition, you can check with local power companies.

Electricity transmission lines require consideration when planting trees. These high-tension lines cross the Dolbel Estate beside Puketapu Road. Source: ***Kevin Thomsen***

Legislation

Farm foresters should be aware of various statutes that impose legal responsibilities that can have considerable impact on farm forestry tree planting activities. In most instances, the various laws and regulations will not prevent you achieving what you desire, but are likely to put some restraints on specific situations. Some of the statutes to be aware of include:

- Resource Management Act 1991 (RMA) 2017 Biosecurity Act 2015
- Forest and Rural Fires Amendment Act 2005
- Historic Places Act 1993
- Heritage New Zealand Pouhere Taonga Act 2014
- Conservation Act 1987
- Forest Amendment Act 1996
- Health and Safety
- Fencing Act 1978-1995
- Soil Conservation and Rivers Control Act 1941

For up-to-date details on any relevant Government Acts, visit the website : http://rangi.knowledge-basket.co.nz/gpacts/actlists.html

The local government authorities that have a responsibility to interpret and enforce some of these laws within the Hawke's Bay area are:

- Hawke's Bay Regional Council
- Hastings District Council
- Napier City Council
- Wairoa District Council
- Central Hawke's Bay District Council
- Taupo District Council
- Rangitikei District Council

Contact your local District Council for information on regulations or requirements in relation to shelterbelts, visual effects and landscape controls, earthworks, location of significant indigenous sites and riparian margins, vegetation clearance, and cultural sites. Contact the Regional Council for information on regulations or requirements in relation to water use, take, damming, diversions, and structures in water, discharges to water, air or ground, wetland drainage, vegetation clearance and soil disturbance.

Fire risk

Fire risk is a serious consideration when planting blocks of trees. As soon as land is retired from grazing, the fire risk is increased. Farm forestry sites are often of lesser risk as grazed pasture or crops may isolate pockets of trees. However, in a drought situation, the fire risk requires early consideration. Blocks adjoining roadsides are at high risk – many fires start from cigarette butts or vehicle exhausts. Trees growing near houses or farm buildings increase the risk of a fire establishing and endangering the buildings and their occupants, especially if buildings are situated on a hilltop with the flanks covered in trees. A non-combustible zone needs to be maintained around the buildings with a reliable water supply available close by. There are a number of exotic and indigenous tree species that have low flammability, such as redwood, lancewood, five-finger, and Coprosma spp.

For more information, obtain the National Rural Fire Authority Fire Management Guidelines for Small Forests, 2003 which is written by Hawke's Bay people and very relevant to farm foresters. Contact the Hastings District Council rural fire manager for a copy. You can also check 'Publications' on https://www.checkitsalright.nz for current area fire status and other information.

Example of controlled burn of blackberry. Source: ***Kevin Thomsen***

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Insurance

Insurance cover for your property is important once trees are established. There are three types of specific cover that need consideration:

1. **Assets** – cover against loss of trees from various perils, particularly fire. Depending on the age and value of the planting at the time of loss, insurance assistance may be based on the cost to re-establish the damaged area, or provide an amount equal to the wood content, or the timber market value. The actual costs incurred in fighting a fire on the grower's own property should be included in this cover.
2. **Interruptions** – the loss of potential future income to maturity of the block.
3. **Public liability** – this cover is intended to protect against liability for damage to the property of others, usually from negligence on the part of the owner. The grower may also become liable due to statute; an act of parliament imposes a liability where there is no negligence - for example, the requirement to pay a levy under the 'Forest and Rural Fires Act' toward fire-extinguishing costs where the culprit is not known and where the grower's property may have been menaced, but not damaged, by the fire. We really emphasise insurance for public liability and fire protection.

Discuss these issues in detail with your insurance agent. More information can also be found on the website www.farmsafe.co.nz

Farm forestry planning calendar

One of the most important aspects for any farm forestry practice is planning. Ideally, you will have developed a long-term programme from which to work, however, this calendar provides a quick guide to a yearly programme.

The list of activities can be related to any farm forestry practice in Hawke's Bay.

Table 1

Activity	Prior to planting year	Summer (Dec - Feb)	Autumn (March - May)	Winter (June - Aug)	Spring (Sept - Nov)	Following years
Planning	Develop a longterm planning approach for your farm forestry work.	Decide on the site and suitable species. Get advice.				Start to plan silviculture work and future stand management for all practices.
Land Use Compliance	Check with both District and Regional Councils if there are rules that may affect your operation.					
Fencing and irrigation (if needed)	Book fencing contractor. Order fencing and irrigation materials.	Fenceline preparation e.g. bulldozina.		If already planted and if dry, start irrigation.		Maintain fences.
		Construct fence and install irrigation.				
Ordering trees		Order trees from the nursery as early as possible.				
Spraying	It is important that one or two years prior to planting, implement spray programme for woody weeds such as gorse, blackberry and broom, particularly if they have been heavily grazed and are therefore difficult to kill.	Follow up spray programme may be required for targeted weeds.	If your site is not grazed pasture, or is pasture with excessive weed problems like thistles, pre-plant spray roughly 6 weeks prior to planting, using either blanket spray or spot spraying methods. If you are planting indigenous seedlings in late autumn, pre-plant spray in early autumn.		If you applied a pre plant spray, particularly Glyphosate, on a pasture site, then another release spray is needed in October or early November to knock the pasture down again. Begin hand weeding if not using a spray.	Maintain spray programme on woody weeds until they are suppressed by tree canopy. (However, the best method is to prepare the site thoroughly so that less follow-up work is required.)
				Follow up with post-plant spraying if none occurred previously. Time spraying so it occurs at least 2 to 6 weeks after planting. Be careful not to be too late or you can lose sight of your plants. Carefully match chemicals and tree species.		
Grazing			If the site is in pasture and you intend to post-plant spray, livestock can graze up until planting occurs - this is also dependent on the suitability of the site to hard grazing. If you intend to preplant spray, the pasture needs to be ungrazed for a short period.		Ensure no stock grazing occurs - especially while trees are small.	
Planting			If you live in an area with a February consistent dry spring, plant bare rooted trees in late May or early June. Container grown plants can be planted later in the season.	Planting season for most areas. If your autumn and early winter has been dry, causing low moisture levels, delay planting until the end of August, depending on soil moisture levels. In extreme cases don't plant at all.		In the following summer (February - March), do a survival count and plan for blanking that winter to replace lost trees.
Pest Management	Eradicate any animal pests, e.g. possums, rabbits, goats, deer, and hares.	Monitor the reappearance of any animal and invasive plant pests. Bait stations can keep possums at manageable levels. Hares require immediate attention. Goats respect electricity - if it is going properly.				
General tasks		Manage fire risk if necessary. Greatest risk occurs where public have access - roads, rivers. Long dry grass burns easily.			Re-ram poplar/willow poles now if you have soils that dry out, and/or you have had strong wind.	If drought conditions occur, spray grass around poles to help with their survival, irrigate if possible.

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Further Reading

- Appleton's Nursery (2003) *Appleton's Nursery Guide*. Main Road South, Wakefield, Nelson.
- Charlton, D. (2003) Coppice blocks for stock feeding. In: *New Zealand Tree Grower*, February 2003, page 24.
- Ell, Gordon (1981) *Encouraging Birds in the New Zealand Garden*.
- Ell, Gordon (1995) *Enjoying Nature in the New Zealand Garden, Attracting Birds and Butterflies, Planting a Natur Garden and Many More Home Projects.*
- Environment Waikato (2002) *Trees on Farms* www.waikatoregion.govt.nz
- Hawke's Bay Regional Council/Department of Conservation (2000) *Planting native plants in Hawke's Bay.* www.hbrc.govt.nz land management
- McWilliam, E., Barry, T., Kemp, P., & Cameron, P. (2002) Feeding willow and poplar to boost lambing. In: *Tree Feed*. Issue No. 3.
- Ministry for the Environment (2001) *Managing Waterways on Farms: a guide to sustainable water and riparian management in rural New Zealand*. Ministry for the Environment, Wellington, New Zealand.
- Ministry for the Environment (2001) *Soil Conservation Technical Handbook*. Ministry for the Environment, Wellington, New Zealand.
- Ministry of Forestry/NZ Farm Forestry Association (1998) *Indigenous Forestry* – Sustainable Management.
- Palmer, H., Gardner, B., Hislop, M. & Buttery, N. (2003) Trees for shelter – basic principles revisited. In: *New Zealand Tree Grower,* February 2003, page 38.
- Smail, P. (1997) Shelter required to increase production. In: *New Zealand Tree Grower*, November 1997, page 4.
- Snook, L.C. (1986) *Tagasaste – High Production Fodder Crop.*
- Sustainable Farming Fund (2002) *Lower North Island Group for Drought Relief from Feeding Poplar / Willow.* Sustainable Farming Fund Grant No. 01/208, Farmer Case Studies.
- Tombleson, J., Moore, I. & Moore, R. (1995) Agroforestry on Te Rakau dairy farm. In: *New Zealand Tree Grower,* February 1995, page 18.

Farm Forestry Zones of Hawke's Bay

How to use this Chapter

The aim of this chapter is to help you:

- understand the physical resources in your area;
- choose the most appropriate farm forestry practices for your property;
- select the tree species most suitable for your property;
- understand the individual tree requirements of those selected trees.

This part of the planning process involves four steps. Each step is very important in achieving successful planting. Once you have made your selection of tree species (Step 4), you can go to Chapter 3 which provides more detailed information on many species to help confirm your choice.

"Trees selected for planting should have always been determined by site" – Bruce Treeby, Manawatu farm forester and tutor.

Step 1 : Identify in which 'Farm Forestry Zone' you will be planting.

Hawke's Bay has 14 Farm Forestry Zones. **Check the map (Figure 31) to identify your** location then read the information relating to that zone. There is no need to refer to any of the other zones. The information in each zone is complete.

Step 2 : Consider why you want to plant trees.

What is it you want to achieve? If you have trouble deciding, refresh yourself in Chapter 1 where the practices are covered in more detail.

The list of farm forestry practices in each zone covers:

1. Commercial forest and woodlot;
2. Erosion control – gully planting and slope planting;
3. Shelterbelts;
4. Riparian planting;
5. Amenity planting.

Step 3 : Assess the site.

What are its physical resources and/or limitations? How will this contribute to the farm business? What is the soil depth? What is the rainfall? and so on. It is important to understand the relationship between characteristics of the site and the needs of your trees.

In each zone there is specific information on the following physical characteristics:

1. Geology;
2. Topography – landform, aspect and altitude;
3. Soils – further detailed information on soil physical characteristics, soil drainage and moisture availability, and rooting depth is contained in Appendix I;
4. Climate – rainfall and evapotranspiration, wind, frost and snow.

Step 4 : Select the tree species for planting from the recommended species.

More specific details about many of the recommended tree species are included in Chapter 3. Remember that the recommended tree species are those we consider to be the most reliable for each of the Farm Forestry Zones.

"Trees will grow anywhere if you plant them well, but how well they grow is dependent upon other factors" – Joe Devonport, Hawke's Bay Regional Council Land Management Officer.

Note: There are many other steps to the planning process, such as establishment, assessing access opportunities, long-term management etc – these are no less important. However, if the first four steps are not considered, the rest will become considerably more difficult. Do it! Get planting!

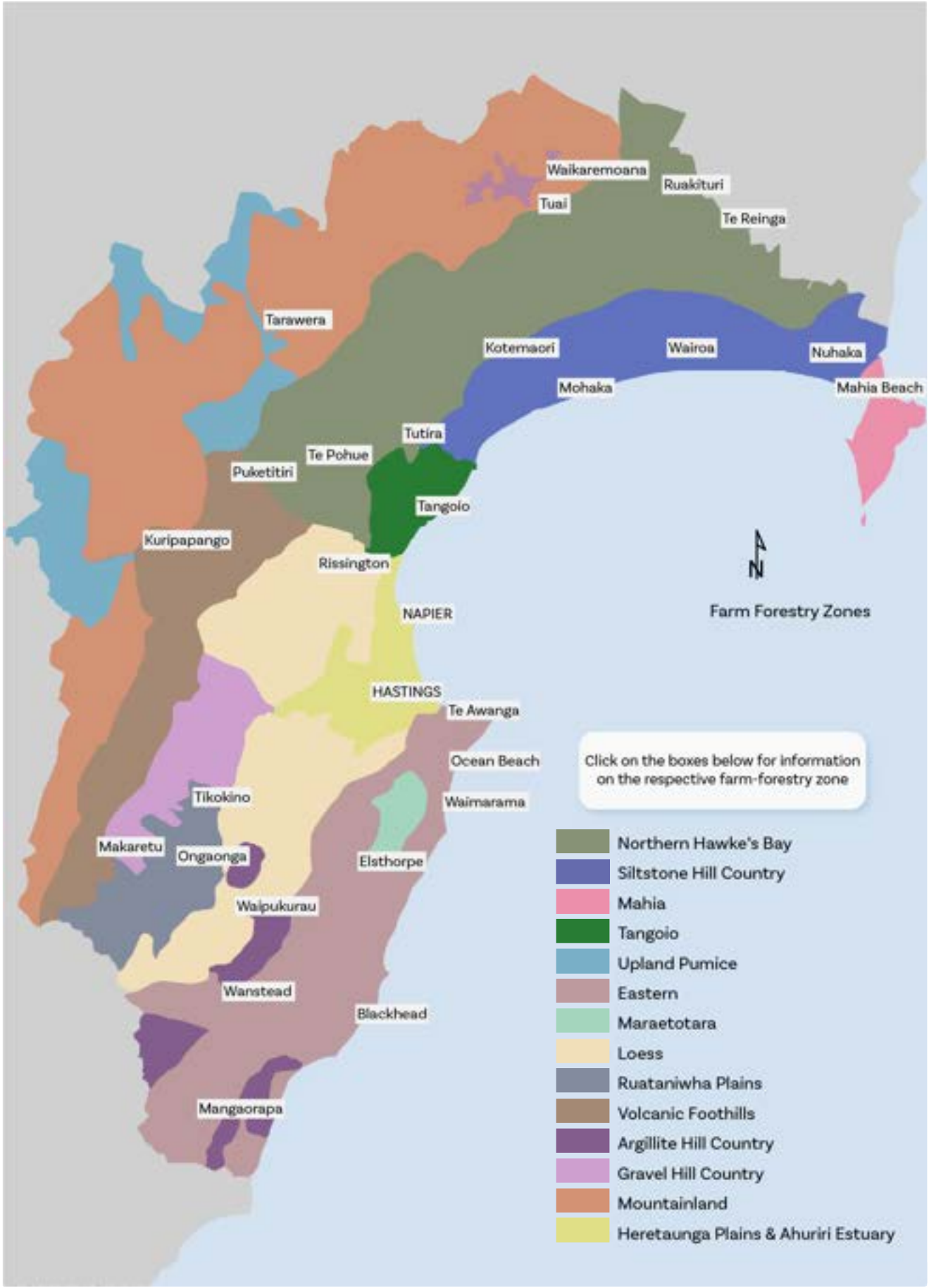

Figure 2: Hawke's Bay region showing the 14 Farm Forestry Zones

Northern Hawke's Bay

Physical characteristics This zone is characterised by its volcanic soils, moderate climate with good annual rainfall, and therefore its ability to grow trees. There are few limitations to farm forestry other than steepness of slope, with the associated lack of rooting depth and access difficulties for harvesting.

Geology Rock types are Tertiary-age marine sediments comprising deposits of sandstone, sandy mud-Figure 3:

Northern Hawke's Bay Farm Forestry Zone stone (siltstone), interbedded mudstone, pumiceous tuffs (volcanic deposits), and conglomerate, sometimes overlain with limestone. Most of this bedrock is still covered in volcanic material from various eruptions that occurred in the Central North Island and Rotorua-Okataina area.

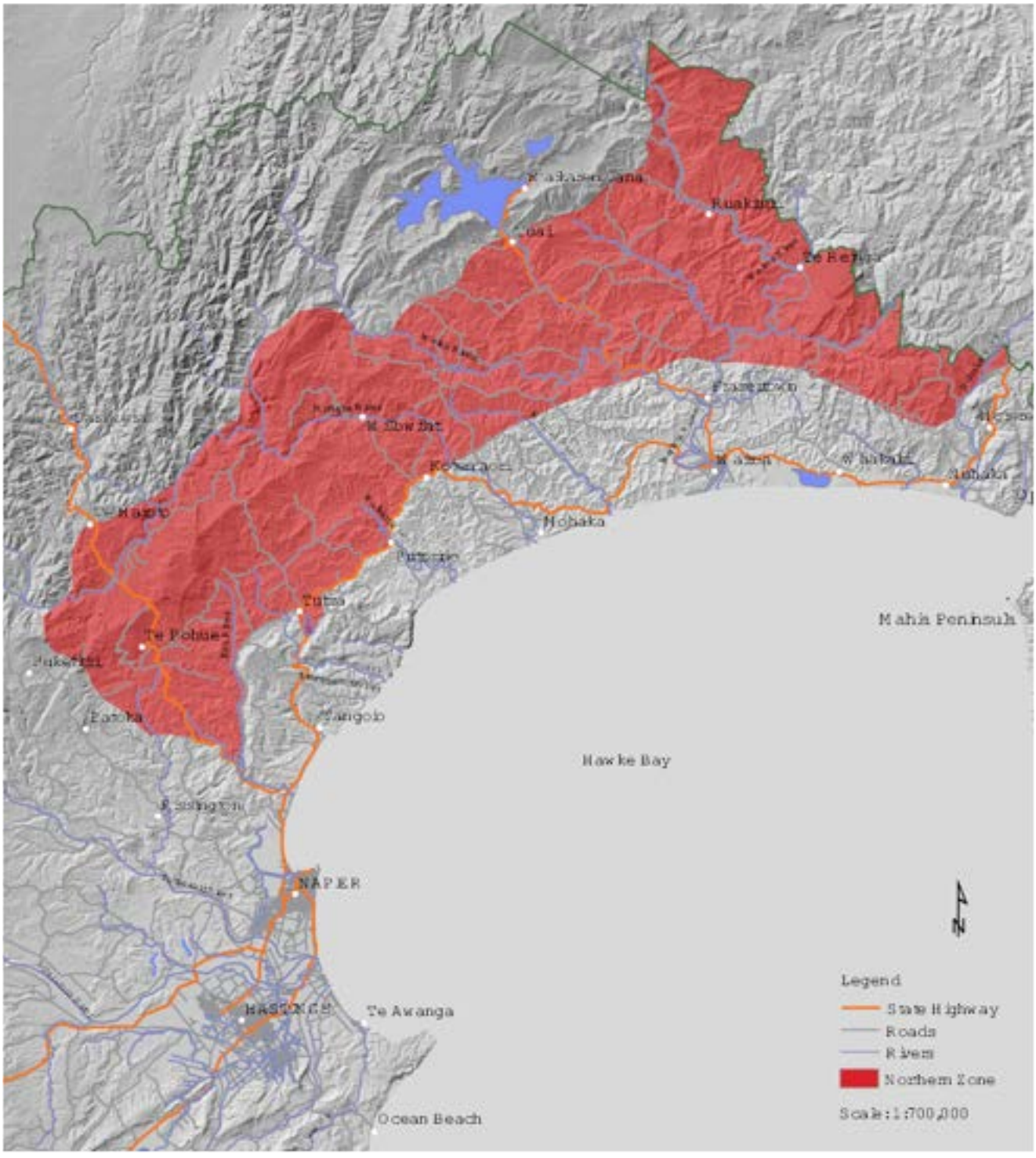

Figure 3: Northern Hawke's Bay Farm Forestry Zone

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Topography Landform is typically hill country varying from rolling to very steep and is mantled in volcanic material. There are large sloping blocks of land (some are called 'cuestas') dipping both west and east, particularly west of Tutira, Putere and Wairoa, heading towards Tiniroto. Whakapunake, at Te Reinga, is the highest cuesta. Associated with these large sloping blocks are very steep scarp slopes and cliffs. Two ranges form the western boundary: the Te Waka/Maungaharuru Range and the Huiarau Range, which is located in the Urewera National Park. The Tangoio and Siltstone Farm Forestry Zones provide the eastern boundary to this zone. There are many rivers: the Mohaka, Wairoa, Upper Waikare and Waikoau, Ruakituri, Mangaaruhe, Waikaretaheke, Mangapoike, and Waiau. Some catchments also drain into the Mangaone and Esk Rivers. Each river has a series of terrace systems, but these are generally not extensive. There are a number of lakes, including three in the Putere area (Rotongaio, Rotonuiaha, and Rotoroa), and Lakes Tutira, Waikopiro, Opouahi, and the Blue Lake.

Slope and aspect (direction of slope) Much of the zone faces east, southeast and south, with only a few west-dipping cuestas facing west and southwest. Aspect is not a critical factor in this zone in relation to wind and rainfall effect as it experiences less wind than other Hawke's Bay zones and has good rainfall coverage. Aspect will have some effect on steep shaded slopes, due to a reduction in sunlight hours on trees. Slope ranges from rolling to very steep and this will have an effect on the soil type and physical characteristics. The greater the angle of slope the higher the erosion potential.

Typical Northern Hawke's Bay landscape, SH36, near McRaeTrust, Wairoa. Source: ***Peter Manson***

Altitude generally ranges from 300 to 600m above sea level. The only higher areas are the Te Waka/Maungaharuru Range (900-1100m) and the high points around Whakapunake (900-951m). Valley floors of the Wairoa, lower Mohaka, and Waiau rivers have a range of 100-200m and are vulnerable to frost.

Soils Type and location The soils of this zone are excellent for farm forestry. They are formed in volcanic deposits, particularly the Tongariro series, Waimihia formation and Taupo pumice showers. These overlay a variety of earlier volcanic deposits in some areas providing considerable soil depth. Other influences dominate over the volcanic impact at some sites. On steep land areas erosion has generally removed volcanic material resulting in shallow soils, and in valley bottoms deposited alluvial material predominates.

The soils can be broadly grouped into two dominant orders – the predominant Pumice soils, and Recent (steep land and alluvial) soils. The terraces and alluvial flats consist of soils developed from volcanic air fall deposits and from water deposited material comprising silts, clays, and volcanic material, sometimes overlain with colluvium. Due to location and drainage patterns, these soils are prone to periods of high water levels (Gley and Recent alluvial soils). Podzol soils occur above 600m above sea level. Where the Pumice soils have eroded, or were never present, the weathering of the bedrock has formed Pallic soils. In rare sites the soil is like a volcanic loam, which is an Allophanic soil. There are also some small compartments of Brown soils present. Appendix I provides more specific details on soil types.

The following table provides the soil orders for this zone in order of dominance across the landscape.

Pumice soils
Recent steepland *and alluvial* soils
Pallic soils
Gley soils
Podzol soils
Allophanic soils
Brown soils

Table 2: Soil orders for Northern Hawke's Bay zone in order of dominance across the landscape.

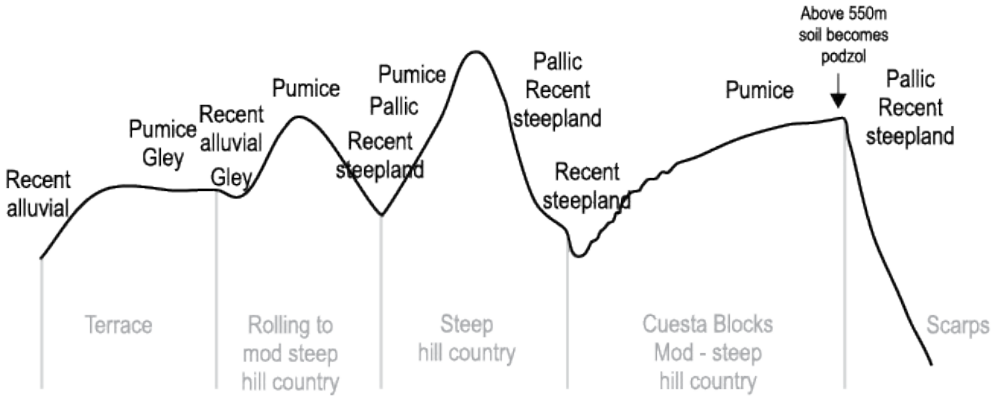

Figure 4: General location of soil orders across the zone. Source: ***Regional Graphics***

Climate Rainfall and soil water balance
The annual rainfall ranges from 1400 to 2000 mm, with most of the area between 1400 to 1600 mm. Annual rainfall increases with altitude and the annual spread is very good. The soil water balance (annual evapotranspiration rate) is 800-850 mm, with a low chance of a deficit and drought. A severe drought occurs every ten years or so, therefore drought tolerance is not a major tree selection factor.

Wind direction is mostly from the north and northwest, tending more westerly towards Tutira and the Maungaharuru Range. Generally, wind is not a major limiting factor. However, occasionally it can be devastating as seen in the Mohaka Forest inland from Raupunga in 1997, when extreme gales smashed Pinus radiata blocks. Wind accelerates soil moisture loss, so steep, shallow soils on north or northwest slopes will become water-short during prolonged windy periods. The most exposed sites for persistently severe winds are on the slopes of the Te Waka/Maungaharuru Ranges.

Frost and snow Frosts are most likely to occur at high altitudes and in the lowland areas and valley floors where cold air will not drain away. Nearly 90% of frosts will occur between May and November, with a range of 115 to 165 frost days per year. In most areas, frost hardiness should be a feature of your selection process, particularly as the planting season is in the main frost period. Snow can occur over most of the area, but it is rarely damaging to plantings except at higher altitudes above 600m where snowfalls may be severe enough to restrict species selection.

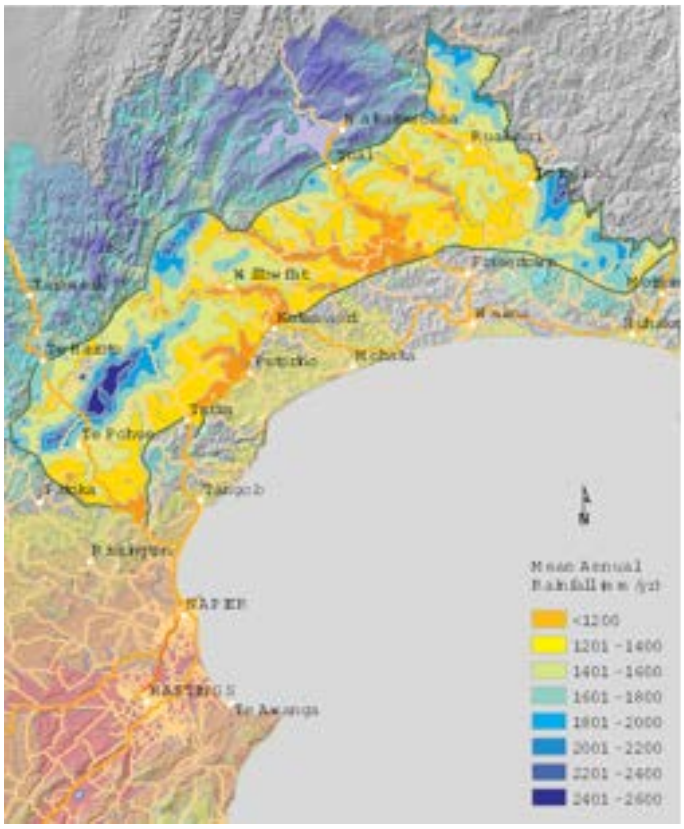

Figure 5 : Rainfall of the Northern Hawke's Bay Farm Forestry Zone.

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Farm Forestry practices and recommended tree species

Chapter 3 contains the detailed information regarding tree species. Any notes in the tables are specific to this zone.

Commercial forest and woodlots

Table 3 : Commercial forest and woodlot species.

Botanical name	Common name	Botanical name	Common name
Pinus radiata	Radiata pine	Acacia dealbata	Silver wattle
Pseudotsuga menziesii	Douglas fir	Eucalyptus fraxinoides	White ash
Cupressus lusitanica	Mexican cypress	Eucalyptus globoidea	White stringybark
Sequoia sempervirens	Redwood	Eucalyptus pilularis	Blackbutt
Cedrus deodara/atlantica	Himalayan/Atlas cedar	Podocarpus totara	Totara
Cupressocyparis ovensii	Ovens cypress	Dacrydium cupressinum	Rimu
Eucalyptus fastigata	Brown barrel	Knightia excelsa	Rewarewa
Eucalyptus nitens	Shining gum	Dacrycarpus dacrydioides	Kahikatea
Eucalyptus regnans	Mountain ash	Nothofagus fusca	Red beech
Eucalyptus obliqua	Tasmanian oak	Agathis australis	Kauri
Eucalyptus muelleriana	Yellow stringybark	Vitex lucens	Puriri
Eucalyptus bosistoana	Coast grey box	Phyllocladus trichomanoides	Tanekaha
Cryptomeria japonica	Japanese cedar		

Eucalyptus nitens Shining gum. Source: ***Jonathon Barron***

Soil conservation – gully erosion

Gully erosion is not common in this zone due to the nature of the landscape and the usually deep, incised stream systems in the hill country. However, the tilted cuestas often have associated weak zones that can contain severely eroding gullies, or are potential sites for severe gully erosion. They can also occur in infilled gully systems located on the rolling and moderately steep hill country as these have unconsolidated volcanic material mixed with silts and sands with the potential to re-erode. There is also significant tunnel gully erosion in this zone that can lead to gullying of slopes.

Before and after: Mackintosh property, Matahorua Rd, Putorino. (a) Gully planted in 1996, after a period of erosion, with Salix matsudana, Poplar varieties Toa and Eridano, and Eucalyptus nitens; and (b) Gully in 2003 showing success of planting, plus manuka regrowth. Source: ***Susan Mackintosh***

Table 4 : Soil conservation - gully erosion species.

Botanical name	Common name	Botanical name	Common name
Salix matsudana, S. alba and their varieties	Tree willows	Salix viminalis, S.purpurea, S. kinuyanagi	Basket and shrubby willows
Populus yunnanensis and var. Kawa, Veronese, Crowsnest, Argyle, Weraiti	Poplars		
The following species are options if the area is retired or restricted from grazing. Note that any of the commercial forest and woodlot species can also be considered if stock are removed and the erosion is not too severe - if erosion is severe to extreme plant P.radiata and willows and manage accordingly.			
Plagianthus regius	Ribbonwood	This is not a complete list of indigenous species. However it does list those species: a) with greater gully control ability because of their root mat systems; or suitability for the site; or b) that allow for long-term management options, such as acting as a nurse crop for further forestry planting.	
Pittosporum tenuifolium	Kahuhu		
Pittosporum eugenioides	Tarata		
Pittosporum crassifolium	Karo		
Griselinia littoralis	Broadleaf		
Sophora microphyllaltetraptera	Kowhai		
Phormium tenaxlcookianum	Native ax		
Dacrycarpus dacrydioides	Kahikatea		
Cordyline australis	Cabbage tree		
Cortaderia toetoelfulvida	Toetoe		
Hoheria populnea	Lacebark		
Alnus glutinosa	Black alder		
Alnus rubra	Red alder		
Taxodium distichum	Swamp cypress		
Ulmus procera	English elm		

Soil conservation – slope erosion

Slope erosion is the most dominant type of erosion in this zone. Where volcanic material is still present slopes are relatively stable, although tunnel gully erosion can occur. Generally, however, all slopes have an erosion potential, with steep slopes having a continually severe potential. Soil conservation planting is an important activity in this zone.

Shelterbelts

This zone is reasonably windy, but being inland there is already a lot of natural shelter provided as there is a hilly profile covered in scattered indigenous trees and some existing exotic plantations. However, in some areas, shelterbelts are required.

Extensive slope planting with poles in the foreground using dynex sleeves protection, with some older plantings in the background, McRae Trust, Wairoa. Source: ***Peter Manson***

Extensive slope planting with poles in the foreground using dynex sleeves protection, with some older plantings in the background, McRae Trust, Wairoa. Source: ***Peter Manson***

Table 5 : Soil conservation - slope erosion species.

Botanical name	Common name	Botanical name	Common name
Populus yunnanensis and var. Kawa, Veronese, Crowsnest, Argyle, Weraiti	Poplars	Salix matsudana, S. alba and their varieties	Tree willows
The following species are options if the area is retired or restricted from grazing. Note that any of the commercial forest and woodlot species can also be considered if stock are removed and the erosion is not too severe - if erosion is severe to extreme plant P. radiata and manage accordingly.			
Quercus robur/palustris	English/Pin oak		
Alnus cordata/rubra/glutinosa	Italian/Red/Black alder		
Juglans regia	Common walnut		
Platanus acerifolia	Plane tree		
Cordyline australis	Cabbage tree		
Podocarpus totara	Totara		
Eucalyptus nitens	Shining gum		
Eucalyptus fastigata	Brown barrel		
Eucalyptus regnans	Mountain ash		
Eucalyptus camaldulensis	Red river gum		
Eucalyptus obliqua	Tasmanian oak		
Eucalyptus muelleriana	Yellow stringybark		
Eucalyptus globoidea	White stringybark		

Table 6 : Shelterbelt species.

Botanical name	Common name	Notes
Pinus radiata Cedrus deodara Cupressocyparis leylandii Cupressocyparis ovensii	Radiata pine Himalayan cedar Leyland cypress -'Leighton Green/Green Spire' Ovens cypress	Single or double row. Often planted with another species as listed here. Totara could be suitable as a leeward species.
Pittosporum eugenioides Pittosporum tenuifolium Pittosporum crassifolium Podocarpus totara Leptospermum scoparium Hoheria populnea Cordyline australis	Tarata Kahuhu Karo Totara Manuka Lacebark Cabbage tree	These species can be planted individually or together with other indigenous species not listed here (personal preference), or with some of the non-conifer exotics listed.
Eucalyptus fraxinoides Eucalyptus nitens Eucalyptus regnans Eucalyptus melliodora Other ground durable eucalyptus species	White ash Shining gum Mountain ash Yellow box	Single row planting with lower shrubby species e.g: Coprosma spp., Pseudopanax spp., Carmichaelia spp. (native broom), Tagasaste (tree lucerne) or with a denser long-term species like C deodara/atlantica
Salix matsudana or S. matsudana var. Tangoio	Tree willows	Single or double row. Potential as a fodder
Populus spp. and var. Crowsnest, Veronese, Kawa Alnus glutinosa/ rubra/cordata	Poplars Black/Red/Italian alder	

Riparian management

There are many different types of watercourses in this zone, and riparian management practices will differ for each. Many watercourse sites are already established with some indigenous vegetation, while some sites are impractical to plant with commercial forest trees or to apply conventional erosion control practices. Most of the pastoral land in this zone is farmed semi-intensively to extensively. As land use becomes more intensive, environmental pressures increase and management of the riparian zone must reflect this. Issues such as sediment runoff carrying other contaminants, such as phosphate and faecal material, must be considered. If the ground water is being affected by nitrogen products then tree species that absorb nitrogen should be targeted.

The good thing about this zone is that it can grow a wide variety of tree species. In many situations, it may be more cost-effective to allow the natural revegetation of indigenous species, aided by a subdivision fence to create a riparian zone. If a planting programme is desired, then indigenous species should be the first option. If you are establishing a commercial forest or woodlot, riparian margins should be left when planting and should regenerate naturally. This will eliminate future harvesting problems near waterways and also provide for indigenous 'set-asides' within the forest system.

If you are planting for erosion control and not using commercial forest species or seedlings, then grazing will probably continue. However a single 'hot- wire' may aid tree growth, allow a wider selection of species to be planted, and limit damage to plants and soils from cattle. If you are grazing deer on a Pumice soil, then riparian areas should be securely fenced off. If you are subdividing your property, plan to isolate and protect riparian margins.

One of the negatives about riparian work in this zone is that there can be significant weed species present (gorse, blackberry) and closing off an area allows these to invade at will. However, gorse areas will revert to indigenous species given time, birds, and a local tree seed source. Blackberry, however, will persist for longer, though eventually some indigenous species may emerge through it.

Table 7 : Riparian management species.

Botanical name	Common name	Notes
Sequoia sempervirens	Redwood	Well spaced in a mix of species to avoid excessive shading causing bare ground.
Popu/us spp. and var. Kawa and Veronese Eucalyptus nitens Eucalyptus regnans Eucalyptus camaldulensis	Poplars Shining gum Mountain ash Red River gum	All are potential users of groundwater nitrogen and will allow indigenous undergrowth to develop, depending on planting density.
Pittosporum crassifolium Cordyline australis Coprosma robusta Phormium tenax Dacrycarpus dacrydioides Coprosma propinqua Cyperus ustulatus Hoheria angustifolia Beilschmiedia tawa Dacrydium cupressinum Brachyglottis repanda Leptospermum scoparium Hebe stricta Coprosma repens Cyathea dealbata Alnus glutinosa/rubra Taxodium distichum	Karo Cabbage tree Karamu Harakeke (flax) Kahikatea Mingimingi Umbrella sedge Lacebark Tawa Rimu Rangiora Manuka Koromiko Taupata Ponga Black/Red alder Swamp cypress	These are just some of the suitable species. There is a long list of indigenous species that can be planted due to the good growing conditions in this Farm Forestry Zone - choices will be determined by personal preference, locality for planting, ecological requirements, and other benets you may wish to gain, such as bird or bee feeding species.

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Example of retained riparian vegetation partly fenced. Good example of the type of terrain and vegetation experienced in this zone and the problems associated with fencing. Source: ***Simon Stokes***

Amenity/shade

As this zone is a very good tree growing area, the variety of species listed below are but some of the many that will grow successfully. Success will depend on the site, how well you protect the trees from stock, and good planting technique.

Metasequoia glyptostroboides Dawn redwood. Source: ***Kevin Thomsen***

Table 8 : Amenity/shade species.

Botanical name	Common name
Platanus acerifolialoccidentalis	Planes
Quercus roburlilexlpalustris etc.	Oaks
Populus yunnanensis and var_ Veronese and kawa	Poplars
Sequoiadendron giganteum	Wellingtonia
Sophora tetraptera	Kowhai
Fagus sylvatica	English beech
Fagus sylvatica var. Purpurea	Copper beech
Magnolia grandiora	Magnolia
Pinus coulterilponderosal sylvestris etc.	Pines
Schinus mo/le	Pepper tree
Metasequoia glyptostroboides	Dawn redwood
Aesculus hippocastanum/indica	Horse/Indian chestnut
Gingko biloba	Gingko

Siltstone

This zone is characterised by its siltstone bedrock, diversity of landscapes, restricted areas of volcanic soils, and low soil moisture levels. It is also affected by its coastal location, and the area is subject to high intensity rainstorms that can cause significant erosion.

Geology Rock types are Tertiary age marine sediments, mainly siltstone or sandy mudstone, with some overlying sandstone. The landscape was once predominantly covered in volcanic material from several eruptions but this is now only found in patches. Sometimes loess is also present.

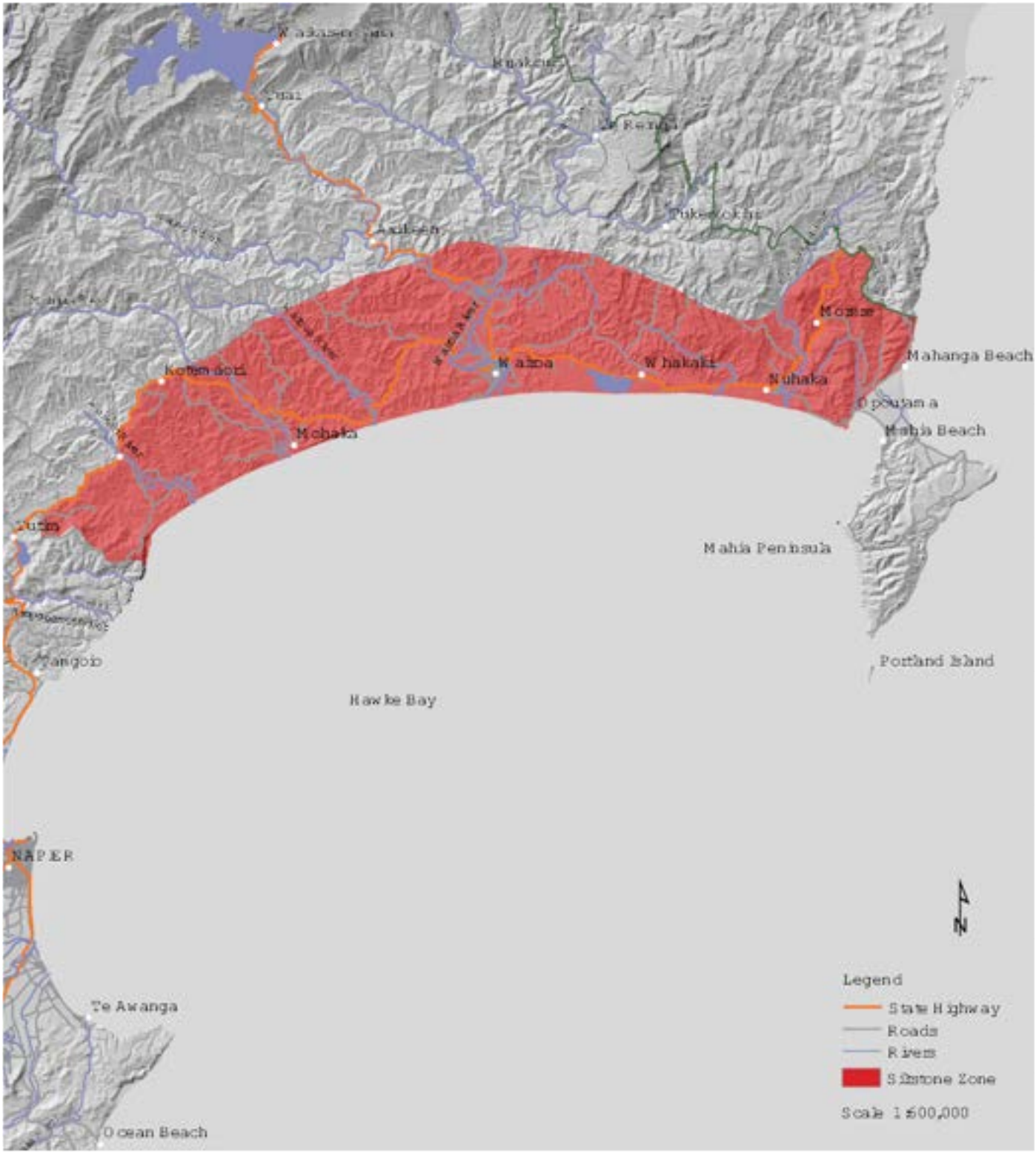

Figure 6 : Siltstone Farm Forestry Zone

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Topography Landform consists of hill country that varies from wide, infilled valley floors to low angle, colluvial 'footslopes', to short, steep slopes or very steep hills, with narrow gullies. There are no main range systems, but there are many dominant sharp-edged ridge systems with secondary ridges. Hawke's Bay provides the eastern boundary. The coastal areas north of Wairoa as far as Nuhaka are a mixture of alluvial flats, wetlands, and coastal dune environments. The coastal flats between Wairoa and Nuhaka were formed about 9,000 years ago. There are old terraces and alluvial flats associated with the Mohaka, Waikare, Wairoa, Waihua, Nuhaka, and Tahaenui Rivers, but these areas are not extensive and have soils that are too valuable for farm forestry activities other than for shelterbelts and amenity/shade trees.

Slope and aspect (direction of slope) are very important in this area. Aspect becomes more influential nearer the coast, particularly on the east and south facing slopes exposed to cyclonic storms that can cause severe erosion. West and north facing slopes will suffer from drying winds and resulting soil moisture deficits.

In this area, slope will determine:

- the soil depth available and the type of soil that has developed;
- soil moisture availability; and
- access to the site.

Generally, slopes over 25-28 degrees will be steep enough to have eroded significantly and will have little volcanic influence. Soils will be shallow.

Altitude ranges from sea level to 600m.

Soils Type and location The soils in this zone are different from the inland Northern Hawke's Bay countryside. Volcanic deposits are sporadic due to the erodible nature of the area and are mostly limited to two eruption showers called the Waimihia formation and the Taupo pumice deposits (Pumice soils). In places, older volcanic layers appear on old terrace systems, rolling country and in valleys amongst the hill country.

Most of the hill country soils have developed from the weathering of the siltstone or other bedrock. These are Pallic soils. They are generally relatively shallow because of the high erosion rates and some may be classified as Recent steepland soils. Young terraces and alluvial flats have soils developed from water deposited material of silts, clays, and volcanic material. Due to location and drainage patterns, these soils (called Gley soils and Recent alluvial soils) are prone to periods of high water levels. There are also soils that have developed on the sand dune areas – these are Raw soils. Check Appendix I for specific details on the different soil types.

The following table provides the soil orders for this zone in order of dominance across the landscape.

Pallic soils
Pumice soils
Recent *alluvial and steepland* soils
Gley soils
Raw soils

Table 9 : Soil orders for Siltstone zone in order of dominance across the landscape.

Looking across the Mohaka River, near Mohaka, into Springhill Station. Established shelterbelts on the terraces with some of the hills planted in forestry. Source: ***Alec Olsen.***

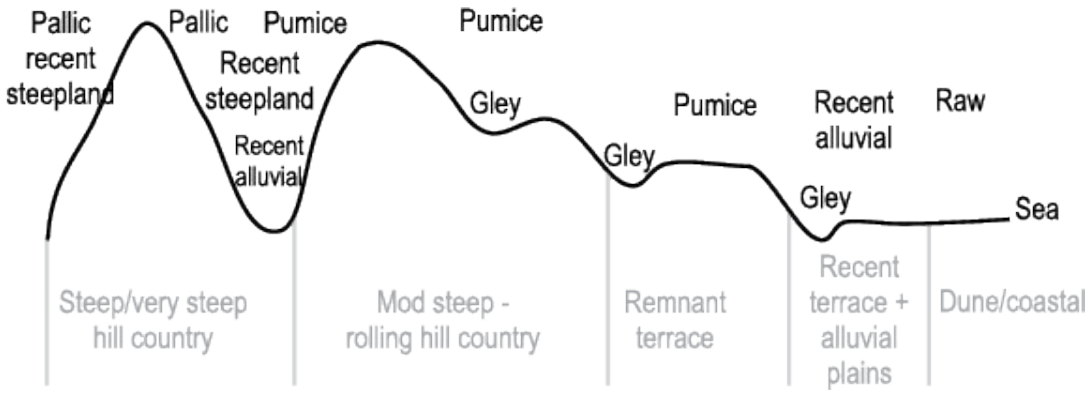

Figure 7 : General location of soil orders across the zone. Source: ***Regional Graphics***

Climate Rainfall and soil water balance Rainfall over most of the area ranges from 1000-1400 mm per annum. Northeast of Wairoa, from behind Whakaki through to Morere and the coast at Mahanga, the rainfall ranges from 1400-2600 mm. The average annual potential evapotranspiration is 950 mm, which is high for Hawke's Bay. From Whakaki south through to the Waikare District, there is a higher chance of soil moisture deficit with higher potential for drought. Therefore, select tree species for drought sites carefully. High intensity rainstorms are likely to occur at least once in every five years; these cause severe erosion, removing any chance of pastoral or forestry land use on the bare areas.

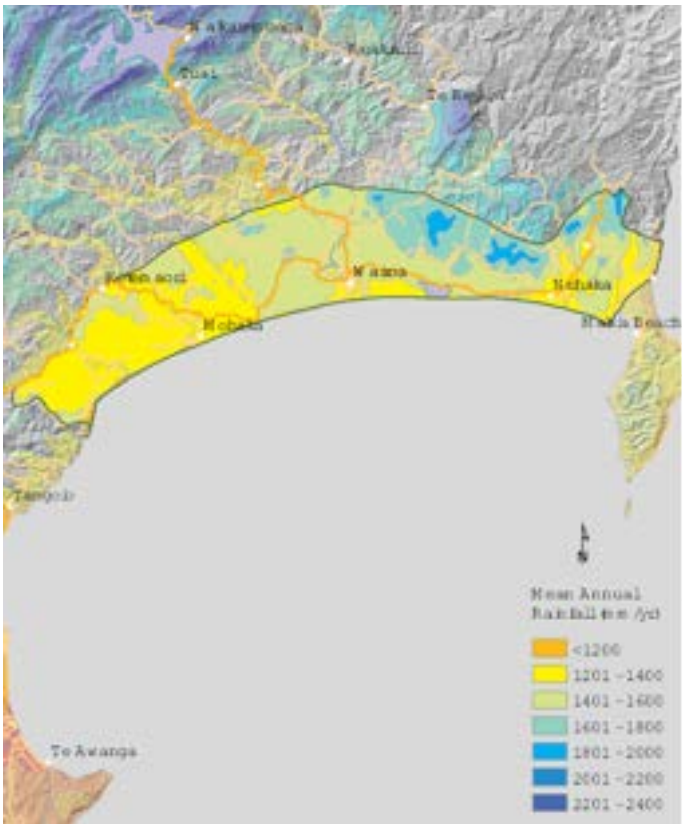

Figure 8 : Rainfall of the Siltstone Farm Forestry Zone.

Wind is predominantly from the north and northwest. However, wind can also come from the south and southeast. Wind is not a major limiting factor but steep slopes facing north to west will dry out rapidly. Wind from the south and southeast is often cold and can cause extreme chill on exposed sites. Salt burn may occur on exposed coastal sites.

Frost and snow Severe frosts are not common, particularly closer to the coast. They are most likely to occur at high altitude locations but can occur in lowland areas and valley floors inland where air drainage is poor. Nearly 90% of frosts will occur between May and November with a range of 65 to 115 frost days per year. Frost hardiness should be a feature of your tree selection process in these areas. Snow is rare and not an issue.

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Farm Forestry practices and recommended tree species

Chapter 3 contains the detailed information regarding tree species. Any notes in the tables are specific to this zone.

Commercial forest and woodlots

Table 10 : Commercial forest and woodlot species.

Botanical name	Common name	Botanical name	Common name
Pinus radiata	Radiata pine	Eucalyptus obliqua	Tasmanian oak
Cupressus lusitanica	Mexican cypress	Cupressocyparis leylandii	Leyland cypress 'Naylor's Blue'
Pseudotsuga menziesii	Douglas r	Cedrus deodaralatlantica	Himalayan/Atlas cedar
Sequoia sempervirens	Redwood	Cupressocyparis ovensii	Ovens cypress
Cryptomeria japonica	Japanese cedar	Cupressus torulosa	Bhutan cypress
Eucalyptus globoidea	White stringybark	Acacia dealbata	Silver wattle
Eucalyptus bosistoana	Coast grey box	Podocarpus totara	Totara
Eucalyptus muelleriana	Yellow stringybark	Agathis australis	Kauri
Eucalyptus melliodora	Yellow box	Vitex lucens	Puriri
Eucalyptus pilularis	Blackbutt	Dacrydium cupressinum	Rimu
		Knightia excelsa	Rewarewa

Other durable eucalyptus species

Cupressus lusitanica Mexican cypress. Source: ***Kevin Thomsen***

Soil conservation – gully erosion

Active gully erosion is not common in this zone, other than around Nuhaka, where there is some landscape that is highly erodible. Most of the Siltstone Zone has infilled valley bottoms that have been filled in with material over many years, and, while many of these are not currently active, there is a high potential for gullying to occur.

Most of the gully erosion occurs in two locations:

- deeply incised gullies which have little sediment to erode other than lower slope material; and
- infilled valley bottoms which are generally low gradient systems filled with eroded material from the hills in the upper catchments.

Gully head creeping back up a gully full of material re-deposited from previous erosion events. Soil conservation gully planting has occurred but was not completed. Source: ***Simon Stoke***

The following species will suit either of these situations.

Table 11 : Soil conservation - gully erosion species.

Botanical name	Common name	Botanical name	Common name
Salix matsudana, S. alba and their variations	Tree willows	Salix viminalis, S. Purpurea, S. kinuyanagi	Basket and shrubby willows
Populus yunnanensis and var. Kawa, Veronese, Crowsnest, Argyle, Weraiti	Poplars		
The following species are options if the area is retired or restricted from grazing. Note that any of the commercial forest and woodlot species can also be considered if stock are removed and the erosion is not too severe - if erosion is severe to extreme plant P. radiata and manage accordingly.			
Plagianthus regius Pittosporum eugenioides Pitfosporum tenuifolium Pittosporum crassifolium Griselinia litforalis Sophora microphylla ltetraptera Phormium tenaxlcookianum Dacrycarpus dacrydioides Cordyline australis Cortaderia toetoelfulvida Hoheria populnea Alnus glutinosa Alnusrubra Taxodium distichuml ascendens Ulmus procera	Ribbonwood Tarata Kahuhu Karo Broadleaf Kowhai Native axes Kahikatea Cabbage tree Toetoe Lacebark Black alder Red alder Swamp/Pond cypress English elm	This is not a complete list of indigenous species. However, it does list those species: a) with greater gully control ability because of their root mat systems; or suitability for the site; or b) that allow for long-term management options, such as acting as a nurse crop for further forestry planting	

Soil conservation – slope erosion

Slope erosion is the most dominant erosion form in this zone. Slopes are generally short and steep, with soil depth becoming shallower about halfway up the hill. Soil movement can occur throughout the whole slope, but the top two-thirds is where erosion potential is the greatest. Slope planting should target the lower two-thirds if using poplar and willow poles, as they will not survive on the higher slopes. Some of the species recommended will require removal of livestock for a period of time. Commercial forestry is a good option if the area is large, grazing is not required, and soil depth is sufficient.

Severe soil slip erosion on siltstone near Nuhaka. Source: ***Simon Stokes***

Willows planted for slope stabilisation with forestry in the background. Source: ***Alec Olsen***

Table 12 : Soil conservation - slope erosion species.

Botanical name	Common name	Botanical name	Common name
Populus yunnanensis and var. Kawa, Veronese, Crowsnest, Argyle	Poplars	Salix matsudana, S. alba and their variations	Tree willows
The following species are options if the area is retired or restricted from grazing. Note that any of the commercial forest and woodlot species can also be considered if stock are removed and the erosion is not too severe - if erosion is severe to extreme plant P. radiata and manage accordingly.			
Quercus robur/ilex/palustris	English/Holm/ Pin oak		
Cordyline australis	Cabbage tree		
Alnus rubra	Red alder		
Chamaecytisus palmensis	Tagasaste		
Gleditsia triacanthos	Honey locust		
Platanus acerifolia	Plane		
Eucalyptus nitens	Shining gum		
Eucalyptus fastigata	Brown barrel		
Eucalyptus regnans	Mountain ash		
Eucalyptus camaldulensis	Red River gum		
Eucalyptus cladocalyx	Sugar gum		
Eucalyptus obliqua	Tasmanian oak		
Eucalyptus muelleriana	Yellow stringybark		
Eucalyptus globoidea	White stringybark		

Shelterbelts

This zone experiences a reasonable amount of coastal wind and is exposed to cold southerlies, particularly the terraces, valleys and open coastal areas. However, as it is relatively hilly, and has many scattered indigenous trees or exotic plantations, plenty of natural shelter and shade is provided. In some locations where you can use remnant indigenous vegetation, a single 'hot-wire' fence to keep cattle off the roots and reduce the grazing can prevent forest deterioration and extend the life of the natural shelterbelt.

Cedrus deodora and P. radiata shelterbelt. Source: ***Jude Addenbrooke***

Table 13 : Shelterbelt species.

Botanical name	Common name	Notes
Pinus radiata Pinus pinaster Cupressocyparis ovensii Cupressocyparis leylandii Araucaria heterophylla	Radiata pine Maritime pine Ovens cypress Leyland cypress 'Naylor's Blue' Norfolk Island pine	Single or double row. Often planted with another species (as listed here). Totara could be suitable as a leeward species. Maritime pine can handle salt spray exposure. Norfolk Island pine is frost tender.
Eucalyptus microcorys Eucalyptus fastigata Populus spp. and var. Crowsnest, Veronese Salix matsudana var. Tangoio, Moutere Platanus acerifolia Alnus rubra	Tallow wood Brown barrel Poplars Tree willows Plane Red alder	 Single row planting interplanted with the following: Coprosma spp., Leyland cypress, Hebe spp.,Carmichaelia spp. (native broom), Tagasaste (tree lucerne). This mix is best suited as a secondary shelter mix.
Cedrus deodara/atlantica	Himalayan/Atlas cedar	For dry hill country planting as a low growing companion species or on its own.
Chamaecytisus palmensis	Tagasaste	Single or double row. Potential as a fodder
Pittosporum crassifolium Pittosporum eugenioides Pittosporum tenuifolium Corynocarpus laevigatus Metrosideros excelsa	Karo Tarata Kohuhu Karaka Pohutukawa	 These species are coastal trees; they can be planted individually or together with other species.
Coprosma repens Hebe stricta Olearia solandri	Taupata Koromiko Coastal tree daisy	These species are suitable as coastal shrubs and would form the lower growing line in hill country. They can be planted with other taller species as listed above.
Cordyline australis Podocarpus totara	Cabbage tree Totara	

Riparian management

There are many different types of watercourses in this zone, and riparian management practices will differ for each. Most of the pastoral land is farmed extensively or semi-intensively on the hills and intensively on the terraces and flat land. The riparian areas fall into two main situations:

Situation 1. Main river and stream catchments that have moderate levels of indigenous remnants, with steep slopes and an incised shape (V-shape). These sites can be left to revegetate as they are often physically impractical to plant.

Situation 2. Infilled valley floors, alluvial flats, or gully systems that have a low gradient with a lot of streambank erosion, often occurring in intensively farmed situations. These watercourses require specific treatment and appropriate fencing, such as a single 'hot-wire', allowing floodwater through and retaining sheep-only grazing. Root mat development and long-term tree management are vital for soil retention.

In parts of this zone, there are wetland and duneland environments that require particular management. If you are planning on subdividing your property, consider fencing options that isolate duneland or wetland areas. One of the negatives about riparian work in this zone is that there are weeds e.g. gorse (Ulex europaens) and blackberry (Rubusspp) which will quickly invade a retired area. Gorse will allow reversion to indigenous species, given time, birds, and a local tree seed source. However, blackberry will persist for a longer period of time, though eventually some indigenous species may emerge and dominate.

Table 14 : Riparian management species.

Botanical name	Common name	Notes	Situation
Commercial forest species Erosion control slope planting species		Will provide species suitable for Situation 1.	1
Sequoia sempervirens Taxodium distichum	Redwood Swamp cypress		1&2 2
Populus spp. and var. Kawa and Veronese Salix spp - S. matsudana, var. Tangoio and Moutere	Poplars Tree willows	All are potential users of groundwater nitrogen and will allow indigenous undergrowth to develop, depending on planting density.	2
Pittosporum crassifolium Cordyline australis Metrosideros excelsa Clianthus puniceus Coprosma repens Hebe stricta Olearia solandri Solanum aviculare Pittosporum ralphii Phormium cookianum/tenax Carex spp. Schoenoplectus validus	Karo Cabbage tree Pohutukawa Kakabeak Taupata Koromiko Coastal tree daisy Poroporo Ralph's pittosporum Native axes Native grasses Lake clubrush		2

Amenity/shade

The zone is partially coastal and quite dry, so the choice of species recommended reflects this. There are many other varieties that will grow. However, success will depend on the site, how well you protect the tree from stock, and good planting technique.

Farm building and stock yards sheltered by attractive amenity trees. Source: ***Kevin Thomsen***

Table 15 : Amenity/shade species.

Botanical name	Common name	Botanical name	Common name
Platanus occidentalis/ acerifolia Quercus robur/ilex/ palustris etc Populus yunnanensis and var. Veronese and Kawa Acer pseudoplatanus/ macrophyllum Sophora tetraptera Cordyline australis Fagus sylvatica Fagus sylvatica var. Purpurea	Planes Oaks Poplars Sycamore/Big Leaf maple Kowhai Cabbage tree English beech Copper beech	Juglans regia Magnolia grandiora Pinus coulteri/ponderosa/ sylvestris etc. Cedrus deodara/atlantica Ginkgo biloba Aesculus hippocastanum Araucaria heterophylla Metrosideros excelsa	Common walnut Magnolia Pines Himalayan/Atlas cedar Ginkgo Horse chestnut Norfolk pine Pohutukawa

Mahia Peninsula

This zone is a coastal peninsula with varying landscape. It also includes the sand tombolo that attaches Mahia Peninsula to the mainland.

Geology Rock types are Tertiary marine sediments that have formed deposits of sandstone, siltstone (sandy mudstone), interbedded mudstone, and pumiceous tuffs (volcanic deposits). In places, these are overlain with limestone, or the bedrock is covered in loess and volcanic material.

Topography Landform is a peninsula surrounded by the Pacific Ocean and attached to the mainland by a tombolo. The hill country is generally steep to very steep with long slopes and there are marine terraces (aged between 80,000 – 130,000 years) along the eastern margin near Table Cape. The landscape is dissected with many dominant sharp edged ridge systems and narrow secondary ridges. There are no major rivers or ranges.

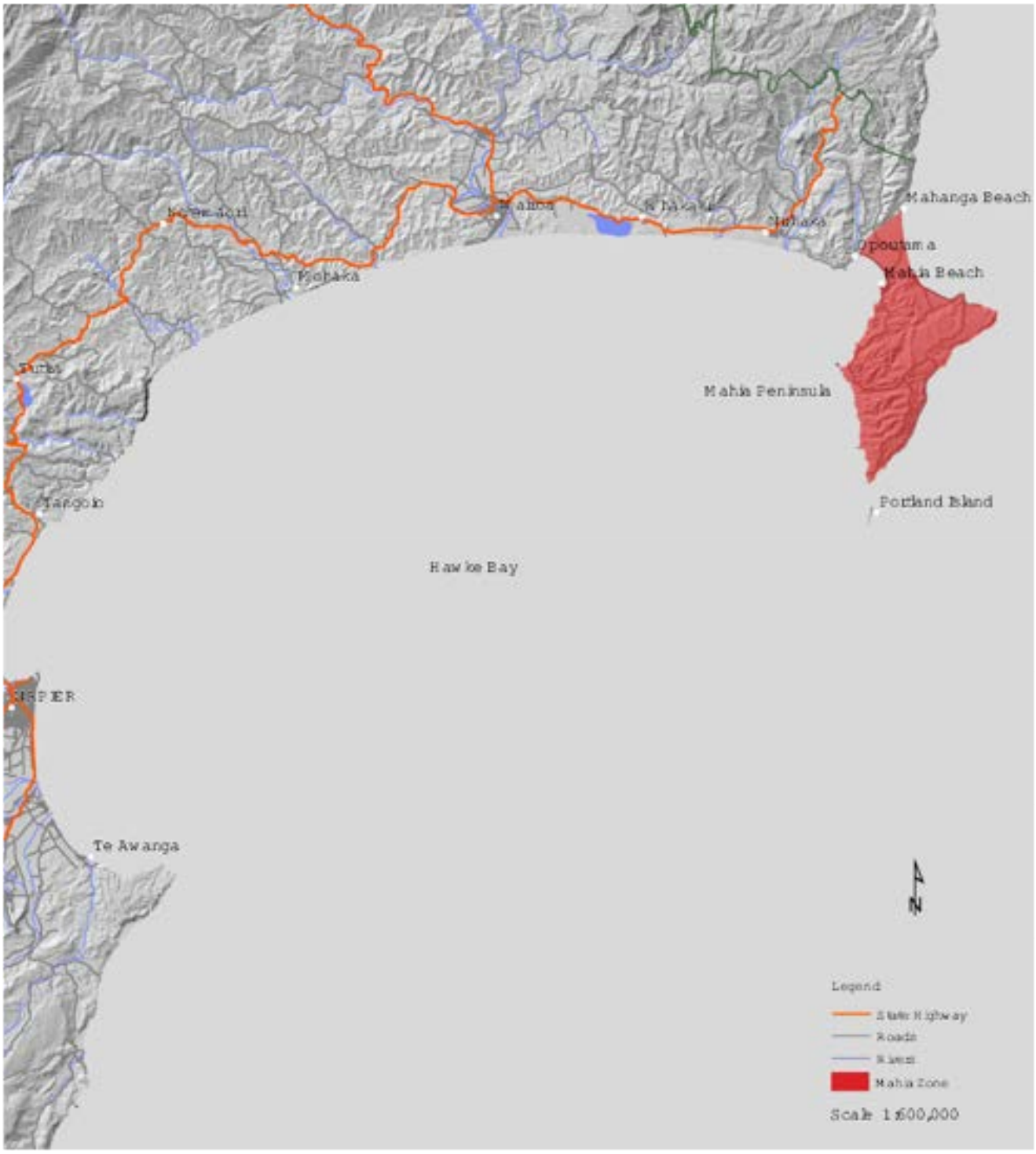

Figure 9 : : Mahia Peninsula Farm Forestry Zone.

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Willows planted for slope stabilisation with forestry in the background. Source: ***Alec Olsen***

Slope and aspect (direction of slope) Mahia Peninsula is exposed in all directions. The hill country can be divided into areas facing either west or east, whereas the terraces are exposed to the northeast or southeast.
Slope will determine :

- the available soil depth and soil type.
- soil moisture availability.
- access to the site.

Generally, slopes over 28 degrees will be steep enough to have eroded significantly and therefore have little volcanic influence or soil depth.

Altitude ranges from sea level to 400m with most of the Peninsula between 150 and 350m. The highest point is Rahuimokairoa.

Soils Type and location The flat to rolling landscape has remnant deposits of volcanic material from the Waimihia formation and older volcanic deposits (Pumice soils). There are few, if any, Taupo pumice deposits. The older volcanic layers underneath the Waimihia formation provide deep profiles. With the exception of the uneroded marine terraces, the volcanic deposits are sporadic due to the erodible nature of the area.

Also present are hill country soils that have developed from weathering processes of the bedrock and, depending on the level of erosion and parent material present, are either Pallic, or Recent steepland soils. They will be relatively shallow because of the weathering timeframe and consistent erosion potential. The soils on the terraces do not contain a sub-soil pan. There are soils that have developed on the sand dune areas; these are very sandy Raw soils. The soils are predominantly Pallic, Pumice, and Recent steepland soils with small areas of Raw and Gley soils. There are some small areas of Allophanic soil but these will have good soil depth and few restrictions for farm forestry – check Appendix I for specific information.

The following table provides the soil orders for this zone in order of dominance across the landscape.

Pallic soils
Pumice soils
Recent *steepland* soils
Raw soils

Table 16 : Soil orders for Mahia Peninsula zone in order of dominance across the landscape.

Figure 10 : General location of soil orders across the zone. Source: ***Regional Graphics***

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Climate Rainfall and soil water balance see Figure 11 for details. Rainfall ranges from 1000-1800 mm per annum, depending on altitude and distance inland, with an overall range over most of the peninsula of 1200-1400 mm per annum. The average annual potential evapotranspiration is 900-950 mm. The soil water balance indicate that there should be few deficit situations. However, Mahia Peninsula is often 'water-short' because of its many steep slopes, and because the rainfall is very seasonal – occurring mainly in winter and draining away fairly quickly. Droughts are not common in the area – about one in every ten years. On drought-prone sites, careful tree selection is needed. Coastal slope areas will experience salt burn, particularly from the south.

Wind direction varies, but is mostly from the north, west, and south, with the southerly winds frequently the strongest, followed by northerlies. Most of the wind from the south will be moisture-laden and will also promote salt burn. Wind is an issue; any coastal cyclonic storms with gales will be potentially devastating for trees.

Frost and snow Frosts are usually light and are not common. If they do occur, there is a 90% chance this will be between May and September. On average, there are 65 frost days per year. Snow is a very rare occurrence on the inland high hills and is not an issue.

Figure 11 : Rainfall of the Mahia Peninsula Farm Forestry Zone.

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Farm Forestry practices and recommended tree species

Chapter 3 contains the detailed information regarding tree species. Any notes in the tables are specific to this zone.

Commercial forest and woodlots

Table 17 : Commercial forest and woodlot species.

Botanical name	Common name	Botanical name	Common name
Pinus radiata Araucaria heterophylla Sequoia sempervirens	Radiata pine Norfolk Island pine Redwood	Quercus ilex/robur Podocarpus totara Vitex lucens	Holm/English oak Totara Puriri

Ground durable eucalyptus species

Araucaria heterophylla Norfolk Island pine. Source : ***Kevin Thomsen***

Soil conservation – gully erosion

Gully erosion is not common in this zone but there is a high potential for it to occur. Most of the gullies fall into two types:

- deeply incised systems, which have little sediment to erode other than lower slope material;
- low gradient systems infilled with material from the hills in the upper catchment. These are usually narrow valley floor areas and not very long due to the short catchment lengths on the peninsula.

The following species will suit either of these situations.

Example of gully planting using willow species in soft tertiary hill country. Source : ***Alec Olsen***

Table 18 : Soil conservation - gully erosion species.

Botanical name	Common name	Botanical name	Common name
Salix matsudana, S. alba and their variations	Tree willows	Salix viminalis, S. Purpurea, S. kinuyanagi	Basket and shrubby willows
Populus yunnanensis and var. Kawa, Veronese, Crowsnest, Argyle, Weraiti	Poplars		
The following species are options if the area is retired or restricted from grazing. Note that any of the commercial forest and woodlot species can also be considered if stock are removed and the erosion is not too severe - if erosion is severe to extreme plant P. radiata and manage accordingly.			
Hoheria populnea	Lacebark		
Plagianthus regius	Ribbonwood		
Pittosporum eugenioides	Tarata		
Pittosporum tenuifolium	Kahuhu		
Pittosporum crassifolium	Karo	This is not a complete list of indigenous species. However, it does list those species: a) with greater gully control ability because of their root mat systems; or suitability for the site; or b) that allow for long-term management options, such as acting as a nurse crop for further forestry planting * Remember Ngaio is poisonous to stock.	
Griselinia littoralis	Broadleaf		
Sophora microphylla/tetraptera	Kowhai		
Phormium tenax/cookianum	Native axes		
Dacrycarpus dacrydioides	Kahikatea		
Cordyline australis	Cabbage tree		
Myoporum laetum*	Ngaio		
Cortaderia toetoe/fulvida	Toetoe		
Eucalyptus ovata	Swamp gum		
Alnus glutinosa	Black alder		
Ulmus procera	English elm		
Taxodium ascendens/ distichum	Pond/Swamp cypress		

Soil conservation – slope erosion

Slope erosion is the most dominant erosion in this zone. Slopes are long and usually steep with soil depth shallowing about halfway up the hill. Soil movement can occur throughout the whole slope, but the top two-thirds is where erosion potential is the greatest. However, slope planting should be on the lower two-thirds if using poplar and willow poles, as they will not survive on the upper slope. Some of the species recommended will require you to de-stock for a period of time. Commercial forestry is an important activity in this zone.

Slope erosion. Source: ***Jude Addenbrooke***

Table 19 : Soil conservation - slope erosion species.

Botanical name	Common name	Botanical name	Common name
Populus yunnanensis and var. Kawa, Veronese, Crowsnest, Argyle, Weraiti	Poplars	Salix matsudana, S. alba and their variations	Tree willows
The following species are options if the area is retired or restricted from grazing. Note that any of the commercial forest and woodlot species can also be considered if stock are removed and the erosion is not too severe - if erosion is severe to extreme plant *P. radiata* and manage accordingly.			
Cordyline australis	Cabbage tree		
Alnus rubra	Red alder		
Chamaecytisus palmensis	Tagasaste		
Myoporum laetum	Ngaio	Remember Ngaio is poisonous to stock.	

Shelterbelts

The zone experiences a high level of coastal wind and some of it is exposed to cold southerlies, particularly the terraces. These areas should have shelterbelts. The remainder of the peninsula is covered in scattered indigenous and exotic trees, and, with the hilly relief, they provide abundant natural shelter and shade. Strategic use of remnant indigenous vegetation or exotic plantations as shelter will be beneficial, especially if roots are protected from animal damage by fencing.

A suitable coastal shelterbelt species – Metrosideros excelsa (Pohutukawa) – on a deer farm. Source: ***Simon Stokes***

Table 20 : Shelterbelt species.

Botanical name	Common name	Notes
Araucaria heterophylla Metrosideros excelsa Cupressocyparis Jeylandii Pinus radiata Pinus pinaster Quercus ilex	Norfolk Island pine Pohutukawa Leyland cypress -'Naylor's Blue' Radiata pine Maritime pine Holm oak	Often planted with another species (as listed here) Totara could be suitable as a leeward species. Maritime pine can handle salt spray exposure. Norfolk Island pine is frost tender.
Alnus rubra/cordata Populus spp. and var. Crowsnest, Veronese Salix matsudana var. Tangoio, Moutere Podocarpus totara	Red/Italian alder Poplar Tree willow Totara	
Chamaecytisus palmensis	Tagasaste	For dry hill country planting as a low growing companion species or on its own.
Pittosporum crassifolium Pittosporum eugenioides Pittosporum tenuifolium Corynocarpus laevigatus Metrosideros excelsa Cordyline australis	Karo Tarata Kohuhu Karaka Pohutukawa Cabbage tree	These species are coastal trees; they can be planted individually or together with other species.
Coprosma repens Hebe stricta Olearia solandri Phormium tenax Coprosma robusta	Taupata Koromiko Coastal tree daisy Harakeke (flax) Karamu	These species are suitable as coastal shrubs and would form the lower growing line in hill country. They can be planted with other taller species as listed above.

Riparian management

There are many different types of watercourses in this zone, each requiring different riparian management practices. Most of the riparian areas are short, steep, narrow catchments leading to infilled valley floors, alluvial flats, or gully systems that have a low gradient with a lot of deposited sediment. These watercourses require specific treatment and appropriate fencing to allow floodwaters

Most work in the riparian areas will be linked to gully erosion control work.

Root-mat development is vital as is long-term tree management to maintain the effectiveness of your planting.

In parts of the zone, there are dune and wetland environments that require specialised management. If you are subdividing your property, consider fencing to isolate and protect riparian, dune, or wetland zones.

Table 21 : Riparian management species.

Botanical name	Common name	Notes
Commercial forest species Erosion control gully planting species		A combination of these two systems can provide good results on large sites.
Populus spp. and var. Kawa, Veronese Salix spp - S. matsudana, var. Tangoio and Moutere	Poplars Tree willows	These are potential users of groundwater nitrogen and will allow indigenous undergrowth to developdepending on planting density
Pittosporum crassifolium Cordyline australis Metrosideros exce/sa Coprosma repens Hebe stricta O/earia solandri So/anum aviculare Pittosporum ralphii Phormium cookianum Carexspp. Schoenoplectus validus	Karo Cabbage tree Pohutukawa Taupata Koromiko Coastal tree daisy Poroporo Ralph's pittosporum Whaarariki (flax) Native grasses Lake clubrush	Many of these provide low and dense ground cover to intercept and filter surface ow water.

Amenity/shade

The zone is coastal and can be very dry, so the species recommended reflect these factors, with the primary role of providing shade. There are many other species that will grow and even thrive. Success depends on the site, good planting technique, and protecting the trees from stock.

Table 22 : Amenity/shade species.

Botanical name	Common name	Botanical name	Common name
Araucaria heterophylla Metrosideros excelsa Banksia integrifolia Corynocarpus laevigatus Araucaria cunninghamii	Norfolk Island pine Pohutukawa Coast banksia Karaka Bunya pine	Platanus acerifolia/ occidentalis Quercus ilex/robur	Planes Holm/English oak
		Karaka pollen is toxic to bees.	
		Bunya pine like warm, moist localities.	

Tangoio

This zone is a unique, elevated area known as the Tangoio Block. It is characterised by massive, tilted escarpments with high, west-facing cliffs, and receives frequent high intensity rainfall events that have contributed to the extensive erosion that marks the landscape.

Geology Rock types are Tertiary marine sediments that have formed deposits of sandstone, siltstone (sandy mudstone), and mudstone, with layers of pumiceous tuffs (volcanic deposits) and marine gravels. These are sometimes overlain with limestone. Because of this mixed geology and the presence of soft, weak material, the area has seen significant erosion. In places, the bedrock is covered in loess and volcanic material.

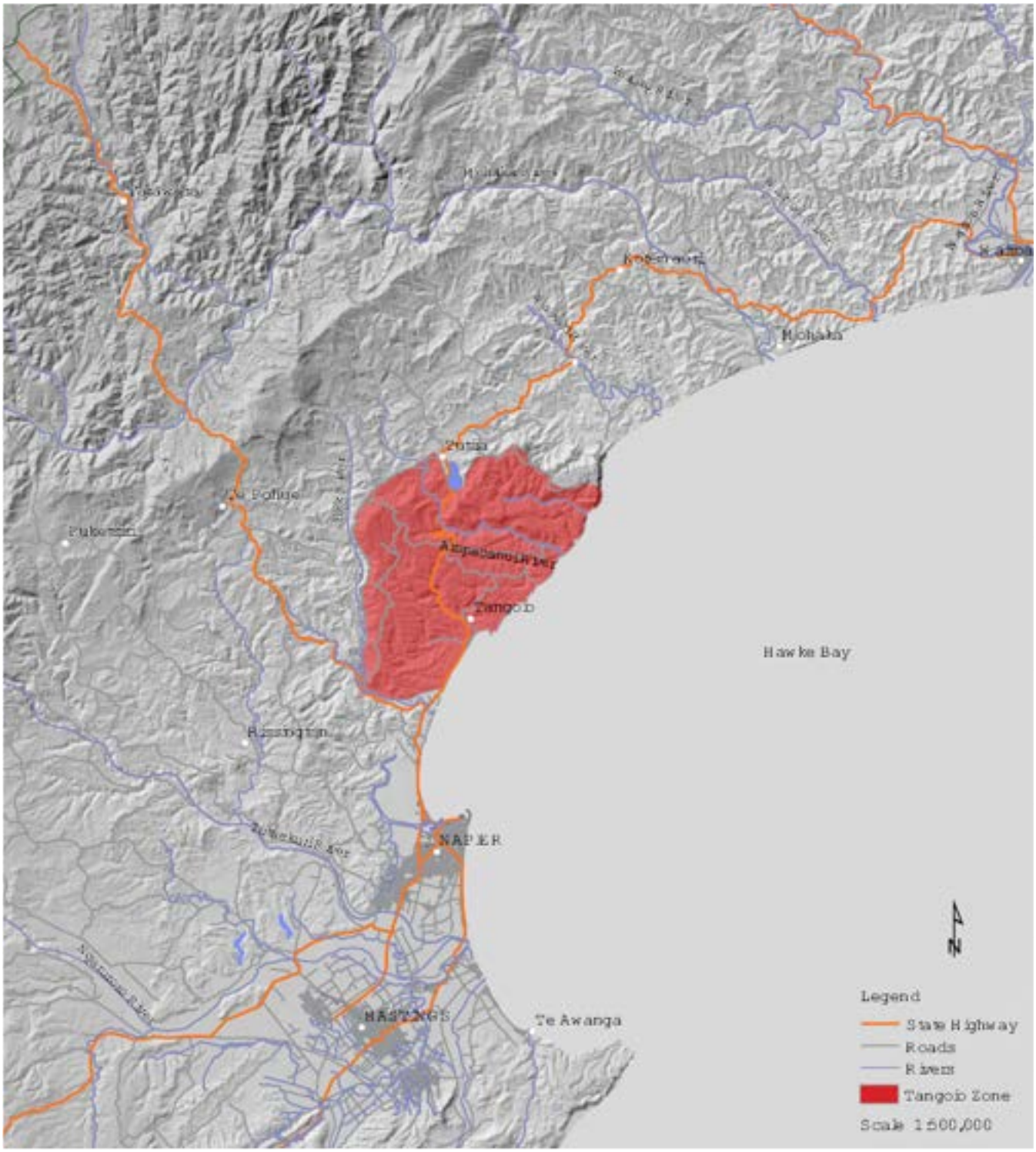

Figure 12 : Tangoio Farm Forestry Zone.

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Topography Landform consists of hill country that varies from moderately steep to very steep. Slopes less than 25 degrees are still mantled in loess and volcanic deposits to varying depths depending upon previous erosion, but steeper slopes are very scarred. The area rises quickly from the coast and then slopes upwards inland, ending along the steep scarps of the Darky's Spur, Tutira and Ridgemount areas. There is a small range called the Rocky Range at Ridgemount. The Esk River in the south and west frames the zone. The steep slopes in the southern sector have rounded ridge tops, generally allowing access into steep areas, and these slopes increase in length further north. There are three rivers – the Aropaoanui and Moeangiangi Rivers, with a small section of the Waikoau River in the zone.

Slope and aspect (direction of slope) Most of the zone is exposed to the east and southeast with the western boundary exposed to the west and northwest. Aspect has a major effect on growing conditions when combined with soil type, wind direction and slope angle, particularly affecting the availability of soil moisture.

In this area, slope will determine :

- the available soil depth and soil type.
- soil moisture availability.
- access to the site.

Generally, slopes over 28 degrees are steep enough to have eroded significantly, having little or no volcanic or loess material or soil depth.

Altitude generally rises quickly from sea level to 150-200m near the coast and then ranges from 200-350m, climbing to 450-600m. The high points are Purahotangihia at 631m on Darky's Spur and the Rocky Range at 517m. This altitude climb affects the development of high intensity rainstorms that are often part of north eastern cyclonic storms.

Soils Type and location The soils range from excellent depth to too shallow for farm forestry purposes. Volcanic deposits, particularly the Waimihia formation and Taupo Pumice, influence this zone and where they have not eroded away there is a good soil depth. Slope angle increases erosion rates resulting in the infilling of valley floors. Where these influences dominate, the soils are more Recent (steepland) with little volcanic influence and if volcanic material is present, it is re-eroded from the hills and very mixed.

The soils can be broadly grouped into three orders – the *Pumice soils, Pallic soils,* and *Recent* steepland soils. The valley floor and terrace soils are quite different, having developed from water deposited material – silts, clays, and volcanic material. Due to location and drainage patterns, these soils are prone to periods of high water levels and are classified as *Recent* alluvial soils or sometimes *Gley* soils. There are possibly some small compartments of Allophanic and Raw soils present. Check Appendix I for more specific details on these soils.

The following table provides the soil orders for this zone in order of dominance across the landscape.

Pallic soils
Pumice soils
Recent *alluvial and steepland* soils
Gley soils

Table 23 : Soil orders for Tangoio zone in order of dominance across the landscape.

The landscape of the Tangoio area, looking into the Waipapa Stream catchment between Aropaoanui and Ridgemount. Source: ***Garth Eyles***

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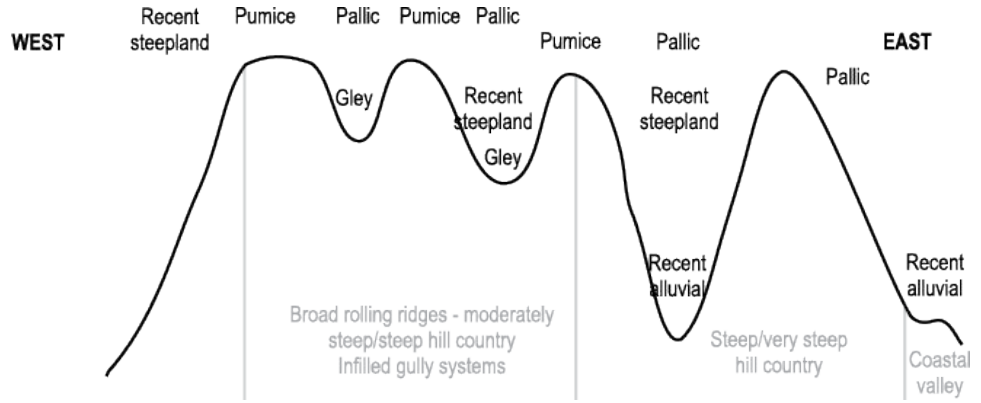

Figure 13 : General location of soil orders across the zone. Source: ***Regional Graphics***

Climate Rainfall and soil water balance Rainfall ranges from 1200-1600 mm per annum, with the high points possibly experiencing more. However, some rainfall intensity can be very high. The soil water balance (annual evapo-transpiration rate) is 950 mm, which is high for Hawke's Bay. There is a moderate chance of a deficit. Droughts are not common – about one every ten years.

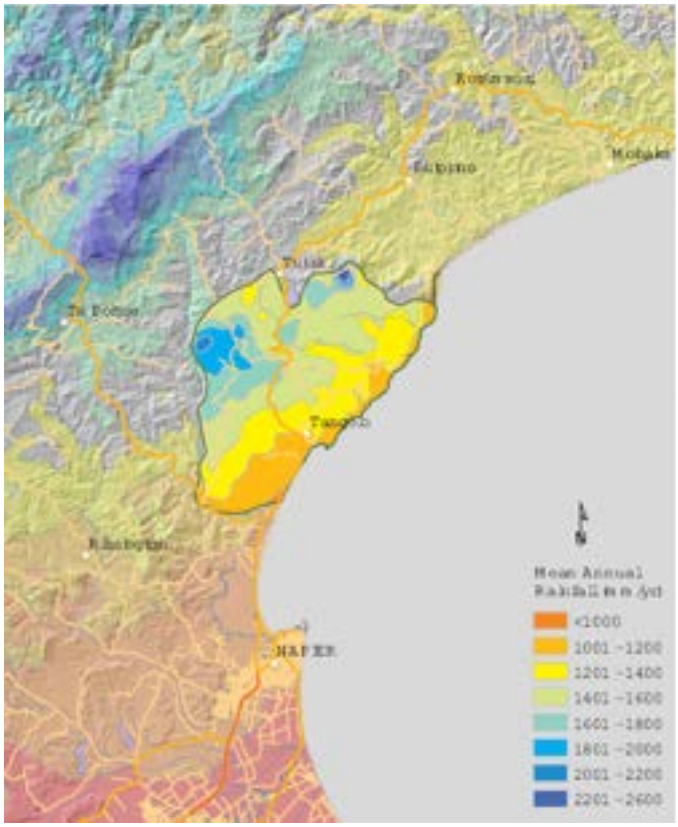

Figure 14 : Rainfall of the Tangoio Farm Forestry Zone.

Therefore, drought resistance is not as strong a consideration as wind resistance during tree selection. More important and devastating are the cyclonic storms coming off the sea once in every five years on average.

Wind direction is mostly from the west and southwest, but closer to the coast the wind tends east to southeast. The wind accelerates soil moisture loss and, therefore, any steep, shallow soil on west to northwest slopes will experience water deficits after prolonged periods of wind. The most exposed sites to constant severe winds are the western slopes of Darky's Spur, the Tutira hills, and Rocky Range. The coast facing slopes are exposed to salt burn.

Frost and snow Frosts are most likely to occur at the higher altitudes, and in lowland valleys where there is slow air drainage. Nearly 90% of frosts occur between May and September with an average of 115 to 165 frost days per year. Frost is a limiting factor in some areas, therefore frost hardiness should be a consideration in your species selection process. Snow is rare, except on the high points of Darky's Spur and Rocky Range.

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Farm Forestry practices and recommended tree species

Chapter 3 contains the detailed information regarding tree species. Any notes in the tables are specific to this zone.

Commercial forest and woodlots

Looking down the Aropaoanui River catchment with well-established forestry and 2003 planted forestry. The photo shows that the forestry is hiding landscape similar to areas that have been recently planted, reminding us of the erodibility of these hills. Source: ***Susan Mackintosh***

Table 24 : Commercial forest and woodlot species.

Botanical name	Common name	Botanical name	Common name
Pinus radiata	Radiata pine	Eucalyptus obliqua	Tasmanian oak
Cupressus lusitanica	Mexican cypress	Cedrus deodara/ atlantica	Himalayan/Atlas cedar
Pseudotsuga menziesii	Douglas fir	Populus spp. and var. Kawa and Veronese	Poplars
Sequoia sempervirens	Redwood	Cryptomeria japonica	Japanese cedar
Eucalyptus fastigata	Brown barrel	Acacia dealbata	Silver wattle
Eucalyptus nitens	Shining gum	Podocarpus totara	Totara
Eucalyptus regnans	Mountain ash	Cupressus torulosa	Bhutan cypress

Soil conservation – gully erosion

Gully erosion is not common in this zone but there is a high potential of occurrence due to the amount of unconsolidated material filling gully landforms.

Most of the gullies fall into two types:

- deeply incised systems, which have little sediment to erode other than the lower slope material; and
- low gradient systems infilled with material from the hills in the upper catchment. These are wide valley floor areas

Gully Erosion. Source: ***Jude Addenbrooke***

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The following species will suit either of these situations.

Table 25 : Soil conservation - gully erosion species.

Botanical name	Common name	Botanical name	Common name
Salix matsudana, S. alba and their variations Populus yunnanensis and var. Kawa, Veronese, Crowsnest, Argyle, Weraiti	Willows Poplars	Salix viminalis, S.Purpurea, S. kinuyanagi	Basket and shrubby willows
The following species are options if the area is retired or restricted from grazing. Note that any of the commercial forest and woodlot species can also be considered if stock are removed and the erosion is not too severe - if erosion is severe to extreme plant P. radiata and manage accordingly.			
Plagianthus regius Pittosporum eugenioides Pittosporum tenuifolium Pittosporum crassifolium Griselinia littoralis Sophora microphylla/tetraptera Phormium tenax/cookianum Dacrycarpus dacrydioides Cordyline australis Cortaderia toetoe/fulvida Hoheria populnea Alnus glutinosa Alnus rubra Ulmus procera	Ribbonwood Tarata Kohuhu Karo Broadleaf Kowhai Native axes Kahikatea Cabbage tree Toetoe Lacebark Black alder Red alder English elm	This is not a complete list of indigenous species. However, it does list those species: a) with greater gully control ability because of their root mat systems; or suitability for the site; or b) that allow for long-term management options, such as acting as a nurse crop for further forestry planting	

Soil conservation – slope erosion

Slope erosion is the dominant type of erosion in this zone. Soil movement can occur throughout the whole slope, but the top two-thirds is where erosion potential is the highest. However, slope planting should target the lower two-thirds if using poplar and willow poles, as these will not survive on the higher slopes. Some of the species recommended will require the site to be de-stocked for a period of time. Commercial forestry is an important option in this zone.

Severe soil slip erosion in the Waikoau River catchment.
Source: ***Garth Eyles***

Table 26 : Soil conservation - slope erosion species.

Botanical name	Common name	Botanical name	Common name
Populus spp. and var. Kawa, Veronese, Crowsnest, Argyle,	Poplars	Salix matsudana, S. alba and their variations	Tree willows
The following species are options if the area is retired or restricted from grazing. Note that any of the commercial forest and woodlot species can also be considered if stock are removed and the erosion is not too severe - if erosion is severe to extreme plant *P. radiata* and manage accordingly.			
Quercus ilex/ robur/ palustris	Holm/English/Pin oak		
Cordyline australis	Cabbage tree		
Alnus rubra	Red alder		
Gleditsia triacanthos	Honey locust		
Platanus acerifolia	Plane		

Shelterbelts

The prevailing wind is westerly, with the southeast wind bringing the chill. This should be the basis for your shelterbelt establishment practice. The open tops will require hardier wind resistant tree species if you are planning on sheltering land from the west. Shelterbelts designed to protect stock from cold southerlies will require different tree species and design.

The zone is covered in scattered ndigenous trees and some exotic plantations, which, with the relatively hilly relief, already provide some shelter and shade. Strategic use of remnant indigenous vegetation or exotic plantations for shelter will be beneficial. (Fencing to protect roots from animal damage is an appropriate practice.)

Table 27 : Shelterbelt species.

Botanical name	Common name	Notes
Pinus radiata	Radiata pine	Single or double row. Often planted with another species (as listed here).
Cedrus deodara/atlantica	Himalayan/Atlas cedar	
Cupressus torulosa	Bhutan cypress	
Cupressocyparis leylandii	Leyland cypress -'Naylor's Blue' or 'Leighton Green' and 'Green Spire' if away from the coast.	Totara could be suitable as a leeward species.
Pinus pinaster	Maritime pine	Maritime pine can handle salt spray
Chamaecytisus palmensis	Tagasaste	For dry hill country planting as a low growing companion species or on its own.
Coprosma repens	Taupata	These species are shrubs and would form the lower growing line in hill country. They can be planted with other taller species as listed above.
Hebe stricta	Koromiko	
Olearia solandri	Coastal tree daisy	
Coprosma robusta	Karamu	
Eucalyptus microcorys*	Tallow wood	Should be used in internal shelterbelts where they arenot too exposed to the westerly wind - running east to west. Single row planting interplanted with the following: Coprosma spp., Hebe spp., Carmichaelia spp. (native broom), Tagasaste (tree lucerne), Pittosporum spp. *intolerant of frost.
Eucalyptus fastigata	Brown barrel	
Populus spp. and var. Crowsnest, Veronese	Poplar	
Salix matsudana var. Tangoio, Moutere	Tree willows	
Alnus rubra	Red alder	
Metrosideros excelsa	Pohutukawa	Can tolerate exposure and salt winds. Some frost.
Pittosporum crassifolium	Karo	Best in situations not exposed to the full force of the wind. They can be planted individually or together with other indigenous species not listed here (personal preference), or with some of the exotics listed above except the conifer species.
Pittosporum eugenioides	Tarata	
Pittosporum tenuifolium	Kohuhu	
Cordyline australis	Cabbage tree	
Corynocarpus laevigatus	Karaka	
Podocarpus totara	Totara	
Pittosporum ralphii	Ralph's pittosporum	
Araucaria heterophylla	Norfolk Island pine	

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Riparian management

There are many different types of watercourses in this zone, and riparian management practices will differ with each. Most of the pastoral land is farmed extensively or semi-intensively.

The riparian areas consist of steep slopes leading to wide, infilled gullies and valley floors or gully systems that have a low gradient with very wet winter environments. These very wet to swampy areas leading to watercourses require specific treatment and appropriate fencing to allow floodwaters through.

A single 'hot-wire' may be suitable in some cases. Root mat development is vital as is long-term tree management. Upper catchments can be either space planted or planted with commercial forestry.

In parts of the coastal Tangoio area, there may be dune environments that require specialised management. If you are subdividing your farm, consider fencing options to isolate and protect riparian, dune or wetland zones.

Table 28 : Riparian management species.

Botanical name	Common name	Notes
Sequoia sempervirens Populus yunnanensis and var. Kawa, Veronese, Crowsnest Taxodium distichum/ ascendens Alnus glutinosa	Redwood Poplars Swamp/Pond cypress Black alder	With the exception of Taxodium, do not plant these species in a permanently saturated site.
Plagianthus regius Hoheria angustifolia/ populnea Coprosma propinqua Machaerina sinclairii Pittosporum eugenioides Pittosporum tenuifolium Phormium tenax/cookianum Dacrycarpus dacrydioides Cordyline australis Cortaderia toetoe/fulvida Aristotelia serrata Leptospermum scoparium Corokia cotoneaster Schoenoplectus validus	Ribbonwood Lacebark Mingimingi Sedge Tarata Kahuhu Native Flaxes Kahikatea Cabbage tree Toetoe Wineberry Manuka Korokio Lake clubrush	This is not a complete list of indigenous species. However it does list those species: a) with greater gully control ability because of their root mat systems; or suitability for the site; or b) that allow for long-term management options, such as acting as a nurse crop for further forestry planting.

Amenity/shade

The list below includes only a few of the tree species that will thrive in this area; success with other species will depend on the site and good planting technique.

The most mportant points to remember are the level of wetness in lower areas and gully bottoms, frost, and wind effect either from the west or from the coast (salt-laden wind).

Table 29 : Amenity/shade species.

Botanical name	Common name	Botanical name	Common name
Pinus coulteri/ponderosa	Pines	Cordyline australis	Cabbage tree
Cedrus atlantica/deodara	Atlas/Himalayan cedar	Fagus sylvatica	English beech
Castanea sativa	Spanish chestnut	Ginkgo biloba	Ginkgo
Populus yunnanensis and var. Kawa and Veronese	Poplars	Magnolia grandiflora	Magnolia
Juglans regia	Common walnut	Platanus occidentalis/ acerifolia	Planes
Acer pseudoplatanus/ macrophyllum	Sycamore/Oregon maple	Quercus robur/ilex/ palustris etc.	Oaks
Sequoiadendron giganteum	Wellingtonia	Aesculus hippocastanum	Horse chestnut
Sophora tetraptera	Kowhai	Metrosideros excelsa	Pohutukawa
Araucaria heterophylla	Norfolk pine		

Upland Pumice

Within the Hawke's Bay region, there is one landscape that is quite different to surrounding areas, the Upland Pumice country. It is mantled with volcanic material and has a high country climate across its wind-swept plains and hills. Options for farm forestry are primarily limited by climate – frost, snow, and wind.

Geology Rock types The zone can be split into three areas:

- The valleys, accessed from SH 5, comprise deep water-sorted Taupo flow tephra and associated ash over previous volcanic deposits, which in turn cover greywacke, ignimbrite, and Tertiary marine deposits. Included in this area is the Pakaututu area behind Puketitiri.
- The upland areas of Te Mahanga and Ngamatea off the Taihape Road. These upland areas comprise Tertiary marine sediments that have formed deposits of sandstone, siltstone, and mudstone, with layers of pumiceous tuffs (volcanic deposits), sometimes overlain with limestone. The bedrock is extensively covered in volcanic material
- The Rangitaiki Plains area, including Lochinver, Poronui and other land of the Ripia and Taharua River catchments.

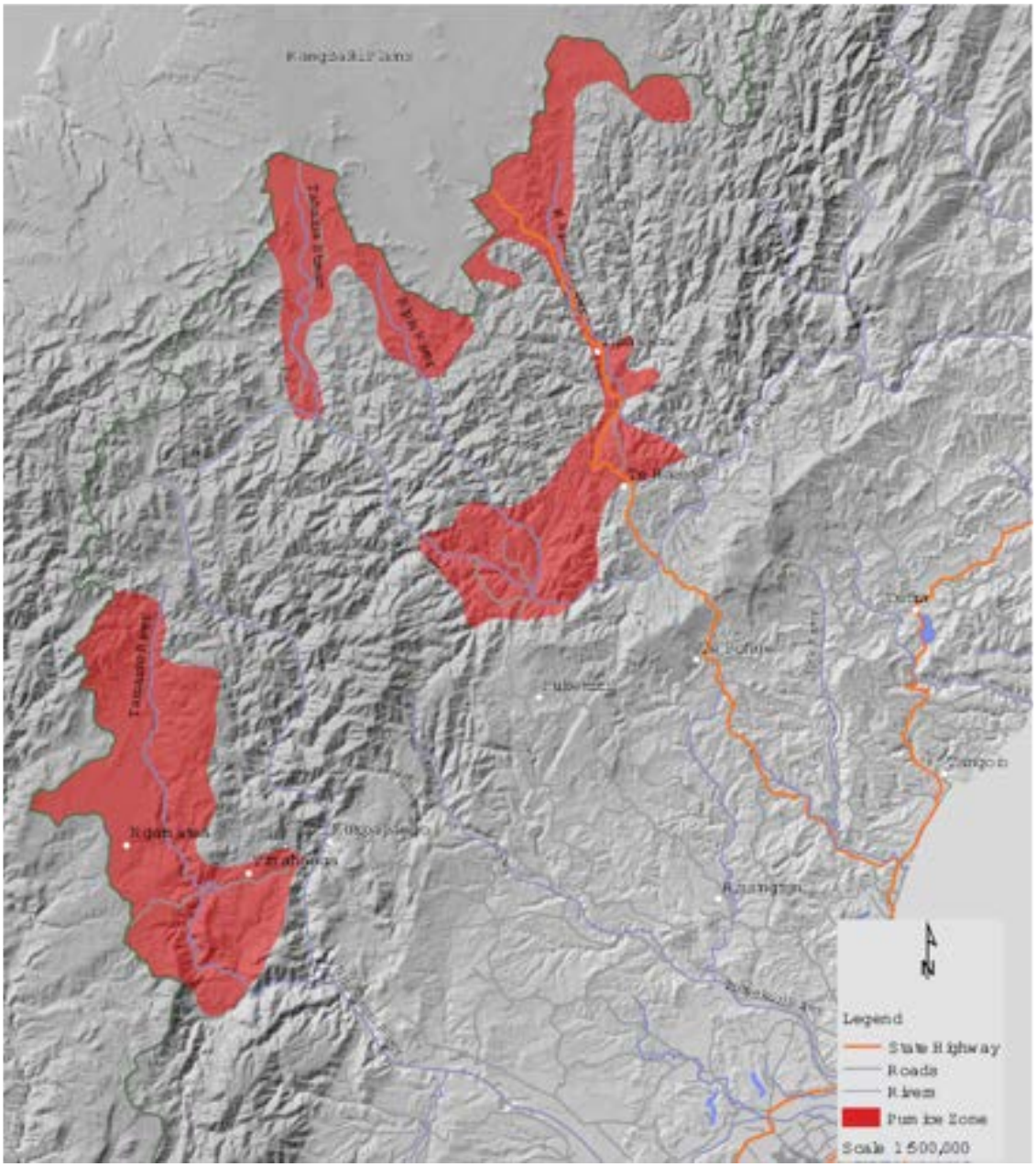

Figure 12 : Tangoio Farm Forestry Zone.

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Topography Landform The zone can consists of infilled valley floors and plains with associated terrace systems, and rolling to very steep hill country cut by deeply incised gorge systems. Slopes less than 28 degrees are still mantled in volcanic material of varying depths and dependent upon the erosion levels. There are several river catchments with some terrace development. The Taruarau River drains the Te Mahanga-Ngamatea area, while the Taharua and Ripia Rivers drain the Lochinver-Poronui area before discharging into the Mohaka River. The Waipunga River also drains some of Rangitaiki Plains and associated terraces before entering the Mohaka River.

Slope and aspect (direction of slope) The tertiary area is mostly exposed to the west and north. In the hill country areas, particularly in the Te Mahanga-Ngamatea area, aspect is a very important consideration, as there is increased exposure to wind. There was such a quantity of volcanic material deposited over this zone that aspect does not influence the nature of deposition; it was a blanket covering. Slope will determine:

- the available soil depth and soil type;
- soil moisture availability;
- access to the site.

Generally, on slopes over 28 degrees, the volcanic material will have eroded significantly, thereby reducing soil depth on the greywacke and marine sediments.

Altitude In the north, the valley floors are generally about 500m above sea level, except on the Rangitaiki Plains where they are 800m above sea level. In the south, Ngamatea starts at about 900-1000m, climbing to 1300m above sea level. Altitude has a significant effect on the climate in this zone and, therefore, on farm forestry options.

Soils Type and location The soils in this zone provide excellent rooting depth, but can be marginal for farm forestry purposes due to the shallowness of the topsoil and the lack of nutrients. This is due to the volcanic parent material of the soils, particularly the Taupo flow tephra (ash and lapilli) and the Waimihia formation deposits and the lack of fertility associated with weathered greywacke bedrock. Another influence is slope, which increases erosion rates. Where erosion has occured, the soils are more recent with little or no volcanic influence. Any soils with a large extent of volcanic influence located over 600m, with high rainfall averages, will be Podzol soils, highly acidic and well leached.

The type of soils in this zone can be broadly separated into two groups - the dominant Pumice soils, and the Recent soils. Some of the valley floor soils may have a perched watertable due to impermeable layers. This needs to be taken into account, as the soils will behave like a Gley soil. There are some areas of Brown and Allophanic soils present; these have good soil depth and present few problems for farm forestry – check Appendix I for their more specific details.

The following table provides the soil orders for this zone in order of dominance across the landscape.

Pumice soils
Recent *alluvial and steepland* soils
Gley soils
Brown soils
Allophanic soils
Podzol soils

Table 30 : Soil orders for Upland Pumice zone in order of dominance across the landscape.

The Upland Pumice landscape. Photo on the left looking into the upper Ripia River catchment; photo on right looking down onto the Rangitaiki Plains, both photos circa early 1970s. Source: ***Kevin Thomsen***

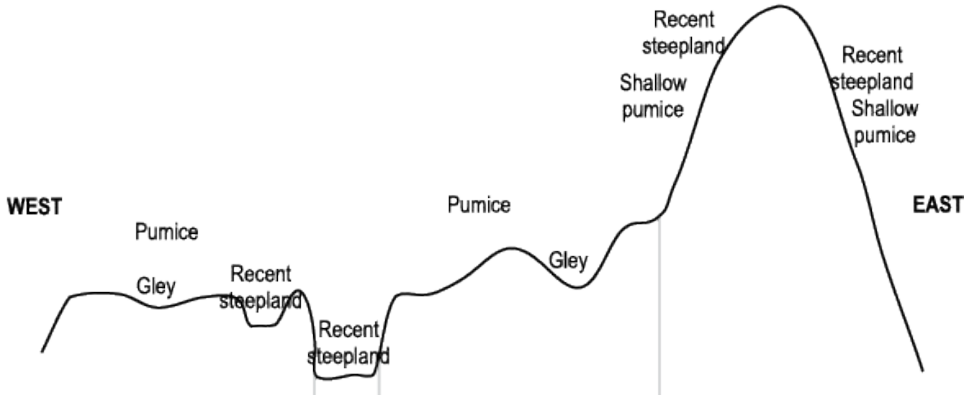

Figure 16 : General location of soil orders across the zone. Source: ***Regional Graphics***

Climate Rainfall and soil water balance (see Figure 17 for details) Rainfall ranges from approximately 1600 mm per annum around Te Haroto and Tarawera, to 2000-2400 mm per year on the Rangitaiki Plains. Rainfall in the Ngamatea and Te Mahanga areas generally ranges from 1400-1800 mm per year, but can be much higher, reaching 2400 mm per annum in wet years. The soil water balance (annual evapo-transpiration rate) in this area is less than 800 mm, so there is little chance of a deficit other than in an extreme drought situation.

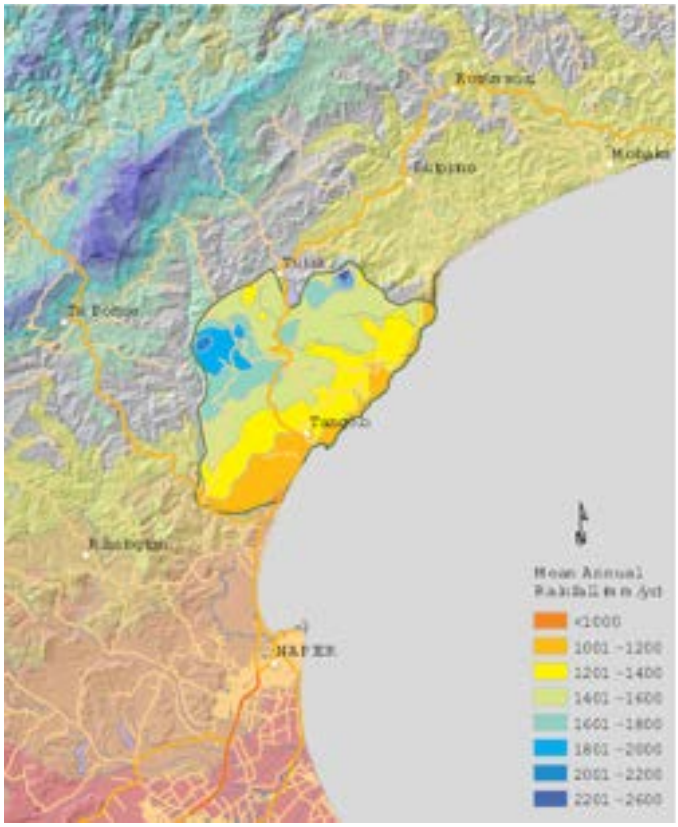

Figure 17 : Rainfall of the Upland Pumice Farm Forestry Zone

Wind is a severely limiting factor in this zone. Wind direction is predominantly from the west and southwest, but the northerly also occurs fairly frequently. The wind accelerates soil moisture loss and, therefore, steep, shallow soils on west to northwest slopes will become water deficient under prolonged wind exposure.

Frost and snow Snowfall does occur and at a level that could cause serious damage to trees. Frost and windchill can be severely limiting to plants in this area, particularly on valley floors. Nearly 90% of frosts will occur between May and November with an average 215 to 265 frost days per year. The biggest problem is that frosts can occur at any time of the year. Out-of-season frosts can be extremely damaging to plantings.

"An out-of-season frost in January 1998, roughly -5 oC, killed all the Eucalyptus regnans established the previous winter while the E. nitens survived to carry on growing" Joe Devonport, Hawke's Bay Regional Council
Land Management Officer.

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Farm Forestry practices and recommended tree species

Commercial forest and woodlots

In this Farm Forestry Zone, frost tolerance is essential in the tree species selection. Frequent out-of-season frosts are harsh on species that are normally winter cold-hardy.

Table 31 : Commercial forest and woodlot species.

Botanical name	Common name	Botanical name	Common name
Pinus radiate Pseudotsuga menziesii Cupressus lusitanica Cupressocyparis ovensii Cupressus torulosa Sequoia sempervirens	Radiata pine Douglas fir Mexican cypress Ovens cypress Bhutan cypress Redwood	Sequoiadendron giganteum Eucalyptus fastigata Eucalyptus nitens Eucalyptus regnans Nothofagus fusca	Wellingtonia Brown barrel Shining gum Mountain ash Red beech
Larix decidua/kaempferi Picea sitchensis	European/Japanese larch Sitka spruce	Species tolerant of high altitude planting, but do not like strong wind.	
Nothofagus obliqua/x alpine	Roble/'hybrid' beech	South American beech that is performing very well at Makahu.	
Pinus sylvestris/nigra	Scots/Corsican pine	Can grow up to 1100m above sea level.	

Soil conservation – gully erosion

Gully erosion can be extreme in this zone, requiring considerable time and investment once it begins. If an area has been repaired, there is also the issue of ongoing maintenance. The best practice is to avoid gully erosion even beginning. Vulnerable sites with water control problems should be fenced and well maintained with pasture. If there is indigenous vegetation present, fencing it to exclude stock will allow a natural revegetation process to occur.

If a gully forms, it will be steep, sheer-sided and have an actively eroding 'gully-head'. Erosion control then becomes extremely difficult and planting trees is not an option. The best method is water control with carefully planned structural work such as detention dams and flumes.

Soil conservation – slope erosion

As with gully erosion, preventing any slope erosion is the best management practice. In particular, this includes avoidance of activities, such as cultivation, that cause rill erosion that can lead to gully erosion. In this zone, slope planting associated with pastoral grazing does not occur often, because slopes are either too steep for planting and grazing, or not steep enough for frequent mass movement erosion to occur. If retaining the pasture is not necessary, then the best option is commercial forestry. Some limited grazing potential may be possible after 5-8 years depending on growth rate and tree species. See the 'Commercial forest and woodlots' list.

An example of gully erosion that can occur in this zone in water sorted Taupo flow tephra. Source: ***Simon Stokes.***

Shelterbelts

This zone experiences a high level of exposure to cold wind, causing high wind-chill levels. Scattered indigenous trees and some exotic plantations are present, but there is still an extensive area of very exposed open country. The following species are recommended to provide stock shelter and crop protection from wind erosion and wind-chill.

Table 32 : Shelterbelt species.

Botanical name	Common name	Notes
Cedrus deodara/atlantica	Himalayan/Atlas cedar	Slow growing, but tolerant of wind and dry. Severe cold winds can hinder establishment
Cupressus torulosa	Bhutan cypress	
Pseudotsuga menziesii	Douglas fir	Suited for the leeward side of a two-row shelterbelt, handles snow, frost tolerant to -16 °C. Can be planted up to 900m above sea level.
Pinus radiata	Radiata pine	Check altitude before mass establishment as P. radiata struggles above 800m above sea level.
Pinus sylvestris	Scots pine	Can withstand extreme cold.
Cupressocyparis leylandii	Leyland cypress	Suited for the windward side of a two -row shelterbelt.
Cupressocyparis ovensii	Ovens cypress	
Larix decidua/kaempferi	European/Japanese larch	Suited for the leeward side of a two-row shelterbelt.
Pseudowintera colorata	Horopito	All can be planted in the open and can handle some frosting. You could also supplement some Hebe spp. and native grass species into the shelterbelt. All are suitable for windward or leeward side planting of a two row shelterbelt.
Pseudopanax edgerleyi	Raukawa	
Pittosporum tenuifolium	Kahuhu	
Pittosporum crassifolium	Karo	
Pittosporum ralphii	Ralph's karo	
Pittosporum eugenioides	Tarata	
Corokia cotoneaster	Korokia	
Podocarpus hallii	Hall's totara	

Sophora tetraptera Kowhai. Source: ***Marie Taylor***

Riparian management

Because there are so many different types of watercourses in this zone, riparian management practices will differ. Most of the pastoral land is farmed extensively or semi-intensively.

The riparian areas occur in two main situations:

Situation 1: Very steep, short slopes cut down through infilled volcanic deposits that have created terraces to a watercourse at the bottom. These areas are mostly covered in revegetating indigenous species and open scars, invasive weed species, or commercial forestry. Erosion control practices such as the exclusion of stock and careful harvest management will help maintain and protect riparian areas. Where these riparian areas exist in pastoral situations, a single 'hot-wire' may be suitable protection. Root mat development is vital as is longterm tree management. For management of the upper catchment areas, see the 'Soil conservation – gully erosion' section.

A good example of riparian management on the Rangitaiki Plains. Source: ***Simon Stokes***

Situation 2: Steep, long slopes that are associated with greywacke hills, where terrace systems or massive A good example of riparian management on the Rangitaiki Plains. Source: Simon Stokes depths of volcanic material are not present. These sites can be left to revert to indigenous species if there is a seed source species nearby, as they are often physically impractical to plant. If the slopes are currently grazed, some form of fencing of the watercourse, if practical, would allow faster regeneration. If commercial forestry exists, or is to be established, this type of planting will also provide riparian management.

The trees recommended for these situations will mostly be interplanted among indigenous or weed species already present. For instance, if gorse is present, interplant if possible, or allow the gorse to act as a nurse crop for regenerating indigenous species.

In parts of the Upland Pumice area, there may be wetland environments that require specialised management. If you are subdividing your property, plan fencing to isolate and protect riparian or wetland zones.

Table 33 : Riparian management species.

Botanical name	Common name	Notes
Some of the commercial forest species could also be interplanted in riparian zones but ideally these areas should be maintained in indigenous species (representative of the existing species or ecosourced).		
Sequoia sempervirens Metasequoia glyptostroboides Eucalyptus delegatensis/regnan/nitens Populus spp. and var. Kawa and Veronese	Redwood Dawn redwood Eucalypts Poplars	Spaced and interplanted with mixed indigenous or other exotics.
Nothofagus fusca/solandri Dacrydium cupressinum Beilschmiedia tawa Dacrycarpus dacrydioides Knightia excelsa Prumnopitys taxifolia	Red/Black beech Rimu Tawa Kahikatea Rewarewa Matai	These are some of the indigenous species that will have a timber potential. There are many other species that can be supplementary planted.

Amenity/shade

This zone is unique to Hawke's Bay and has the problems of high altitude and weather extremes. There are limited choices for amenity and shade planting that will successfully grow in the open and many of these will be slow. Success depends on species selection to suit the site, protecting the trees from stock, and good planting technique. Primary shelter from persistent wind is necessary.

Table 34 : Amenity/shade species.

Botanical name	Common name	Botanical name	Common name
Quercus spp.	Oaks	Juglans regia	Common walnut
Betula pendula/pubescens	Silver/Downy birch	Aesculus hippocastanum /indica	Horse/Indian chestnut
Populus spp. and var. Kawa and Veronese	Poplars	Acer negundo	Box elder
Castanea sativa	Sweet chestnut	Pinus coulteri/ponderosa/nigra	Pines
Eucalyptus pauciflora/regans/ fastigata/obliqua/nitens/ delegatensis	Eucalypts	Cedrus deodarala/atlantica	Himalayan/Atlas cedar
Ginkgo biloba	Ginkgo	Prunus cerasus/avium	Sour/Mazzard cherry
Malus spp.	Crabapple tree varieties	Sequoiadendron giganteum	Wellingtonia
Metasequoia glyptostroboides	Dawn redwood		
Ulmus procera	English elm		

Sequoiadendron giganteum make a spectacular shade and shelter specimen, suitable for cold, exposed sites. Source: ***Kevin Thomsen***

Eastern

Including information on the Coastal and Mudstone Earthflow subzones.

This zone is identified by its complex geology, distinct soil types and climate. An important point to note is that the northern section of the Tukituki Valley, from Kahuranaki to the hills behind Te Awanga, receives significantly less annual rainfall than the rest of the zone. Therefore it is more drought-prone. At the end of this section, we have included notes on two distinct and different types of land-scape within the Eastern Zone - the Coastal and Mudstone Flow subzones.

Geology Rock types The Eastern area is very complex geologically and contains some of the oldest rocks in Hawke's Bay. (Only the greywacke rocks found in the Kaweka/Ruahine Ranges are older.) The Lower Cretaceous and Tertiary marine sediments consist of mudstones which are massive, interbedded or bentonitic in type, as well as argillite, sandstone, and limestone. These are sometimes interlaid with pumiceous tuff (volcanic deposits). Generally, the area is mudstone dominant.

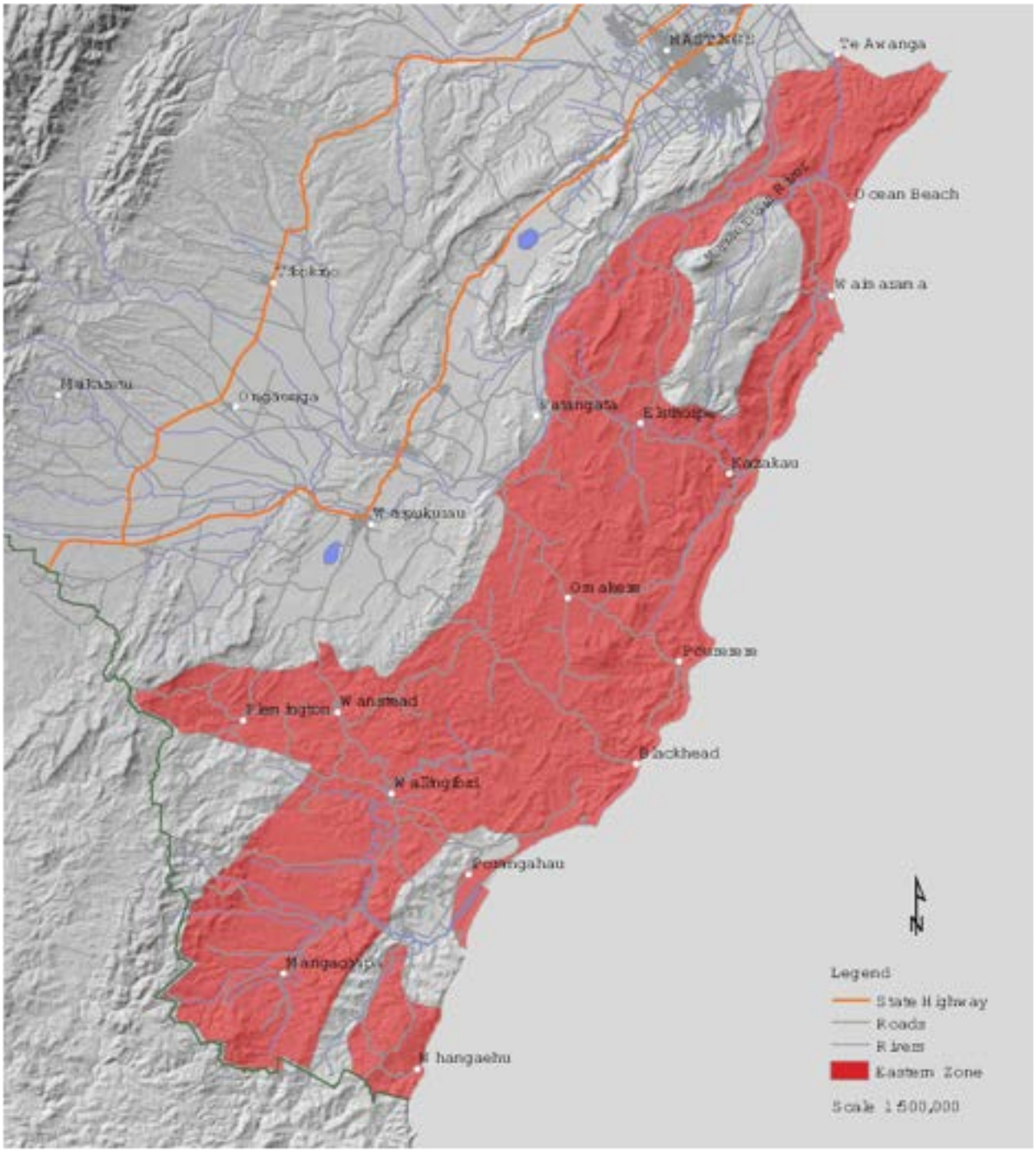

Figure 18 : Eastern Farm Forestry Zone

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The zone has a very patchy covering of remnant loess and ash material blown onto it, particularly the area north of the Maraetotara plateau out to Cape Kidnappers.

Topography Landform comprises alluvial plains and infilled valley floors surrounded by hill country that varies from rolling to very steep mudstone with scree-like cliffs. The small alluvial plains can be very wet for long periods, such as in the Elsthorpe/Atua and Omakere districts, and include extensive swamp systems such as those near Wanstead. There are some highpoints that affect localised rainfall; these stretch in a line from Omakere Hill to Rangitapu Hill and on to Te Atua Hill. The area has one designated range called Silver Range; a dramatic landform tilted at 45 degrees and made of interbedded sandstone.

There are several river catchments with some terrace development, particularly along the Tukituki River. The Tukituki River receives about two-thirds of the drainage catchment, with the Porangahau River at the southern end dominating the remaining third, and the mid to lower section of the Maraetotara River picking up a small area in the north. There is a distinctive line of smaller tributary catchments that drain direct to the coast. There are three small lakes – Purimu Lake near Wanstead, Long Range Lake on the way to Blackhead, and Horseshoe Lake near Patangata.

Slope and aspect (direction of slope) This zone has a real mix of slope directions, with no real pattern emerging. The influence of aspect is very important when combined with soil type, wind direction and slope angle.

Looking south down the Hawea Stream catchment with Silver Range on the left. Source: ***Garth Eyles***

Slope will determine:

- the available soil depth and soil type;
- soil moisture availability; and
- access to the site.

All these factors assume greater influence as the landscape changes from rolling to steep hill country, limiting the farm forestry opportunities and tree species choices. The long coastline facing the southeast is exposed to southern ocean weather patterns.

Altitude generally ranges from 100-500m above sea level, with most of the landscape ranging from 200-300m above sea level. The alluvial plains and infilled valley floors are generally around 100m, with some sites lower. The high points are located around the Omakere, Rangitapu, Te Atua hills and Silver Range.

Soils Type and location While the soils have a relatively high natural fertility, the physical nature of the soil is more relevant to farm forestry. Potential soil limitations are; available soil moisture, potential rooting depth, soil temperature, and soil aeration. The soils, while sometimes complex on a farm scale, are generally clay-dominant, a product of the weathering mudstones that are the dominant bedrock. The most dominant soil order is Pallic. Where the soil limitations become more extreme due to slope, the soils will fall into the Recent steepland soils.

Another large group of soils are the Gley soils which are located in infilled valley floors and alluvial plains with perched watertables. There are possibly some small compartments of Pumice soils in the Cape Kidnappers area – check Appendix I for specific details on the different soil types.

The following table provides the soil orders for this zone in order of dominance across the landscape.

Pallic soils
Recent *alluvial and steepland* soils
Gley soils
Pumice soils

Table 35 : Soil orders for Eastern zone in order of dominance across the landscape.

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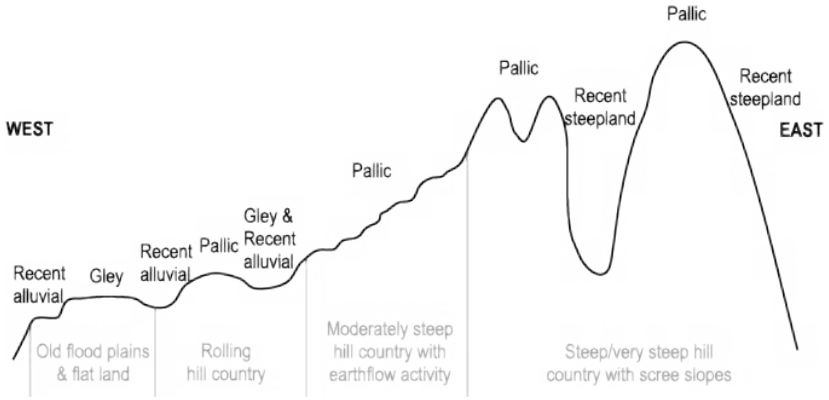

Figure 19 : General location of soil orders across the zone. Source: **Regional Graphics**

Climate Rainfall and soil water balance (see Figure 19 for details) Rainfall ranges from 800-1600 mm per annum. The range for most of the area is 1000-1200mm per year with only the Elsthorpe, Omakere–Rangitapu, and Mangaorapa areas receiving slightly more (around 1400 mm per year). However, the lower Tukituki River Valley, locked between the Kohinurakau Range (Te Mata Peak) and the Maraetotara Plateau, receives considerably lessrainfall with recordings as low as 550 mm annually. The soil water balance (annual evapotranspiration rate) is extremely variable, ranging from 850 mm in the south to 950 mm in the north. Therefore, there is a moderate to high chance of a moisture deficit, creating summer drought conditions across most of the Eastern area. The lower Tukituki area should be considered as a severe drought risk.

Wind is a severely limiting factor. On exposed slopes facing the dominant wind direction, there will need to be provision of buffer trees, or tree species suitable to cope with the wind stress. Wind direction is mostly from the southwest and west, with the southerly also fairly common. The wind will accelerate soil moisture loss and, therefore, any steep, shallow soil on west to southwest slopes will become water deficient under prolonged wind. Easterly storms are frequent and can cause tree toppling.

Frost and snow Frost is not severely limiting in this area. Nearly 90% of the frosts will occur between May and September with on average 115 to 165 frost days per year. Therefore, frost hardiness is not a high priority for tree selection unless you are planting in a site that is a 'frost pocket'. Snow is not an issue.

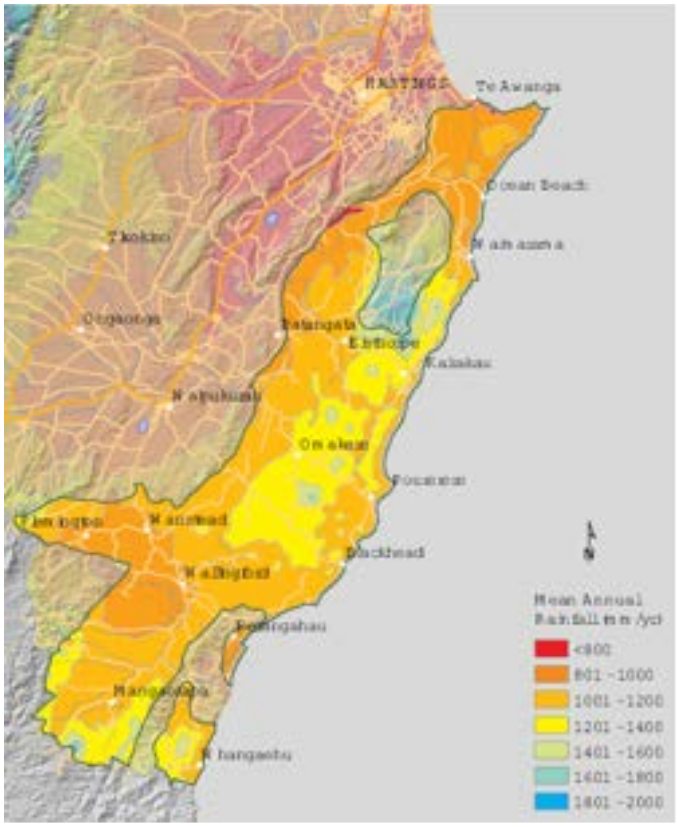

Figure 20 : Rainfall of the Eastern Farm Forestry Zone

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Farm Forestry practices and recommended tree species

Chapter 3 contains the detailed information regarding tree species. Any notes in the tables are specific to this zone.

Commercial forest and woodlots

Table 36 : Commercial forest and woodlot species.

Botanical name	Common name	Botanical name	Common name
Pinus radiata	Radiata pine	Cupressocyparis ovensii	Ovens cypress
Cupressus lusitanica	Mexican cypress	Eucalyptus fastigata	Brown barrel
Sequoia sempervirens	Redwood	Cryptomeria japonica	Japanese cedar
Cupressus torulosa	Bhutan cypress	Acacia dealbata	Silver wattle
Cedrus deodara/atlantica	Himalayan/Atlas cedar	Quercus ilex/robur /palustris	Holm/English/Pin oak
Durable eucalyptus species		Podocarpus totara	Totara
Eucalyptus muelleriana	Yellow stringybark	Agathis australis	Kauri
Eucalyptus globoidea	White stringybark	Vitex lucens	Puriri
Eucalyptus obliqua	Tasmanian oak	Dacrydium cupressinum	Rimu

Soil conservation – gully erosion

Gully erosion is found throughout this zone and it needs to be controlled to reduce the level of sediment leaving the farm. Species planted in the gully area, depending on the level of erosion, need to have vigorous root development and an ability to survive moist to very moist conditions.

Trees planted are often not harvestable due to the species and the nature of the terrain in which they are planted. Where the gully is actively eroding or there is strong potential for erosion, stock grazing should be prevented permanently, thus increasing the species options. The construction of debris dams or other debris structures will help with the retention of sediment.

An example of willows pair planted down an eroding gully, Pearson's property, Kahuranaki Road. Source: ***Garth Eyles***

Soil conservation – slope erosion

Slope erosion occurs throughout this zone and it needs to be controlled. Most of the slope erosion is on land that can still be grazed. Spaced tree planting stabilises slopes but does not destroy pasture cover long-term. The variety of species that can be planted is limited if stock grazing is allowed. If pasture retention is not necessary, the option may be commercial forestry or, if stock can be removed for a period of time, the tree species choices increase.

Looking underneath Pearson's gully planting, this is what debris dam construction looks like in an eroding gully which has been backfilled with sediment. Source: ***unknown***

An example of erosion control forestry and indigenous forest regeneration in the Ponui Stream catchment. Source: ***Simon Stokes***

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Table 37 : Soil conservation - gully erosion species.

Botanical name	Common name	Botanical name	Common name
Salix matsudana, S. alba and their variations	Tree Willows	Salix viminalis, S.Purpurea, S. kinuyanagi	Basket and shrubby willows
Populus yunnanensis and var. Kawa, Veronese, Crowsnest, Argyle, Weraiti	Poplars		
The following species are options if the area is retired or restricted from grazing. Note that any of the commercial forest and woodlot species can also be considered if stock are removed and the erosion is not too severe - if erosion is severe to extreme plant P. radiata and manage accordingly.			
Plagianthus regius Pittosporum eugenioides Pittosporum tenuifolium Pittosporum crassifolium Griselinia littoralis Sophora microphylla/tetraptera Phormium tenax/cookianum Dacrycarpus dacrydioides Cordyline australis Cortaderia toetoe/fulvida Hoheria populnea Alnus glutinosa Alnus cordata Ulmus procera	Ribbonwood Tarata Kahuhu Karo Broadleaf Kowhai Native axes Kahikalea Cabbage tree Toetoe Lacebark Black alder Italian alder English elm	This is not a complete list of indigenous species. However, it does list those species: a) with greater gully control ability because of their root mat systems; or suitability for the site; or b) that allow for long-term management options, such as acting as a nurse crop for further forestry planting.	

Table 38 : Soil conservation - slope erosion species.

Botanical name	Common name	Aspect
Populus yunnanensis and var. Kawa, Veronese,	Poplars	E,S,N
Salix matsudana, S. alba and their variations	Willows	E,W,S,N
The following species are options if the area is retired or restricted from grazing. Note that any of the commercial forest and woodlot species can also be considered if stock are removed and the erosion is not too severe - if erosion is severe to extreme plant P. radiata and manage accordingly.		
Quercus robur/palustris Cordyline australis Alnus cordata/incana Gleditsia triacanthos Platanus acerifolia	English/Pin oak Cabbage tree Italian/Grey alder Honey locust Plane	E, W, S, N E, W, S, N E,S E,W,S,N E,W,S,N
Eucalyptus leucoxylon Eucalyptus ovata Eucalyptus muelleriana Eucalyptus globoidea Eucalyptus fastigata	Yellow gum Swamp gum Yellow stringybark White stringybark Brown barrel	E, N with shelter
Eucalyptus obliqua	Tasmanian oak	E,N,S
Acacia melanoxylon Acacia dealbata	Australian blackwood Silver wattle	E, S, N with shelter

Other durable eucalyptus species

Shelterbelts

This zone is very exposed to westerlies and icy blasts from the south. There are a few scattered indigenous remnants with exotic plantations becoming more common. Although the hilly relief provides some natural shelter, it is not ideal for protecting stock from a very cold storm. Most of the planting will occur on the flat to rolling land that has high watertables, but there is also a need for some of the steeper hill country to have primary shelterbelts.

The following list is recommended for shelterbelts to provide stock and crop shelter.

Table 39 : Shelterbelt species.

Botanical name	Common name	Notes
Pinus radiata Cupressus torulosa Cedrus deodara/atlantica Pinus pinaster Cupressus sempervirens	Radiata pine Bhutan cypress Himalayan/Atlas cedar Maritime pine Mediterranean cypress	Single or double row. Often planted with another species (as listed here). Totara could be suitable as a leeward species. Maritime pine can handle salt spray.
Cupressocyparis ovensii Cupressocyparis leylandii	Ovens cypress Leyland cypress -'Naylor's Blue', or 'Leighton Green' and 'Green Spire' if away from the coast.	
Populus spp. and var. Crowsnest, Veronese Salix matsudana var. Tangoio,Moutere Alnus rubra/cordata/ glutinosa	Poplar Willow Red/Italian/Black alder	Should be used in internal shelterbelts on moist soils (Gley and Recent alluvial) where they are not too exposed to the westerly wind - running east to west. Single row planting or interplanted with the following: Coprosma spp., Hebe spp., Carmichaelia spp. (native broom), Pittosporum spp., flax spp.
Chamaecytisus palmensis	Tagasaste	For dry hill country planting as a low growing companion species or on its own.
Araucaria heterophylla	Norfolk Island pine	
Pittosporum crassifolium Pittosporum eugenioides Pittosporum tenuifolium Cordyline australis Coprosma rigida Coprosma propinqua Dodonaea viscosa Phormium tenax Myoporum laetum Metrosideros excelsa Podocarpus totara	Karo Tarata Kahuhu Cabbage tree Sti karamu Mingimingi Akeake Harakeke (flax) Ngaio Pohutukawa Totara	Should be used in internal shelterbelts on moist soils (Gley and Recent alluvial). Prefer not to be exposed to the full force of the wind. They can be planted individually or together with other species. Ngaio is suited to coastal planting but is poisonous to stock.
Coprosma repens Hebe stricta Olearia solandri Coprasma robusta	Taupata Koromiko Coastal tree daisy Karamu	These species are shrubs and would form the lower growing line in hill country. They can be planted with other taller species as listed above.

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Riparian management

There are many different types of watercourses in this zone, and riparian management practices will differ for each. Most of the pastoral land is farmed semi-intensively to intensively.

The riparian areas fall into three main situations:

Situation 1: Very steep mudstone slopes, with deeply incised watercourses, usually with a high degree of erosion. Where possible these sites can be left to regenerate, as they are often physically impractical to plant. A protection fence, even a single 'hot-wire', is vital. Most of these situations are best managed by planting commercial forest or woodlot species.

Situation 2: Infilled valley floors, and alluvial flats with some active streambank erosion, or gully systems that have a low gradient. These watercourses require specific treatment and appropriate fencing – to allow floodwaters through and to reduce erosion potential. A single 'hot-wire' would be suitable in most situations. Root mat development and long-term tree management are vital to the success of the work.

Situation 3: Eroding gullies that were infilled and are now actively eroding. These are difficult sites to control and require pair planting, using mostly willows and, possibly, debris dams. They can be managed using gully erosion control systems.

Table 40 : Riparian management species.

Botanical name	Common name	Notes
Sequoia sempervirens Taxodium distichum Metasequoia glyptostroboides Betula pubescens Elaeagnus angustifolia Eucalyptus camaldulensis Populus yunnanensis and var. Crowsnest, Veronese,Kawa	Redwood Swamp cypress Dawn redwood Downy birch Russian olive Swamp gum Poplars	These species are recommended for Situation 2 where they could be interplanted with indigenous species or planted singly. Do not plant close enough to deplete the groundcover.
Salix matsudana var. Tangoio, Moutere	Tree willows	These species are recommended for Situation 3.
Pittosporum crassifolium* Cordyline australis* Coprosma robusta* Phormium tenax* Carex secta Carex solandri Carex lucida/maorica Dacrycarpus dacrydioides Coprosma propinqua Cyperus ustulatus Hoheria angustifolia Corokia cotoneaster Olearia virgata Cortaderia fulvida* Leptospermum scoparium Schoenoplectus validus	Karo Cabbage tree Karamu Harakeke (flax) Pukio Native grass Native grasses Kahikatea Mingimingi Umbrella sedge Lacebark Korokia Twiggy tree daisy Toetoe Manuka Lake clubrush	These species are recommended for Situation 2. Frost tolerance and being planted on Gley and Recent alluvial soils are critical factors with these species being the most suitable. Most can be planted in the open without shade or in semi shade. *Also will do well in Situation 1.
Hebe stricta Coprosma repens Sophora tetraptera Kunzea ericoides Carmichaelia odorata Pittosporum tenuifolium Pittosporum ralphii Phormium cookianum Cassinia letophylla Chamaecytisus palmensis	Koromiko Taupata Kowhai Kanuka Scented broom Kohuhu Ralph's karo Whaririki (flax) Tauhinu Tagasaste	These species are recommended for Situation 1.

In parts of the Eastern zone there may be wetland or dune environments that require specialised management. If you are subdividing your property, consider fencing to isolate riparian, dune and wetland areas.

Amenity/shade

For open paddock planting to succeed, primary shelter is necessary as the zone is exposed and windy. The soils are subject to swelling and cracking from wet/dry variations. There are regular droughts, occurring about once in every five years. The choice of tree species reflects these factors. There are other choices that will thrive, but success depends on the site, protecting the tree from stock, and good planting technique.

Pittosporum eugenioides Tarata, Lemonwood. Source: ***Marie Taylor***

Table 41 : Amenity/shade species.

Botanical name	Common name	Botanical name	Common name
Platanus acerifolia/occidentalis	Planes	Juglans regia	Common walnut
Quercus robur/ilex/ palustris etc.	Oaks	Magnolia grandiora	Magnolia
Populus yunnanensis and var. Veronese and Kawa	Poplars	Pinus coulteri/patula/ sylvestris/montezumae etc.	Pines
Acer pseudoplatanus/ macrophyllum/negundo	Sycamore/Oregon/ Box/maples	Cedrus deodara/atlantica	Himalayan/ Atlas cedar
Sophora tetraptera	Kowhai	Araucaria heterophylla	Norfolk Island pine
Cordyline australis	Cabbage tree	Melia azedarach	Persian lilac
Fagus sylvatica/var. Purpurea	English/Copper beech	Ginkgobiloba	Ginkgo
Aescu/us hippocastanum/ indica	Horse/Indian chestnut		

Coastal Subzone

Within the Eastern Farm Forestry Zone is a large coastal zone strip that runs from Te Awanga and Cape Kidnappers to just north of Herbertville, south of Porangahau. This area requires special mention, due to:
effects of coastal weather patterns;

- the level of extreme erosion in several locations;
- the dune environments;
- the high archaeological value of some sites;
- the potential increase in coastal development.

This is a difficult zone for farm forestry management. The coastal cliffs can be left to naturally regenerate, although this will take a long time and is very dependent on the vegetation present, the rate of regeneration, and any nearby seed sources for birds to transfer in. Any large and very active areas of coastal erosion could also be left to revegetate but usually the level of vegetation is insufficient due to the erosion. It would be very expensive to plant such areas in indigenous species unless aerial oversowing was possible, using indigenous colonisers such as manuka, bracken, fern, tauhinu, or some other species. Presently, erosion control forestry is the most cost effective process on the eroding slopes and can be implemented to at least slow down the erosion process. It should be noted that the forestry species planted might never be harvested due to access and the potentially low timber quality.

The dune environments are unique to the East Coast and should be retired from grazing and permanently protected. Information on protecting dunes or coastal revegetation is available from the Department of Conservation or Hawke's Bay Regional Council.

Otherwise, depending on the farm forestry practice required, see the Mahia Peninsula Farm Forestry Zone for tree species recommendations.

Coastal erosion, north of Pourerere; very difficult country to control. Source: ***Garth Eyles***

The massive 'Rosewood' earthflow in the Makara catchment with soil conservation planting – mostly eucalypts and willow. Source: ***Sally Hobso***

Mudstone Earthflow Subzone

Within the Eastern Farm Forestry Zone there is a landscape associated with mudstone that is severely to extremely eroding or has the potential to be. The erosion is associated with 'bentonitic' mudstone or fault crushed argillite and mudstone, or mudstone zones where massive bedrock failure has occurred creating block slides and massive land collapse. The soils are difficult, often with high shrinking and swelling capability (smectite clays), and often very poorly drained, with dense profiles such as the Wanstead soil.

On these sites, implementing farm forestry is very difficult. They require specific erosion control techniques to establish cost effective, close-planted tree species often with debris dams and contour drainage (channelling excessive water flow sideways from a slope). Local landowners have tried various tree species over the years but many have failed. The best current technique is to establish erosion control forestry using P. radiata combined with targeted willow and poplar on the wetter slopes or in the gullies. At the same time, debris dams should be installed and contour drainage lines formed where possible to divert water off the earthflow. The first crop of trees may not be of high quality because of the effect of the site (stem sweep from ground movement or toppling), however they should stabilise the site enough to allow a more profitable second crop. Stock grazing of these erosion sites should be avoided. The main purpose of any activity on Mudstone flow country is erosion control. Therefore the main tree species recommended are P. radiata, poplars and willows.

Maraetotara

This zone is separated from the surrounding Eastern Farm Forestry Zone by its landform. It is dominated by the Maraetotara plateau, the soils and climate, which are quite different from those of the surrounding landscape.

Geology Rock types The Maraetotara area is not as complex as the Eastern zone as it is basically Tertiary marine sediments, mostly sandy in nature, overlain by limestone.

The limestone is composed of two different series deposited during different geological periods. The 'Kairakau series' is the oldest and spreads from the coast inland and then along the entire length of the Maraetotara Road on its western side to Waipoapoa Road. The limestone located from this point onwards towards Kaokaoroa and Kohinurakau Ranges and TeMata Peak is the younger 'Te Mata series'. The limestone and other rock types are covered in loess and volcanic material blown onto the area from the west.

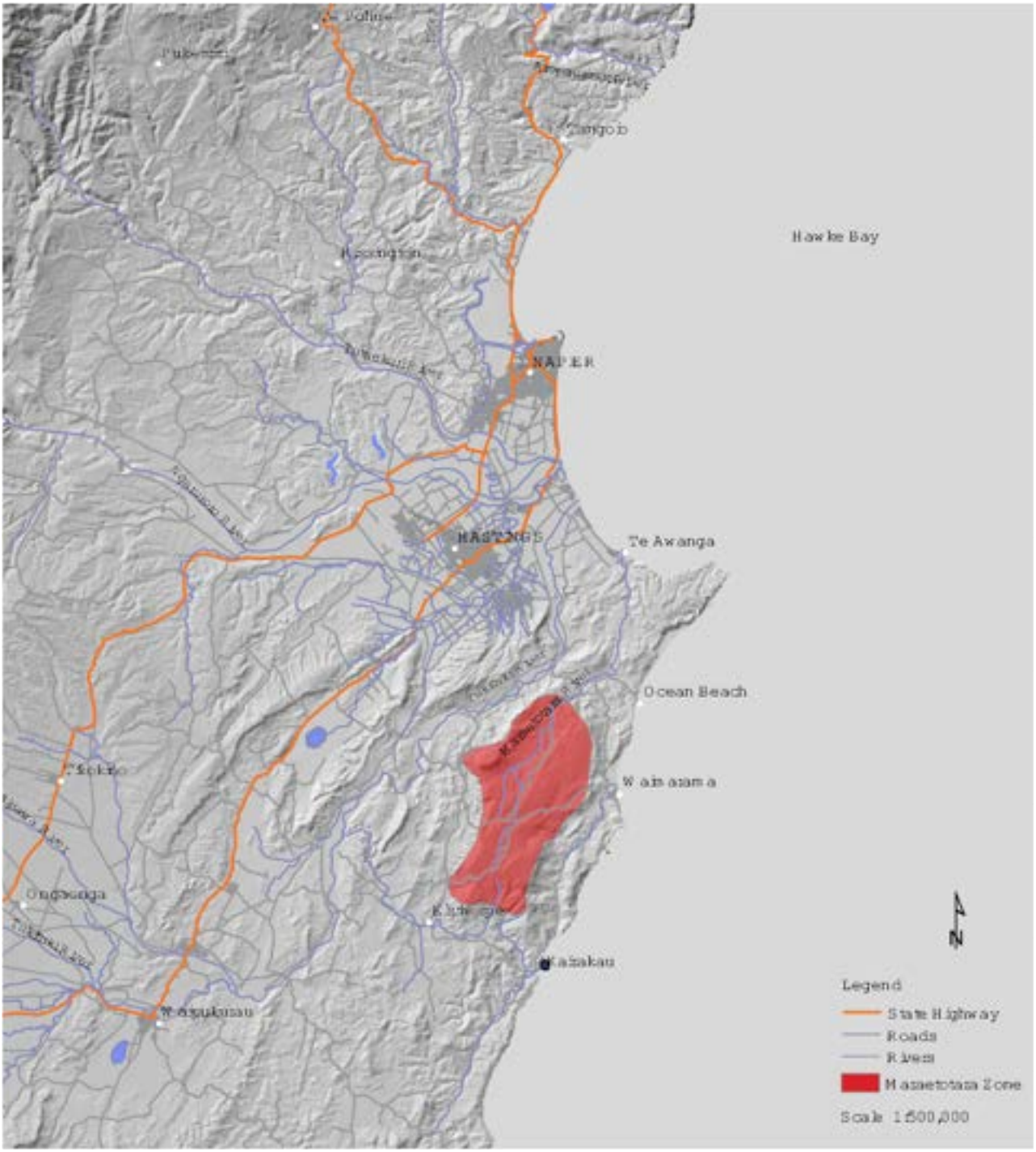

Figure 21 : Maraetotara Farm Forestry Zone

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Topography Landform is dominated by the Maraetotara plateau, with its flat to rolling to moderately steep hill country. Off the plateau, the slopes are much steeper. Contained within the plateau area is Mt. Kahuranaki at 646m. The plateau primarily drains into the Maraetotara River with smaller tributaries collecting the remaining drainage areas.

The Maraetotara River meandering through the landscape of the Maraetotara Zone. Source: ***Sally Hobson***

Slope and aspect (direction of slope) The area has a real mix of aspect, with no obvious pattern other than the aspects associated with the steep scarp edges running around the plateau and Mt. Kahuranaki. Aspect is an important factor, when combined with soil type, wind direction and slope angle. The growing conditions will be significantly different on all aspects of the compass, particularly the soil moisture availability and wind effect on plants. As the landscape changes from rolling to steep hill country, the effects of these factors increase dramatically, limiting the farm forestry opportunities and tree species choices.
In this area, slope will determine:

- the available soil depth and soil type;
- soil moisture availability; and
- access to the site.

Generally, slopes over 28 degrees will be steep enough to have eroded significantly or have little soil development, and are quite rocky.

Altitude ranges from 300-646m above sea level, with the majority of the landscape between 350-500m. The plateau is lower at the northern end, averaging around 350m, rising towards the south where it averages 500m. Mt. Kahuranaki is a high point at 646m with another highpoint on Waikereru Station at 434m above sea level.

Soils Type and location The soils of this zone are excellent for farm forestry. Loess and volcanic material, from the Tongariro and Waimihia showers in particular, mantle the landscape. While there is plenty of this material, it is not dominant enough for the soils to fit the Pumice soils order. However, there is enough allophanic clay present to classify some soils as Allophanic. Where there is no volcanic material influence, the soils are Pallic. A less common group, due to the lack of erosion, is the Recent steepland or alluvial soils. There are some small areas of limestone-based soils (Melanic soils - formerly known as Rendzina). Some lower lying points may be saturated continuously enough to be called Gley soils, but they will be quite distinctive and will be located in very wet environments.

The following table provides the soil orders for this zone in order of dominance across the landscape.

Pallic soils
Allophanic soils
Recent *alluvial and steepland* soils
Gley soils
Melanic soils

Table 42 : Soil orders for Maraetotara zone in order of dominance across the landscape.

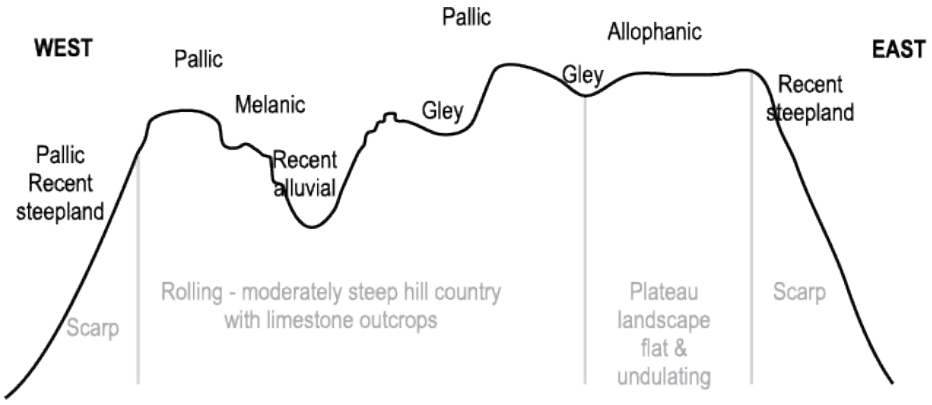

Figure 22 : General location of soil orders across the zone. Source: ***Regional Graphics***

Climate Rainfall and soil water balance (see Figure 23 for details) Rainfall ranges from approximately 1200-2200 mm per annum. The range for most of the area is 1200-1400 mm per year with only Mt. Kahuranaki and the Waipoapoa Station end of the Plateau receiving much higher levels. The soil water balance (annual evapo-transpiration rate) is extremely variable, ranging from 850 mm on the high points to 900 mm in the lower areas. Therefore, there is a low chance of a moisture deficit
creating serious summer drought situations.

Wind from the north and northwest dominates but wind can also come from the south and southeast. Wind is not such a serious limiting factor in this area as in the eastern or inland areas. However, it will be an issue on any areas exposed to the coast, subject to frequent cyclonic storms with gales, usually from the east.

Frost and snow Frost is not severely limiting in this area. Nearly 90% of the frosts will occur between May and September, with an average of 115 to 165 frost days per year. Therefore, frost hardiness does not restrict the tree species choices unless you are planting in a site that is in a 'frost pocket'. Snow is rare and not an issue.

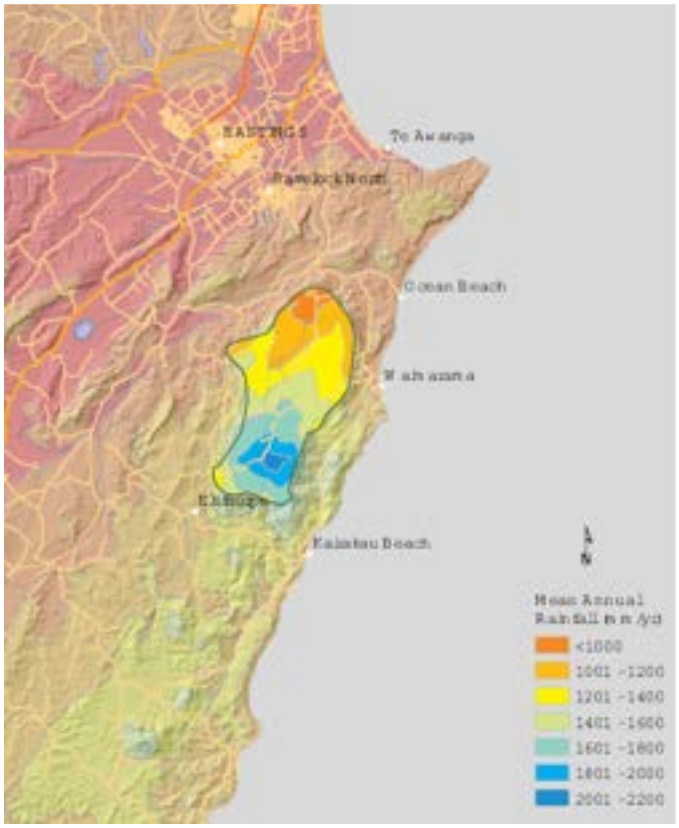

Figure 23 : Rainfall of the Maraetotara Farm Forestry Zone

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Farm Forestry practices and recommended tree species

Chapter 3 contains the detailed information regarding tree species. Any notes in the tables are specific to this zone.

Commercial forest and woodlots

Table 43 : Commercial forest and woodlot species.

Botanical name	Common name	Botanical name	Common name
Pinus radiata	Radiata pine	Eucalyptus bosistoana	Coast grey box
Pseudotsuga menziesii	Douglas r	Cedrus deodara/atlantica	Himalayan/Atlas cedar
Cupressus lusitanica	Mexican cypress	Juglans regia	Common walnut
Sequoia sempervirens	Redwood	Acacia dealbata	Silver wattle
Cryptomeria japonica	Japanese cedar	Podocarpus totara	Totara
Cupressocyparis ovensii	Ovens cyprus	Agathis australis	Kauri
Cupressus torulosa	Bhutan cyprus	Nothofagus fusca	Red beech
Eucalyptus nitens	Shining gum	Dacrycarpus dacrydioides	Kahikatea
Eucalyptus regnans	Mountain ash	Dacrydium cupressinum	Rimu
Eucalyptus fastigata	Brown barrel	Knightia excelsa	Rewarewa
Eucalyptus obliqua	Tasmanian oak		
Eucalyptus muelleriana	Yellow stringybark		
Eucalyptus globoidea	White stringybark		

Other durable eucalyptus species

Pseudotsuga menziesii Douglas fir. Source: ***Marie Taylor***

Soil conservation – gully erosion

Gully erosion is not common in this zone because the overlying limestone bedrock prevents most erosion. However, when this bedrock is not present, gully erosion increases. Most of the gullies fall into two types:

- deeply incised systems that have little sediment to erode other than lower slope material; and
- low gradient systems filled in with material from the hills in the upper catchment. These are usually wide valley floor areas.

The following species will suit either of these gully situations.

Table 44 : Soil conservation - gully erosion species.

Botanical name	Common name	Botanical name	Common name
Salix matsudana, S. alba and their variations Populus yunnanensis and var. Kawa, Veronese, Crowsnest, Argyle, Weraiti	Tree Willows Poplars	Salix viminalis, S.Purpurea, S. kinuyanagi	Basket and shrubby willows
The following species are options if the area is retired or restricted from grazing. Note that any of the commercial forest and woodlot species can also be considered if stock are removed and the erosion is not too severe - if erosion is severe to extreme plant P. radiata and manage accordingly.			
Plagianthus regius Pittosporum eugenioides Pittosporum tenuifolium Pittosporum crassifolium Griselinia littoralis Sophora microphylla/ tetraptera Phormium tenax/cookianum Dacrycarpus dacrydioides Cordyline australis Cortaderia toetoe/fulvida Hoheria populnea	Ribbonwood Tarata Kahuhu Karo Broadleaf Kowhai Native flaxes Kahikatea Cabbage tree Toetoe Lacebark	This is not a complete list of indigenous species. However, it does list those species: a) with greater gully control ability because of their root mat systems; or suitability for the site; or b) that allow for long-term management options, such as acting as a nurse crop for further forestry planting.	
Taxodium distichum Sequoia sempervirens Alnus glutinosa Alnus rubra Ulmus procera	Swamp cypress Redwood Black alder Red alder English elm		

Soil conservation – slope erosion

Slope erosion is not common in this zone and is generally associated with the steeper mudstone slopes on the edge of the plateau. Where it is found, it can be quite severe and the following tree species are recommended to control it.

Argyle poplar.
Source: ***Simon Stokes***

Table 45 : Soil conservation - slope erosion species.

Botanical name	Common name	Botanical name	Common name
Populus spp. and var. Kawa, Veronese,Crowsnest, Argyle, Weraiti	Poplars	Salix matsudana, S. alba and their variations	Tree willows
The following species are options if the area is retired or restricted from grazing. Note that any of the commercial forest and woodlot species can also be considered if stock are removed and the erosion is not too severe - if erosion is severe to extreme plant *P. radiata* and manage accordingly.			
Commercial forest options	Refer to Commercial Forest recommendations.		
Quercus ilex/robur/ palustris	Holm/English/Pin oak		
Cordyline australis Alnus cordata/rubra/glutinosa	Cabbage tree Italian/Red/Black alder		
Platanus acerifolia	Plane		
Eucalyptus obliqua Eucalyptus camaldulensis Eucalyptus muelleriana Eucalyptus globoidea	Tasmanian oak Red river gum Yellow stringybark White stringybark		
Eucalyptus fastigata Eucalyptus regnans Eucalyptus nitens	Brown barrel Mountain ash Shining gum		

Shelterbelts

This zone is exposed to wind from the west or chilly blasts from the south. There are existing scattered indigenous trees and a few exotic plantations. There is some hilly relief that provides some natural shelter, but there is also a lot of open plateau landscape that requires planted shelter for stock protection.

The following list of tree species is recommended for shelterbelts to provide stock and paddock shelter.

An option for a secondary shelterbelt for the area – cabbage tree (Cordyline australis) with flax. Source: ***Kevin Thomsen***

Table 46 : Shelterbelt species.

Botanical name	Common name	Notes
Pinus radiata Cupressocyparis Jeylandii Cupressus torulosa Cedrus deodara/atlantica	Radiata pine Leyland cypress 'Leighton Green' Bhutan cypress Himalayan/Atlas cedar	Single or double row. Often planted with another species (as listed here). Totara could be suitable as a leeward species.
Eucalyptus fraxinoides Populus spp. and var. Crowsnest, Veronese, Kawa Alnus glutinosa Eucalyptus nitens Eucalyptus regnans Eucalyptus melliodora	White mountain ash Poplars Black alder Shining gum Mountain ash Yellow box	Should be used in internal shelterbelts where they are not too exposed to the westerly wind - running east to west. Single row planting interplanted with the following: Coprosma spp., Hebe spp., Carmichaelia spp. (native broom), Tagasaste (tree lucerne), Pittosporum spp.
Metrosideros excelsa Pittosporum crassifolium Cordyline australis Pittosporum eugenioides Pittosporum tenuifolium Corynocarpus laevigatus Podocarpus totara Pittosporum ralphii	Pohutukawa Karo Cabbage tree Tarata Kohuhu Karaka Totara Ralph's pittosporum	These species can be planted individually or together with other indigenous species not listed here (personal preference), or with some of the non -conifer exotics listed.
Coprosma repens Hebe stricta Olearia solandri Coprosma robusta	Taupata Koromiko Coastal tree daisy Karamu	These species are suitable as coastal shrubs and would form the lower growing line in hill country. They can be planted with other taller species as listed above.

Riparian management

There are many different types of watercourses in this zone, each requiring different riparian management practices. Most of the pastoral land is farmed semiintensively or intensively. The riparian areas mostly consist of broken, rocky watercourses with minimal erosion despite free stock access. Some areas are steep sided; these sites can be left to regenerate where they are physically impractical to plant and where there are sufficient remnant indigenous species left to provide a seed source. Often the riparian management issue is being dealt with by subdivision and water reticulation schemes, or included in a commercial forestry option.

In parts of the Maraetotara zone, there may be wetland environments that require specialised management. If you are subdividing your farm, consider fencing to isolate and protect riparian or wetland areas.

Existing riparian indigenous vegetation in the Maraetotara River catchment suitable for protection. Source: ***Sally Hobson***

Table 47 : Riparian management species.

Botanical name	Common name	Notes
Eucalyptus nitens Eucalyptus regnans Eucalyptus camaldulensis Populus spp. and var. Kawa, Crowsnest, Veronese	Shining gum Mountain ash red river gum Poplars	All are potential users of groundwater nitrogen and will allow indigenous undergrowth to develop, depending on planting density.
Carex secta Carex solandri/lucida/maorica Carmichaelia odorata Cassinia letophylla Coprosma propinqua Coprosma robusta Coprosma repens Cordyline australis Corokia cotoneaster Cortaderia fulvida Cyperus ustulatus Dacrycarpus dacrydioides Hebe stricta Hoheria angustifolia Kunzea ericoides Leptospermum scoparium O/earia virgata Pittosporum crassifolium Pittosporum tenuifolium Pittosporum ralphii Phormium cookianum/tenax Schoenoplectus validus Sophora tetraptera	Pukio Native grasses Scented broom Tauhinu Mingimingi Karamu Taupata Cabbage tree Korokia Toetoe Umbrella sedge Kahikatea Koromiko Lacebark Kanuka Manuka Twiggy tree daisy Karo Kohuhu Ralph's pittosporum Native axes Lake clubrush Kowhai	All can be planted in the open without shade, or in semi-shade.
Sequoia sempervirens Taxodium distichum Alnus glutinosa/rubra	Redwood Swamp cypress Black/Red alder	

Amenity/shade

The zone is exposed and windy and the choice of tree species for open paddock planting reflects this. Primary shelter is beneficial before establishing most of the amenity choices provided. There are other varieties that will thrive. Success depends on the site, protecting the trees from stock, and good planting technique.

Cordyline australis Cabbage tree. Source: ***Marie Taylor***

Table 48 : Amenity/shade species.

Botanical name	Common name	Botanical name	Common name
Platanus occidentalis/ acerifolia	Planes	Juglans regia	Common walnut
Quercus robur/ilex/palustris etc.	Oaks	Magnolia grandiora	Magnolia
Populus yunnanensis and var. Kawa and Veronese	Poplars	Pinus coulteri/patula/ sylvestris etc.	Pines
Acer pseudoplatanus/ negundo/macrophyllum	Sycamore/Box/ Oregon maple	Aesculus hippocastanum/incana	Horse/Indian chestnut
Sophora tetraptera / microphylla	Kowhai	Fraxinus excelsior	European ash
Cordyline australis	Cabbage tree	Tsuga heterophylla	Western hemlock
Fagus sylvatica	English beech	Cedrus deodara/atlantica	Himalayan/Atlas cedar
Fagus sylvatica var. Purpurea	Copper beech	Sequoiadendron giganteum	Wellingtonia
Ginkgo biloba	Ginkgo	Cupressus torulosa	Bhutan cypress

Loess

This inland Hawke's Bay zone is identified by its common soil type and drier climate (averages less than 1100 mm per annum), plus its potential for wet-dry extremes. It is a large area that extends from the Mangaone River in the north, to Nicholl and Farm Road just south of Waipukurau, and east as far as Patangata.

Geology Rock types comprises some Tertiary material, but mostly Quaternary marine sediments, that have formed deposits of sandy mudstone (siltstone), soft sandstone, mudstone, limestone, conglomerate, and marine gravels, with periodic volcanic layers.

There are some shallow gravel bands in the northern part of the loess zone that run from the Matapiro terraces through to Flag Range Road and into Rissington and Glengarry Road. What makes this landscape distinctive is the extent of the wind-blown material, known as loess, that mantles it. Loess can be mainly fine-grained silts and sands, but can also be tephric i.e. from a volcanic origin. There are many infilled valley systems, which were initially swamps, but most of these have long since been drained and most are now intensively farmed.

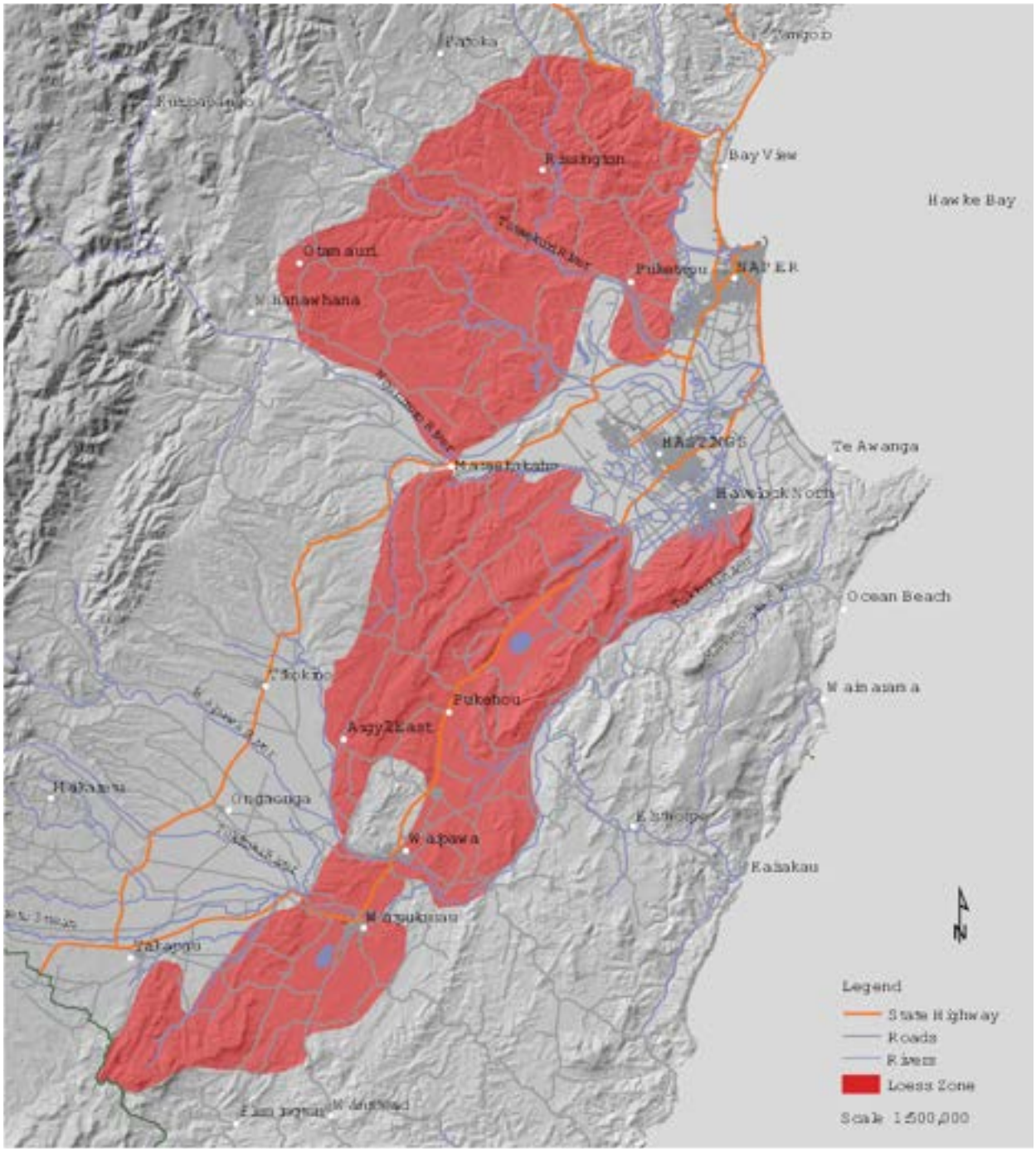

Figure 24 : Loess Farm Forestry Zone

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The Loess Farm Forestry Zone of broad ridged hills in the Sherenden district, with Tuna Nui homestead in foreground. Source: ***James Lawson***

Topography Landform comprises flat to rolling to moderately steep hill country, with many deep and steepsided gorges interspersed throughout the area north of the Ngaruroro River. There are some remnant river terraces associated with the main river systems, which provide a well-used landscape. There are some large, sloping blocks of land (called cuestas), usually capped with limestone, which dip east in the northern portion of the area, and west at Whatuma and in the Turiri Range. Associated with these cuestas are very steep scarp slopes and cliffs. A large portion of the area comprises the Raukawa and Turiri Ranges, as well as the Kohinurakau and Kaokaoroa Ranges. The Loess area drains into several large stream catchments, particularly in the area between the Ngaruroro and Tutaekuri Rivers. The end points for all catchments are the three main rivers - the Tutaekuri, Ngaruroro, and Tukituki. The large valley systems and plains margins were originally swamps but are now drained, providing cropping land on Organic soils. Some swamps remain including the Pekapeka, Kautuku, Hautapu, and Hurimoana. The area has many lakes including Poukawa, Whatuma, Rotokare, Runanga, Oingo, Potaka and Rotokiwa.

Lake Poukawa nestled amongst hills of the Loess Farm Forestry Zone. Source: ***Garth Eyles***

Slope and aspect (direction of slope) The area has a considerable mix of slope direction with no particular pattern emerging due to the rolling nature of the hill country. There are only small pockets of steep slopes where a western or northern aspect will become an issue related to wind and drought. The land is exposed across all points of the compass. An easterly aspect dominates, except south of the Tukituki River, where it changes to the west and along the western fringe of the Raukawa Range to Argyll.

Slope will determine:

- the available soil depth and soil type;
- soil moisture availability; and
- access to the site.

Other than the steep sided stream and river catchments or scarps, slopes are generally less than 21-25 degrees.

Altitude ranges from less than 100m to 489m, with most of the landscape between 100-300m above sea level. Mt. Erin is the highest point at 489m but there are other notable high points such as Mt. Cameron (383m), Mt. McNeil (351m), Te Mata Peak (399m), and the 'Peak' in the Turiri Range (486m). Altitude is generally not a limitation in this area. However, in higher areas, the site may be severely affected by wind, lack of soil depth, and drought.

Soils Type and location While the soils in this zone have a relatively high natural fertility, the presence of a dense subsoil layer or pan can limit farm forestry. This pan can increase the incidence of toppling, as the roots cannot penetrate vertically and get a foothold, particularly where the pan is less than 40 cm from the surface (e.g. Okawa soils). The soils, while complex at a farm scale, are generally sand and silt dominant in the topsoil and silt and clay dominant in the subsoil. The topsoil is a product of the volcanic ash and loess influence. The volcanic ash component in the topsoil is not dominant enough to describe the soils as Pumice.

The main type of soils found are Pallic and often have a pan. In some areas, soils are derived from the weathered bedrock. The two other main types of soils will be in either the lower lying areas and saturated enough to be called Gley soils, or the Allophanic soils (volcanic ashes are andesitic in origin), located on the remnant terraces found mostly in the Ngaruroro, Tutaekuri, and Mangaone River catchments.

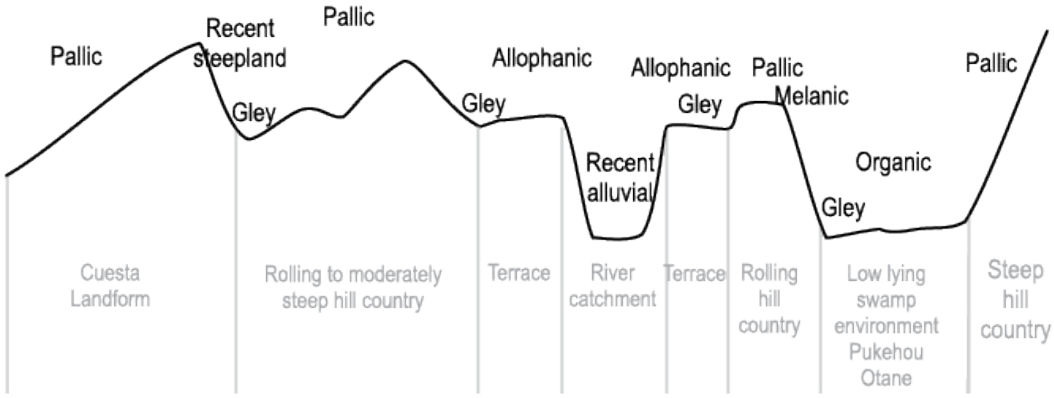

Figure 25 : General location of soil orders across the zone. Source: ***Regional Graphics***

There are some small areas of Recent soils from steepland erosion or alluvial deposition and very rare sites of limestonebased Melanic soils. Organic soils from peat locations are extensive through the Poukawa/Otane Basin.

The following table provides the soil orders for this zone in order of dominance across the landscape.

Pallic soils
Gley soils
Allophanic soils
Recent *alluvial and steepland* soils
Melanic soils
Organic soils

Table 49 : Soil orders for Loess zone in order of dominance across the landscape.

Climate Rainfall and soil water balance (see Figure 26 for details) Rainfall ranges from 800-1200 mm per annum. The range for most of the area is around 800-1000 mm per year with only the areas closer to the Ruahine and Kaweka Ranges receiving more. The soil water balance (annual evapotranspiration rate) varies from 900-950 mm. Therefore, there is a very high chance of soil moisture deficit causing summer drought.

Wind is a limiting factor, except in some sheltered pockets in the stream and river catchments. Wind direction is mostly from the west and southwest, with southerlies also quite common. Easterly storms are frequent and can be moisture-laden, causing toppling. On exposed slopes facing the dominant wind direction, there will need to be some provision for buffer trees designed to cope with the wind.

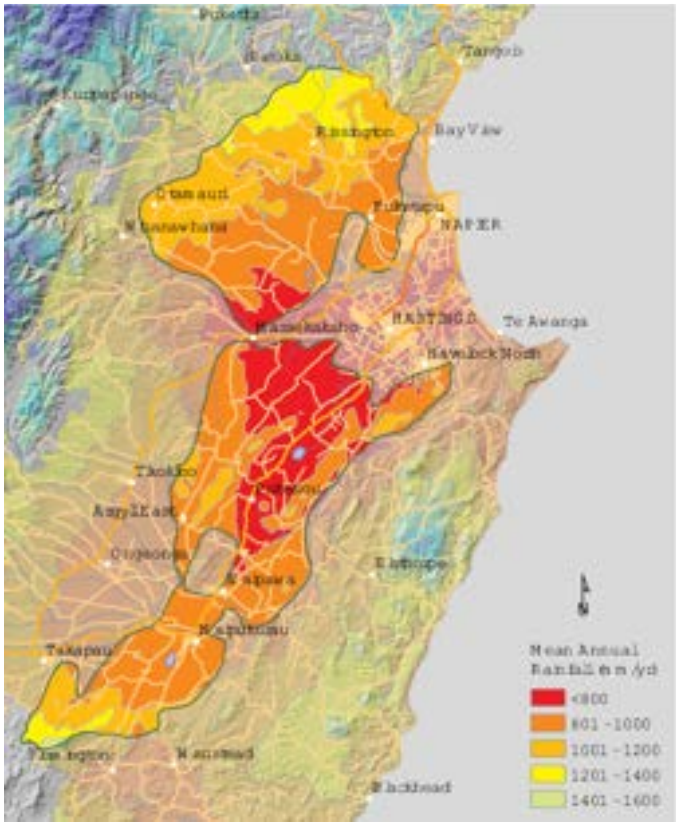

Figure 26 : Rainfall of the Loess Farm Forestry Zone

Frost and snow Frost can be severely limiting, particularly in hollows and valley floors. Nearly 90% of the frosts will occur between May andNovember with an average 165 to 215 frost days per year. Therefore, frost hardiness is a necessary consideration for your tree species selection unless you are planting in a site that is not frostprone. Snow is not an issue.

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Farm Forestry practices and recommended tree species

Chapter 3 contains the detailed information regarding tree species. Any notes in the tables are specific to this zone.

Commercial forest and woodlots

Table 50 : Commercial forest and woodlot species.

Botanical name	Common name	Botanical name	Common name
Pinus radiata	Radiata pine	Eucalyptus fastigata	Brown barrel
Cupressus lusitanica	Mexican cypress	Populus spp.	Poplars
Cupressocyparis ovensii	Ovens cypress	Sequoia sempervirens	Redwood
Cupressus torulosa	Bhutan cypress	Cryptomeria japonica	Japanese cedar
Cedrus deodara/ atlantica	Himalayan/Atlas cedar	Acacia dealbata	Silver wattle
Eucalyptus obliqua	Tasmanian oak	Platanus occidentalis	Plane
Eucalyptus muelleriana	Yellow stringybark	Quercus robur/palustris	English/Pin oak
Eucalyptus globoidea	White stringybark		

Other durable eucalyptus species

Soil conservation – gully erosion

This zone does not have severe gully erosion compared to other zones, but it does have many gully systems that have the potential to erode. This potential arises from inappropriate cultivation or stock damage, particularly by bulls or deer, removing ground cover.

Table 51 : Soil conservation - gully erosion species.

Botanical name	Common name	Botanical name	Common name
Salix matsudana, S. alba and their variations	Tree Willows	Salix viminalis, S.Purpurea, S. kinuyanagi	Basket and shrubby willows
Populus yunnanensis and var. Kawa, Veronese, Crowsnest, Argyle, Weraiti	Poplars		
The following species are options if the area is retired or restricted from grazing. Note that any of the commercial forest and woodlot species can also be considered if stock are removed and the erosion is not too severe - if erosion is severe to extreme plant P. radiata and manage accordingly.			
Plagianthus regius	Ribbonwood	This is not a complete list of indigenous species. However, it does list those species: a) with greater gully control ability because of their root mat systems; or suitability for the site; or b) that allow for long-term management options, such as acting as a nurse crop for further forestry planting.	
Pittosporum eugenioides	Tarata		
Pittosporum tenuifolium	Kahuhu		
Pittosporum crassifolium	Karo		
Griselinia littoralis	Broadleaf		
Sophora microphyllaltetraptera	Kowhai		
Phormium tenax/cookianum	Native flax		
Dacrycarpus dacrydioides	Kahikatea		
Cordyline australis	Cabbage tree		
Cortaderia toetoe/fulvida	Toetoe		
Hoheria populnea	Lacebark		
Alnus glutinosa	Black alder		
Alnus rubra	Red alder		
Sequoia sempervirens	Redwood		
Taxodium distichum	Swamp cypress		
Ulmus procera	English elm		

Soil conservation – slope erosion

Most of the slopes are moderately steep and there is potential for slipping and shallow earthflow to occur, requiring spaced tree planting for control. The soil limitations and the climate make tree selection important and you must take into account aspect and exposure to wind.

Table 52 : Soil conservation - slope erosion species.

Botanical name	Common name	Aspect
Populus yunnanensis and var. Kawa, Veronese, Crowsnest, and Argyle	Poplars	E,S,N
Salix matsudana, S. alba and their variations	Willows	E,W,S,N
The following species are options if the area is retired or restricted from grazing. Note that any of the commercial forest and woodlot species can also be considered if stock are removed and the erosion is not too severe - if erosion is severe to extreme plant P. radiata and manage accordingly.		
Commercial forest choices	Refer to Commercial forest species recommendations	
Quercus robur/palustris/ ilex etc. Cordyline australis	Oaks Cabbage tree	E,W,S,N
Alnus cordata/incana	Italian/Grey alder	E,S
Gleditsia triacanthos Platanus acerifolia	Honey locust Plane	E,W,S,N
Eucalyptus muelleriana Eucalyptus fastigata	Yellow stringybark Brown barrel	E, N with shelter
Eucalyptus regnans	Mountain ash	E,N,S
Acacia dealbata	Silver wattle	E, S, N with shelter

Some durable eucalyptus species

Shelterbelts

This zone is very exposed to wind either from the west or southwest. There are a few scattered indigenous tree remnants and some exotic plantations. Although the hilly relief provides some natural shelter, it is not completely ideal for protecting stock in a very cold storm or crops and pasture from persistent wind. Much of the planting will occur on the flat to rolling hills with higher water tables, but there is also a need for some of the hill country to have shelterbelts.

The following list of species is recommended for shelterbelts to provide stock and paddock shelter.

These older Cedrus deodara on Apley Road, near Puketapu, make an excellent shelterbelt for dry soils and very windy sites. When side trimmed the shelter is even better.
Source: ***Kevin Thomsen***

Table 53 : Shelterbelt species.

Botanical name	Common name	Notes
Pinus radiata Cedrus deodara/atlantica Cupressus torulosa Cupressocyparis leylandii Cupressocyparis ovensii Cupressus sempervirens	Radiata pine Himalayan/Atlas cedar Bhutan cypress Leyland cypress - 'Green Spire' Ovens cypress Roman cypress	Single or double row. Often planted with another species (as listed here). Totara could be suitable as a leeward species.
Populus spp. and var. Crowsnest, Veronese Salix matsudana var. Tangoio, Moutere Alnus rubra/cordata/glutinosa	Poplars Willows Red/Italian/Black alder	Should be used in internal shelterbelts on moist soils (Gley and Recent alluvial) where they are not too exposed to the westerly wind - running east to west. Single row planting or interplanted with the following: Coprosma spp., Hebe spp., Carmichaelia spp. (native broom), Pittosporum spp., flax spp.
Chamaecytisus palmensis	Tagasaste	For dry hill country planting as a low growing companion species or on its own.
Pittosporum eugenioides Pittosporum ralphii Pittosporum crassifolium Pittosporum tenuifolium Cordyline australis Coprosma rigida Coprosma propinqua Dodonaea viscosa Phormium tenax Podocarpus totara Clianthus puniceus	Tarata Ralph's pittosporum Karo Kahuhu Cabbage tree Sti karamu Mingimingi Akeake Harakeke (flax) Totara Kakabeak	Should be used in internal shelterbelts on moist soils (Gley and Recent alluvial). Prefer to not be exposed to the full force of the wind. They can be planted individually or together with other species.
Coprosma repens Hebe stricta Olearia solandri Coprosma robusta	Taupata Koromiko Coastal tree daisy Karamu	These species are shrubs and would form the lower growing line in hill country. They can be planted with other taller species as listed above.
Abies concolor/pinsapo	White/Spanish fir	Both will tolerate very dry conditions but not wet feet, so not in Gley or Recent alluvial soils with poor drainage. Could be best suited to single row or windward side of

Riparian management

There are many different types of watercourses in this zone, each requiring different riparian management practices. Most of the pastoral land is farmed semi-intensively to intensively. The riparian areas fall into two main situations:

Situation 1: Main river and stream catchments that generally have a reasonable vegetation presence, have steep sides and are U-shaped. These sites can be left to regenerate as they are often physically impractical to plant. If the indigenous species presence is very low, replanting may be necessary where possible. Often riparian management (retirement) can be achieved using subdivision and water reticulation schemes, or by commercial forestry and erosion control practices removing the watercourse from the farm activities.

Situation 2: Infilled valley floors, alluvial flats, terraces, or gully systems that have a low gradient with significant streambank erosion. These often occur in intensively farmed locations and require specific treatment including fencing designed to allow floodwater through - a single 'hot-wire' may be suitable. Root mat development is vital, as is long-term tree management. Subdivision and water reticulation will assist with management of these areas.

In parts of the Loess area, there are wetland environments that require particular management. If you are subdividing your property, consider fencing options that isolate and protect riparian or wetland zones.

An example of an infilled valley with a high watertable due to poor drainage, that has an open drain, double 'hot-wire' fenced to keep cattle out – a good riparian management practice. Source: ***Garth Eyles***

Table 54 : Riparian management species.

Botanical name	Common name	Notes
Sequoia sempervirens Taxodium distichum Betula pubescens/papyrifera Eucalyptus camaldulensis Eucalyptus cladocalyx Populus yunnanensis and var. Crowsnest, Veronese, Kawa Chamaecytisus palmensis	Common name Redwood Swamp cypress Downy/Paper birch Red river gum Sweet gum Poplars Tagasaste	These species are recommended for Situation 1 where they could be interplanted with indigenous species. Sweet gum foliage are toxic to goats and horses. Tagasaste is an excellent nurse crop for indigenous species
Hebe stricta Coprosma repens Sophora tetraptera Kunzea ericoides Carmichaelia odorata Pittosporum tenuifolium Pittosporum ralphii Phormium cookianum Cassinia tetophylla	Koromiko Taupata Kowhai Kanuka Scented broom Kohuhu Ralph's karo Whararikí (flax) Tauhinu	These indigenous species are recommended for Situation 1. Some of the species listed below will also do well in this situation (marked with *).
Cordyline australis * Coprosma propinqua Coprosma robusta * Phormium tenax • Carex secta Carex solandri Carex lucida/maorica Dacrycarpus dacrydioides Cyperus ustulatus Hoheria angustifolia Corokia cotoneaster Olearia virgata Cortaderia fulvida * Schoenoplectus validus	Cabbage tree Mingimingi Karamu Harakeke (flax) Pukio Native grass Native grasses Kahikatea Umbrella sedge Lacebark Korokia Twiggy tree daisy Toetoe Lake clubrush	These species are recommended for Situation 2. Frost tolerance and being planted on Gley and Recentalluvial soils are critical factors with these species being the most suitable. Most can be planted in the open without shade or in semi shade. *Will also do well in Situation 1.

Amenity/shade

The Loess area is large, with many microclimate sites. However, the trees listed below are for planting in open paddocks where they need to be able to withstand animals and wind exposure. Primary shelter must be provided to ensure good success from the following recommendations. There are other choices, but success depends on the site, protecting trees from livestock, and good planting technique.

Taxodium distichum (swamp cypress) are spectacular in the autumn. They are best suited to wetter sites, shown here on Glazebrook's property on Valley Road, Maraekakaho. Source: ***Kevin Thomsen***

Table 55 : Amenity/shade species.

Botanical name	Common name	Botanical name	Common name
Platanus occidentalis/acerifolia	Planes	Magnolia grandiora	Magnolia
Quercus robur/ ilex/palustris etc	Oaks	Juglans regia	Common walnut
Populus yunnanensis and var. Veronese and Kawa	Poplars	Cedrus deodara/atlantica	Himalayan/Atlas cedar
Acer pseudoplatanus/macrophyllum	Sycamore/Oregon maple	Melia azedarach	Persian lilac
Sophora tetraptera	Kowhai	Sequoiadendron giganteum	Wellingtonia
Cordyline australis	Cabbage tree	Aesculus hippocastanum etc.	Horse chestnut
Fagus sylvatica	English beech	Castanea sativa	Sweet chestnut
Fagus sylvatica var. Purpurea	Copper beech	Brachychiton populneus	Kurrajong
Cupressus torulosa	Bhutan cypress	Taxodium distichum	Swamp cypress

Ruataniwha Plains

This zone is identified by its location as a plain back dropped by the Ruahine Ranges and by its associated climate, including wind and frost issues, and soil-type variations. Farm forestry practices are limited to shelterbelt, amenity, and riparian management as the opportunity for commercial forestry is limited by the easy contour and the quality of the soils resulting in intensive land use. This flat land is on recent and intermediate terraces and has a boundary line towards the Ruahine Ranges marked by the the 1000 mm average annual rainfall.

Geology Rock types are mostly Quaternary deposited alluvial material. This alluvial material overlies Tertiary marine deposits that are seen in the foothills of the Ruahine Ranges and in the hills that flank the eastern boundary from Argyll to Takapau. The alluvium overlies river and marine gravels and is either greywacke in origin, or from volcanic ash. There is also extensive wind blown material known as loess, that mainly consists of fine-grained silts and sands, but can also be tephric (volcanic) in origin. A lot of this material has been reworked and re-deposited as alluvium.

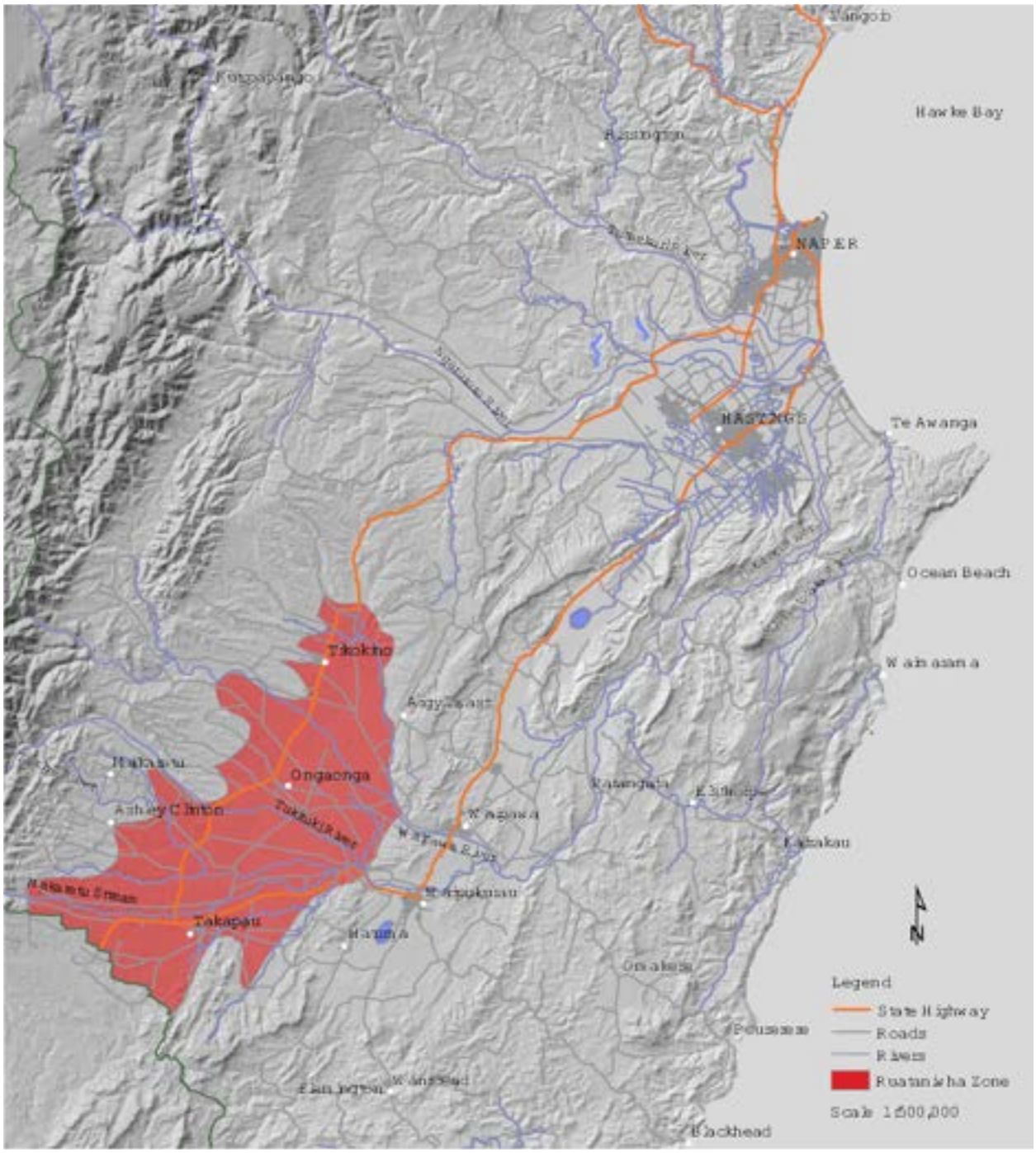

Figure 27 : Ruataniwha Plains Farm Forestry Zone

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Topography Landform The Plains are flat to undulating, with a terrace formation. Within the terraces are steep sided slopes that are remnant features of river flow catchments. The landscape tilts slightly to the east and therefore all the drainage networks run eastwards. The Plains accommodate several waterways, with the main river catchments being the Tukituki and Waipawa Rivers fed by the Tukipo, Makaroro and Makaretu Rivers and many streams such as the Maharakeke and Mangaonuku.

Looking northwest on the versatile Ruataniwha Plains, with crop, shelterbelt, and ranges in the distance.
Source: ***Simon Stokes***

Slope and aspect (direction of slope) This zone has no real dominant aspect due to the flat nature of the landscape. The only slopes of note are the terrace edges, which generally face north (very dry) and south (moister, but can also become very dry) and therefore suffer extremes of climate. The land is exposed across all points of the compass, but dips to the southeast due to the sloping nature of the Plains.

Slope will determine:

- the available soil depth and soil type;
- soil moisture availability; and
- access to the site.

Other than the short, steep sided terrace slopes, all of this zone is flat to undulating.

Altitude ranges from less than 150m to 250m above sea level, with the average being 200m above sea level.

Soils Type and location While most of the soils have a relatively high natural fertility, the soil depth is more relevant to farm forestry because of the variation in depth to gravels, whether they are near the surface or further down the profile, and the frequent occurrence of a hard layer or pan. While the soils may be complex on a farm scale, they are generally sand and silt dominated throughout the profile, although there is some clay present in the subsoils. The topsoil is often a mix of old loess and more recent volcanic ashes.

There are three dominant soil orders - Pallic, Recent, and Allophanic. Dense grey soils that are usually loess dominant are Pallic soils, and often have an associated pan. The volcanic ash component in the topsoil of some Pallic soils is not dominant enough to describe the soils as Allophanic or Pumice. The Allophanic soils, such as Takapau and Kopua soils, have high levels of allophane clay present. Some areas will have soils derived from the weathered bedrock and they may also be Pallic.

Recent soils are located in the lower reaches of the Plain's river catchments and include recently developed or still developing soils. Where the soil depth is very shallow on gravels, the soils are Raw. Another distinctive soil type is present in the lower-lying areas, particularly where loess is present and drainage is impeded. These soils are saturated enough to be called Gley soils.

The following table provides the soil orders for this zone in order of dominance across the landscape.

Pallic soils
Allophanic soils
Recent *alluvial and steepland* soils
Gley soils
Raw soils

Table 56 : Soil orders for Ruataniwha zone in order of dominance across the landscape.

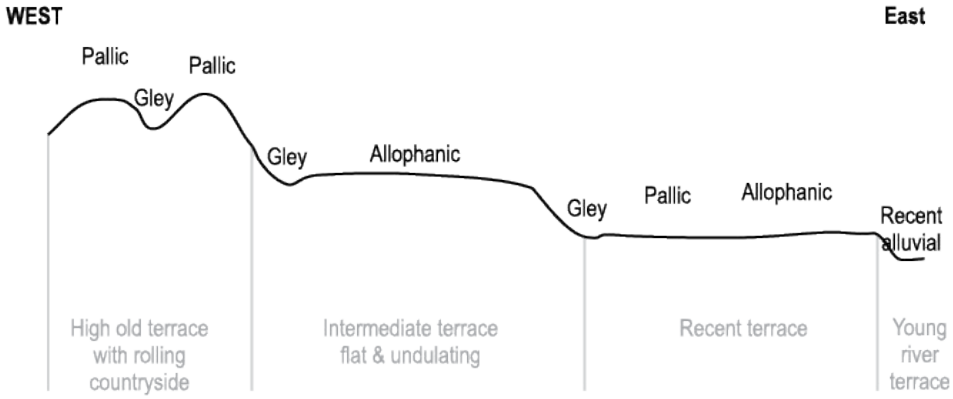

Figure 28 : General location of soil orders across the zone. Source: ***Regional Graphics***

Climate Rainfall and soil water balance (see Figure 29 for details) Rainfall ranges from approximately 800-1200 mm per annum. The range for most of the area is 1000-1200 mm. The soil water balance (annual evapotranspiration rate) is approximately 900 mm. Therefore, deficit situations will occur often, with drought conditions always possible. This is extremely probable on the terrace slopes and where shallow gravels occur.

Wind is a severely limiting factor except in some sheltered pockets on the stream and river catchments. As the area is fully exposed, there will need to be provision of buffer trees, designed to cope with the wind stress. Wind direction is mostly from the west and southwest, with cold southerlies also quite frequent. The cold, southerly storm events can be devastating at lambing/calving time, causing high stock fatalities.

Frost and snow Frost can be severely limiting in this area, particularly in hollows and valley floors. Nearly 90% of frosts will occur between May and November with an average 215 to 265 frost days per year. Therefore, frost hardiness is a necessary consideration for your tree species selection unless you are planting in a site that is not frostprone. Out-of-season frosts can be very hard to predict and protect against.

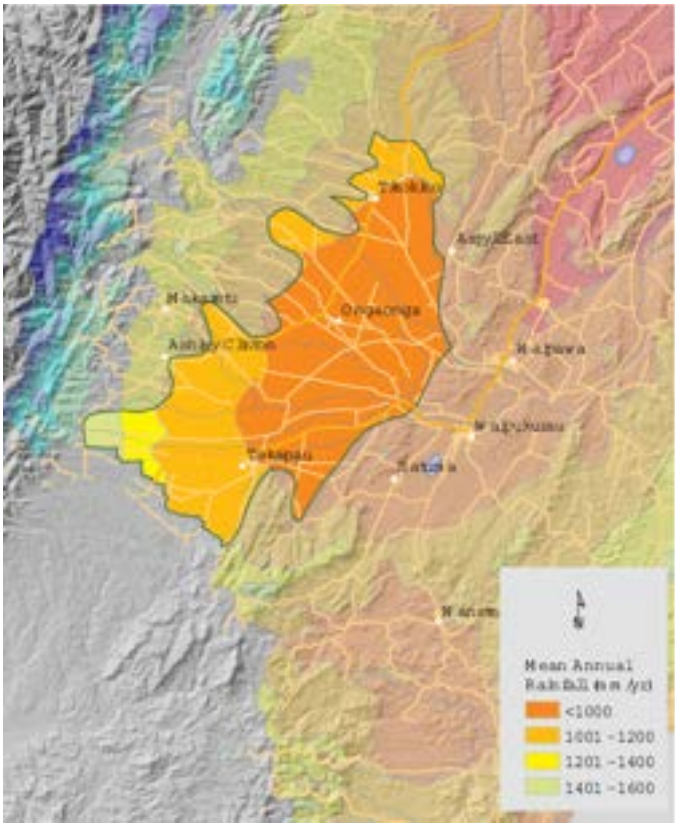

Figure 29 : Rainfall of the Ruataniwha Farm Forestry Zone

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Farm Forestry practices and recommended tree species

Chapter 3 contains the detailed information regarding tree species. Any notes in the tables are specific to this zone.

Commercial forest and woodlots

This zone has limited opportunity for commercial forestry on a large scale, however there will be terrace slopes that may have potential for woodlot size forestry blocks. These would also help to reduce wind problems and provide other benefits.

Table 57 : Commercial forest and woodlot species.

Botanical name	Common name	Botanical name	Common name
Pinus radiata	Radiata pine	Eucalyptus globoidea	White stringybark
Cupressus lusitanica	Mexican cypress	Eucalyptus obliqua	Tasmanian oak
Cupressocyparis ovensii	Ovens cyprus		
Cupressus torulosa	Bhutan cypress	Eucalyptus regnans	Mountain ash
Cedrus deodara / atlantica	Himalayan/Atlas cedar	Eucalyptus fastigata	Brown barrel
Sequoia sempervirens	Redwood	Acacia dealbata	Silver wattle
Cryptomeria japonica	Japanese cedar	Platanus acerifolia	Plane
Eucalyptus nitens	Shining gum	Ulmus procera	English elm
Eucalyptus muelleriana	Yellow stringybark	Quercus robur/palustris	English/Pin oak

P. radiata forestry. Source: ***unknown***

Soil conservation – gully erosion

Gully erosion is not common in this zone, and riparian management generally deals with most of the work associated with gully land-forms. If there is a need for erosion control of a gully, then see the 'Loess Farm Forestry Zone' for information on species recommendations.

Soil conservation – slope erosion

There is little evidence of slope erosion in this zone other than surface and sheet erosion on terrace risers where gravels are found. The intermediate terrace hill country in this zone has little mass movement slope erosion. If required see the 'Loess Farm Forestry Zone' for information on species recommendations.

Shelterbelts

The area is very exposed to wind either from the west or chilly blasts from the south. There are scattered indigenous remnants and shelterbelts on the Ruataniwha Plains but there is still a need for further shelter. Shelterbelts are also necessary to reduce soil loss caused by wind erosion. What should also be considered is the use of technology and management practices such as direct drilling and strip cropping to reduce soil erosion potential. The following list of species is recommended for shelterbelts to provide stock and paddock shelter.

Table 58 : Shelterbelt species.

Botanical name	Common name	Notes
Pinus radiata Cedrus deodara/atfantica Cupressus torulosa Cupressocyparis leylandii Cupressus sempervirens	Radiata pine Himalayan/Atlas cedar Bhutan cypress Leyland cypress - 'Green Spire' Roman cypress	Single or double row. Often planted with another species (as listed here). Totara could be suitable as a leeward species.
Populus spp. and var. Crowsnest, Veronese Salix matsudana var. Tangoio, Moutere Alnus rubra/cordata/glutinosa	Poplars Willows Red/Italian/Black alder	Should be used in internal shelterbelts on moist soils (Gley and Recent alluvial) where they are not too exposed to the westerly wind - running east to west. Single row planting or interplanted with the following: Coprosma spp., Hebe spp., Carmichaelia spp. (native broom), Pittosporum spp., flax spp.
Chamaecytisus palmensis	Tagasaste	For dry hill country planting as a low growing companion species or on its own.
Pittosporum eugenioides Pittosporum ralphii Pittosporum crassifolium Pittosporum tenuifolium Cordyline australis Coprosma rigida Coprosma propinqua Dodonaea viscosa Phormium tenax Podocarpus totara Clianthus puniceus	Tarata Ralph's pittosporum Karo Kahuhu Cabbage tree Sti karamu Mingimingi Akeake Harakeke (flax) Totara Kakabeak	Should be used in internal shelterbelts on moist soils (Gley and Recent alluvial). Prefer to not be exposed to the full force of the wind. They can be planted individually or together with other species.
Coprosma repens Hebe stricta Olearia solandri Coprosma robusta	Taupata Koromiko Coastal tree daisy Karamu	These species are shrubs and would form the lower growing line in hill country. They can be planted with other taller species as listed above.
Abies concolor/pinsapo	White/Spanish fir	Both will tolerate very dry conditions but not wet feet, so not in Gley or Recent alluvial soils with poor drainage. Could be best suited to single row or windward side of

An example of wind erosion of soils on Snee Road in 2000.
Source: ***Stu Bennie***

Recently trimmed Leyland cypress Leighton Green shelterbelt on Rumbal's property, Tikokino.
Source: ***Simon Stokes***

Riparian management

There are many different types of watercourses, each requiring different riparian management practices. Most of the pastoral land in this zone is farmed intensively.

The riparian areas fall into two main situations:

Situation 1: Infilled, shallow valley floors or alluvial (gravel) flats, that have a low gradient with high flooding potential. Often occurring in intensively farmed locations. These watercourses require specific treatment and appropriate fencing to allow floodwater through. A single 'hot-wire' may be suitable. Root-mat development is vital as is long-term tree management.

Situation 2: Main river and stream catchments that have a reasonable level of vegetation present, that are U-shaped, some with steep sides, or are more like braided river channels. Most of the vegetation is willow trees. These watercourses are often managed specifically for flood and erosion control, therefore any activity requires consultation with the Hawke's Bay Regional Council. Fencing is difficult and often a single 'hot-wire' is all that is suitable. Root mat development is vital as is long-term tree management.

In parts of the Ruataniwha Plains zone, there are also wetland environments that require particular specialised management. If you are subdividing your property, consider fencing options to isolate and protect riparian or wetland zones.

Table 59 : Riparian management species.

Botanical name	Common name	Notes
Sequoia sempervirens Taxodium distichum Betula pubescens Eucalyptus camaldulensis Eucalyptus cladocalyx Populus yunnanensis and var. Crowsnest, Veronese, Kawa Chamaecytisus palmensis	Redwood Swamp cypress Downy birch Red river gum Sweet gum Poplars Tagasaste	These species are recommended for Situation 1 where they could be interplanted with indigenous species. Sweet gum foliage are toxic to goats and horses. Tagasaste is an excellent nurse crop for indigenous species.
Pittosporum crassifolium * Cordyline australis * Phormium tenax * Carex secta Carex solandri/ lucida/maorica Dacrycarpus dacrydioides Coprosma robusta * Coprosma propinqua Cyperus ustulatus Hoheria angustifolia Corokia cotoneaster Olearia virgata Cortaderia fulvida * Leptospermum scoparium Schoenoplectus validus	Karo Cabbage tree Harakeke (flax) Pukio Native grasses Kahikatea Karamu Mingimingi Umbrella sedge Lacebark Korokia Twiggy tree daisy Toetoe Manuka Lake clubrush	These species are recommended for Situation 1. Frost tolerance with Gley and Recent alluvial soils is critical - with these species being the most suitable. Most can be planted in the open without shade or in semi shade. *Also will do well in Situation 2.
Hebe stricta Coprosma repens Sophora tetraptera Kunzea ericoides Carmichaelia odorata Pittosporum tenuifolium Pittosporum ralphii Phormium cookianum Cassinia letophylla	Koromiko Taupata Kowhai Kanuka Scented broom Kahuhu Ralph's pittosporum Whaririki (flax) Tauhinu	These species are recommended for Situation 2 but will grow well in drier hill country riparian situations. Some of the species listed above will also do well in this situation (marked with *).

An example of riparian management with remnant indigenous vegetation fenced along the Mangatewai River. Source: ***Simon Stokes***

Amenity/shade

This zone has numerous sites with microclimates that impact on tree planting. However, the trees listed below are for open paddock planting and the choice of tree species reflects this. Primary shelter is essential. There are other species that will thrive in this zone, but success depends on the site, protecting trees from livestock, and good planting technique.

Aesculus hippocastanum (horse chestnut) makes an attractive shade tree that is suitable for this zone. Source: ***Kevin Thomsen***

Table 60 : Amenity/shade species.

Botanical name	Common name	Botanical name	Common name
Platanus occidentalis/acerifolia	Planes	Juglans regia	Common walnut
Quercus robur/ilex/palustris etc.	Oaks	Aesculus hippocastanum/ incana	Horse/Indian chestnut
Populus yunnanensis and var. Veronese and Kawa	Poplars	Cedrus deodara/atlantica	Himalayan/Atlas cedar
Acer pseudoplatanus/negundo/ macrophyllum	Sycamore/Box/ Oregon maple	Melia azedarach	Persian lilac
Sophora tetraptera	Kowhai	Sequoiadendron giganteum	Wellingtonia
Cordyline australis	Cabbage tree	Brachychiton populneus	Kurrajong
Fagus sylvatica	English beech	Grevillia robusta	Silky oak
Fagus sylvatica var. Purpurea	Copper beech	Ginkgo biloba	Ginkgo
Magnolia grandiora	Magnolia		

Volcanic Foothills

This long and narrow zone is located under the shadow of the main axial ranges. It comprises a landscape mantled with volcanic material which provides excellent soils and growing conditions. The increase in altitude is accompanied by a corresponding increase in rainfall. The main limitation to farm forestry in this zone is the severity of the westerly wind and, in places, the incidence of frost.

Geology Rock types This zone is not geologically complex, being predominantly Triassic and Jurassic greywacke rock, bounded by Tertiary and Quaternary marine sediments. A large part of the area is overlain with loess and volcanic deposits, particularly in the northern area from Willowford to Puketitiri. The amount of volcanic material still present is another reason why this area differs from the other zones.

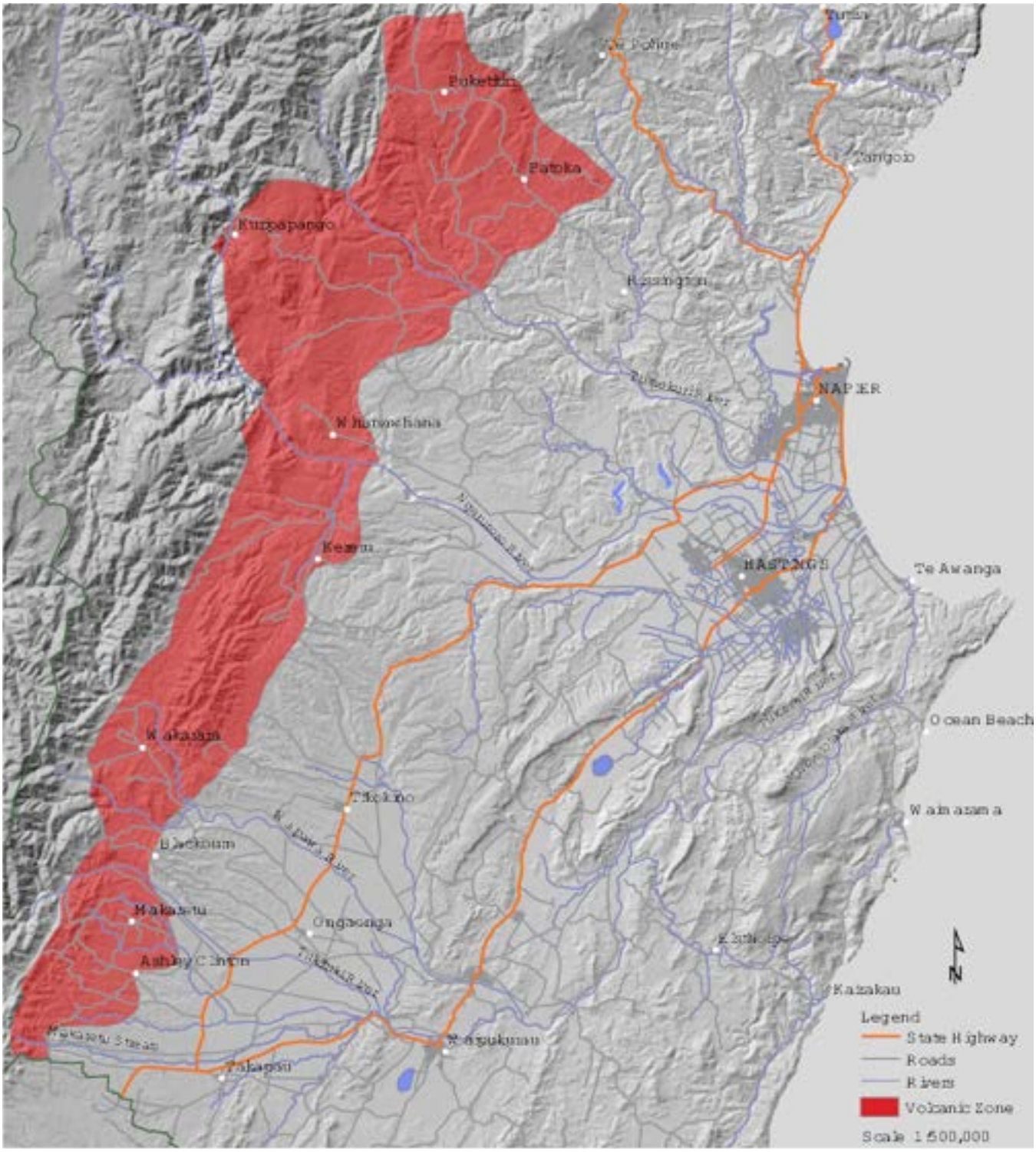

Figure 30 : Volcanic Foothills Farm Forestry Zone

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Topography Landform is dominated by the Ruahine and Kaweka Ranges that run along the entire western boundary providing a steep backdrop. Behind the Gwavas/ Kereru district is the Wakarara Range, which is offset to the main axial range. It is not as high as the main range, but is still significant in terms of landscape and land use. Near these ranges the hill country is steep but it gradually flattens into a much gentler landscape the further east you travel. Remnant high terraces remain behind the Ruataniwha Plains and at Mangleton, Wakarara, and Whana Whana. Areas of plateau also remain, such as 'The Blowhard' behind Waiwhare, and at Willowford, Omahaki, Patoka, and Puketitiri. Steep gorges and ravines that contain waterways dissect the landscape. The area drains primarily into all the upper watersheds of the Tutaekuri, Ngaruroro, Tukituki, Makaroro, Tukipo, Makaretu, and Waipawa Rivers.

The volcanic (ash) mantled landscape of Mangatutu Station framed by the Tutaekuri River and Mangatutu Stream. Source: ***James Lawson***

Slope and aspect (direction of slope) As most of the landscape dips to the east, the area's aspect is east to southeast, but there are some large hills that have a westerly aspect such as Wakarara Range, Big Hill, and the Omahaki/Glenross Range. There are also some distinctive north-northeast/south-southwest slopes in the old remnant terrace systems behind the Ruataniwha Plains. In some cases, these are steep enough for aspect to be an important physical factor affecting soil type and moisture retention. Because of the extent of volcanic airfall deposits and the relatively low-angle landscape, aspect does not determine soil type as much as in other zones. Any major effects are limited to slopes over 26-28 degrees (steep hill country).

Slope will determine:

- the available soil depth and soil type;
- soil moisture availability; and
- access to the site.

Generally, slopes over 28 degrees will have eroded significantly resulting in little volcanic influence and shallow soils.

Altitude ranges from 300-1015m above sea level, with most of the landscape from 400-750m. However, there is considerable variation due to the length of the area along the ranges, and the nature of the 'uplift' created by land movement. The highest point is the trig on the Wakarara Range at 1015m, with Kohinga on the Blowhard Plateau at 1009m. Altitude will be a serious consideration for some tree species selected, particularly above 600m, as exposure to the persistent westerly wind increases, as does the potential for regular snow damage. For example, P. radiata reaches an upper limit around 750m above sea level.

Soils Type and location This zone is identified by its consistent soil type that is excellent for farm forestry purposes. Volcanic deposits, particularly the Tongariro ash, are significant as far north as the Blowhard Plateau. Shallow layers of Waimihia and Taupo ash overlie the landscape and deepen further north. These soils are either Allophanic or Pumice.

Where the Waimihia and Taupo layers have been eroded or were never present, the soil is like a volcanic loam (Allophanic soils) and different to the Pumice soils but just as valuable for tree growing. Where erosion has removed most volcanic influence or alluvial deposition has occurred the soils are Brown or Recent soils.

The dominant soil type is Allophanic, with Brown, Pumice and Recent soils also present. There is some depth of loess present in the subsoil also, but it is not a limiting factor because of moisture levels and location at depth. There are possibly some small compartments of Gley soils present but these will be restricted to saturated sites with impeded drainage. Check Appendix I for more specific details on soils.

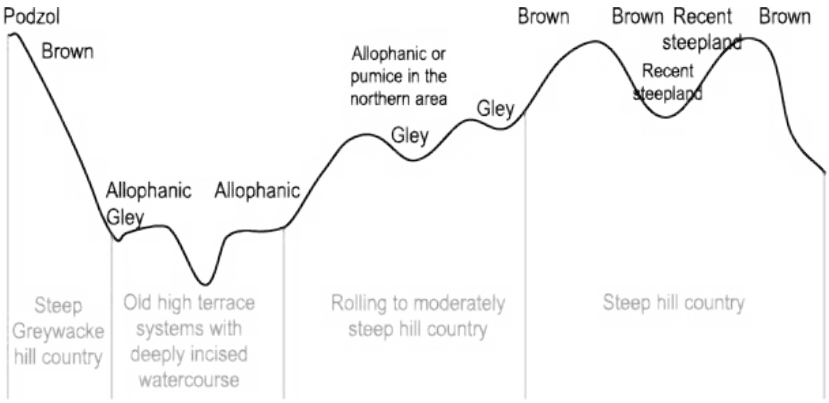

Figure 31 : General location of soil orders across the zone. Source: ***Regional Graphics***

The following table provides the soil orders for this zone in order of dominance across the landscape.

Allophanic soils
Brown soils
Pumice soils
Recent *alluvial and steepland* soils
Gley soils

Table 61 : Soil orders for Volcanic Foothills zone in order of dominance across the landscape.

Climate Rainfall and soil water balance (see Figure 32 for details) Rainfall ranges from 1200-2400 mm per annum, dependent on the proximity to the Ranges, but most of the area receives between 1400-2000 mm per year. The soil water balance (annual evapotranspiration rate) varies from 800-850 mm. Generally, this means there is a low chance of a deficit. Severe droughts are not common, but they can occur and in any season.

Wind is a severe to extreme limiting factor except in some sheltered pockets. On exposed slopes facing the dominant wind direction, there will need to be provision of buffer trees, designed to cope with the wind stress. Wind direction is mostly from the northwest to southwest, although a southerly can be damaging to stock. While there is plenty of wind, moisture loss is not dramatic due to the higher annual rainfall.

Frost and snow Frost can be severely limiting, particularly in hollows and valley floors. Nearly 90% of frosts will occur between May and November with, on average, 215 to 265 frost days per year. Therefore, frost hardiness is a necessary consideration for tree species selection. The worst problem to deal with is out of season frosts that can devastate even normally frost-hardy trees. Snowfall is generally not heavy enough to be a limiting factor, except on the highest areas.

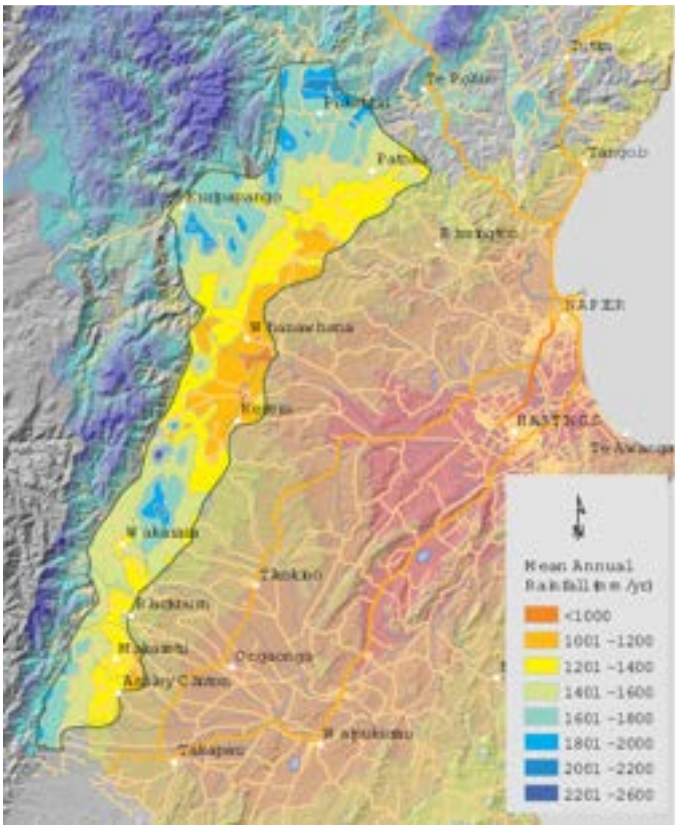

Figure 32 : Rainfall of the Volcanic Foothills Farm Forestry Zone

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Farm Forestry practices and recommended tree species

Chapter 3 contains the detailed information regarding tree species. Any notes in the tables are specific to this zone.

Commercial forest and woodlots

This zone has good moisture levels and soils for growing commercial forests and woodlots. However, the wind factor can be a problem. It is suggested that you plant a buffer zone of trees on the western edge to protect the crop inside. These trees could be the same as the commercial forest species but considered as 'sacrifice' trees, which are cut to waste when harvesting occurs, or they could be species chosen because they are more resilient to the wind and may protect the main crop for more than one cycle.

Woodlot forestry amongst highly productive pastoral land, with pine in the foreground and Eucalyptus further back. Source: ***Jonathan Barran***

Table 62 : Commercial forest and woodlot species.

Botanical name	Common name	Botanical name	Common name
Pinus radiata	Radiata pine	Eucalyptus bosistoana	Coast grey box
Cupressus lusitanica	Mexican cypress	Psuedotsuga menziesii	Douglas r
Cupressocyparis ovensii	Ovens cyprus	Cedrus deodara/atlantica	Himalayan/Atlas cedar
Sequoia sempervirens	Redwood	Cupressus torulosa	Bhutan cypress
Cryptomeria japonica	Japanese cedar	Acacia dealbata	Silver wattle
Eucalyptus nitens	Shining gum	Podocarpus totara	Totara
Eucalyptus regnans	Mountain ash	Nothofagus fusca	Red beech
Eucalyptus fastigata	Brown barrel	Dacrycarpus dacrydioides	Kahikatea
Eucalyptus obliqua	Tasmanian oak	Dacrydium cupressinum	Rimu
Eucalyptus muelleriana	Yellow stringybark	Knightia excelsa	Rewarewa
Eucalyptus globoidea	While stringybark	This species would need to be well sheltered from wind in this zone.	
Larix decidua/kaempferi	European/Japanese larch		

Other ground durable eucalyptus series

Soil conservation – gully erosion

Gully erosion is not common, but where it occurs it can be quite severe. Gullying occurs in the volcanic material or soft marine sediments. Other gully erosion will be minor due to the greywacke bedrock present.

Table 63 : Soil conservation - gully erosion species.

Botanical name	Common name	Botanical name	Common name
Salix matsudana, S. alba and their variations	Willows	Salix viminalis, S.Purpurea, S. kinuyanagi	Basket and shrubby willows
Populus yunnanensis and var. Kawa, Veronese, Crowsnest, Argyle, Weraiti	Poplars		
The following species are options if the area is retired or restricted from grazing. Note that any of the commercial forest and woodlot species can also be considered if stock are removed and the erosion is not too severe - if erosion is severe to extreme plant P. radiata and manage accordingly.			
Plagianthus regius Pittosporum eugenioides Pittosporum tenuifolium Pittosporum crassifolium Griselinia littoralis Sophora microphylla/ tetraptera Phormium tenax/cookianum Dacrycarpus dacrydioides Cordyline australis Cortaderia toetoe/fulvida Hoheria populnea	Ribbonwood Tarata Kahuhu Karo Broadleaf Kowhai Native axes Kahikatea Cabbage tree Toetoe Lacebark	This is not a complete list of indigenous species. However, it does list those species: a) with greater gully control ability because of their root mat systems; or suitability for the site; or b) that allow for long-term management options, such as acting as a nurse crop for further forestry planting.	
Alnus glutinosa Alnus rubra Eucalyptus regnans Eucalyptus nitens Eucalyptus camaldulensis Sequoia sempervirens Cryptomeria japonica Ulmus procera	Black alder Red alder Mountain ash Shining gum Red river gum Redwood Japanese cedar English elm		

Soil conservation – slope erosion

Wind experienced on west and northwest slopes can be too severe for traditional soil conservation species. These slopes will need a different management regime and tree species to be successful. Consider commercial forestry options, as the pasture production is often very low, sometimes even resulting in a negative economic return. On southern and eastern aspects, the aim is to maintain the at-risk slopes in pasture with spaced tree planting. This will control erosion but will not destroy pasture cover and, therefore, will allow sheep grazing to continue. (Cattle should be excluded for the establishment phase.) However, the variety of species that can be planted with continued grazing is limited. If stock can be removed for a period of time, then the species list increases. If pasture retention is not necessary, the option can be commercial forestry.

Alnus rubra Red alder. Source: ***Kevin Thomsen***

Table 64 : Soil conservation - slope erosion species.

Botanical name	Common name	Botanical name	Common name
Populus spp. and var. Kawa, Veronese,Crowsnest, Argyle, Weraiti	Poplars	Salix matsudana, S. alba and their variations	Willows
The following species are options if the area is retired or restricted from grazing. Note that any of the commercial forest and woodlot species can also be considered if stock are removed and the erosion is not too severe - if erosion is severe to extreme plant *P. radiata* and manage accordingly.			
Quercus ilex/robur/ palustris	Holm/English/Pin oak		
Cordyline australis	Cabbage tree		
Alnus cordata/rubra/glutinosa	Italian/Red/Black alder		
Platanus acerifolia	Plane		

Shelterbelts

This zone is very exposed to wind from the west or chilly blasts from the south. Shelter may be provided by scattered indigenous remnants, often in watercourse areas, and some existing exotic plantations. The relatively hilly relief provides some natural shelter, however some of the foothills and remnant terraces are very exposed. Shelterbelts are also necessary to reduce the potential of wind erosion on land that is cultivated or intensively grazed with cattle or deer. Strategic use of existing indigenous vegetation and exotic plantations as shelter will be very practical. Try to fence these areas from stock as they will damage the shallow roots of the indigenous species and shorten their lifespan.

There are extensive shelterbelts in the Mangleton area; most of which were trials in the 1950-70s. Have a look, and talk to the farmers about suitable species and silviculture.

The following list of species is recommended for shelterbelts to provide stock and paddock shelter.

An example of two-year old Leyland cypress var. 'Leighton Green' shelterbelt planted at Mangleton. Source: ***Simon Stokes***

Table 65 : Shelterbelt species.

Botanical name	Common name	Notes
Pinus radiata Cedrus deodara/atlantica Cupressus torulosa	Radiata pine Himalayan/Atlas cedar Bhutan cypress	Single or double row. Often planted with another species (as listed here). Totara could be suitable as a leeward species.
Eucalyptus regnans/nitens/ fraxinoides	Eucalypts	Fast shelter for internal shelterbelts, two-row system, with firewood or timber extraction in time. Can be pruned or side-trimmed. Needs a row of pine on windward side for protection.
Cupressocyparis leylandii	Leyland cypress 'Leighton Green'	Can be planted on all types of country across all aspects. Not on Gley soils.
Pseudotsuga menziesii	Douglas fir	Suited for the leeward side of a two-row shelterbelt, handles snow, frost tolerant to -16° C degrees, can be planted up to 900m.
Larix decidua/kaempferi	European/Japanese larch	Suited for the leeward side of a two -row shelterbelt.
Populus spp. and var. Crowsnest, Veronese, Kawa	Poplars	Should be used in internal shelterbelts on moist soils (Gley and Recent alluvial) where they are not too exposed to the westerly wind - running east to west. Single row planting or interplanted with the following: Coprosma spp., Hebe spp., Carmichaelia spp. (native broom), Pittosporum spp., flax spp.
Pseudowintera colorata Pseudopanax edgerleyi Pittosporum tenuifolium Pittosporum crassifolium Pittosporum ralphii Pittosporum eugenioides Corokia cotoneaster Podocarpus hallii	Horopito Raukawa Kahuhu Karo Ralph's pittosporum Tarata Korokia Hall's totara	All can be planted in the open and can handle some frosting. You could also supplement some Hebe spp. and native grass species into the shelterbelt. All are suitable for windward or leeward side planting of a two - row shelterbelt.
Alnus rubra/glutinosa/cordata	Red/Black/Italian alder	Wind tolerant. Deep rooting system with nitrogen xing capabilities. Can be side trimmed. (see Table 89)
Fagus sylvatica Fagus sylvatica var purpurea	English/Copper beech Copper beech	Very wind, dry and cold hardy. Deciduous. Can be regularly trimmed as a hedge. (see Table 101) Similar attributes to above, but has spectacular purple foliage.
Betula pendulalpubescens	Silver/Downy birch	Suited for the leeward side of a two-row shelterbelt, handle snow and cold.

Riparian management

There are many different types of watercourses in this zone, each requiring different riparian management practices. Most of the pastoral land is farmed extensively or semi-intensively.

The riparian areas fall into two main situations:

Situation 1: Infilled, shallow valley floors or alluvial flats, that have a low gradient with high flooding potential. These often occur in farmed locations and require specific treatment, including appropriate fencing to allow floodwaters through. A single 'hot-wire' may be suitable. Root mat development is vital, as is long-term tree management.

Situation 2: Main river and stream catchments that already have very high vegetation levels and are U-shaped with steep sides. These sitescan be left to regenerate, or riparian management can be included in a commercial forestry or erosion control practice. A protection fence, even a single 'hot-wire', is vital to exclude animals to allow retirement of these areas.

In parts of the Volcanic Foothills Zone, there are wetland environments that require specialised management. If you are subdividing your property, consider fencing options to isolate and protect riparian or wetland zones.

An example of riparian vegetation naturally regenerating after the zone was fenced and the stock were excluded. Source: ***Brett Stansfield***

Table 66 : Riparian management species.

Botanical name	Common name	Notes
Sequoia sempervirens Taxodium distichum Alnus glutinosa/rubra	Redwood Swamp cypress Black/Red alder	These species are recommended for Situation 1 where they cou Id be interplanted with indigenous species.
Eucalyptus nitens Eucalyptus regnans Eucalyptus camaldulensisPopulus spp. and var. Kawa, Crowsnest, Veronese	Shining gum Mountain ash Red river gum Poplars	These species are recommended for Situation 1. All are potential users of groundwater nitrogen and will also allow indigenous undergrowth to develop, depending on planting density.
Cordyline australis Phormium cookianum/tenax Carex secta Carex solandri Carex lucida Dacrycarpus dacrydioides Coprosma propinqua Coprosma repens Coprosma robusta Cyperus ustulatus Hoheria angustifolia Corokia cotoneaster Olearia virgata Cortaderia fulvida Leptospermum scoparium Hebe stricta Sophora tetraptera Kunzea ericoides Carmichaelia odorata Pittosporum tenuifolium Pittosporum ralphii Pittosporum crassifolium Cassinia letophylla Schoenoplectus validus	Cabbage tree Native axes Pukio Native grass Native grass Kahikatea Mingimingi Taupata Karamu Umbrella sedge Lacebark Korokia Twiggy tree daisy Toetoe Manuka Koromiko Kowhai Kanuka Scented broom Kahuhu Ralph's pittosporum Karo Tauhinu Lake clubrush	These species are recommended for Situation 1. All can be planted in the open without shade or in semi shade.

Amenity/shade

This zone is a large area with many sites having their own microclimates. However, the trees listed below are for space planting in open areas where they will be exposed to strong winds and animal pressures. Primary shelter is essential to ensure success. There are more choices than those provided below, but success will depend on the site, protecting the trees from stock, and good planting technique.

Table 67 : Amenity/shade species.

Botanical name	Common name	Botanical name	Common name
Platanus occidentalis/acerifolia	Planes	Pinus coulteri	Pines
		patula/sylvestris	Himalayan/Atlas cedar
Quercus robur/ilexlpalustris etc	Oaks	Cedrus deodara/atlantica	Roman cypress
Aesculus hippocastanum/indica	Horse/Indian chestnut	Cupressus sempervirens	Birch
Castanea saliva	Sweet chestnut	Betula spp.	English walnut
Sophora tetraptera	Kowhai	Juglans regia	Ginkgo
Fagus sylvatica/var. Purpurea	English/Copper beech	Ginkgobiloba	
Sequoiadendron giganteum	Wellingtonia		

Sequioadendron giganteum Wellingtonia. Source: ***Kevin Thomsen***

Argillite

This zone is identified by its distinctive argillite rock, the soils, and the dry environment. It includes some sandstone hill country that has similar physical limitations. There are four areas spread around Otane/Waipawa, Waipukurau, the Whangai Range, and the coastal block around Porangahau/Blackhead.

Geology Rock types are Tertiary marine sediments that have formed argillite bedrock, with some sandstone. The rocks have formed from sediments deposited in deep water before being uplifted and eroded into the present landscape. The argillite bedrock is commonly called the 'Whangai shale'. There is very little, if any, loess or volcanic material present on the Argillite country.

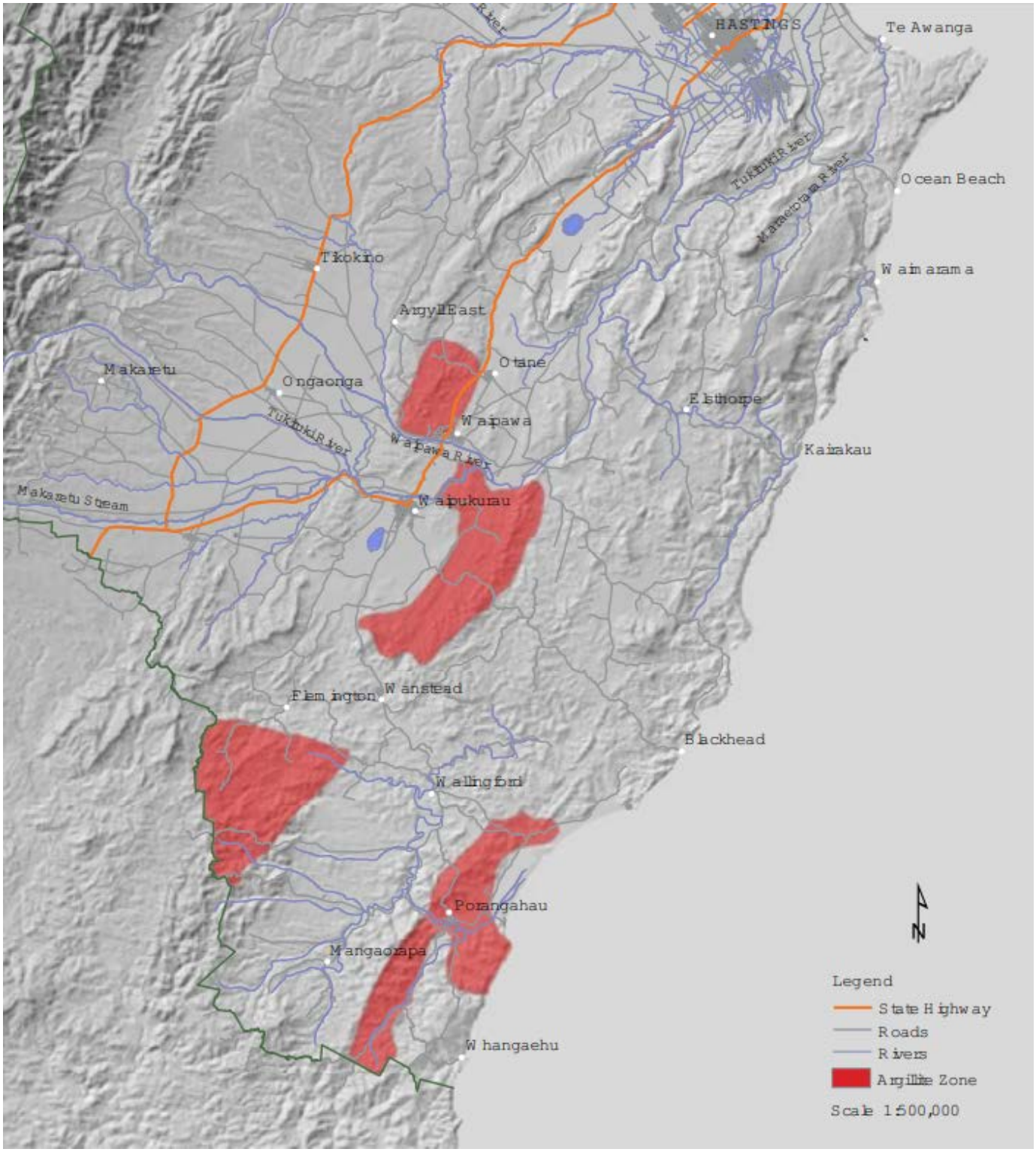

Figure 33 : Argillite Farm Forestry Zone

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Topography Landform comprises moderately steep to steep hill country. Among the four areas there is only one named range – the Whangai Range near Flemington – although the argillite hills are more pronounced than the surrounding mudstone hill country. The catchments drain to the Tukituki and Porangahau Rivers.

Hills with argillite between Otane and Waipawa planted in commercial forestry, with a Eucalyptus woodlot in the foreground. Source: ***Simon Stokes***

Slope and aspect (direction of slope) The hills have a predominantly northeast alignment, therefore the two dominant aspects are northwest and southeast. The influence of aspect is very important combined with soil type, wind direction, and slope. The combination of low rainfall and a northwest to west aspect restricts the opportunities for farm forestry and limits the tree species that can be grown. The southeast aspect is less of a problem, but growing trees on these slopes is still not easy.

Slope will determine:

- the available soil depth and soil type;
- soil moisture availability; and
- access to the site.

Generally, slopes over 25 degrees will have shallow soils.

Altitude ranges from less than 100m to 532m above sea level, with most of the slopes between 200-400m. The highest point is Taumatanui at 532m in the Whangai Range with other high points being Howe trig (530m) on the Te Uri Road, Mt Carlyon (394m), and Ben Lomond (360m). The higher hill country is exposed to severe climatic extremes, which is an issue for farm forestry.

Soils Type and location The soils, while complex on a farm scale, are generally silt dominant in the topsoil, and silt and clay dominant in the subsoil. There is little overlying loess or volcanic material and the soils are generally developed from bedrock weathering – argillite or sandstone. They belong to the Pallic soils. There is no pan in this type of Pallic soil.

A second soil type is present in the lower lying areas, and is saturated enough to be called Gley soils. These soils are quite distinctive and probably were or are associated with valley floors or previous swampy environments. There are some small areas of Recent soils created from steepland erosion or alluvial deposition. The following table provides the soil orders for this zone in order of dominance across the landscape.

Pallic soils
Gley soils
Recent *alluvial and steepland* soils

Table 68 : Soil orders for the Argillite zone in order of dominance across the landscape.

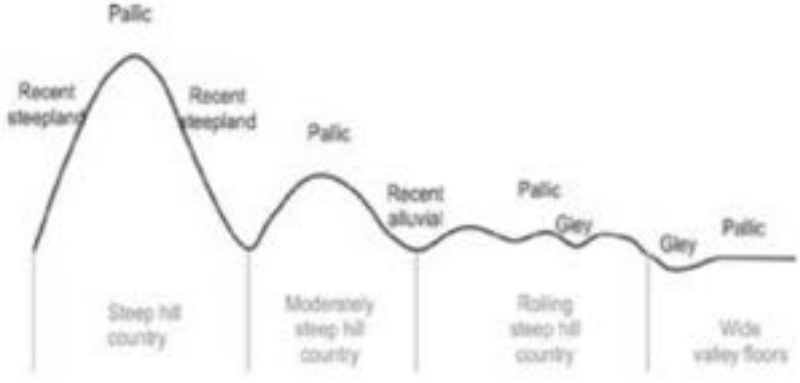

Figure 34 : General location of soil orders across the zone. Source: ***Regional Graphics***

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Climate Rainfall and soil water balance (see Figure 107 for details) Rainfall ranges from 800-1400 mm per annum with the majority of the area receiving 800-1000 mm. The soil water balance (annual evapotranspiration rate) is approximately 900 mm. This shows a potential for soil moisture deficit situations resulting in drought. Remember that aspect, slope and soil depth will always influence the moisture availability. This is extremely relevant on the north and west facing slopes.

Wind is a serious to extreme limiting factor except in some sheltered pockets. On exposed slopes facing the dominant wind direction, there will need to be some provision of buffer trees that can cope with the stress. Wind direction is mostly from the west and southwest, although the southerly can be cold and hard on both plants and stock.

Frost and snow Frost can be severely limiting, particularly in hollows and valley floors. Nearly 90% of the frosts occur between May and September, with on average 165 to 215 frost days per year. Therefore, frost hardiness is a necessary selection criteria, unless you are planting a frostfree hill country site. Snow is not a concern.

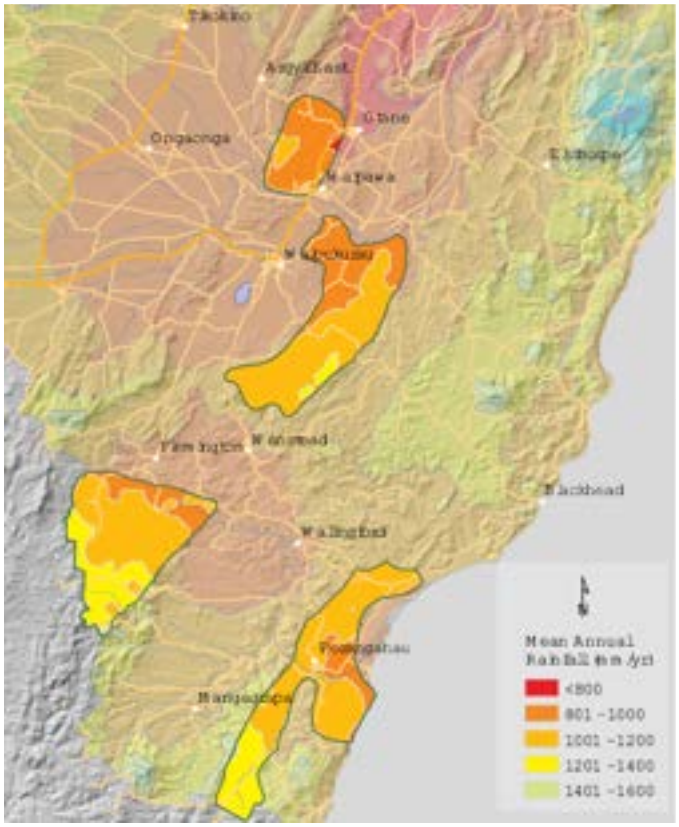

Figure 35 : Rainfall of the Argillite Farm Forestry Zone

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Farm Forestry practices and recommended tree species

Chapter 3 contains the detailed information regarding tree species. Any notes in the tables are specific to this zone.

Commercial forest and woodlots

This zone is extremely prone to drought, with west and north facing slopes frequently experiencing soil moisture deficit situations. These slopes are also affected by severe wind conditions. The recommended tree species reflect these climatic limitations.

Table 69 : Commercial forest and woodlot species.

Botanical name	Common name	Botanical name	Common name
Pinus radiata	Radiata pine	Eucalyptus obliqua	Tasmanian oak
Cedrus deodara/atlantica	Himalayan/Atlas cedar	Eucalyptus regnans	Mountain ash
Cupressus torulosa	Bhutan cypress	Eucalyptus fastigata	Brown barrel
Cupressus lusitanica	Mexican cypress	Acacia dealbata	Silver wattle
Cupressocyparis ovensii	Ovens cyprus		
Eucalyptus globoidea	White stringybark	Quercus robur/palustris/ ilex etc.	English/Pin/Holm oak
Eucalyptus muelleriana	Yellow stringybark		

Other ground durable eucalyptus series

Pinus radiata planted on the steep dry argillite hills.
Source: ***Simon Stokes***

Willow planting along a gully to reduce erosion.
Source: ***Simon Stokes***

Soil conservation – gully erosion

There is little gully erosion in this zone except where the argillite bedrock has been shattered and crushed by faulting. In this circumstance, the level of erosion control required is considerable. The gullies are mostly infilled systems that could erode severely if erosion occured.

Soil conservation – slope erosion

Slope erosion does not occur in this zone due to the nature of the bedrock. Instead, most erosion is surface erosion. However, if there is a zone of crushed material that has earthflow activity, then the recommendations under the 'Eastern Mudstone Earthflow Subzone' should be followed. To reduce the surface erosion levels, it is very important to have suitable dryland pasture species, well grazed and fertilised. Also monitor grass grub levels.

Table 70 : Soil conservation - gully erosion species.

Botanical name	Common name	Botanical name	Common name
Salix matsudana, S. alba and their variations	Willows	Salix viminalis, S.Purpurea, S. kinuyanagi	Basket and shrubby willows
Populus yunnanensis and var. Kawa, Veronese, Crowsnest, Argyle, Weraiti	Poplars		
The following species are options if the area is retired or restricted from grazing. Note that any of the commercial forest and woodlot species can also be considered if stock are removed and the erosion is not too severe - if erosion is severe to extreme plant P. radiata and manage accordingly.			
Plagianthus regius Pittosporum eugenioides Pittosporum tenuifolium Pittosporum crassifolium Griselinia littoralis Sophora microphylla/tetraptera Phormium tenax/ cookianum Dacrycarpus dacrydioides Cordyline australis Cortaderia toetoe/ fulvida Hoheria populnea Alnus glutinosa/rubra Ulmus procera	Ribbonwood Tarata Kahuhu Karo Broadleaf Kowhai Native axes Kahikatea Cabbage tree Toetoe Lacebark Black/Red alder English elm	This is not a complete list of indigenous species. However, it does list those species: a) with greater gully control ability because of their root mat systems; or suitability for the site; or b) that allow for long-term management options, such as acting as a nurse crop for further forestry planting.	

Table 71 : Shelterbelt species.

Botanical name	Common name	Notes
Pinus radiata Cedrus deodara/atlantica Cupressus torulosa Cupressus sempervirens	Radiata pine Himalayan/Atlas cedar Bhutan cypress Roman Cypress	Single or double row. Often planted with another species (as listed here). Totara could be suitable as a leeward species.
Populus spp. and var. Crowsnest, Veronese Salix matsudana var. Tangoio, Moutere Alnus rubra/cordata/ glutinosa	Poplar Willows Red/Italian/Black alder	Should be used in internal shelterbelts on moist soils (Gley and Recent alluvial) where they are not too exposed to the westerly wind - running east to west. Single row planting or interplanted with the following: Coprosma spp., Hebe spp., Carmichaelia spp. (native broom), Pittosporum spp., flax spp.
Chamaecytisus palmensis	Tagasaste	For dry hill country planting as a low growing companion species or on its own.
Abies concolor	White fir	Will tolerate very cold and dry conditions, but not wet feet - so do not plant in Gley or Recent alluvial soils with poor drainage. Best suited to single row or windward side of double row.
Pittosporum crassifolium Pittosporum eugenioides Pittosporum tenuifolium Cordyline australis Coprosma rigida Coprosma propinqua Dodonaea viscosa Phormium tenax Metrosideros excelsa Podocarpus totara	Karo Tarata Kahuhu Cabbage tree Sti karamu Mingimingi Akeake Harakeke (flax) Pohutukawa Totara	Should be used in internal shelterbelts on moist soils (Gley and Recent alluvial). Prefer to not be exposed to the full force of the wind. They can be planted individually or together with other species. Pohutukawa can stand both dry and wind but is frost tender.
Coprosma repens Hebe stricta Olearia solandri Coprosma robusta	Taupata Koromiko Coastal tree daisy Karamu	These species are shrubs and would form the lower growing line in hill country. They can be planted with other taller species as listed above.

Shelterbelts

The zone is very exposed to wind, either from the west or chilly blasts from the south. There are some scattered indigenous remnants and a few existing exotic plantations. Although there is a hilly relief providing some natural shelter, this is not adequate for stock protection in a cold storm. Shelterbelts are also necessary to reduce the severity of wind erosion where land is cultivated. The following list of tree species is recommended for shelterbelts to provide stock and crop shelter.

Riparian management

There are many different types of watercourses in this zone, each requiring different riparian management practices. Most of the pastoral land is farmed extensively or semi-intensively. The riparian areas are described as infilled valley floors, alluvial flats, or gully systems that have a low gradient, with a lot of streambank erosion. These watercourses require specific treatment and appropriate. fencing to allow floodwaters through. A single 'hot-wire' may be suitable. Root mat development is vital, as is long-term tree management.

In parts of the Argillite Zone, there are wetland environments that require specialised management. If you are subdividing your property, consider fencing options to isolate riparian and wetland zones.

Table 72 : Riparian management species.

Botanical name	Common name	Notes
Sequoia sempervirens Taxodium distichum Betula pubescens Eucalyptus camaldulensis Eucalyptus cladocalyx Populus yunnanensis and var. Crowsnest, Veronese, Kawa, Argyle	Redwood Swamp cypress Downy birch Red river gum Sugar gum Poplars	These species are recommended for sheltered sites where they can be interplanted with indigenous species. The faster growing, taller trees will provide a frost and shade canopy that helps establish less hardy indigenous species. Sugar gum foliage can be toxic to goats and horses
Chamaecytisus palmensis	Tagasaste	Suitable as a nurse crop; great for birds and bees.
Pittosporum crassifolium * Cordyline australis * Coprosma propinqua Coprosma robusta * Phormium tenax * Carex secta Carex solandri/lucida/maorica Dacrycarpus dacrydioides Cyperus ustulatus Hoheria angustifolia Corokia cotoneaster Olearia virgata Cortaderia fulvida * Leptospermum scoparium Schoenoplectus validus	Karo Cabbage tree Mingimingi Karamu Harakeke (flax) Pukio Native grasses Kahikatea Umbrella sedge Lacebark Korokia Twiggy tree daisy Toetoe Manuka Lake clubrush	Frost tolerance is important as planting sites in this zone are usually in hollows. All can be planted in the open or in semi shade. * Will handle drier conditions - see below.
Hebe stricta Coprosma repens Sophora tetraptera Kunzea ericoides Carmichaelia odorata Pittosporum tenuifolium Pittosporum ralphii Phormium cookianum Cassinia letophylla	Koromiko Taupata Kowhai Kanuka Scented broom Kahuhu Ralph's pittosporum Whaririki (flax) Tauhinu	These species will handle drier conditions along with some of the species listed above (marked with *). All can cope with planting in the open without shade.

Amenity/shade

The tree species recommended below are for planting in open paddocks where they need to withstand exposure and animals. If your property is near the coast, the chosen tree species must be able to handle coastal conditions. There are many other choices that will thrive, but success depends on the site, protecting trees from animals, and good planting technique.

Castanea sativa Sweet chestnut. Source: ***Kevin Thomsen***

Table 73 : Amenity/shade species.

Botanical name	Common name	Botanical name	Common name
Platanus occidentalis/acerifolia	Planes	Pinus coulteri	Pines
		patula/sylvestris	Himalayan/Atlas cedar
Quercus robur/ilexlpalustris etc	Oaks	Cedrus deodara/atlantica	Roman cypress
Aesculus hippocastanum/indica	Horse/Indian chestnut	Cupressus sempervirens	Birch
Castanea saliva	Sweet chestnut	Betula spp.	English walnut
Sophora tetraptera	Kowhai	Juglans regia	Ginkgo
Fagus sylvatica/var. Purpurea	English/Copper beech	Ginkgobiloba	
Sequoiadendron giganteum	Wellingtonia		

Gravel

This zone is characterised by gravel hills landscaped from marine and river deposition, the soils and the dry environment. The zone is relatively stable, with attractive rolling hills. The area includes small pockets of siltstone and mudstone hill country.

Geology Rock types The Gravel Farm Forestry Zone is not complex, being mostly of marine origin and/or extensive river deposits.

Some of the landscape is overlain with loess and volcanic material that influences the soil type, but this is mostly associated with the lower lying areas and remnant river terraces. Most of the area is located in the Gwavas/ Mangatahi districts, but some gravel bands run through to Sherenden, Patoka and Rissington. As these bands have more loess present, they are added to the 'Loess Zone'.

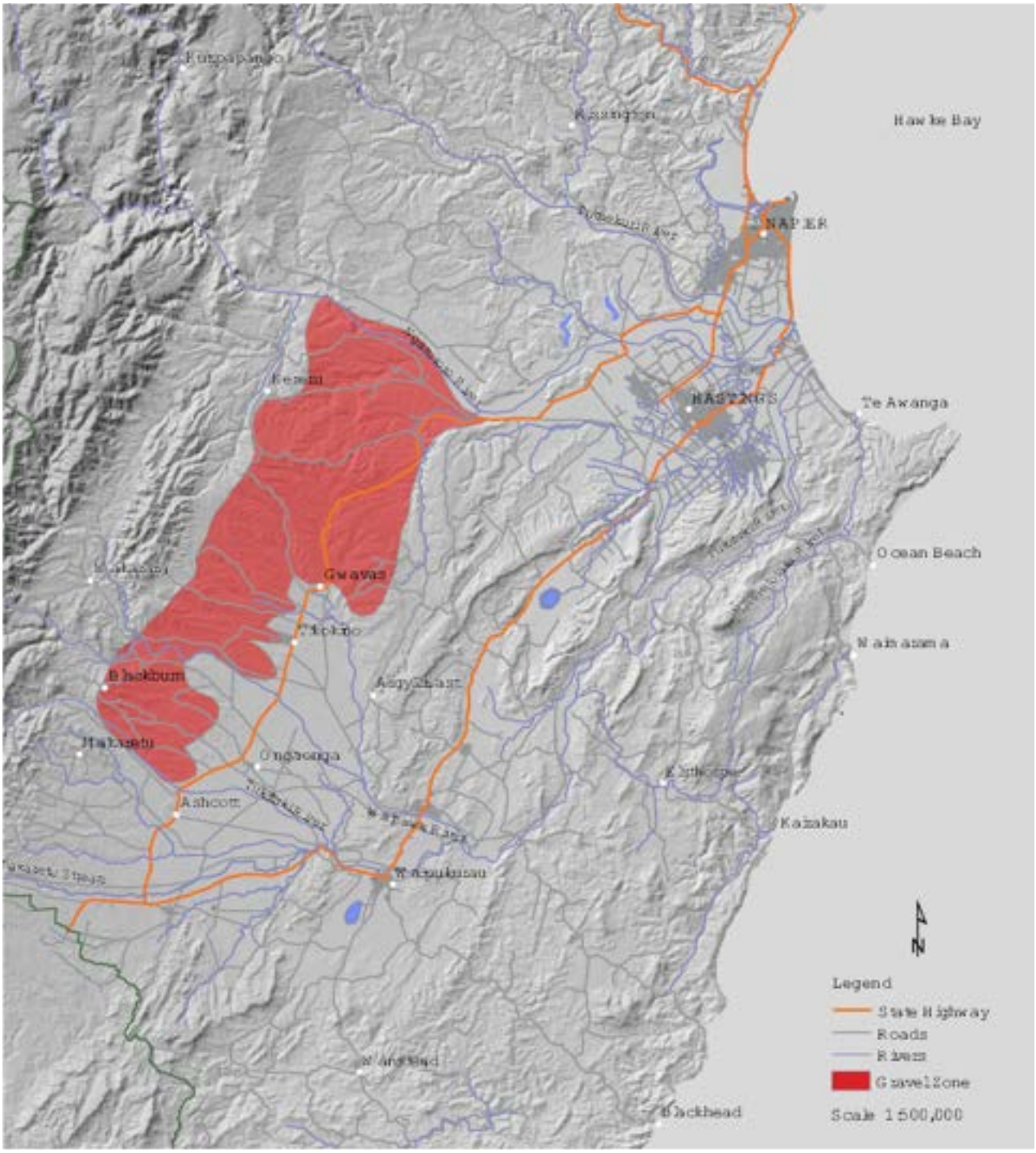

Figure 36 : Gravel Farm Forestry Zone

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Topography Landform is moderately rolling to steep hill country. There is no main range system and the water catchments drain to the Ngaruroro River via the Mangatahi and Maraekakaho Streams, and via the Mangaonuku Stream to the Waipawa River.

Slope and aspect (direction of slope) The Gravel Farm Forestry Zone has ridgelines running mainly east/southeast, therefore the two dominant aspects are north/northeast and southwest. The influence of aspect is very important in combination with soil type, wind direction, and slope angle. Because the soils are drought-prone and rainfall is low, the northwest through to southwest aspect is very dry, thus limiting farm forestry opportunities and tree species choices. The sheltered aspects have fewer problems.
Slope will determine:

- the available soil depth and soil type;
- soil moisture availability; and
- access to the site.

Typical landscape of gravel hills leading to terrace flats. Remnant indigenous vegetation is located along the water catchment with some extra exotics planted as well. Source: ***Simon Stokes***

Altitude ranges from less than 200m up to 564m above sea level, with most of the area between 300-400m. The highest point is a trig in the Gwavas forest, (B2 - at 564m).

Soils Type and location In the topsoil, sand or silt is generally dominant, depending on the level of volcanic influence. In the subsoil, silt or clay is dominant, depending on the presence of loess. Where the soils have developed from weathering of the underlying gravels, the dominant soil type is Brown. The overlying loess or volcanic material is found on the flat to moderately rolling country. These are Pallic or Allophanic soils.

The Gley soils occur in the low-lying areas and are saturated for long periods. They are quite distinctive and are associated with valley floors or swamp-like environments. There are possibly some rare small compartments of Pumice soils, but as these have good soil depth, there are few restrictions for farm forestry. Check Appendix I for specific details on the different soil types.

The following table provides the soil orders for this zone in order of dominance across the landscape.

Pallic soils
Gley soils
Recent *alluvial and steepland* soils

Table 74 : Soil orders for the Gravel zone in order of dominance across the landscape.

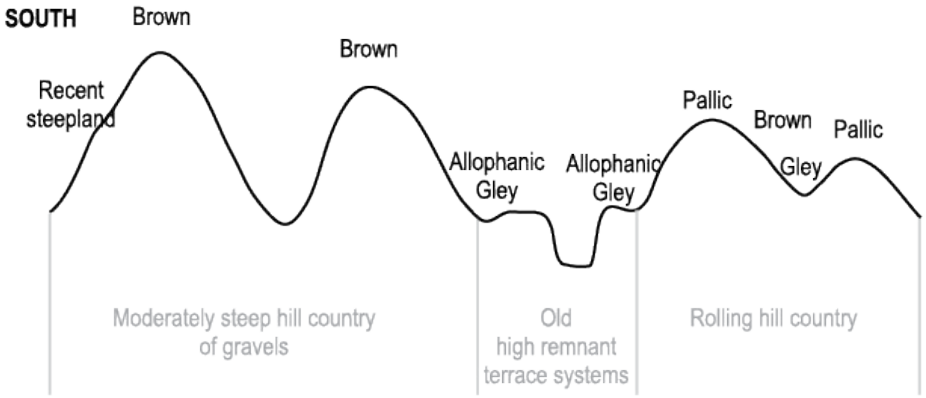

Figure 37 : General location of soil orders across the zone. Source: ***Regional Graphics***

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Climate Rainfall and soil water balance (see Figure 38 for details): Rainfall ranges from 800-1600 mm per annum, increasing closer to the Wakarara Ranges. The average for most of the area is 1000 mm. The soil water balance (annual evapo-transpiration rate) ranges from 900-950 mm. Therefore, deficit situations will often occur, with drought conditions always possible on the shallow hill soils.

Wind is moderately limiting depending on location. On exposed slopes facing the dominant westerly and southwesterly winds, there will need to be provision of buffer trees to cope with the increased wind stress. Southerlies can be cold and hard on plants and stock. Easterlies are frequent and are often moisture-laden which can cause toppling.

Frost and snow Frost can be severely limiting, particularly in hollows and on valley floors. Nearly 90% of the frosts occur between May and November with on average 165 to 215 frost days per year. Therefore, frost hardiness is a necessary condition for selection of tree.

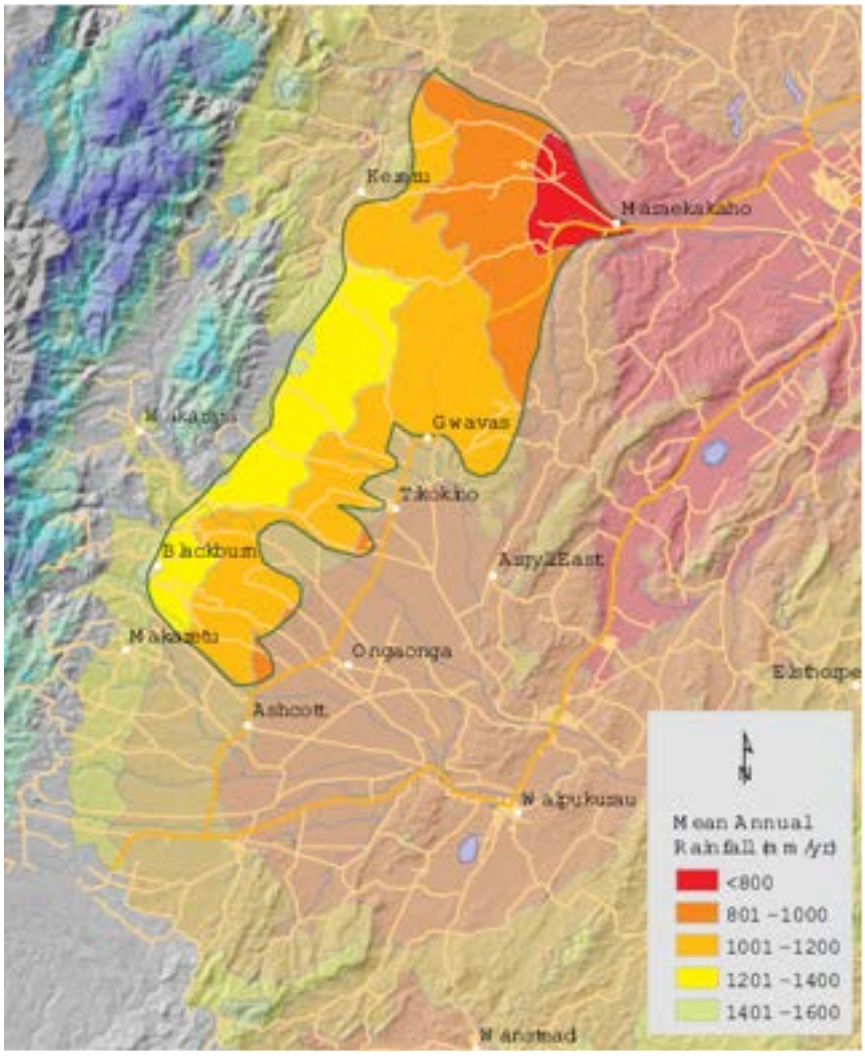

Figure 38 : Rainfall of the Gravel Farm Forestry Zone

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Farm Forestry practices and recommended tree species

Chapter 3 contains the detailed information regarding tree species. Any notes in the tables are specific to this zone.

Commercial forest and woodlots species unless you are planting a hill country site that is not prone to frost. Snow is rare.

Table 75 : Commercial forest and woodlot species.

Botanical name	Common name	Botanical name	Common name
Pinus radiata	Radiata pine	Eucalyptus muelleriana	Yellow stringybark
Cedrus deodara/atlantica	Himalayan/Atlas cedar	Eucalyptus obliqua	Tasmanian oak
Cupressus torulosa	Bhutan cypress	Eucalyptus regnans	Mountain ash
Cupressus lusitanica	Mexican cypress	Eucalyptus nitens	Shining gum
Cupressocyparis ovensii	Ovens cyprus		
Sequoia sempervirens	Redwood	Eucalyptus fastigata	Brown barrel
Cryptomeria japonica	Japanese cedar	Acacia dealbata	Silver wattle
Eucalyptus bosistoana	Coast grey box	Quercus robur/palustris	English/Pin oak

Other ground durable eucalyptus series

The gravel hills of Gwavas Forest were planted many years ago. This photo shows an area harvested and the slash raked into rows to allow for easier re-planting. Some poplars are visible in the gully over the hill and more forest due to be harvested in the background. Source: ***Simon Stokes***

Soil conservation – gully erosion

There is very little gully erosion in this zone. In most cases, gullies will be deep and relatively well vegetated leading to gorge systems, or infilled areas located in the lower slopes of some of the hill country. If there is a need for gully erosion control, then see the 'Loess Farm Forestry Zone' for information on methods and species recommendations as the measures are similar.

Soil conservation – slope erosion

There is little evidence of slope erosion other than surface erosion where there is poor pasture cover. To reduce the risk of surface erosion, it is important to have suitable dryland pasture species that are properly grazed and fertilised. See the 'Loess Farm Forestry Zone' for information on methods and species recommendations.

Shelterbelts

This zone is very exposed to wind, either from the west or southwest, or chilly blasts from the south. Some locations are well covered in scattered indigenous remnants, but these are often in watercourse areas. There are some existing exotic plantations. The relatively hilly relief provides natural shelter. However, some of the hills and terraces are very exposed. Shelterbelts are also necessary to reduce the potential for wind erosion on land that is being cultivated. The following list of tree species is recommended for shelterbelts to provide stock and paddock shelter.

Table 76 : Shelterbelt species.

Botanical name	Common name	Notes
Pinus radiata Cedrus deodara/atlantica Cupressus torulosa Cupressus sempervirens	Radiata pine Himalayan/Atlas cedar Bhutan cypress Roman Cypress	Single or double row. Often planted with another species (as listed here). Totara could be suitable as a leeward species.
Populus spp. and var. Crowsnest, Veronese Salix matsudana var. Tangoio, Moutere Alnus rubra/cordata/ glutinosa	Poplar Willows Red/Italian/Black alder	Should be used in internal shelterbelts on moist soils (Gley and Recent alluvial) where they are not too exposed to the westerly wind - running east to west. Single row planting or interplanted with the following: Coprosma spp., Hebe spp., Carmichaelia spp. (native broom), Pittosporum spp., flax spp.
Chamaecytisus palmensis	Tagasaste	For dry hill country planting as a low growing companion species or on its own.
Abies concolor	White fir	Will tolerate very cold and dry conditions, but not wet feet - so do not plant in Gley or Recent alluvial soils with poor drainage. Best suited to single row or windward side of double row.
Pittosporum crassifolium Pittosporum eugenioides Pittosporum tenuifolium Cordyline australis Coprosma rigida Coprosma propinqua Dodonaea viscosa Phormium tenax Metrosideros excelsa Podocarpus totara	Karo Tarata Kahuhu Cabbage tree Sti karamu Mingimingi Akeake Harakeke (flax) Pohutukawa Totara	Should be used in internal shelterbelts on moist soils (Gley and Recent alluvial). Prefer to not be exposed to the full force of the wind. They can be planted individually or together with other species. Pohutukawa can stand both dry and wind but is frost tender.
Coprosma repens Hebe stricta Olearia solandri Coprosma robusta	Taupata Koromiko Coastal tree daisy Karamu	These species are shrubs and would form the lower growing line in hill country. They can be planted with other taller species as listed above.

Riparian management

There are many different types of watercourses in this zone, each requiring different riparian management practices. Most of the pastoral land is farmed semiintensively or intensively. The riparian area may be described as mainriver and stream catchment, U-shaped with steep sides that usually have considerable areas of remnant vegetation. These steep sites can best be left to regenerate where possible, or they can be replanted. The riparian management issue can also be included in a commercial forest option, or with subdivision and water reticulation schemes. A protection fence, even a single 'hot-wire', is vital for success.

In parts of this zone, there are wetland environments that require specialised management. If you are subdividing your farm, consider fencing options to isolate riparian or wetland zones.

A well planted catchment with cedars located in the upper dry area leading to remnant indigenous species, predominantly kanuka, providing the lower riparian vegetation, with some woodlots also planted. Source: ***Simon Stokes***

Table 77 : Riparian management species.

Botanical name	Common name	Notes
Sequoia sempervirens Taxodium distichum Metasequoia glyptostroboides Betula pubescens Eucalyptus camaldulensis Eucalyptus cladocalyx Populus yunnanensis and var. Crowsnest, Veronese, Kawa	Redwood Swamp cypress Dawn redwood Downy birch Red river gum Sugar gum Poplars	These species are recommended for sheltered sites where they can be interplanted with indigenous species. The faster growing, taller trees will provide a frost and shade canopy that helps establish less hardy indigenous species. Sugar gum foliage can be toxic to goats and horses
Chamaecytisus palmensis	Tagasaste	For drier sites, good for birds and bees.
Pittosporum crassifolium * Cordyline australis * Coprosma robusta * Coprosma propinqua Phormium tenax * Carex secta Carex solandri/lucida/maorica Dacrycarpus dacrydioides Cyperus ustulatus Hoheria angustifolia Corokia cotoneaster Olearia virgata Cortaderia fulvida * Leptospermum scoparium Schoenoplectus validus	Karo Cabbage tree Karamu Mingimingi Harakeke (flax) Pukio Native grasses Kahikatea Umbrella sedge Lacebark Korokia Twiggy tree daisy Toetoe Manuka Lake clubrush	Frost tolerance with Gley and Recent alluvial soils is critical - with these species being the most suitable. Most can be planted in the open without shade or in semi shade. * Will handle drier conditions - see below.
Hebe stricta Coprosma repens Sophora tetraptera Kunzea ericoides Carmichaelia odorata Pittosporum tenuifolium Pittosporum ralphii Phormium cookianum Cassinia letophylla	Koromiko Taupata Kowhai Kanuka Scented broom Kahuhu Ralph's pittosporum Whaririki (flax) Tauhinu	These species will handle drier conditions along with some of the species listed above (marked with *).

Amenity/shade

This zone has several sites with their own microclimates. However, the trees listed below are for planting in open paddocks where they need to be able to survive exposure and animals. There are other choices, but success depends on the site, protecting the trees from stock, and good planting technique.

Ginkgo bilboa Ginkgo. Source: ***Kevin Thomsen***

Table 78 : Amenity/shade species.

Botanical name	Common name	Botanical name	Common name
Platanus occidentalis/acerifolia	Planes	Pinus coulteri/patula /sylvestris etc.	Pines
Quercus robur/ilex/palustris etc.	Oaks	Cedrus deodara/atlantica	Himalayan/Atlas cedar
Sophora tetraptera	Kowhai	Castanea sativa	Sweet chestnut
Cordyline australis	Cabbage tree	Aesculus hippocastanum	Horse chestnut
Gleditsia triacanthos	Honey locust	Melia azedarach	Persian lilac
Ginkgo biloba	Ginkgo	Brachychiton populneus	Kurrajong
Fagus sylvatica/var. purpurea	Beech/copper		

Mountainlands

The Mountainlands are greywacke formations that have formed the distinctive backbones of the local ranges. In the south, the Ruahine Range stretches from south of Dannevirke up to the Ngaruroro River. From there, the zone extends over two ranges - the Kaweka and Kaimanawa Ranges, with the Ahimanawa Range surrounding the Napier-Taupo highway. To the northeast, there is no dominant range system except the Huiarau Range in the Urewera National Park. Lake Waikaremoana is in this zone.

Most of the Mountainlands are contained within Department of Conservation managed areas. However, there are significant areas of privately owned land. The Department of Conservation managed land is mostly contained in the Urewera National Park, the Kaimanawa, Kaweka, and Ruahine Forest Parks.

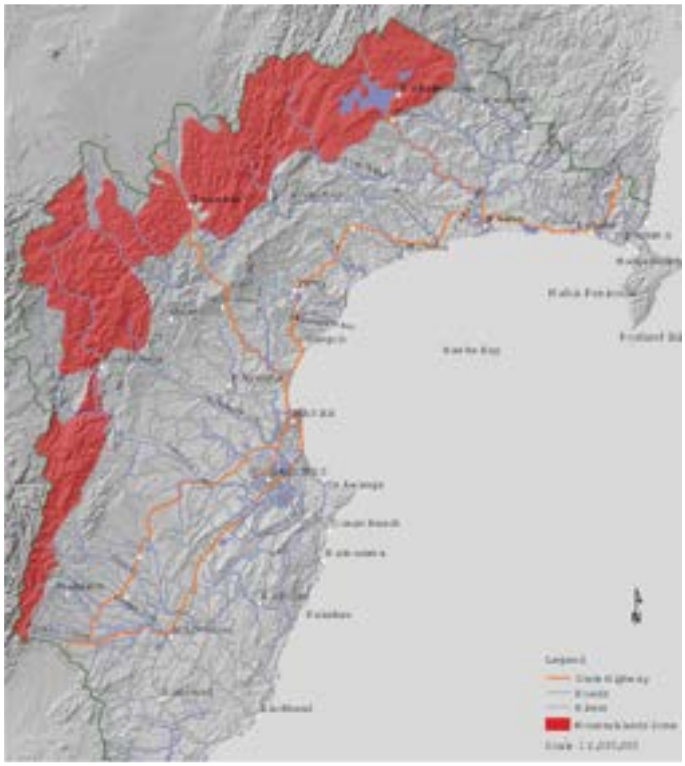


Figure 39 : : Mountainlands Farm Forestry Zone

Most of this area is covered in regenerating scrub and other pioneering ndigenous species, Podocarp-dominant lowland forests and the higher altitude beech-dominant forests. Some areas were cleared for farming and some were harvested but, currently, most of these areas have significant areas of regenerating indigenous forest. As altitude increases, the vegetation changes to alpine scrubland, grasslands/tussock and alpine bog areas.

Because of the current land use, land ownership, location and vegetation, the zone does not form part of the Hawke's Bay farm forestry guidelines. Where there is potential for farm forestry it would probably be with commercial forestry/woodlot opportunities. The 'Upland Pumice' or 'Northern Hawke's Bay' commercial forest recommendations would be suitable. Include in that list the Nothofagus (beech) species for planting.

Looking into the Mountainlands Farm Forestry Zone with 'The Lakes' of the Blowhard Plateau in the foreground surrounded by indigenous and exotic forest, with the Kaweka Range in the background. Source: ***James Lawson***

Heretaunga Plains and Ahuriri Estuary

The Heretaunga Plains lie between the Havelock North hills and Napier, stretching inland to Pakipaki and west to Maraekakaho. They then follow the hills around Fernhill on the northwestern border. (Swamp Road could be included in this area.) The Heretaunga Plains and Ahuriri Estuary receive the lowest annual rainfall in Hawke's Bay, between 500-800 mm.

Farm forestry opportunities for both the Heretaunga Plains and the Ahuriri Estuary are limited, due to the intensive land use and the urban localities. Where there is a need for any of these practices, refer to the 'Ruataniwha Plains Farm Forestry Zone' as the requirements will be similar.

On the Plains, there are requirements for shelterbelts, riparian management, specifically around wetlands, and amenity/shade provision.

The Ahuriri Estuary lies on the northern side of Napier extending to Bay View. It is a unique landscape due to being uplifted in the 1931 earthquake. The excessive saltiness of this estuarine area requires specialist planting knowledge that can be acquired from the Department of Conservation

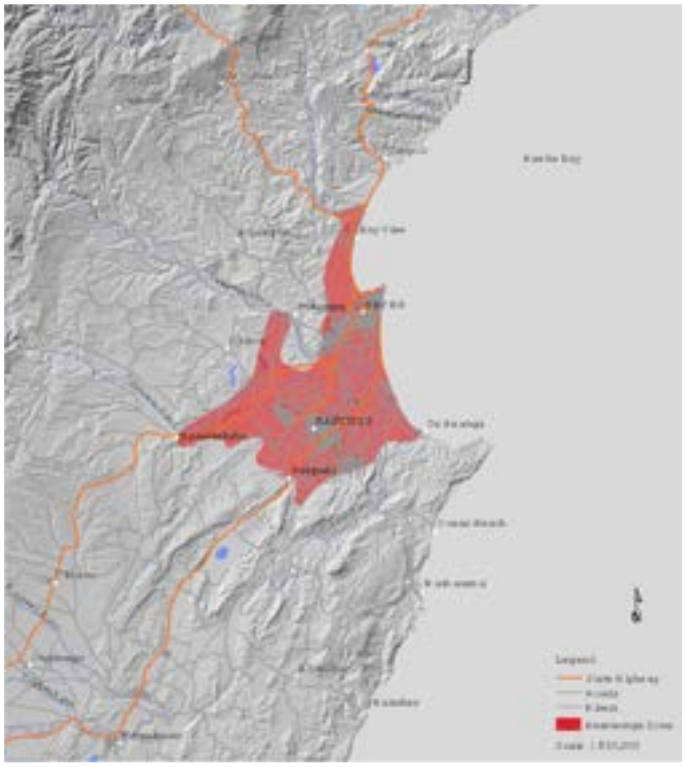
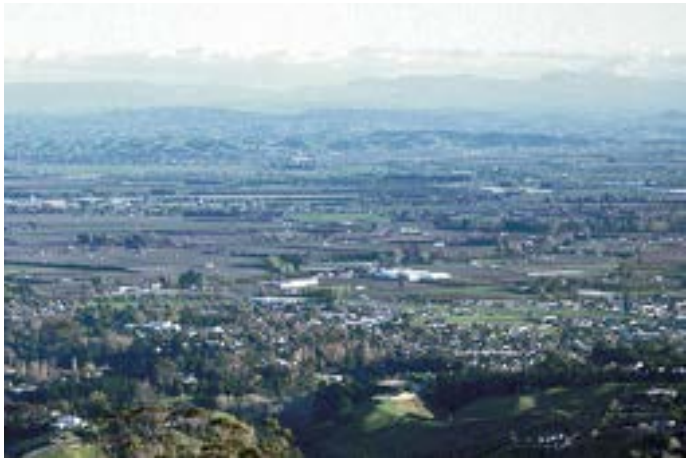


Figure 39 : Heretaunga Plains Farm Forestry Zone

Ahuriri Estuary with Poraiti in the background. Source: ***Susan Wylie***

Ahuriri Estuary at high tide. Source: ***Kevin Thomsen***



Heretaunga Plains from Te Mata Peak. Source: ***Kevin Thomsen***

Tree Information

Introduction

The previous two chapters have introduced you to farm forestry in Hawke's Bay, encouraged you to plan some planting and choose the species, and described your "Zone." Now you need more specific information about each species.

This chapter provides detailed information about tree species. The information is sourced from a multitude of references and from the personal experiences of Hawke's Bay farm foresters.

Also included is information on phonetic pronunciation and plant hardiness zones.

Tree species included in this chapter

1. Timber species: this includes trees that havebeen shown to grow well in Hawke's Bay through forestry crops, trials, and experience. They include three main groups: **P. radiata, Special Purpose Species (SPS)**, and **Indigenous Species.**

- ***Pinus radiata*** is and will be, for the foreseeable future, the main commercial choice. In the Pinus species guide, we provide specific information on this species, with particular reference to growing pine on farm sites, which is different to traditional, commercial forestry sites. Because of the importance of P. radiata to the region, we have provided a number of references containing valuable information.
- ***Special Purpose Species*** (SPS) are those species other than radiata pine that have a recognised timber potential. Most of these SPS are not currently produced in sufficient volume to have achieved market assurance. However, species like Cupressus lusitanica, Pseudotsuga menziesii and Sequoia sempervirens are now being established in commercial sized forests, sometimes with the backing of substantial overseas investment.
- ***Indigenous Timber Species*** choices are known to succeed in Hawke's Bay. In the past, the timber industry was built on many of these species, but now the resource is mostly protected. However, the demand for native timber is still very strong and there is potential for long-term timber production.

2. Trees that have a multi-purpose role for farm forestry sites - providing animal shelter and shade, soil and water protection, fodder for animals, food for birds and bees. Many of the **riparian, amenity/shade and erosion** choices listed in the Farm Forestry Zones section are not covered in the species guide, especially the shrubby indigenous species. Information can be found on these in the many books that are available, some of which are in the reference list.

We have only included a small proportion of the many potential choices of species. However, our list has been based on the experiences of farm foresters within the Hawke's Bay region or on our belief that they will be successful on specific sites. Some species are still promoted and planted in the region despite a high risk of failure (e.g. Thuja plicata and Cupressus macrocarpa). It is always important to verify your tree selection with someone who knows.

Plant hardiness zones

For rating the hardiness of tree species, we have used an internationally accepted system developed by the United States Department of Agriculture, originally for North America. Trees can be successfully established in colder areas than those recommended if shelter is provided, particularly during juvenile years. However, there is always a degree of risk and losses may occur in a very cold year even when trees are quite large.

Trees may be able to withstand cold, even snowy conditions, but if they are placed in a frost pocket they will succumb in an extreme season. Often the out-of-season frosts are the greatest risk as they can occur when the trees are in a soft, active growth stage.

Both a minimum and maximum zone is given for each species. This shows the range of temperatures in which the plant is most comfortable growing. Sometimes very cold-hardy plants will not survive in the hot temperatures of summer.

These zones only refer to temperature – other climatic factors must be considered. Humidity, day length, season length, wind, soil temperatures, and rainfall quantities and

patterns all must be taken into account when evaluating a species' suitability for a site. **Hardiness zones are based on the minimum winter temperature expected for each zone.**

Zone 1	Below -46 degrees Celsius sub-arctic climate of Alaska and Siberia	
Zone 2	-46 to -41	
Zone 3	-41 to -35	
Zone 4	-35 to -30	
Zone 5	-30 to -24	
Zone 6	-24 to -18	
Zone 7	-18 to -12	
Zone 8	-12 to -7	
Zone 9	-7 to -1	
Zone 10	-1 to 4	mostly frost free.
Zone 11	4 to 10	
Zone 12	10 and above	equatorial regions.

NOTE: The majority of New Zealand is between Zone 7 and Zone 11.

Cedrus deodara in Onga Onga township during winter of 2003. Source: ***Christine Taylor***

Key to the phonetic guide

This information is included to assist readers with the correct pronunciation of botanical names and to encourage the use of these names rather than the often misleading common names. The following information is mostly derived from Stirling Macoboy's 'What Tree is That?' (1979).

Each species guide in this chapter is headed by the tree's generic name, followed by a simple phonetic guide to its pronunciation. There are still many differences of opinion as to how these botanical names should be pronounced, but the phonetic guide should help set you on the right track. The aim of a phonetic guide is to give constant pronunciation values to the symbols used.

Vowels, and some consonants, can be pronounced in many different ways in English (look at the vowel 'a' in fat, fates, father and fare or the consonant 'c' in cat and ace). A phonetic guide makes it necessary to select one special letter or group of letters to represent each specific sound, and that sound only. But because there are more sounds in English than there are letters in the English alphabet, we also use one extra symbol (ə) to represent the many indeterminate vowel sounds heard in words like alone, system, terrible, gallop and circus.

Each syllable is separated from the next by a space, and an accent (') is placed immediately after the syllable to be stressed. Each separate letter or letter combination is always pronounced according to the following:

a	fat
ae	pay, fate, sleigh
ah	mark, father
ai	ice, high, buy
ə	alone, system, terrible, gallop, circus
e	deaf, den
ee	teach, see
e ə	air, dared
i	fit, tif
o	sot, toss
oh	oath, both, crow
oi	boy, royal
oo	prove, pool, glue
or	ought, more, roar
ou	cow, crouch, slough
u	suck, son, rough
ur	err, circus
b	bat, tab
ch	chip, patch
d	do, cod
f	reef, rough, phone
g	gas, bag
h	help, ahoy
j	jaws, gem, rage

k	cat, sack
l	limb, mill
m	more, rummy
n	ton, tonight
p	pal, lap
r	rot, trot
s	sale, lace
sh	shade, motion
t	tone, note
th	thin, both, loathe
v	vat, cave
w	win, twin
y	yellow
z	zip, toes, rose
zh	measure, invasion

Remember, the sounds of each phonetic letter or letter-group remain constant. As examples, here are five tree entries with their generic names and the phonetic pronunciations.

ABIES	ae' bees	Firs
ACACIA	ə kae' sh ə	Wattles
ACER	ae' sur	Maples
ADANSONIA	ad an son' ee ə	Baobabs

Eucalyptus spp (yoo' kəl iptus)

Eucalypts

The Eucalyptus genus is a remarkable collection, numbering in excess of 650 species. Over the millennia, they have adapted to almost every environment possible in their home territory – Australia, Tasmania, Papua New-Guinea and some surrounding islands. They have established themselves up to the permanent snow line on mountain ranges, amongst tropical jungles, in semideserts, often existing in extreme saline soils and in areas that are prone to prolonged flooding. The majority of Eucalyptus species do not grow in a tree form that may be considered for timber production. Of those that do, many have characteristics that make them unsuitable for quality timber production. The few species that are suitable each have their own site preferences.

Hawke's Bay has a long history of growing eucalypts. Many varieties were planted as farming properties established in the region from the mid 1800s. In fact, there have probably been more eucalypt species established in this district than anywhere else in New Zealand. Some of the families who took a role in those early years are the Chambers family of Havelock North, the Field family of Waimarama, and the Russell families of Sherenden and Apley. The notable eucalypt species that were successfully established and have been milled for timber are: E. fastigata, cladocalyx, obliqua, regnans, muelleriana, saligna, botryoides and camaldulensis. Also established successfully, but largely eliminated by the insect Paropsis charybdis (tortoise shell beetle), were E. nitens, maidenii, and globulus. Today, an introduced parasitic wasp assists in the control of this problem.

In the past, many plantings of high value, mature eucalypts were cut up for firewood due to a lack of knowledge of the milled timber value of some species and the drying and

New Zealand foresters have a tendency to try 'blanket planting' tree species. These may establish successfully on the majority of sites and perform well until some natural adversity occurs to stress them beyond their capabilities. Extreme frost can kill even large trees. Severe drought can quickly dispose of trees of any age, while some species appear to be totally unaffected. reconditioning requirements.

Unless the species and seed source originates from a zone that is capable of withstanding the extremes your site may throw at them in their lifetime – possibly for up to 50 years - a great risk is being taken! You can be sure that nature is going to perform in the future to the same extremes as it has in the past 50 years.

Obviously you can never avoid all risk, but by taking care in identifying the characteristics of your site and matching those to a suitable tree variety you can be more confident of having a successful long-term outcome.

"Be bold enough to try some of the eucalypts, even if it is just for the sake of diversity."

– Alec Olsen (pers. comm.).

Fifteen-year-old Eucalyptus nitens on 'Longridge', Patoka, still providing some grazing. Source: ***Jonathan Barran***

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Amenity/shade choices

There is a huge range of foliage colour and shapes available, many spectacular flowering varieties that will attract birds and bees, and all sorts of interesting stem colours and effects. It is possible to have continuous flowering throughout the year by selecting a number of different species. Some examples are apple box (E. bridgesiana), yellow gum (E. leucoxylon), brittle gum (E. mannifera), silver peppermint (E. tenuiramis), and the broad-leafed peppermint (E. dives).

Timber production

Why bother to plant eucalypts?

- Eucalypts provide the greatest range of fast growing hardwood species.
- The world's hardwood resource is diminishing faster than the softwood resource, due largely to international conservation of indigenous forests. Forest Certification will further restrict the acceptable sources of these timbers.
- For diversity of your own plantings for economic and aesthetic reasons.
- Demand for 'solid wood' furniture is strong at present and is sure to continue in the future.
- Eucalyptus species provide an excellent nectar source for birds and bees, with at least one different variety flowering each month of the year.
- The Eucalyptus genus generally has an appetite for nitrogen products. This can be utilized where a surplus of nitrogen is an environmental concern, for example near effluent ponds or feedlots and in riparian zones beside high intensity production land.

We know we can successfully grow specific varieties of eucalypts on most sites in New Zealand. Unfortunately, many of those that suit the majority of the country are not the best quality timber producers. A survey of those trees already successfully established in the region will give an excellent guide to suitable species.

Improvements in technology are making it possible to successfully utilise the timber from Eucalyptus varieties. Currently, the Ash group (E. fastigata, fraxinoides, obliqua, regnans) and E. nitens, commonly grown on inland areas, are the most popular although they do have some sawing, drying, and processing limitations. Numerous 'durable timber species' are now tested and provide the best choices for most carefully selected planting sites in Hawke's Bay. View 'Table 79' for options to suit your site. Make sure you obtain the best genetically improved seed source for each species – the difference is dramatic.

Proseed NZ Ltd is a supplier of improved Eucalyptus species seed selections.

New Zealand Dryland Forests Initiative (NZDFI) have five trial sites in Hawke's Bay testing the potential of durable timber species in regard to their climatic and soil suitability. There is also a lot of important scientific analysis being done to genetically select the highest performing species (and families within species) for growth, form and early heartwood development (durability). An extensive market for this timber already exists in New Zealand with posts (vineyard and orchard), poles and sawn timber (decking and exterior furniture).

For further information check the informative NZDFI website www.nzdfi.org.nz

Laminated veneer lumber (LVL) is one of the developments that may lead to greater demand. There is increasing New Zealand experience with milling, drying and reconditioning eucalypt timbers that is helping to reduce the problems associated with them.

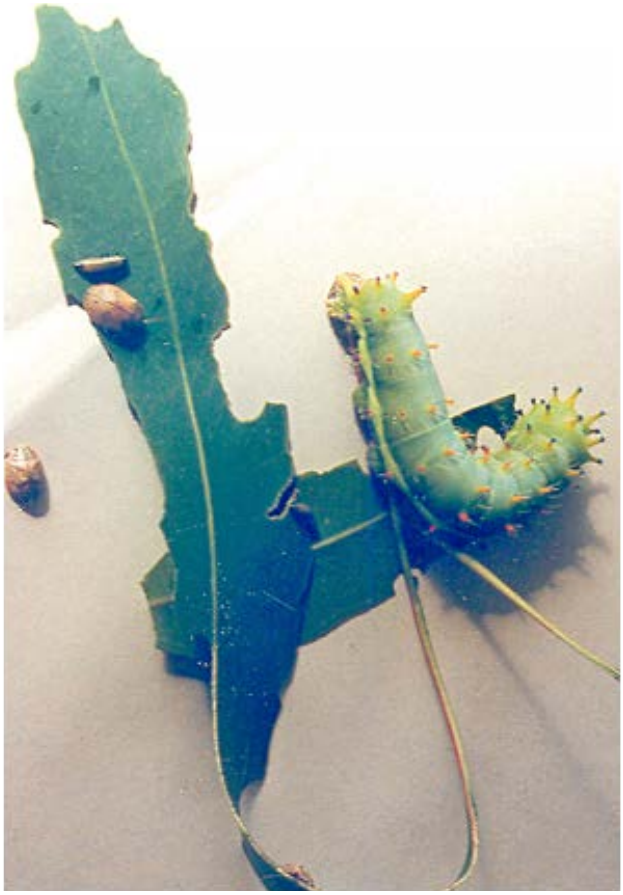
Within the Hardiness zones 9, 10, and 11, that are considered moderate to light frost zones, there are some excellent eucalypts to choose from that produce high quality, durable and attractive timbers that can easily compete with imported hardwoods. These will be harder to establish successfully in Hawke's Bay but are well worth the effort of matching the site and tree. Many Hawke's Bay landowners can identify frost-free or low frost-risk sites on their properties. Hillside slopes where there is good air drainage will have a lower risk of damaging frost than the flats or valley bottoms where cold air is trapped. These are the sites to target for planting potentially high value timber trees. Note that most eucalypts dislike salt-laden winds.

Pests

Animals: Possums are a problem with some eucalypt varieties. Once the trees are reasonably mature, there is lower risk from grazing stock – with the exception of deer and horses.

Insects: There is a long list of pests which love munching on many varieties of eucalypts. Almost all of these hitch a ride on nor'westers or aircraft from Australia and, unfortunately, very few bring with them the natural parasites that keep them in balance in Australia. In most cases, the trees can survive the attacks that can be debilitating if persistent. A number of biological control agents have been successfully introduced to create a balance, making it possible to utilise varieties that were previously not an option.

Diseases: Attacks on the leaves by various fungi, especially in humid sites, can largely be avoided by the correct siting of the species. Also, pruning in dry conditions and avoiding bark damage can reduce the risk of fungal invasion into the trunk. In Hawke's Bay, 'silver leaf' fungal infection can be a major problem



Two examples of the many insect browsers of eucalypt foliage – 'Emperor gum moth' caterpillar and 'tortoise-shell beetle' (Paropsis charybdis).Source: ***Kevin Thomsen***

Eucalyptus species suitable as potential timber choices for Hawke's Bay

Note: The use of botanical names is recommended as common names are confusing and sometimes misleading. The numbers link to the comments following the table.

Note: All of the growth attributes in table 79 are strongly influenced by genetic selection. There is plenty of evidence within New Zealand of poor seed selections for growth and milling qualities. Ideally, we need to know the provenance (precise origin) of the seed – particularly the milling qualities at the same age and dimensions we are targeting with our planting. This provides the best base for selection, but does not provide absolute guarantees due to the possibility of cross-pollination. If, in about 30 years' time, the trees are proven to be of high quality, you will be able to stipulate the same seed provenance to repeat the exercise with confidence. Seek advice from experienced nursery staff and foresters!!

(1) Frost tolerance: For successful establishment, it is critical to obtain suitably sourced seed to provide an adequate hardiness to suit your site, plus supply good growth characteristics for timber production. Eucalypt species often originate from a wide, natural climatic range and, therefore, have an inherent variability in withstanding cold.

(2) E. saligna and E. botryoides are excellent timbers, but the trees have become fodder for many insects and subject to many diseases. This makes it impossible to recommend planting these in any large scale, unless you like to take a risk. If you do, the 'Barr/Woodhill' strain of E. botryoides has good form, mills well and has better resistance to insect pests. The 'Bartletts' strain of E. saligna has good form, mills well and produces an attractive 'figured' wood.

(3) Caution: E. cladocalyx foliage can be poisonous to horses and goats.

(4) E. cladocalyx, maidenii, and melliodora are listed because they have good timber potential but they are not listed in any of the farm forestry zones as there are too few examples planted to feel confident about allocation. E. delegatensis is not listed, as it is considered unsuitable for timber.

(5) As seedlings, all are very palatable to possums, hares, and rabbits!

Establishment

'Microclimate! – Microclimate! – Microclimate!'

Once you have decided to 'have a go' at growing eucalypts, there are 5 steps to successful establishment:

1. Selecting the species:

- Seek advice from local foresters and

nurserymen.

- Take a drive and see if you can find a stand of eucalypts in your area.
- Ask the owners of the stands if they can tell you what the species are - if they can't, ask if you can get an identification made. To do this, you will need seed capsules, flower buds, leaf samples and bark samples. Some nursery staff have the skill to help; otherwise you will need to seek assistance from Forest Research Institute.

Do not take a nursery catalogue or a book about eucalypts and make 'gut feeling' choices or wish lists without going through the above procedures. **Seek advice!**

2. After selecting a suitable site and species, consider the best method of seedling presentation: **Open ground (OG) grown -bare-rooted seedlings:**

- With many varieties, well prepared OG seedlings transplant very successfully in late winter or early spring in moist conditions. They must be a hardy species - able to withstand late season frosts and not be too stressed by dry conditions in the first period of settling in.
- **Container grown – root trainers or similar containers:** Some varieties of eucalypts do not handle transplanting very well, so are best handled in this form so the roots are undisturbed. With frost-tender plants, being in a container allows later seasonal planting in warmer and sometimes drier conditions. Some nurseries report that the majority of container grown eucalypts sold are planted in the late winter or early spring. This may not be an ideal time for successful establishment unless the ground-moisture levels are likely to be too low for planting in late spring or where frost is not a problem.

Note: Eucalypts in containers can be compared to tomato seedlings. They require adequate moisture (which is not very much) and, most importantly, heat. Make sure the seedlings are actively growing and have been adequately boosted with fertiliser if they have been held over from last season. More mature plants, possibly topped to maintain the root/ stem ratio, have stronger stems and more fibrous roots, which makes them easier to transplant.

3. Plant siting and spacing: Sites shoul be middle or lower slopes, less than 25 degrees with plenty of soil depth. Target east and south facing slopes mostly, with some north facing slopes in good rainfall areas suitable.
The trees should be planted in sufficient numbers to provide competition to each other, thereby enhancing height growth, branch restriction, tree form and reducing trunk diameter growth in the early formative years. Even with good genetic seed selection, trees perform differently on different sites. The final crop will be dramatically improved by culling out 75% of the establishment numbers! Planting at 3 by 3 metre intervals (1110 sph) or 4 by 4 metre intervals (625 sph) is generally recommended as a starting stem per hectare rate, depending on the site fertility, tree species and wind exposure.

4. Release spraying: Unless weed competition is kept under control for the first season, the results will be disappointing or even disastrous. Pre-plant spraying is beneficial, but post-plant spraying is essential.

Below is a recommendation for release spraying from Tim Parker, an experienced nurseryman and eucalypt enthusiast - this method has been successful on thousands of eucalypt seedlings!

Calibrate the knapsack for each operator – everyone has a different pace and spray coverage speed. Refer to Appendix III for instructions on calibration.

Use a mix of:

- Gallant™ @ the rate of 3 litres/sprayed hectare (0.3 mls/square metre);
- Versatill™ @ the rate of 1.5 litres/sprayed hectare (0.15 mls/square metre);
- Sun Spray™ – spraying oil @ the rate of 6.0 litres/sprayed hectare (0.6 mls/ square metre).

Refer to each individual spray container's instructions to ensure the application is right!

Table 79 : Eucalyptus species suitable as potential timber choices for Hawke's Bay

Botanical Name	Timber durability	Frost tolerance (1)	Climate preferences	Soil preferences
E. bosistoana Box Group	Very durable	Light frosts down to -5 degrees. (Hardiness zone 9)	Drought hardy. Prefers a moderate climate without extremes.	Prefers deep, well-drained soils. Tolerates gravel soils {Glazebrook's).
E. botryoides (2) Eastern blue gum Group	Durable	Light frosts down to -6 degrees. (Hardiness zone 9)	Drought hardy. Tolerates salt wind, but not severe winds.	Prefers moist sites, tolerates wet sites, saline sand and peat.
E. cladocalyx (3) (4)	Moderately durable	Unknown but probably down to -5 degrees. (Hardiness zone 9)	Drought hardy.	Tolerates quite impoverished soils ('Maraetara' on a ridge). Examples on Havelock hills.
E. fastigata Ash Group	Moderately durable	Down to-12 degrees, first winter. (Hardiness zone 8)	Tolerates considerable exposure. Drought tender.	Prefers medium/ heavy moist soils.
E. fraxinoides Ash Group	Non durable	Down to-15 degrees, first winter. (Hardiness zone 7)	Drought tender. Intol-erant of climate extremes.	Well drained, never the extreme of wet or dry.
E. globoidea Stringybark Group	Durable	Light frosts down to -4 degrees. (Hardiness zone 9)	Drought tender.	Prefers poor, sandy but moist, well-drained soils.
E. maidenii (4)	Durable	Down to -9 degrees first winter. (Hardiness zone 8)	Drought tender. Prefers cooler, moist climate.	Prefers deep, heavier and moist soils.
E. melliodora (4)	Very durable (40 years in the ground)	Down to-10 degrees first winter. (Hardiness zone 8)	Drought hardy.	Prefers light/medium moist soils.
E. microcorys	Very durable (40 years in the ground)	Doesn't like frosts at all. (Hardiness zone 11)	Drought hardy. Prefers warm, sheltered sites and moderate rainfall.	Well-drained soils. Has grown well near the coast at Haumoana.
E. muelleriana Stringybark Group	Very durable (40 years in the ground)	Light frosts down to -4 degrees.	Drought hardy. Reputed to handle exposed sites.	Tolerates medium/ heavy soils to sand or sandy clays
E. obliqua Ash Group	Moderately durable	Down to-10 degrees first winter. (Hardiness zone 8)	Drought tender. Prefers mild, moist climate.	Well-drained, medium/ heavy soils.
E. pilularis Stringybark Group	Durable	Down to -3 degrees first winter, but really likes no frost. (Hardiness zone 10)	Drought hardy. Prefers sheltered, reasonably moist conditions.	Well-drained, light soils provide the best results.
E. regnans Ash Group	Non durable	Down to-11 degrees first winter. (Hardiness zone 8)	Drought tender. Medium rainfall, cool site or valley bottom.	Well-drained, deep, moist soils.
E. saligna (2) Eastern blue gums	Durable	Mild frosts down to -6 degrees. (Hardiness zone 9)	Drought hardy. Prefers mild climate. Intolerant of severe wind.	Prefers light/medium, moist soils.
E. camaldulensis (4)	Durable	Unknown but probably down to -6 degrees. (Hardiness zone 9)	Drought hardy. Will tolerate a range of climates.	Thrives on river margins. Tolerates a range of soils.
E. ovata	Durable	Down to-11 degrees. (Hardiness zone 8)	Drought hardy. Will tolerate a range of climates.	Site specic - wet to very wet, but also will grow in dry hills. Not for milling use.
E. globulus	Moderately durable	Down to -8 degrees. (Hardiness zone 8)	Drought tender. Prefers mild, moist climate.	Can handle heavy, but well drained soils.
E. nitens	Moderately durable	High	Drought tender. Will tolerate some salt wind. Prefers a well spread rainfall, mild climate.	Tolerates heavy, damp soils

Silviculture

The important facts to keep in mind when growing eucalypt species for timber are:

- ***Clearwood*** is the aim – either in the pruned trunk or in 'shorts' cut out from between branches further up the tree. The core of the trunk – up to 30 cm in diameter - is problematic low-value wood containing juvenile compression wood, plus the stubs of pruned branches.
- ***Diameter of the log*** is important to provide stability at milling and quality on processing. A minimum of 75 cm diameter at breast height (DBH) should be the target before harvest. Size is more important than age or tree height. Unless you are content with producing pulp logs there is no purpose in having a high stocking of tall, slim logs.
- ***Uniformity of growth*** – both in diameter and in crown shape. Like many other species, eucalypts will readily bend away from competition unless the spacing is even. This bending creates considerable tension wood in the trunk that will cause serious milling problems. The evenness of growth rate also affects the milling stability, therefore it is important to thin on time as the trees get larger and demand more space, nutrients and moisture.

Branches must be pruned, even if small and dead, if clearwood is the aim on a short rotation (30 years). Trees will self-prune but the process can take longer than desired, leaving undesirable imperfections in the timber. Some varieties of eucalypts will withstand ultra-high pruning (8-10 metres) without any growth restriction, increasing the volume of clearwood harvestable from the tree.

Thinning needs to be performed strategically at a number of stages as the trees mature. The timing must be set by individual observation of tree performance and anticipation of imminent stresses e.g. a drought magnifying moisture deficiency. The combination of dry and persistent wind can cause 'kino' (resin bands) in the trunk. The final stocking rate should result from an evaluation of tree variety and the tree's environment in regard to soil moisture, rainfall, and extremes of temperature.

Points to note:

- ***Species/variety:*** as discussed earlier, all eucalypts have different forms. Some have a round crown that demands headroom from an early age, while others stay in a narrow 'ricker' stage for a long time (possibly as long as 30 years).
- ***Environment is a restriction*** on any plant and becomes more critical with maturity and the tree's demand for moisture. Final crop spacing will vary from site to site and with aspect, depending on soil moisture, seasonal rainfall patterns and altitude/temperature effects - particularly in the summer heat. Available moisture is the greatest restriction to continued tree growth.

Seventeen-year-old Eucalyptus regnans on 'Longridge', Patoka. Planted in a gully location, protecting the eroding soil and filtering water 'runoff'. Also providing shade and future timber, with regenerating indigenous species underneath. Source: ***Jonathan Barran***

Timber qualities and utilisation

The properties of the eucalypt timbers vary greatly, from some of the most durable and dense woods in the world to some that are very light and non-durable. In Hawke's Bay, the majority of sites suit the Ash group of eucalypts (E. obliqua, regnans, fastigata, fraxinoides) plus E. nitens. These are in the low to medium density range and are non-durable to semi-durable. If they are milled (preferably 'quarter -sawn') and seasoned carefully, they make good furniture, flooring and structural timbers. Trials have shown they can slice well for veneers and E. fastigata is recognised as a good short-rotation pulp crop, plus a high quality timber.

Two other commonly planted varieties – E. saligna and E. botryoides – have great timber potential, but are target hosts for a number of insect pests and diseases. Unfortunately, this puts them in a high-risk category, but they may still be worthwhile as the pest/disease situation is constantly changing.

The frost susceptible varieties have a greater timber potential as they have higher density, durability and stability on milling. Their timber is suitable for high quality interior use as well as exterior use on decks and furniture

(replacing the imported tropical hardwoods) e.g. E. pilularis, E. globoidea, E. muelleriana, E. bosistoana, E. microcorys and E. cladocalyx.

Forty Eight-year-old Eucalyptus botryoides being milled on Olsen's property, Glengarry Road. Source: ***Alec Olsen***

Comments from Richard Davies-Colley from 'Eucqual' sawmilling in Whangarei (December, 2000).

"Early plantings were for strength and durability. Today, the emphasis is on surface hardness, visual effect and stability; i.e. flooring, furniture and cabinetry. It is interesting to note that some of those first chosen species in early plantings fit the requirements of today.

The greatest volume of mature trees available for high quality saw logs are E. saligna and E. botryoides. A light-red timber, that darkens with age. These species have a few problems in milling and drying, but with the right techniques, a good product is obtained. The demand for export to Australia is very high.

The Ash group of E. fastigata, obliqua and regnans: of these the most successful has been E. fastigata for timber production and even then major variations occur in wood properties within the species. The main problem being cell collapse during drying. E. obliqua tends to develop 'kino' veins and E. regnans timber has low wood density (extra age may help).

E. nitens veneer slices well, has a light coloured timber and possibly mills better at a young age than E. regnans. E. maidenii and E. bicostata have variable milling reports, but the wood has a nice brown colour and a high density.

E. pilularis would be grouped with E. muelleriana and E. globoidea plus other less known 'stringybarks'. Of these species, E. muelleriana would have the best overall processing qualities, but the others are not far behind.

E. microcorys is well known for its durability and strength, hence its wide use as an engineering timber, now mainly in cross-arms. Great timber for flooring but its greasy nature makes it difficult to glue and to coat with normal polyurethane products.

E. cladocalyx will grow over a wide area of New Zealand, is hardy, withstands wind and produces an excellent timber. Yellow-brown in colour, hard and heavy, but with correct saw milling techniques, it processes well through all stages."

Conclusion

Eucalypts are amazing trees that have proved to be the most adaptable and successful exotic species in the world. They could, if sensibly planted, reduce the pressure on tropical rainforests. They are capable of exhibiting phenomenal growth and they may well become major producers of 'bio-energy' (incinerating to produce energy or the extraction of oil for fuel) and essential oils. They could also play a major role in effluent/sewage renovation and utilisation.

Further reading

- Barr, N (1996) Growing Eucalypt Trees for Milling on New Zealand Farms.
- McWhannell, F.B. (1960) Eucalypts for New Zealand farms, parks, and gardens. Paul's Book Arcade, Hamilton, New Zealand.
- Miller, K. et al (2000) Ash Eucalypts. FRI Bulletin No. 124 – Part 18.
- New Zealand Farm Forestry Association – Information Leaflets.
- Hawke's Bay Farm Forestry Book Survey results in Appendix II.
- FRI Bulletin No 124 – Issue 18 (Ash Eucalypts)

Quercus spp. (kwur' k əs)
Oaks

The Quercus family is very large, with extensive international connections. There are some 600 species of both evergreen and deciduous trees and shrubs spread throughout the northern hemisphere, with a few in the Andes mountains of Colombia. Some species are reputed to live up to 700 years. Oaks have adapted to a variety of environments; from semi-desert to swamp, from sub-tropical to alpine conditions. Oak timber has been used for thousands of years and acorns are used for food by animals and humans. Many of the deciduous varieties are valued for their landscaping qualities, providing impressive autumn displays of colour. The bark of Q. suber is used as cork in insulation, flooring and bottles. The bark of some oak species is used to extract tannins.

Quercus varieties

The following is a selection of trees that have good, general application for Hawke's Bay sites. They have potential heights of 20-40 metres and good timber potential. Based on local knowledge, these are all sound choices but there are others that will also thrive in our region.

New Zealand's grown timber utilisation experience and knowledge is limited, but it has been shown that fast-grown wood is generally heavier and stronger although more difficult to season and process. Maturity to harvest is in the region of 80 -100 years.

Amenity shade trees including a selection of oaks, on 'Nga-roto' driveway, Dartmoor-Waihau Road.
Source: ***Kevin Thomsen***

Table 80 : Quercus species suitable for general use and as potential timber choices for Hawke's Bay

Botanical name	Common name/s	Origin	D/E *	General information	Plant hardiness Zone
Q. alba	White oak	Eastern North America	D	Timber is valuable for furniture and cooperage (making wine barrels and casks).	3-9
Q. canariensis	Canary/ Mirbeck's oak	North Africa, southern Portugal & Spain	D	Tolerates dry exposed sites and adaptable to heavy and light soils.	7-9
Q. cerris	Turkey oak	Southern Europe & Middle East	D	Tolerates dry exposed sites.	7-10
Q. coccinea	Scarlet oak	Eastern & central USA	D	Red autumn colours.	2-9
Q. ellipsoidalis	Northern Pin oak	Central & southern USA	D	Tolerates dry sites, crimson - purple autumn colours.	5-10
Q. ilex	Holm/ Holly oak	Southern Europe & North Africa	E	Tolerates dry, exposed sites, shade and salt spray.	6-10
Q. imbricaria	Shingle oak	Eastern USA	D	Purple autumn colours, timber used for split roong shingles.	8-10
Q. palustris	Pin oak	Eastern North America	D	Scarlet autumn colours, tolerates wet sites.	3-10
Q. robur	English/ European oak	Europe, North Africa & western Asia	D	Tolerates wet sites. Probably the greatest used tree for timber in Europe over the ages.	3-10
Q. rubra	Red oak	Eastern Canada to Texas	D	Tolerates shade, red autumn colours.	3-9
Q. virginiana	Live oak	South-eastern USA, Mexico & Cuba	E	Valuable, very durable timber, used in boat building and posts.	7-11

NOTE:* D = deciduous, E = evergreen

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Establishment and silviculture

There is enormous potential for Quercus species in Hawke's Bay, especially if the area becomes progressively drier. Oaks have the ability to perform many of the on-farm tasks required of a tree. They are wind-resistant, well suited to exposed conditions and to wide spacing for shade or erosion control.

Selection: whichever species you choose, make certain the seed source is reliable (they cross-breed readily) and that the seedlings are growing straight. This last factor is very important, as they may never produce good form if their genetics are suspect. Big is not necessarily beautiful. Large container-grown plants are riskier to establish in drier conditions, especially if it is a windy season. The smaller plants will often perform better in the long term. Some nurseries produce hybrid oaks that have superior form.

A spectacular stand of Quercus coccinea, plus some Q. palustris and Q. rubra planted as a long term timber crop on 'Ngaroto', Dartmoor-Waihau Road.
Source: ***Kevin Thomsen***

Planting spacing: a four-metre grid is probably ideal if planting for timber. This will provide early competition and, in time, a surplus number of trees for the final crop, enabling a selection to be made of the best, based on form and spacing. To reduce the initial cost, it is possible to companion plant using compatible species such as Chamaecytisus palmensis (tagasaste) or Alnus spp. This will allow the more expensive oak trees to be planted at 6 to 8 metre intervals while the companion plants provide the required early competition and shelter, plus the benefits of natural nutrients. Acorns from reliable sources can be successfully planted 'in situ' by placing two or three in a shallow hole and later selecting the most vigorous stem. The addition of slow-release fertiliser and irrigation on dry sites will assist dramatically with establishment.

Oaks could be very useful for erosion control in Hawke's Bay on sites that require a hardy, long-term species. Tree spacing is difficult to predict for erosion control, but 4 to 10 metre spacing should be adequate. This would enable a closer planting for timber potential early on, with thinning to a wider spacing later. The area would need de-stocking until the trees can withstand grazing. Oaks are slow growing and unsuitable for any actively eroding site but are fine for slopes that have the potential to erode.

Oaks can also be used in shelterbelts, either planted closely or, at wider spacing, interplanted with other species. They can be managed by fan pruning or trimming.

Milling an old oak on-site on the Mackintosh property, Matahorua Road, Putorino. Source: ***Susan Mackintosh***

Silviculture: form pruning and the steady removal of branches is necessary to improve the shape of the tree. For isolated shade trees, remove low branches as they can create too much shading. For timber management, gradual pruning to produce a clearwood trunk ensures development of quality timber for future harvest. Be aware of the branch 'collar' that should not be damaged when pruning. The collar can extend out from the trunk on some branches up to 10 cm.

Final spacing: this depends on the purpose of the trees, remembering that oaks can reach very large sizes. If planted for shade and shelter within pasture, quite wide spacing is more suitable – possibly 50 metres apart. In a woodlot, to maintain steady growth rates, thinning progressively down to 100 sph (10 × 10 metres) may be required, depending on the

species and soil moisture availability. Time to maturity will be more than 50 years. Oaks can be healthy for centuries!

Springvale Station at Puketapu has a spectacular avenue of 23-year-old Quercus palustris (pin oak) as seen in these photos taken in summer and autumn, 2003. Source: ***Kevin Thomsen***

CAMEO EXPERIENCE

by T.R. Hartree – Hawke's Bay Farm Forester (Te Motu)

"To me, oaks reign supreme amongst the important trees of the world. There are over six hundred species of deciduous and evergreen oaks giving not only timber but also food for animals and birds. Some botanists divide them into two groups: Red oaks and White oaks. The latter give us wine barrels and flooring. Most are durable timbers and have many uses. We have chairs at home made with Quercus ilex from a 100 year old tree felled by wind at Korokipo.

In autumn the deciduous species of oak are a riot of colour and a bounteous feast for our two free-range pigs and other animals. We now have a small pheasant population that love the small black acorns of the Quercus palustris and imbricaria.

In Hawke's Bay, establishing young trees can be hard. Trickle irrigation, fertiliser and weed control can all help for greater success. They will grow in all types of soil depending on species. Appleton's Tree Nursery (Nelson) catalogue is a good place to start when purchasing a wide variety of Quercus."

Tom and Dora Hartree beside an avenue of Quercus palustris and Q. coccinea on the 'Ngaroto' driveway. Source: ***Kevin Thomsen***

Pinus genus (pine us)

Pines

For most New Zealanders, 'pine tree' is synonymous with the species Pinus radiata, but this accepted notion is far from the truth. In fact, there are about 110 species within this evergreen conifer genus. All except one are indigenous to the Northern Hemisphere and range from the Arctic Circle to northern Africa and Central America.

Some of these pine species are suitable for specialist purposes within Hawke's Bay. The majority are large trees but many are medium-sized shrubs and some are prostrate, ground-cover shrubs. They mostly prefer sites with plenty of sunlight, although some do suit companion or understory planting.

Pinus aristata var. longaeva (bristlecone pine) is believed to be the oldest living plant in the world at 4600 years old. It survives in an incredibly harsh environment at very high altitude in eastern California, USA. Blasted by snow in winter and very hot and dry in summer, it has what we might consider a dead appearance. Other pine species require much more benign climates, some growing next to the sea, others in near-tropical environments.

There are many species well suited to ornamental purposes with spectacular cones (P. coulteri), foliage (P. patula, P. palustris and P. montezumae), bark (P. silvestrisand P. pinaster) and edible seeds (P. pinea, P. coulteri, P. cembra,

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P. armandi, P. cembroides, P. sabiniana and P. torreyana). Do not plant Lodgepole pine (Pinus contorta) as it spreads vigorously and is highly invasive.

An example of P. radiata on Matahorua Rd, Putorino. The trees have been planted on a commercial scale but have also controlled the hill country erosion and framed a gully area.Source: ***Susan Mackintosh***

Many promising timber-potential species have been evaluated in New Zealand over the last century, but most have been discarded as having little or no commercial potential. Table 81 includes some that may be useful for various purposes on Hawke's Bay sites.

The wood 'hardness' of some of the species in table 81 is as follows (hardest first): P. palustris, nigra, ponderosa, pinaster, radiata, coulteri. (Dallimore & Jackson, 1961).

Radiata pine

Of the species within the Pinus genus, radiata pine is the most common and dominates New Zealand forestry. It is the easiest species to establish on many sites and to manage to a profitable harvest. It has a short rotation length to harvest - 30 years is very brief on a world scale. Importantly, there is a comprehensive infrastructure set up in Hawke's Bay to process and market the timber. In New Zealand forestry, it is the most researched and documented species and there is plenty of information and published material available. We recommend a very comprehensive book, "Radiata Pine Growers' Manual" (Maclaren, 1993), as a 'must read' document for anyone serious about successfully growing radiata pine commercially. We also recommend the Green Solution, a software programme for calculating forest management regimes to suit the site. See the end of the Pinus section for where to obtain a copy.

The following checklist was compiled so readers can begin to understand that Hawke's Bay has a multitude of variable planting sites, each requiring different regimes to maximise forest returns. Most readers will probably be planting onto land that has been farmed. If that is the case, make sure you look at the parameters of soil fertility, location, and climate to give you an idea of planting density. There are many technical terms in this section: for definitions refer to the Glossary section or to Maclaren's (1993) glossary for a more comprehensive coverage.

An example of mature Pinus pinaster(Maritime pine) on Puketapu Road by the Springfield Road junction, showing its very attractive bark. Source: ***Kevin Thomsen***

An example of Pinus pinea (Stone pine, Umbrella pine) 'Valhalla' Glengarry Road. Source: ***Alec Olsen***

Examples of Pinus canariensis (Canary Island pine)'Valhalla' - Glengarry Road. Source: ***Alec Olsen***

Table 81 : Pinus genus species suitable for general use and as potential timber choices for Hawke's Bay

Botanical name	Common name/s	Site tolerances	Potential tree hgt in metres	General information	Plant hardiness Zone*
P. canariensis	Canary Island pine	Drought tolerant. Fire resistant and will coppice from the stump and roots.	40	The timber from mature trees (50 year old) is strong and durable. The long tap root makes it hard to transplant.	8-11
P. coulteri	Big-cone pine or Coulter's pine	Tolerates dry sites well.	30	Secondary shelter or shade planting. The cones are spectacular - up to 35 cm long and, when green, up to 2.3 kg.	8-10
P. muricata	Bishop pine	Tolerates salt wind and sand. It has a 'pyramidal' growth form. Low wilding risk.	30	Very well suited to shelter as it retains its lower branches. Timber is very light, with conspicuous resin ducts. It is often utilised along with radiata as framing timber	8-10
P. nigra P. nigra laticio P. nigra austriaca	Black pine Corsican pine (coastal) Austrian pine	Withstands wind and a variety of soils from sand to clays. Corsican pines wildling risk is moderate so take care of siting inwindy areas.	36	Slow growth make these good post or pole material. Their annual 'branch whorl' habit creates a weakness in the timber. Very susceptible to dothistroma pini needle blight and to sapstain in drying untreated timber.	4-9
P. palus tris	Longleaf pine or pitch pine	Suits warm, wet and temperate climate. Tolerates sandy soils.	30	The very long needles (up to 45 cm) make it an attractive ornamental specimen if it survives.	7-10
P. patula	Mexican pine or Jelecote pine	Thrives on dry sites and infertile, well drained soils. Brittle branches in the wind.	30	Mostly used for ornamental or shade purposes in New Zealand or secondary shelter. Its timber is brittle, light and weak. However, it is used for timber in some warmer countries.	7-10
P. pinaster	Maritime pine or cluster pine	Suits warmer coastal sites, as it dislikes frost. It is intolerant of clay soils. Suits shady sites. Low wilding risk.	30	Good shelter option, especially in salt-wind and on sand sites. Its open foliage form means it does not create very heavy shade. For ornamental purposes, it has attractive bark.	7-10
P. ponderosa	Ponderosa pine or western yellow pine	Tolerates extreme cold, drought and infertile sites. It is intolerant of heavy clays.	40+	Slow growing species. Drying timber is susceptible to sapstain infection. Light, low strength, brittle timber -used for panelling, furniture and joinery.	3-9
P. radiata	Radiata pine or Monterey pine	Tolerates most sites except permanently wet (Gley, Organic) soils. Medium to high wilding risk	50	The principal timber roundwood and pulp tree in N.Z. Partly due to the vast amount of research and development that has occurred during the last 50 yrs.	7-10
P. sylvestris	Scots pine	Withstands extreme cold. It is intolerant of warm, humid sites. Be careful of siting in windy areas as it has a relatively high wildling risk.	30	Secondary shelter purposes, with attractive bark. The timber is of excellent quality, moderately strong and has prominent resin ducts.	3-9

Forest Regime Checklist

The following checklist allows you to identify the characteristics of your site. You can then expand on these with further information identified by the 'letters' you have chosen.

PARAMETERS:

Identify your property's characteristics:

Locality

- ☐ (a) a warm environment (<1100mm annual rainfall)
- ☐ (b) higher altitude/colder climate (>1100 mm annual rainfall)

Climate

- ☐ (c) severe moisture restrictions in most seasons (<1100mm annual rainfall)
- ☐ (d) adequate moisture in most seasons (>1100 mm annual rainfall)
- ☐ (e) incidence of heavy snowfalls
- ☐ (f) persistent and/or severe wind exposure
- ☐ (g) well sheltered site

Soil fertility

- ☐ (h) high – livestock camps and a history of fertiliser application
- ☐ (i) medium/low – steeper slopes, possibly with eroded soils

Market factors

- ☐ (j) oversize logs – >94 cm – will they be readily accepted by the market?

Genetic quality

- ☐ (k) prepared to order early and pay a premium for top potential material?

Access

- ☐ (l) are harvesting / extraction / roading costs significant?

Pinus radiata grows well on many variable sites. This forest is growing well right beside the sea above the cliffs at the southern end of Waimarama Beach.
Source: ***Kevin Thomsen***

Specific information related to your choices (a – l) from above

(a) Sites with low rainfall and shallow soils are on the margins of radiata profitability. Stocking has to be managed to minimise periods of soil moisture deficits. Prior to the Green Solution, forest research growth models had limited application for such sites. On these sites, trees naturally tend to develop a higher density in the juvenile stem. This allows harvesting of quality trees early (23-25 years), if they can be grown to acceptable diameters by this time. Earlier thinning and lower final stocking rates are necessary (about 200 stems per hectare - sph). To gain early high density and rapid growth, suitable improved genetic stock is desirable; i.e. a GF Plus seed source.

(b) In a cool climate, trees naturally develop a low wood density in the juvenile stem, resulting in the need to aim for a longer harvest rotation (28-35 years) to achieve adequate late-wood that has a greater density. Improved density genetic material will assist in the quality; i.e. a GF Plus seed source. The tree grows well up to 700 metres above sea level and will grow at 800 metres but any higher is likely to be beyond its capability.

(c) Low soil moisture levels require earlier thinning to a lower final stocking rate (e.g. 200 sph) and possibly early harvest if the wood density and log diameter are sufficient to achieve premium prices. The greatest influences are rainfall quantity and annual spread, but soil type and its moisture retention influence the moisture available throughout the year.

(d) Higher soil moisture levels will allow a later thinning – achieving branch control – and a higher final stocking rate (e.g. 320 sph). Also, a longer rotation may be more profitable. The greatest influence is rainfall quantity and spread, but soil type and its moisture retention influence the moisture available throughout the year.

(e) Heavy snowfalls, particularly on young pines, can be very damaging causing breakage and toppling. If there is a high risk, consider other species of trees that handle snow better e.g. Douglas fir.

(f) Severe windstorms are the greatest uninsurable risk to a forest. Toppling is most common in the first five years, but can occur at all ages. Sites with persistent winds, particularly when linked with high fertility sites, need

careful management to minimise problems. On the riskiest sites, establish using closely planted seedlings (e.g. 1200 sph) to provide mutual protection and competition. Move to wider spacing as the risk diminishes on more sheltered sites. Alternatively, 'physiologically aged cuttings' have been shown to be more wind stable.

(g) It is a truism that plantation trees need shelter for best results. Depending on other factors, a sheltered site can be targeted for a top potential crop – either high genetic (GF Plus) P. radiata, or one of the timber potential Special Purpose Species e.g. Cupressus, Sequoia, Eucalyptus etc.

(h) High fertility on farm sites, especially livestock camp / fertility transfer areas are a serious problem for all species of trees. It is difficult to mitigate the detrimental effects on quality on these sites. As already mentioned, these problems are compounded by persistent wind. The best remedy is to plant high numbers of trees (for example, 1111 sph – 3m by 3m, 1250 – 4m by 2m or higher rates) so they maximise competition and mutual protection. Thinning should not be done until absolutely necessary otherwise branch size, wood quality and tree height will be compromised.

(i) If the fertility is in the medium/low range, the initial plant spacing can be opened out (for example 833 sph – 4m by 3m), provided winds are not too severe. "Our experience is that early thinning leads to better stability for trees five years and older" J.M Aitken, (pers. comm.) from Tukituki Valley experiences. If cuttings are used, a lower stocking rate is less of a risk, both financially and physically, as long as other site factors justify their use. Early thinning must be balanced against maintaining good log qualities.

(j) Oversize logs (OS) may be a result of longer rotations, genetics, fertile sites, wide spacing and edge trees. If a premium is being paid at harvest time, this is not a concern. However, it is impossible to forecast what markets may be in 20-30 years' time. To minimise the number of OS logs, thinning can be delayed, final stocking rates can be kept higher, and pruning can be done above 6.5 metres, especially on edge trees. This all has the effect of slowing the log diameter growth, but can result in higher harvest quality and quantity. If the target harvest age is 30-35 years of age, on good sites the final stocking rate will need to be kept higher than presently generally accepted to accommodate the increase in time spent growing.

(k) The final crop potential can only be developed on the quality of the initial product. Well in advance of planting, it is important to order high quality nursery stock of the genetic material that has the best potential for the site (Note 1). Aim for high quality cutting material plants for the best sites to maximise their potential. 'GF Plus – improved density' seedlings may be a valuable investment on naturally low wood density sites.

An example of a recently thinned pine block – final thinning to 300 stems/ha with an average of 6m prune. Source: ***Susan Mackintosh***

(l) The access for planting and silviculture operations is not usually much of an issue. However, when it comes to considering production thinning (Note 2), or final harvesting, the roading access is a very important consideration. The road needs to be suitable for logging truck units even in wet weather. If your forest block is going to cost a lot to access, then you must have an economy of scale to justify the expense.

Note 1 – "The price differential between well pruned logs and saw logs is such that the potential grower should decide at the outset which product is to be pursued. A dual purpose regime can end up in neither objective being attained." J.M Aitken, (pers. comm.).

Note 2 – "Production thinning has become historic.

To present it as an option is to offer false hope that leads to delaying thinning because cash is not available and leads to economic disaster." J.M Aitken, (pers. comm.).

For further help

- Obtain a copy of "Radiata Pine Growers' Manual" (Maclaren, 1993). This will provide a good understanding of the issues and options for growing a radiata crop. Join your local branch of the Farm Forestry Association.
- Attend farm forestry field trips and read the various articles in the 'Tree Grower' magazine that describe personal experiences. A comprehensive index of articles is available from the NZFFA office at 04-472-0432 or check the website www.nzffa.org.nz
- The 'Green Solution' (developed for NZFFA by Forest Research, with financial support from a grant from the 'MAF Sustainable Farming Fund') is a valuable tool you can use to calculate land use profitability and comparisons with livestock farming. This remarkable program consists of an easy-to-use spreadsheet, which can evaluate the optimum forestry regime for any part of your property and compare projected forestry returns with grazing returns. It includes an inbuilt database containing summaries of extensive tree measurement plots from all areas of New Zealand. (You can easily access and use the relevant data from your locality to help you make an informed decision on the most suitable areas for tree planting.)
- View the NZFFA website - www.nzffa.org.nz

Always a great moment when the trees are finally loaded onto a truck for processing. Source: ***Alec Olsen***

Pine industry terms

The following information explains some of the terms used in the pine forestry industry.

1. Even growth rings: This is important as it minimises stress in the log and produces top quality timber. However, it is very difficult to achieve in many parts of Hawke's Bay due to wind and drought.

2. Knotty core/defect core: On high fertility sites, especially those with persistent winds, it is very difficult to achieve a small 'diameter over pruned stubs' (DOS), because juvenile trees tend to develop large diameter branches and a large tapered trunk out of proportion with its height. To prevent this, plant high numbers of seedlings on these sites, possibly 1200 sph, to provide early competition for light and nutrients. Improved genetic seedlings or physiologically aged cuttings will be beneficial if the wind factor is not too severe.

3. LED (large end diameter) maximum: 94 cm is the largest diameter log that some local mills can process at the present time. Oversize logs can achieve premiums on some markets but these are less competitive.

4. Low wood density: Where this is a problem, restricting the diameter growth in the first 10 years is beneficial, as long as a longer rotation will compensate by adding higher density wood in the 10-30 year period. The only method of achieving this is by maintaining a high tree-stocking rate of about 600 sph until this time (9-14 years of age). A recent development is the 'GF Plus – improved density' seed source, which should provide significant wood quality gains.

5. Log taper: Hawke's Bay trees tend to have more taper than central North Island due to more wind and higher soil fertility. Fertility increases trunk diameter growth, while wind reduces height growth. Wide spaced young trees will develop a lot of trunk taper. Closer spacing produces a more even columnar trunk by pushing the diameter growth further up the tree. Taper is an important factor affecting the yield of timber from a log – the SED (small end diameter) controls the usable size of the log, the taper is wastage!

6. Pruned height: Standard practice has established 6-6.5 metres pruned tree as the ideal. On the drier sites, a 5.5 metre pruning lift opens up the current lucrative 5 metre log market, requires fewer pruning lifts and places less stress on the tree by reducing the number of defoliations. Today, logs and the timber go to very diverse markets that can use variable log lengths. This can result in logs from the pruned trunk varying in length from 2.5 to 6.5 metres. The top grade, top quality log may

be the first 4.5 to 6.5 metres. Even though the next length has the required dimensions, it contains a greater proportion of young wood. The 'log maker' on the skid site has a crucial role to play making the best cuts from the material available.

7. Round logs: This is a very important factor if the logs are to be rotary peeled for veneer production. The timber yield is assisted by the evenness of the log shape.

8. Resin pockets: At present there are no methods for detecting these prior to milling. However, it will be possible in the future. Knowledge of resin pockets is becoming a little clearer as more pruned logs are subjected to pre and post-harvest analysis. The indications are that resin pockets are the result of tree stress caused by soil moisture deficit. Low rainfall, high evapotranspiration and shallow soil are key factors. Other factors contributing towards resin pockets are genetics, moisture stress from overstocking (not thinning on time) and wind. When wind is combined with moisture stress, the risk is amplified. Sites that have these conditions may not be worthwhile pruning – in extreme cases, potential harvest returns will be reduced.

9. Small diameter branches: While genetics has some influence on branch diameter, the site and management has more. Low fertility sites produce slower growth rates but improved form with smaller branches Multi-nodal type trees have a greater number of branches, which contributes to smaller branch diameter. Managing the timing of thinning is the factor that you can control. Competition restricts branch size on the top unpruned trunk, but must be finely balanced to maintain optimal tree health and growth rate. This type of management on longer rotations can make a significant difference to harvest quality and therefore financial returns.

10. Straightness: Straightness of the tree is vital for quality clearwood. Any 'sweep' adds to the size of the defect core and reduces the value of the log $/m^3$. The value of the pruned log will depend on the amount of clearwood that can be cut. This is limited by the size of the knotty core, the sweep and the diameter measured at the small end of the log.

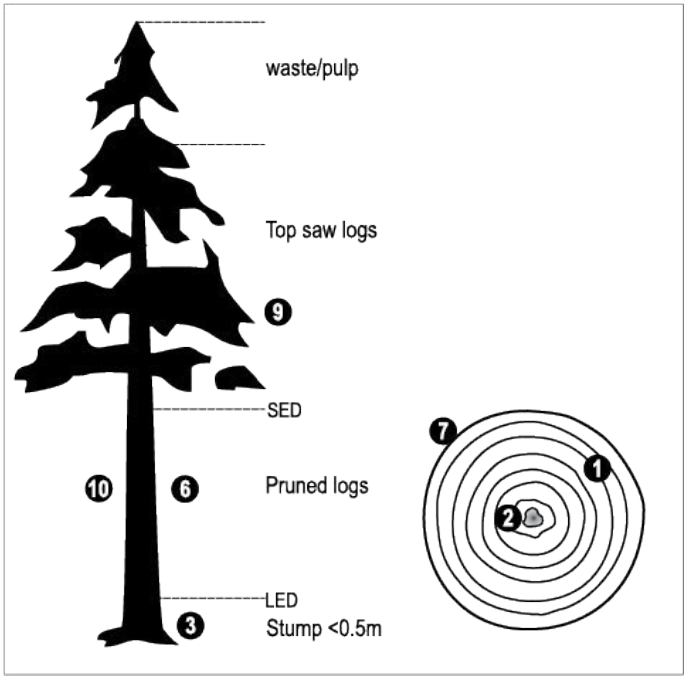

Figure 41 : This is a sketch of an ideal tree with reference points to the list below. Source: ***Regional graphics***

Final comments about radiata pine

Keep in mind that the present indication from the major East Coast corporate growers and from a number of timber processors and exporters is that the harvesting age will increase to between 30 to 35 years. This is to ensure that timber is of high quality/density. This fact has a big influence on all aspects of the management regime, costs and expectations.

Further Reading

- Dallimore, W. & Jackson, A.B. (1961) A Handbook of Coniferae.
- Krussmann, Gerd (1985) Manual of Cultivated Conifers.
- MacLaren, J.P. (1993) Radiata pine growers' manual. Forestry Research Institute Bulletin No. 184. New Zealand Forest Research Institute Ltd., Rotorua.
- Maxwell, E. (1930) Afforestation in Southern Lands.

Populus spp. (pop u lus)

Poplars

About 30 species of poplar are in digenous to the temperate zone of the northern hemisphere. They are rapid growing, deciduous trees of considerable economic importance. Poplars are easily hybridised, both naturally and artificially. Many thousands of hybrids have been propagated from cuttings and tested for various attributes of economic and environmental importance. Some varieties have been selected in New Zealand for local conditions, with emphasis in recent years on qualities such as resistance to possums, drought, wind, and leaf rust diseases. Other features selected include stem straightness and wood density for timber production. Poplars are an icon tree species for New Zealand soil conservation.

Recognition of the main species

Most poplars grow into large trees with a single stem that eventually has heavy branches, forming a wide crown. Young (15-20 year old) poplars are conical in shape and make a very attractive addition to the pastoral landscape. Four commonly seen poplars are the silver poplar, black poplar (or cottonwood), Lombardy poplar, and Yunnan poplar. All four develop into very large trees, and are associated with early soil conservation or amenity planting.
Today, many new hybrids of black poplar, in particular, are seen on farms as soil conservation plantings, shelterbelts, and occasional timber plantations.

- Silver poplar is a suckering type that is recognised by the dark green leaf with a silver underside. It is notorious for toppling with age, and is not commonly planted today.
- Black poplar has triangular leaves and deeply furrowed bark.
- Lombardy poplar is probably the most widely distributed poplar in the world. It is recognised as the tall, upright species seen on many farms marking old fence lines and shelterbelts. It is another old type, seldom planted now due to its susceptibility to leaf rust disease. However, a rust resistant hybrid cross – Crowsnest – is available with very similar traits.
- The fourth poplar species of note is Chinese or Yunnan poplar, which has shiny, dark green foliage and keeps its leaves well into the winter. This is still in demand for farm and garden beautification, but is not planted on a large scale.

Many of the mature, soil conservation poplar plantings seen on erosion-prone hill country are 'Italian hybrids' planted during the 1960s and early 1970s.

A springtime scene looking across Nelson's property to 'Falomai' on the Hendley Road, showing soil conservation poplar and willow plantings on unstable sites.
Source: ***Kevin Thomsen***

Economic value

Poplars have economic value in the northern hemisphere with the timber having special qualities such as white colour, lack of smell and resins, good workability and softness, as well as light weight and surface toughness on impact (does not splinter). In Italy, it is processed on a large scale in specialised factories where it is peeled or chipped to make plywood or reconstituted building products.

In New Zealand, the use of poplar timber has been minimal, confined mostly to on-farm use. There are, however, examples of the timber being used for joinery and house doors, where its stability is important. Its economic value in New Zealand is in its ability to hold soil as its root development is vigorous. The thousands of trees used in a soil conservation role on hills have enabled pastoral farming to become a sustainable land use.

Pests and diseases

Possums: Balsam poplars (Yunnanensis types, including Kawa and Toa) are possum resistant. But possums still damage branches. Most other commonly used poplars are palatable to possums. However, improved possum control in recent years has reduced this threat.

Rust: Rust mutates annually and seems to vary in intensity and between poplar species each year. The Italian hybrids were severely affected by rust disease in 1972/73 and lost favour as a conservation tree. Some of these susceptible varieties appear to have become resistant, or, for some other reason, are only mildly affected in the field. Nursery conditions provide an environment that encourages rust disease and this is where poplars are most at risk.

Eight-year-old Veronese poplars space-planted to protect a track winding up a hill. Source: ***Jonathan Barran***

Site requirements

Modern varieties have been bred for specific purposes, giving the landowner sufficient choice to use poplars on most areas of the farm. As a general guide, poplars grow best on moist sites or deep soils, sheltered from severe winds in gullies and on slopes. Slope planting is more specific in Hawke's Bay because of the climate and wind. Generally you can plant lower to mid slope, often in drainage lines or depressions. Where it is traditionally summer dry or, more relevantly, spring dry you should avoid north and west slopes unless the planting is kept on low slopes or in gullies. Slopes over 25 degrees are marginal for planting.

Planting methods

The simplest, reliable method of planting is as a cutting, stake or pole taken during the dormant winter period – early June through August. These poles can either be planted using a spade and soil rammer, or rammed in with a specialised, long handled, steel thumper. Poles or stakes must be planted at least one-third of their length into the ground if they are less than 2.5m length, or 600-700 mm deep for 2.5-3 m poles.

Small poles and stakes should be kept free of competing weeds and grass, therefore a spot spray or scarfing of the ground is appropriate. Large (2.5-3m) poles can be planted into grazed pasture but should be kept free of cattle for 12 months, and individually protected with special plastic sleeves.

Before planting, soak the pole bases for at least 8 to 12 days to 'load up' with water to ensure a good start. Make sure the pole or stake has a fresh cut on the end you're putting into water to allow soakage to occur. If they have been cut previously, the end going into water may have
hardened off not allowing water passage.
During the first season, particularly in dry conditions, check the poles for looseness from stock rubbing or wind movement. If there is a gap, pour in fine soil or sand or re-ram, but avoid damage to new roots near the surface.
This "back filling" will ensure new roots are not broken with the movement.

John Dean, a farm forester from Nuhaka says:
"Remove a square of turf and loosen 250 mm of soil, then ram the pole a minimum of a third its length or 675 mm into the ground. Firm the soil and turf around the base. If there is a pan, it must be broken."

Spacing

Soil conservation: Poles may be planted at any spacing that the type of erosion demands. Most planting will be at a spacing of 10-12m on slopes or pair planted in gullies that are not yet eroding. This spacing is sufficient to allow for roots to still interlock and provide enough tensile strength to hold the soil. Any further apart and the effectiveness of the trees is lost. Severely eroding sites should be planted at much closer spacing, e.g. 4m to 8m, with the trees thinned later to a spacing that allows for more light to come through the canopy.

Spacing also has an effect on the form of the tree, and the amount of light that can penetrate. Some thinning of treesis required on heavily planted sites to allow groundcover to be maintained, which is necessary for erosion control. Pruning of widely spaced trees may be necessary. Poplar trees can have multiple leaders, which can result in the tree splitting at a later stage. While reducing fodder quantity somewhat, form pruning the tree will increase

the amount of light reaching the ground and reduce form problems later on.

Timber: A timber plantation may be planted using 1m stakes or wands. These could be planted at up to 800-1000 sph then thinned to approximately 300 sph. A timber plantation will need either an even site (similar landscape) or a good match of tree variety to site conditions. Therefore, on some uneven hill country, two or more varieties may be used. The initial planting density allows for selection of trees based on variability of growth due to site.

Three-year-old Veronese, Belcher property, Waimarama. Note the dominant leader form of the trees.
Source: ***Simon Stokes***

Fodder

Poplars have been used for stock feed in times of drought, although not as commonly as willows. There has been a recent upsurge in research into the use of poplars for fodder, and this should be considered as a potential use of the trees if you are planting many of them on your farm. Planting specific fodder blocks may be a more practical and less risky option than having fodder trees in gullies and on erosion sites.

Salix (say lix)

Willows

About 30 species of willow are commonly found throughout New Zealand, plus a number of varieties that have been crossbred from these parents. They are used mainly for shelter and soil conservation. This is another icon tree associated with New Zealand soil conservation. Willows have been, and still are, the most efficient tree at developing a root mat that reduces erosion by binding the soil, particularly on severely eroding sites. They grow quickly and are robust enough to survive most situations.

During the selection processes of the early willow breeding programmes only male clones were selected. The significance of this is that willows used for river control work may spread rapidly if there is a mix of male and female plants.

The total area of willows in New Zealand is second only to that of Pinus radiata plantations. Willows range in size from large trees to small shrubs. Most species have long narrow leaves, with some of the shrub willows having oval shaped leaves

Poplars provide a spectacular autumn sight as well as stabilising the soils, as seen here on the Ellis Estate, near Dillons Hill on State Highway 5. Source: ***Alec Olsen***

Table 82 : Uses and site tolerances of some poplar varieties in Hawke's Bay

Variety Name	Suitable for shelterbelt	Suitable for timber	Foliage colour/ effect	Performance if first season is very dry	Tolerance to strong winds	Unpalatable to possums	Development of stock resistant bark
Veronese	Excellent	Excellent	Good	Good	Excellent	Poor	Poor
Kawa	Good	Excellent	Good	Poor	Poor	Excellent	Good
Yunnanensis	Poor	Poor	Excellent	Poor	Poor	Excellent	Excellent
Crowsnest	Excellent	Poor	Excellent	Good	Excellent	Poor	Poor
Argyle	Good	Good	Good	Excellent	Poor	Good	Excellent
Weraiti	Good	Good	Good	Good	Good	Good	Good

Three willows

The most common tree willows seen on farms include: crack willow (S. fragilis), golden willow (S. alba var. vitellina), weeping willow (S. babylonica), golden weeping willow hybrid (S. alba var. tristis), and the matsudana willow (S. matsudana). S. matsudana crossed with S. alba provides several cultivated hybrids that are used for shelter and soil conservation plantings. For many decades, throughout Hawke's Bay, tree willows have been widely used for stock feed in times of drought, with a notable upsurge in interest during the dry 1990s.

Common example of willows planted in a gully to reduce erosion. These are older trees that have been used previously as fodder. Source: ***Jonathan Barran***

Osier willows

Osier, or basket, willows are medium-sized shrubs comprising many stems and are represented mainly by the common osier (S. viminalis) and the purple osier (S. purpurea) plus several hybrids. These two are commonly used as a component of river berm protection. As their common name suggests, these and other less common species are used for basket making. Not commonly used now, they are excellent for severely eroding gullies and containing the 'toe' of an earthflow or slump.

Ten-year-old Salix matsudana on 'Glencairn', Glenross Road. Source: ***Simon Stokes***

Weeping willow (Salix babylonica) providing stock shade. Source: ***Simon Stokes***

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Shrub willows

Shrub willows are low shrubs to small trees with multiple stems and stout branches.

The best known and most common shrub willow is the pussy willow (S. x reichardtii), a hybrid between S. caprea and S. linerea. These are not commonly planted now and in some areas are a significant plant pest infesting waterways.

Site requirements

The Salix tree willows give farmers enough choice for most areas of the farm. As a general guide, willows grow best on fertile, moist sites, i.e. on sites similar to poplars. Where they differ from poplars, however, is in their ability to be planted on slightly drier and hardier sites higher up the slope. Planting experience in Hawke's Bay supports this. The planting season and management of the tree after planting are also important factors contributing to success on the harder sites.

Willows love gullies and are the best tree for eroding gully or slope systems. They are not vulnerable to frosts (except the weeping willow). Contrary to common belief, while they tolerate a higher watertable than most trees, they do not like continually waterlogged sites. Therefore, plant willows around the edges of such sites. Willows should also be kept away from sites exposed to severe winds.

Classic example of space planted willows on an earthflow, good spacing and ground cover present.
Source: ***Simon Stokes***

Planting methods

The simplest, reliable method of planting is as a cutting, stake or pole taken during the dormant winter period – early June through August. Poles can either be planted using spade and soil rammer, or rammed in with a specialised long handled, steel thumper. Stakes are best not rammed and holes should be hand dug. Poles or stakes must be planted with at least one-third to half their length into the ground if they are less than 2.5m in length, or 600-700 mm deep if 2.5-3m poles. If you buy rooted stock, then dig a hole as normal.

Small poles and stakes should be kept free of competing weeds and grass. Therefore, spot spray or scarfing of the ground is appropriate. Large (2.5-3m) poles can be planted into grazed pasture but should be kept free of cattle for 12 months and individually protected with special plastic sleeves.

Before planting, soak the poles for at least 8-12 days, to 'load up' with water and ensure a good start. Make sure the pole or stake has a fresh cut on the end you are putting into water to ensure soakage can occur.

During the first season, particularly in dry conditions, check the poles for looseness caused by stock rubbing or wind movement. If there is a gap, pour in fine soil or sand, or re-ram. Avoid damage to new roots near the surface.

Spacing

Soil conservation

Spacing of poles and stakes will be dictated by the type of erosion. Most planting will be at a spacing of 10-12m on slopes, or pair planting between 2-10m between pairs in gullies that are not yet eroding. This spacing is s ufficient to allow the roots to interlock and to provide enough tensile strength to hold the soil. Any further apart will reduce the effectiveness of the trees.

Severely eroding sites should be planted at much closer spacing, from 2-8m, with the trees thinned later to a spacing that allows more light through the canopy. The idea is to grow as much root mass as possible to stabilise the site. The 'toe' of an earthflow or slump is often heavily planted with small stakes (lowest cost, easiest planting). This also allows for the loss of poles and stakes from further erosion and animal damage. Remember that on severely eroding sites, you will need to replace the lost material for several years.

Spacing also has an effect on the form of the tree, and the amount of light that can penetrate to the ground. Some thinning of trees is required on heavily planted sites to maintain

groundcover. This is necessary for erosion control. Pruning of widely spaced trees may be necessary, as willow trees often have multiple leaders, which can result in the tree splitting at a later stage. While reducing fodder quantity somewhat, form pruning the tree will increase the amount of penetrating light and reduce form problems later on.

An example of the 'multi leader effect' that can occur with willows and the end result of tree splitting. Note the bare ground from the lack of sunlight. Source: ***Simon Stokes***

Fodder

Throughout Hawke's Bay, tree willows have been widely used for stock feed during drought for many decades. There has been a recent upsurge in research into the use of willows for fodder, and this should be considered as a potential use if you are planting many of them on your farm. Planting specific fodder blocks may be a more practical and less risky option than having fodder trees in gullies and on erosion sites. 'Using Trees on Farms' is a very good publication for further reading.

An example of willows being felled for fodder during the 1998 drought, on the Thomsen property, Hendley Road, Patoka. Source: ***Neil Faulknor***

Pests and diseases

Possums: Most willows are palatable to possums. However, the osier types are not due to their bitter taste from a high level of salicin.

Leaf Disease: Willows were relatively free of any serious disease until the 1990s. Now, there are two leaf diseases which have changed the approach to willow planting. By the early 1990s, a leaf disease known as Marsonnina salicicola had become well established on some matsudana hybrid willows. While no deaths have been observed, most nurseries have ceased production of susceptible varieties. The S. matsudana species (not including hybrids) has also suffered mildly from a leaf rust disease, which appears to have little effect in the field, but is devastating in nursery conditions.

Insects: Yet another insect pest to arrive in New Zealand is the willow sawfly (Nematus oligospilus). This was discovered in Auckland in 1997. Since then, the insect has spread to most parts of the country and has become a major threat to shelter, erosion and river control plantings. Less damage has occurred on willows in the hill country. However, there have been many thousands of tree deaths on river berms in Hawke's Bay and the Gisborne district. Warm and dry east coast summer conditions are ideal for the breeding of willow sawfly, whereas a cool spring and/or wet summer season is less favourable to the insect. Several of the S. matsudana species have shown some resistance and a breeding programme is underway at Hort Research to develop resistant varieties more suitable to conservation needs. Existing species with some resistance include Japanese willow, common osier and Egyptian willow.

An example of the pest willow sawfly (Nematus oligospilus). Source: ***Hawke's Bay Regional Council***

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Table 83 : Uses and site tolerances of some willow varieties in Hawke's Bay

	Uses			Site tolerances				
Species/ variety	**Shelter**	**Soil conservation**	**Fodder**	**Drought tolerance**	**Strong wind**	**Sawfly resistance**	**Possum resistance**	**Comments**
S. matsudana	Ex	Ex	Ex	Gd	Gd	Pr	Pr	Rough bark
S. mats. x alba hybrids								
Tangoio	Ex	Ex	Ex	Gd	Gd	Pr	Pr	Highest leaf protein
Hiwinui	Gd	Gd	Ex	Gd	Gd	Pr	Pr	
Moutere	Ex	Ex	Ex	Gd	Gd	Pr	Pr	Good all-rounder
Hathaway	Gd	Gd	Gd	Gd	Gd	Pr	Pr	Attractive foliage
Weeping willow	Pr	Pr	Pr	Gd	Gd	Gd	Pr	Rust disease in wet areas
Golden willow	Gd	Pr	Pr	Gd	Gd	Pr	Pr	Winter colour
Japanese willow	Pr	Gd	Pr	Pr	Pr	Ex	Pr	Attractive foliage

Ex = excellent **Gd = good** **Pr = poor**

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Key to the species guide

(If there are blanks, there is insufficient knowledge available. All photographs in the species guide are courtesy of Kevin Thomsen)

Table 84

BOTANICAL NAME: **COMMON NAME:**	The Farm Forestry Association encourages the use of botanical names to minimise confusion. The most popular common name/s are shown.
ORIGIN: **FORM:** **POTENTIAL HEIGHT:** **GROWTH RATE:** **MATURITY TO HARVEST:** **TIMBER QUALITIES and UTILISATION:**	The original geographic origin of the species. A brief description of the characteristic shape of the mature tree. Where possible, the maximum international recorded height is provided. Pinus radiata is used as the base line for comparison since it is well recognised and widespread. The age provided is an estimate of the minimum years required to provide a quality timber product, based on the best knowledge available. Where possible, NZ experience has been provided. Unfortunately, with many species, there is very limited knowledge available about mature trees, so overseas experiences have been used. When known, Hawke's Bay experience has been contributed.
SITE PREFERENCES: Soils: Cold tolerance: Wind tolerance: General:	Most trees thrive in 'moist, fertile, well drained soils'. However, the aim in this section is to provide the individual tolerances of the species to challenging sites. A brief general description is provided, followed by the suitable soil orders to provide a link with the information in the Farm Forestry Zones. Indicates plant hardiness to cold or frosting. This is a very dicult guideline owing to microclimates and out-of-season frost problems. Local information is provided. Species vary dramatically from the eect of wind on their form and growing potential. General comments are given about the species.
RISKS: Animal pests: Insect pests: Diseases: General:	Basic facts on commonly occurring problems in Hawke's Bay are provided. The list is not necessarily complete, but additional information may be accessed from publications listed in the Further Information section.
PURPOSE: Amenity: Shelterbelt: Erosion: Forestry:	Suitable as shade for animals, yards, and buildings. Suitable for protection from wind for stock, crops and buildings. Suitable for slope or gully erosion control. Suitable for the species to grow into a timber crop within the microclimates of Hawke's Bay.
TREE MANAGEMENT: Planting spacing: Pruning: Final stocking:	Forest management needs to be tailor made for each site, so the information provided here must be considered as a general guide to be used as a basis for further investigation. An indication of the initial planting or stocking rate is given. An indication of pruning requirements is given remembering they have varying requirements to achieve the best results. The gure provided is the number of trees per hectare remaining for harvest after the final thinning.
GENERAL COMMENTS: **FURTHER INFORMATION:** **EXAMPLES IN HAWKE'S BAY:**	Any relevant information that may be of benet to you. While there is an abundance of information available in books, bulletins and databases, we have attempted to select those that are the most relevant to the Hawke's Bay farm forester. We recognise that there are many other good references not listed, but we are unable to cover them all. Where possible, locations of good local examples of the species are provided. However, they are often on private properties and may not be readily accessible for inspection. If you wish to locate a specic site, please contact a Farm Forestry Association member.

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Table 85

BOTANICAL NAME: **COMMON NAME:**	Abies grandis (a' biaes) Giant fir
ORIGIN: **FORM:** **POTENTIAL HEIGHT:** **GROWTH RATE:** **MATURITY TO HARVEST:** **TIMBER QUALITIES and UTILISATION:**	Western North America. Evergreen conifer, with a narrow conical form. 90 metres. Medium. 35 to 40 years on a good site (examples at Gwavas forest provenance trials established in 1958). Pale coloured, low density, non-durable, stable wood with good nishing qualities. Used in USA for structural construction.
SITE PREFERENCES: Soils: Cold tolerance: Wind tolerance: General:	 Well drained soils - Pumice, Pallic slopes, Recent steeplands,Allophanic, Brown and Melanie. Hardiness 6-9. Wind-rm in the open, but extreme exposure will slow growth. Best within primary shelter. Under-rated for colder, higher altitude planting.
RISKS: Animal pests: Insect pests: Diseases: General:	 Minor foliage damage (A. nordmanniana & A. alba seriously aected by an aphid-like insect). Armillaria root-rot is a problem on heavy and/or wet soils.
TREE MANAGEMENT: Planting spacing: Pruning: Final stocking:	 Has good natural form, but will require control of the branch size on fertile sites. Suggest 600 sph but due to the high cost of individual trees, this stocking may be reduced on good sites. Dead knots degrade timber, so a multi-visit regime is required to produce clearwood. Very few examples in NZ to assess, so around the 250 sph nal spacing, depending on the site.
GENERAL COMMENTS: **FURTHER INFORMATION:** **EXAMPLES IN HAWKE'S BAY:**	For this guide, A. grandis was chosen due to its proven growth at Gwavas. However, there are many other great Abies varieties to choose from for ornamental purposes, originating from many parts of the northern hemisphere. Other varieties were involved in the 1958 provenance trials and have performed well in the South Island. A total of 24 varieties have been established at the McKean Pinetum near Taihape. 'The silver rs', K. Miller (1989). • 'Gwavas Forest' provenance trials; • Ridgemount Road - Tutira; • Near Sherenden by roadside SH36 .

Table 86

BOTANICAL NAME: **COMMON NAME:**	Acacia dealbata (akae' sha) Silver wattle, mimosa
ORIGIN: **FORM:** **POTENTIAL HEIGHT:** **GROWTH RATE:** **MATURITY TO HARVEST:** **TIMBER QUALITIES and UTILISATION:**	Southeast Australia and Tasmania. Evergreen, tall with a round-headed crown. 20 metres. medium/fast. 25 to 30 years. Silky brown/reddish brown wood, often with an attractive wavy grain. It is a very decorative timber with under-rated potential. However, it does require treatment against borer invasion.
SITE PREFERENCES: Soils: Cold tolerance: Wind tolerance: General:	 Well drained, warm site. Does well on drier, lower fertility sites - Pallic, Recent slopes, Pumice, Brown and Melanie. Hardiness 9-11. Low, needs predominantly sheltered site - branches and top are easily broken by strong winds and can be unstable in windy areas. West and northwest slopes in some zones will be too exposed. Snow can cause considerable bending and breakage of the stem.
RISKS: Animal pests: Insect pests: Diseases: General:	 Seedlings are palatable and the bark is always susceptible to cattle stripping. Fungal rots can emerge from the centre as the tree ages. Armillaria root-rot is a problem on heavy and/or wet soils. Gall-fungus disease has seriously aected some Acacia plantations in the past in NZ. Suckers can be an invasive problem on an ungrazed site particularly in an area destined for indigenous species.
PURPOSE: Amenity: Shelterbelt: Erosion: Forestry:	 Has a very attractive, late winter, yellow ower - Mimosa - attractive to bees and birds. Excellent fast secondary shelter, but short-lived. Don't plant close to fences. Suitable for lower slope and gully erosion control - the roots sucker and stumps coppice. However, the end result may not produce limber crop. Can produce magnicently gured timber.
TREE MANAGEMENT: Planting spacing: Pruning: Final stocking:	 Seed source is important. Requires close competition; suggest 1100 sph, or a 'light well' situation to encourage good form. Form and lift pruning when necessary to produce clearwood and to reduce the degree of uting on the trunk. Progressively thin to about 250 sph, thus providing sucient room to maintain trunk diameter growth.
GENERAL COMMENTS: **FURTHER INFORMATION:** **EXAMPLES IN HAWKE'S BAY:**	In a neglected regeneration site, the dominant trees quite rapidly suppress competition and become good quality trees. Also consider A. meamsii, especially for firewood. NZFFAAMIGO Group, Cl - Kees Weytmans, Forest Care Ltd. Ph: 06 862 5444 Email: kees@forestmeasurement.co.nz • Rumbal's - Tikokino; • 'Raumati' - Patoka; • Arthur's - Waiwhare.

Cameo experience

Sowed seed in a gorse block, and then burnt it. Seven years later, the gorse was dead under 6 metre high acacia.

Peter Arthur - Waiwhare

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Table 87

BOTANICAL NAME: **COMMON NAME:**	Acacia melonoxylon (akae' sha) Australian Blackwood, formerl Tasmanian Blackwood
ORIGIN: **FORM:** **POTENTIAL HEIGHT:** **GROWTH RATE:** **MATURITY TO HARVEST:** **TIMBER QUALITIES and UTILISATION:**	Southeast Australia. Evergreen, naturally occurring round headed shape, often with multiple leaders - depending on the growing environment. 35 metres. Often occurs naturally as an understorey to Eucalyptus species. Medium/fast - very dependant on the site. 35 to 40 years. Variable black/reddish brown heartwood, medium density, moderately durable, pale sapwood. Can be dicult to saw. Mature trees are harsh on chainsaws and saw blades. Very good woodworking qualities, strong and decorative. Used mainly for decorative purposes.
SITE PREFERENCES: Soils: Cold tolerance: Wind tolerance: General:	 Prefers soils that are moist but not wet - therefore probably best in rainfall areas >1200 mm. Will grow on drier sites but more slowly. Lower slope Pallic, some Recent alluvial, Melanie, Pumice, Allophanic and Brown. Hardiness 8-11, very dependent on the seed sources. Susceptible to distortion and branch breakage with severe damage on large trees, plus uprooting in damp, soft soils. The best situation is in 'light wells' (must not get too shaded). It is a 'leguminous' species and may have potential as a mixed variety planting.
RISKS: Animal pests: Insect pests: Diseases: General:	 Highly susceptible to browsing while young; with age, the bark becomes rough and resistant to stock. 'Psyllid' damage on the growing tips causes multiple leaders creating a 'broccoli' shaped tree! The native puriri moth and the pinhole borer cause trunk damage. Suckers can be an invasive problem on an ungrazed site, particularly in an area destined for indigenous species.
PURPOSE: Amenity: Shelterbelt: Erosion: Forestry:	 Not suitable. Not suitable. Occasionally used for secondary shelterbelts. Suitable for lower slope and gully erosion control - the roots sucker and stumps coppice. However, the end result may not produce a timber crop. A dicult species to manage being extremely site specic, but potentially a very valuable furniture timber.
TREE MANAGEMENT: Planting spacing: Pruning: Final stocking:	 Competition is essential; suggest 1100 sph, or plant in a cleared 'light well'. Form prune from year one; do not expect a tall clear trunk (3-4 metres is sucient for furniture), so clear prune to whatever height is achievable. Once the optimal trunk has been achieved, thin to provide plenty of 'head' room so the trunk diameter growth is sustained - about 200 sph. Saw-logs need to be grown quickly as the trunks begin to internally deteriorate from about 40 years of age.
GENERAL COMMENTS: **FURTHER INFORMATION:** **EXAMPLES IN HAWKE'S BAY:**	If the original seedlings are not showing good potential after a few years, consider cutting them down and letting the suckers grow - they are usually of better form - then progressively thin and prune those for your crop. NZFFAAMIGO Group, C/ - Kees Weytmans, Forest Care Ltd. Ph: 06 862 5444 Email: kees@forestmeasurement.co.nz 'New Zealand Timbers', N.C. Clifton (1991); New Zealand Farm Forestry Association - Information Leaflets • Weichbrodt's - Tutira; • Longridge- Patoka; • Bill Shaw - Te Awanga.

Table 88

BOTANICAL NAME: **COMMON NAME:**	Agathis Australis (ag athi' s) Kauri
ORIGIN: **FORM:** **POTENTIAL HEIGHT:** **GROWTH RATE:** **MATURITY TO HARVEST:** **TIMBER QUALITIES and UTILISATION:**	Northern North Island, New Zealand. Evergreen conifer, with a consistently good form, possessing strong apical dominance when young. 50 metres. Medium. 80+ years. Heartwood is a light brown to reddish-brown colour, often speckled. The wood is soft, moderately durable and easy to work for turning and furniture. It is non-tainting and resistant to chemicals in industrial uses. Considered the most useful indigenous timber available in NZ. Note that the wood is extremely durable in constantly wet conditions.
SITE PREFERENCES: Soils: Cold tolerance: Wind tolerance: General:	 Tolerant to a wide range of soils, but the best results occur in more fertile soilsOrganic, Allophanie, mid steepland Pallic, Melanic, lower slope Brown, and Recent alluvial. Their Pumice soil tolerance is unknown - they are growing in pumice at Holt Forest Trust, but pumice soil may be too acidic. Susceptible to frost when young, but withstands cold on higher slopes (e.g. TaupoBolanic Garden). Damaged or growth slowed by severe winds. Best started in association with, but not overtopped by sheltering, vegetation. i.e still receives sunlight.
RISKS: Animal pests: Insect pests: Diseases: General:	 Deer rubbing at all ages Susceptible to drought, even when quite large. Fire - kauri are highly inammable.
PURPOSE: Amenity: Shelterbelt: Erosion: Forestry:	 It is unsuitable for open paddock planting unless on a sheltered site. Its form will need to be managed as it may produce double leaders. Possibly an east-west shelterbelt, but will be susceptible to frost. Interplanted with other indigenous species, it could be spectacular. Suitable for gully sides and lower slope erosion control, facing south, east, and possibly north. Would be assisted by a nurse crop. Not suitable for actively eroding or very wet sites. Has outstanding potential due to excellent timber qualities, growth rates and naturally good form. Kauri timber is one of the world's great timbers and the trees are solid to the core even in old age.
TREE MANAGEMENT: Planting spacing: Pruning: Final stocking:	 700 sph should be sucient when interplanted with companion species - (3m by 5m). In a forest situation they shed lower branches. Best to prune to create maximum clearwood. Could require form pruning. Timely thinning and fertiliser application has shown growth rate increases of 300%. Mature trees may need to be thinned to 100-150 sph to maintain growth rates.
GENERAL COMMENTS: **FURTHER INFORMATION:** **EXAMPLES IN HAWKE'S BAY:**	"In my experience pruning kauri stimulates adventitious growth. The branches will dehisce (die and detach from the stem) even in an open grown situation. However, kauri is a proud and independent tree, and the branches dehisce only when the tree wants them to. They seem quite unfazed by the needs of impatient humans!" - quote from Ashley Cunningham, a HBFFA member whose career involved protecting indigenous forests. 'New Zealand Timbers', N.C. Clifton (1991); 'Indigenous Forestry - Sustainable Management', Ministry of Forestry/NZ Farm Forestry Association (1998); 'What's New in Forest Research?' - No. 173 & No. 243. • 'Trelinnoe' - Te Pohue; • 'Mahoe' - Patoka; • Holt Forest Trust - Waikoau.

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Table 89

BOTANICAL NAME: **COMMON NAME:**	Alnus rubra (syn. A. oregona) (al' nas) Red alder, Ore on alder
ORIGIN: **FORM:** **POTENTIAL HEIGHT:** **GROWTH RATE:** **MATURITY TO HARVEST:** **TIMBER QUALITIES and UTILISATION:**	Western North America. A pyramid-shaped, deciduous tree with horizontal or slightly weeping branches. 25 metres. Fast. Probably about 30 years on good sites. Fresh cut it is pale, but turns a bright orange -brown with age. It is a light, medium density wood, but is not durable. Some Alnus spp. have an extremely water resistant timber (city of Venice is supported by it). "A. rubra has heartwood that is said to be equivalent to rimu in use" - John Dean, an experienced farm forester from Nuhaka.
SITE PREFERENCES: Soils: Cold tolerance: Wind tolerance: General:	 Recent alluvial and steeplands Pallic and Pumice lower slopes, Melanic and Allophanic. Hardiness 6-9. Flushes early so can be damaged by late frosts. Has a deep rooting system and exible foliage that assist it to tolerate all but the most severe winds. The roots host nitrogen-xing nodules, that assist them to thrive in impoverished soils. In spring, the emerging leaves and catkins have a very attractive red blush.
RISKS: Animal pests: Insect pests: Diseases: General:	 Palatable to possums. Dead branches or wounds allow boring insects to penetrate.
PURPOSE: Amenity: Shelterbelt: Erosion: Forestry:	 Suitable for paddock planting, but not in open, windy sites. Best as trimmed shelter, but A cordata/glutinosa are more commonly used in horticultural situations due to their non-invasive root system. East to west orientation preferred. A. rubra survives on soil-depleted slip scars and has the ability to dramatically rejuvenate the soils. A.glutinosa has a good root system suited to damp conditions around marshes and watercourses. The alders are under-rated. An excellent nurse tree for indigenous establishment, with the timber having some potential.
TREE MANAGEMENT: Planting spacing: Pruning: Final stocking:	 For erosion control work, suggest 800 to 1100 sph, with thinning later on. Unknown root range. Wider spacing probably less eective. Pruning would only occur if you intended to produce some clearwood - the trunks produce epicormic growths readily in open situations. Final stocking is unknown, but would probably need to come down to 200sph.
GENERAL COMMENTS: **FURTHER INFORMATION:** **EXAMPLES IN HAWKE'S BAY:**	A. rubra performs very well in the higher rainfall areas, but seems to struggle in drier and hotter sites. Better choices for the lowland areas are A. cordata (Italian alder), with A. glutinosa (black or common alder) thriving on sites with lots of moisture e.g. drains/ swamps. 'What tree is that?' S. Macoboy (1979); 'The trees in New Zealand - Exotic Trees: The Broadleaves', J.T. Salmon (1999). • Geoff Prickett - Morere; • John & Heather Dean - Nuhaka; • 'Beehive Gardens' - Norton Road (Hastings); • 'Raumati' - Patoka (A. cordata shelterbelts).

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Table 90

BOTANICAL NAME: **COMMON NAME:**	Araucaria heterophylla (syn. A. excetsa) (a rah kah' ree a) Norfolk Island Pine
ORIGIN: **FORM:** **POTENTIAL HEIGHT:** **GROWTH RATE:** **MATURITY TO HARVEST:** **TIMBER QUALITIES and UTILISATION:**	Norfolk Island. Evergreen conifer with a strongly apical form, developing whorls of branches at even intervals up the trunk. 60 metres. Medium. Not normally considered as a timber tree, but possibly 50 years in good conditions. Not well known, but in early Sydney, Australia, builders used a lot of this tree sourced from . Norfolk Island. The timber is similar to kauri as they are closely related. Heartwood is formed after 30 years.
SITE PREFERENCES: Soils: Cold tolerance: Wind tolerance: General:	 Stands dry soil conditions< 1000 mm, especially near the sea where moisture is gained from mists. Suers on raw sand unless clay soil is added - Pallic, Recent alluvial, Raw and Pumice. Hardiness 10-11. Requires protection from frost when young. Able to withstand extreme wind exposure. It is very tolerant of harsh conditions and will grow next to the sea or on suitable inland sites.
RISKS: Animal pests: Insect pests: Diseases: General:	
PURPOSE: Amenity: Shelterbelt: Erosion: Forestry:	 A stunning ornamental tree with its tiered 'Pagoda' eect. May be a sound choice if eventual high shelter is required, particularly on the seaward side. Unknown, but could be very useful for slope planting near the coast, but not on actively eroding sites as it would be too slow growing. Yet to be tried - in the winter of 2002, one hectare was planted on 'Maraetara', Bay View by Kipper Holt.
TREE MANAGEMENT: Planting spacing: Pruning: Final stocking:	 Very little is known, however ii could be closely grown, similar to Douglas r i.e. 1000 - 1200 sph. Again, similar requirements to Douglas r, maintain clearwood programme regardless. Apparently, it can support high basal areas and grow large volumes of timber per hectare. +/- 400s.p.h.
GENERAL COMMENTS: **FURTHER INFORMATION:** **EXAMPLES IN HAWKE'S BAY:**	There is potential for more widespread use of this species and its relations A. bidwillii (Bunya-Bunya) and A. araucana (monkey puzzle) for limber and nut production. 'What tree is that?' S. Macoboy (1979). • Wairoa and Napier City foreshores and parks; • Pourerere Beach; • 'Maraetara', Seafield Rd.

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Table 91

BOTANICAL NAME: **COMMON NAME:**	Castanea sativa (kas tan' ee a) Sweet chestnut, Spanish chestnut
ORIGIN: **FORM:** **POTENTIAL HEIGHT:** **GROWTH RATE:** **MATURITY TO HARVEST:** **TIMBER QUALITIES and UTILISATION:**	Southern Europe (introduced to Britain by the Romans), North Africa, Asia Minor. Deciduous, with a short trunk and a wide spreading crown. 20-25 metres. Medium. For posts and pole production, about 15 to 20 years on a good site (the stumps coppice for the next crop). For timber the requirements are probably similar to oak50 to 80 years. Pale brown wood with distinctive growth rings. A high proportion of durable heartwood suitable for exterior in-ground use. Corrosive to iron in moist conditions. It is a slow drying wood that requires careful conditioning, but once dry it machines, glues and nishes well. Tannin has been extracted from the wood for use in tanning leathers.
SITE PREFERENCES: Soils: Cold tolerance: Wind tolerance: General:	 Well drained, slightly acid soils - mid slope Pumice, Allophanic, Brown, and sheltered mid slope Pallic. Does not like high lime content in soil. Hardiness 5-9. Withstands wind quite well, but should not be considered a wind-hardy species. Drought tolerant once established.
RISKS: Animal pests: Insect pests: Diseases: General:	 Bark is always vulnerable to stock damage. Brown and green beetles cause some defoliation, but it is seasonal and not too serious. Susceptible to an Asiatic fungal chestnut blight, and to Phytophthora root infection on wet sites. Coppices profusely from the base of the trunk.
PURPOSE: Amenity: Shelterbelt: Erosion: Forestry:	 Often used, a handsome shiny-leafed specimen, with potential nut production. Not suitable. Suitable for slope erosion control, but not actively eroding sites. The practice of coppicing ensures a permanent root structure holding soils. Short rotation coppice for ground-durable posts or poles. Timber is worth producing.
TREE MANAGEMENT: Planting spacing: Pruning: Final stocking:	Has good potential for qua lily timber production on selected sites. There is not much experience with this species. Trees will need competition during the early years to encourage a straight stem, and then be thinned to allow room for the development of a 'crown' so stem diameter growth occurs. Suggest establishment at 600 sph, thinned down to about 200 sph.
GENERAL COMMENTS: **FURTHER INFORMATION:** **EXAMPLES IN HAWKE'S BAY:**	The North American chestnuts C. dentata and C. pumila have been devastated by the chestnut blight. Asiatic species C. crenata and C. mollissima are smaller trees but produce good limber. Grafted plants are preferable for high quality edible nut production. 'New Zealand Timbers', N.C. Clifton (1991); 'What tree is that?' S. Macoboy (1979). • 'Sudley' - Puketapu; • 'Eland' driveway - S.H.5; • 'Raumali' - Patoka; • Hill's property - Fernhill; • Redcliffe - Taradale.

Table 92

BOTANICAL NAME: **COMMON NAME:**	Cedrus deodora (see' dras) Deodar, Himalayan cedar
ORIGIN: **FORM:** **POTENTIAL HEIGHT:** **GROWTH RATE:** **MATURITY TO HARVEST:** **TIMBER QUALITIES and UTILISATION:**	Himalayas. Evergreen conifer with strong apical growth, developing wide -spreading horizontal branches, tending pendulous. 60 metres. Medium/slow. 40 plus years. Pale coloured soft timber, may distort as it dries, retains a scent. It is not a strong wood, but works well, providing a ne nish. Used mainly for decorative purposes and is known for its natural durability.
SITE PREFERENCES: Soils: Cold tolerance: Wind tolerance: General:	 Tolerates very dry sites, dislikes wet sites - suitable for mid to upper steepland Pallic, Allophanic, Pumice, Brown, Melanic, and Recent steepland soils. Hardiness 7-10. Keeps good form in exposed sites. Grows well in most regions, dislikes salt wind.
RISKS: Animal pests: Insect pests: Diseases: General:	 Animals can damage the bark at any age. Susceptible to some herbicides - can refoliate afterwards.
PURPOSE: Amenity: Shelterbelt: Erosion: Forestry:	 An impressive ornamental/shade tree requiring a lot of space at maturity. Excellent in exposed, windy places. Can be eectively side -trimmed and planted in a single row. Eective slope erosion control species, particularly in low rainfall areas. Not suitable for really wet gullies with inlled oors and Gley soils. Suitable as a long-term choice on dry, wind -exposed sites.
TREE MANAGEMENT: Planting spacing: Pruning: Final stocking:	 Suggest 600 sph, but can be planted at up to 5-6 metre spacing due to its strong apical dominance. Being slow starters, two year old plants are best on most sites to compete with weeds. Require competition to control branching on good sites - increase stems per hectare. Necessary if timber is the aim. Desirable if used for amenity to reduce excessive ground shading from the wide-spreading branches. Suggest about 200 sph because of the longer time to harvesting.
GENERAL COMMENTS: **FURTHER INFORMATION:** **EXAMPLES IN HAWKE'S BAY:**	Becoming a more popular choice as a shelter and possible timber option, especially in dry, exposed situations. If the climate predictions are correct about increasing heat and dry, it is a sound choice for Hawke's Bay. Its relations C. atlantica (Atlas cedar) and C. libani (Cedar of Lebanon) have as much or more to oer as hardy trees with timber and shelter potential. They appear to vary in form and foliage. The timber of C. libani is very durable but its processing dust is carcinogenic. 'What tree is that?' S. Macoboy (1979). • 'Te Motu' - Waihau Road; • Holt Forest Trust - Waikoau. • Geoff Prickett - Morere; • 'Maraetara' - Seafield Road; • Lyons - Raukawa. • Absolum and McNeill Farm - Rissington

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Table 93

BOTANICAL NAME: **COMMON NAME:**	Chamaecytisus palmensis (cham ae sai' tis as) Tagasaste, tree lucerne
ORIGIN: **FORM:** **POTENTIAL HEIGHT:** **GROWTH RATE:** **MATURITY TO HARVEST:** **TIMBER QUALITIES and UTILISATION:**	Canary Islands. Short-lived, evergreen, leguminous shrub. 4-5 metres. Very fast. Seems to have a healthy lifespan of about 8-10 years. Seeds prolically. Possible to survive to 20 years of age Excellent hard rewood, but poor form and many branches make it slow gathering! Dry timber is hard on chainsaws, has a pungent smell, but is excellent for wood - turning.
SITE PREFERENCES: Soils: Cold tolerance: Wind tolerance: General:	 Will handle many situations including very dry conditions. All soil types except Gley and Organic. Hardiness 9-11. Susceptible to heavy frost. Dislikes severe wind - but will survive in most situations. Will not survive or germinate in heavily shaded areas.
RISKS: Animal pests: Insect pests: Diseases: General:	 Palatable to all animals and some birds! Readily hosts a borer insect - which is probably why its life is so short. Browsing by animals and birds (e.g. kereru) does not usually do it any serious harm.
PURPOSE: Amenity: Shelterbelt: Erosion: Forestry:	 The great merit of this shrub is its benet to other trees as a nurse crop and nitrogen fixer, to birds and bees for the winter/spring nectar and to the kereru for all year round grazing on the foliage. It is an option for animal grazing (has very high nutritional values and yield) but it is dicult to manage successfully to maintain plant health. Frequent trimming is benecial. Has been used successfully to rejuvenate impoverished and saline soils in Australia. Can be used for low-growing shelter and is excellent as a slope erosion control plant on tough, dry sites.
TREE MANAGEMENT: Planting spacing: Pruning: Final stocking:	 A good option is to interplant tagasaste as a companion plant between ornamental species at 8 10 metre spacing. This provides shelter and nitrogen in the early years when it is most benecial - and looks good too.
GENERAL COMMENTS: **FURTHER INFORMATION:** **EXAMPLES IN HAWKE'S BAY:**	Plant this species to attract tui, kereru and korimako (bellbird) within two years. No other species beats it for this purpose. Once established, there will be a never-ending supply of seedlings germinating unless the area is grazed or shaded. 'Tagasaste - High Production Fodder Crop', L.C. Snook (1986). • 'McNeil Farm' - Rissington; • 'Langridge' - Patoka; • Poraiti hills by the Puketitiri Road.

Table 94

BOTANICAL NAME: **COMMON NAME:**	Cryptomeria japonica (krip toh mea ree a) Japanese Cedar, sugi
ORIGIN: **FORM:** **POTENTIAL HEIGHT:** **GROWTH RATE:** **MATURITY TO HARVEST:** **TIMBER QUALITIES and UTILISATION:**	Japan and parts of China. Evergreen conifer with a strong apical dominance. 40 metres. Medium. 35 - 40 years. Strong cultural and religious signicance in Japan. The heartwood is a warm, reddish brown colour with brown streaked, pale sapwood. Very light, low density, moderately durable, fragrant wood used for panelling, joinery and exterior cladding.
SITE PREFERENCES: Soils: Cold tolerance: Wind tolerance: General:	 Requires >1200 mm/annum rainfall or consistent soil moisture - suers on wet/dry sites. Pumice, Allophanic, Brown, Recent steeplands and Melanic soils. Hardiness 7-11 - late season frosts are damaging. Susceptible to wind damaging the growing tip and some branch distortion. Does not like open, windy sites. Similar requirements to redwoods. Can tolerate some salt wind. Is very shade tolerant.
RISKS: Animal pests: Insect pests: Diseases: General:	 Magpies can break the growing tip; palatable to possums. A number of non -serious insect browsers. Cones and branchlets contaminate wool and are very dicult to remove.
PURPOSE: Amenity: Shelterbelt: Erosion: Forestry:	 Attractive ornamental specimen. Commonly used for horticulture with regular side trimming. Would be a good choice for some sites facing south and east, as the stumps coppice, and therefore the roots stay alive. Not suitable for really wet gullies with inlled oors and Gley soils. Good option in relatively sheltered and moist soil sites.
TREE MANAGEMENT: Planting spacing: Pruning: Final stocking:	 Requires competition to restrict branch size. A high population allows selection to counter malformation. Suggest 800 - 1000 sph. Will self-prune in time in a forest but pruning is certainly recommended to produce a quality timber. Produces epicormic growths if over-pruned or in open situations. Depending on soil moisture, probably somewhere around 250 -350 sph.
GENERAL COMMENTS: **FURTHER INFORMATION:** **EXAMPLES IN HAWKE'S BAY:**	Very impressive straight trunks when pruned, with bronze coloured foliage in cold conditions. Branches are quite brittle when pruning and dry foliage is prickly. Can grow up through light kanuka scrub canopy with little abrasion on the growing tips. 'Cryptomeria, Thuja and Tsuga', K. Miller (1994); 'What tree is that?' S. Macoboy (1979). • Holt Forest Trust - Waikoau; • Geoff Prickett - Morere; • 'Langridge' - Patoka.

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Table 94a

BOTANICAL NAME: **COMMON NAME:**	Cupressocyparis ovensii (koopre' sohsai paris) Oven's Cypress
ORIGIN: **POTENTIAL HEIGHT:** **GROWTH RATE:** **MATURITY TO HARVEST:** **TIMBER QUALITIES and UTILISATION:**	Hybrid – C. Lustanica x Chamaegyparis nootkatensis (Alaska to Oregon) +/- 30 metres Medium to fast 30 year – but untested in most areas of NZ. Same situation as C.leylandii, but expect to be good.
SITE PREFERENCES: Soils: Cold tolerance: Wind tolerance: General:	Tolerates a range of soils & sites but prefers well drained soils – Pumice, Allophanic, Brown etc (leylandii) Hardiness 4 – 10 Replacing C.leylandii in many cases for shelterbelts Not suitable to coastal situations
RISKS: Animal pests: Insect pests: Diseases: General:	 Bark is soft, os is at risk from ring-barking at all ages by animals. Resistant to canker problems. Grown from cuttings, so form and growth rate are reliable, Foliage may be of risk to colos when trimmed and wilted.
PURPOSE: Amenity: Shelterbelt: Erosion: Forestry:	 Trimmed shelter similar to C.leylandii Promoted as a high potential special timber species mainly due ot itscanker resistance. Good reliable form.
TREE MANAGEMENT: Planting spacing: Pruning: Final stocking:	 Cutting grown plants are expensive, but with their reliable form they can be planted at wider spacing – possibly 4 x 4 metres (625 sph) A multi-visit pruning regime to control large brances but not over-prune. Similar to other cypress varieties, about 250 – 320 sph (untested yet).
GENERAL COMMENTS: **EXAMPLES IN HAWKE'S BAY:**	Fairly new to NZ scene, so is unproven yet. However, the fact that so many of the spress species have been increasingly aected by canker make this hybrid worth trying. 'McNeill Farms' Rissington 'Winirana', inland Te Awanga – by Maraetotara Stream

Table 95

BOTANICAL NAME: **COMMON NAME:**	Cupressocyparis leylandii (koopre' sohsai paris) Leyland cypress
ORIGIN: **FORM:** **POTENTIAL HEIGHT:** **GROWTH RATE:** **MATURITY TO HARVEST:** **TIMBER QUALITIES and UTILISATION:**	A hybrid between Cupressus macrocarpa and Chamaecyparis nootkatensis. Evergreen conifer of apical form with spreading lower branches on fertile sites. Available in various coloured strains - 'Naylor's Blue', 'Leighton Green', 'Green Spire' etc. 35 metres. Fast - faster than its parents listed above. 30 years - untested as a forest timber tree in New Zealand. There is little experience with the timber, but ii will probably be similar to the Cupressus timber species. There have been some very positive verbal reports on the timber qualities.
SITE PREFERENCES: Soils: Cold tolerance: Wind tolerance: General:	 Tolerates a range of soils and sites but prefers well drained soils - Pumice, Allophanic, Brown, upper slope Pallic, Melanie, and Recent steeplands. Hardiness 5-10. Proven to be well able to withstand high wind situations as a trimmed shelter. The glaucous 'Naylor's Blue' variety withstands moderate salt winds well.
RISKS: Animal pests: Insect pests: Diseases: General:	 Bark is soft, so is at risk from ring-barking at all ages by animals, especially juvenile cattle. Palatable to possums. Reasonably resistant to canker. Should not be planted on sites that have heavy wet soils. As it is grown from cuttings, the establishment cost for a forest is high. Foliage can induce abortion in cattle, especially pruned/trimmed foliage that has wilted.
PURPOSE: Amenity: Shelterbelt: Erosion: Forestry:	 To dale, most plantings of the coloured strains have been ornamental. A fast growing, good choice if frequent side trimming is performed resulting in a dense hedge. Keep trimmings away from pregnant cows. Suitable for erosion control work and would be particularly useful on drier sites. Not suitable for inlled wet gullies. This use is being promoted due to the better canker resistance and the tree's fast growth. 'Green Spire' has a better form with lighter branching. However, the canker risk is of concern in Hawke's Bay's variable climate where tree stress is common.
TREE MANAGEMENT: Planting spacing: Pruning: Final stocking:	 Although the plants are cutting grown and, therefore, uniform, they need competition to control branching, particularly on fertile sites. Suggest planting about 800 sph. A multi-visit pruning regime must be performed to obtain quality timber. This will be similar to other cypress varieties, about 250 -350 sph (untested as yet).
GENERAL COMMENTS: **FURTHER INFORMATION:** **EXAMPLES IN HAWKE'S BAY:**	This species has been noted from around the region as one of good promise, particularly for shelter and limber. Where there is sea exposure, use the 'Naylor's Blue' strain as it is much more salt tolerant, although slower growing. 'The cypresses', J Miller et al (1996); • 'Maraetara' - Seafield Road; • Corner of Longlands/Maraekakaho Roads; • Helen Swinburn - Makaretu; • Gull Flat Road - Mangleton.

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Table 96

BOTANICAL NAME: **COMMON NAME:**	Cupressus lusitanica (koo pres' sas) Mexican cypress
ORIGIN: **FORM:** **POTENTIAL HEIGHT:** **GROWTH RATE:** **MATURITY TO HARVEST:** **TIMBER QUALITIES and UTILISATION:**	Mexican and Guatemalan highlands. Evergreen conifer with spreading, pendulous branches but more apical than C. macrocarpa. 36 metres. Medium. 25-35 years, depending on chosen regime. Classied as having similar qualities to our native kauri and to C. macrocarpa, making it suitable for turning, furniture, boat building and framing. The heartwood is durable above the ground. Medium/low density, stable, easily processed limber.
SITE PREFERENCES: Soils: Cold tolerance: Wind tolerance: General:	 Well drained soils in moist sites, receiving over 1000 mm rainfall - Pumice, Allophanic, Brown, Recent steepland and Pallic. With Pallic soils, it would have to be mid to upper slope. Hardiness 8-9 - withstands ground frost of -5 °C. Relatively sheltered inland sites for best performance. Fertiliser application is benecial on impoverished sites. Reasonably shade tolerant. Susceptible to toppling in soft soils within rst few years (need to consider 'crown lightening').
RISKS: Animal pests: Insect pests: Diseases: General:	 Trunk susceptible to ring-barking from animals, especially juvenile cattle. Use 'Poodle - cut' (see Glossary) for this protection. Foliage is more sensitive to browsing than C. macrocarpa. 'Case-moth' strangles branch tips but rarely the growing lip. Canker is less of a problem than in C. macrocarpa. Foliage can induce abortion in cattle, especially pruned/trimmed foliage that has wilted.
PURPOSE: Amenity: Shelterbelt: Erosion: Forestry:	 Can be side-trimmed or 'fan-pruned' (see Glossary) for shelterbelts. Suitable for slope erosion control on east and south aspects, but not on actively eroding gullies, avoiding the wet oor. A top special purpose species when grown in a woodlot. Site on the warmer, more sheltered, east and south facing slopes.
TREE MANAGEMENT: Planting spacing: Pruning: Final stocking:	 The wide variability of seedlings requires high planting numbers for later selection, plus competition is required for branch control, especially on fertile sites or edge trees (1000+ sph). For maximum clearwood production, use a multi-visit pruning method, removing only a few branches each lime to minimise compensatory growth of remaining branches. To maintain steady diameter growth, depending on soil moisture, gradual thinning to about 250-300 sph is required. The heartwood from the larger size thinnings can be utilised for posts or poles. Good quality timber can be recovered in to the pith.
GENERAL COMMENTS: **FURTHER INFORMATION:** **EXAMPLES IN HAWKE'S BAY:**	Genetic improvement trials are continuing to provide higher potential plant material. NZFFA Cypress Action Group , C/- Graham Milligan Ph/Fax: 03 248 5147 Email: milliganseeds@xtra.co.nz 'New Zealand Timbers', N.C. Clifton (1991); 'The cypresses', J Miller et al (1996); Zealand Farm Forestry Association - Information Leaflets. • 'Langridge' - Patoka; • Just downstream from White Pine Bush Scenic Reserve - Tulira; • 'Glenlands' - SH5; • 'Makahu Station' - Pakaututu.

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BOTANICAL NAME: **COMMON NAME:**	Cupressus macrocarpa (koo pres' sas) Macrocarpa, Monterey cypress
ORIGIN: **FORM:** **POTENTIAL HEIGHT:** **GROWTH RATE:** **MATURITY TO HARVEST:** **TIMBER QUALITIES and UTILISATION:**	Monterey, California, USA. Evergreen conifer of variable habits, bushy in the open, but potentially good form in a forest. 30 metres. Medium. 25-35 years, depending on chosen growing regime. Classied as having similar qualities to our native kauri, making it suitable for turning, furniture, boat building and framing. The heartwood is durable above the ground. Medium/low density, stable, easily processed timber.
SITE PREFERENCES: Soils: Cold tolerance: Wind tolerance: General:	 Well drained soils receiving >700-1000 mm rainfall- Pallic Recent steeplands, and well drained Recent alluvial, Raw and low rainfallAllophanic. Hardiness 6-9 - withstands ground frost of-10 °C. Relatively sheltered sites for best performance. Humid sites are suspected of increasing canker infection. Close proximity to the sea seems very desirable. Fertiliser application is benecial if the soils are impoverished. Susceptible to toppling in soft soils within the rst few years. High nitrogen levels will cause poor form with heavy branching.
RISKS: Animal pests: Insect pests: Diseases: General:	 Trunk is always susceptible to ring barking from animals, especially juvenile cattle. Use 'poodle-cut' (see Glossary) for this protection. Foliage is fairly unpalatable. Native borer insects can penetrate heartwood on stressed trees- not usually a concern. Currently, canker is a serious problem for successful growth in most of Hawke'sBay. Until canker resistant varieties are proven, this species should not be commercially planted in Hawke's Bay. Foliage can induce abortion in cattle, especially pruned/trimmed foliage that has wilted.
PURPOSE: Amenity: Shelterbelt: Erosion: Forestry:	 In the past, it was used as a regularly trimmed hedging shelter around homesteads. Suitable in coastal locations on south and east aspects. Not suitable on actively eroding sites. A very high quality, sought after timber, but there does not seem to be a canker-free area within Hawke's Bay. A canker-resistant strain shows promise- 'Faulkner/Bain' strain, but has yet to be proven.
TREE MANAGEMENT: Planting spacing: Pruning: Final stocking:	 The wide variability of seedlings requires high planting numbers for later selection, plus competition is required for branch control especially on fertile sites or edge trees (1000+ sph). For maximum clearwood production, use a mult~visit pruning method, removing only a few branches each time to minimise compensatory growth of remaining branches. To maintain steady diameter growth, depending on soil moisture, gradual thinning to about 250-300 sph is required. The heartwood from the larger size thinnings can be utilised for posts or poles.
GENERAL COMMENTS: **FURTHER INFORMATION:** **EXAMPLES IN HAWKE'S BAY:**	At present, there are no proven canker resistant strains available, so in most of Hawke's Bay this species is not a sound choice. The 'Faulkner/Bain strain' has shown good potential in some coastal areas. Genetic improvement trials are continuing to provide higher potential plant material. In the meantime, consider C. lusitanica or C. torulosa as safer options. Another variety, Cupressus goveniana (Gowen cypress) growing at Puketitiri is showing no signs of canker after 6 years - comment from Jack Nicholas. NZFFA Cypress Action Group , C/- Graham Milligan Ph/Fax: 03 248 5147 Email: milliganseeds@xtra.co.nz 'New Zealand Timbers', N.C. Clifton (1991); 'The cypresses', J Miller et al (1996); • Gollan's - Wimbledon; • 'Oakmere' - Te Pohue. • Gwavas homestead garden - Tikokino

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Table 98

BOTANICAL NAME: **COMMON NAME:**	Cupressus torulosa (koo pres' sas) Bhutan cypress
ORIGIN: **FORM:** **POTENTIAL HEIGHT:** **GROWTH RATE:** **MATURITY TO HARVEST:** **TIMBER QUALITIES and UTILISATION:**	Western Himalayas. Evergreen conifer with a narrow, pyramidal shape, wider spreading branches on fertile sites. 50 metres. Medium on warm, fertile sites. 40-50 years. Have yet to discover someone who has used this timber, but the general comment is that it would be similar to C. macrocarpa.
SITE PREFERENCES: Soils: Cold tolerance: Wind tolerance: General:	 Particularly tolerant of dry conditions - suits all soils except Gley, Organic, and Raw. Hardiness 7-9. Severe, persistent wind distorts branch growth away from the prevailing direction. Hardy for exposed and/or dry sites, but is slow growing.
RISKS: Animal pests: Insect pests: Diseases: General:	 Sometimes develops canker on the trunk. Can develop double leaders - possibly due to wind or magpie damage. The foliage may have some risk of inducing abortion in cows.
PURPOSE: Amenity: Shelterbelt: Erosion: Forestry:	 Suitable for planting in the open paddock area where it has excellent form. Very good choice for a shelterbelt on dry or cold sites. Suitable for slope erosion control or gully planting as long as you avoid the soils it will not like. A good choice for an exposed dry site and in areas where other Cupressus spp. do not perform well.
TREE MANAGEMENT: Planting spacing: Pruning: Final stocking:	 There is very little experience to date on forest management, but suggest 600 -800 sph. Regular early pruning (with secateurs), then a similar regime to C. lusitanica should be suitable. On a very dry site, thinning will need to be greater - possibly down to 200 sph or lower.
GENERAL COMMENTS: **FURTHER INFORMATION:** **EXAMPLES IN HAWKE'S BAY:**	Essential to obtain a 'good form' seed source, especially if planting on fertile sites where the branches may develop out of proportion. What tree is that?' S. Macoboy (1979). • 'Maraetara' - Seafield Rd; • 'Kohotea Farm' - Te Aute; • 'Makahu Station' - Pakaututu; • Orchard Road - Hastings; • 'Kautuku' - Fernhill; • 'Te Tua Station' - Maraekakaho.

Table 99

BOTANICAL NAME: **COMMON NAME:**	Dacrydium cupressinum (dakri' deeum) Rimu, red pine
ORIGIN: **FORM:** **POTENTIAL HEIGHT:** **GROWTH RATE:** **MATURITY TO HARVEST:** **TIMBER QUALITIES and UTILISATION:**	New Zealand. Tall, apical, evergreen conifer with pendulous foliage. 60 metres. Slow. 100+ years. Mature heartwood is a beautifully gured, deep reddish brown to yellow colour, hard and durable. Care must be taken to separate heart and sapwood for drying. Susceptible to surface checking if not kept out of the sunlight. Valuable for furniture and nishing.
SITE PREFERENCES: Soils: Cold tolerance: Wind tolerance: General:	 On a sheltered forest site, rimu seems to tolerate a wide range of soils - all soils except Gley, Organic, Podzol, and Raw. Occurs in most parts of NZ. Susceptible to frost when young. Intolerant to wind exposure until mature. Susceptible to drought, therefore will need careful siting for Hawke's Bay conditions. Can be dicult to grow in the open.
RISKS: Animal pests: Insect pests: Diseases: General:	 Less palatable than other Podocarp varieties to deer and possum, but at risk from rubbing and bark stripping. Cicada damage may deform seedlings and saplings. Damage to roots and stems can introduce fungal rots that weaken the stem and roots. On wet, shallow soils, 'wind throw' seems to be the greatest risk in natural forests.
PURPOSE: Amenity: Shelterbelt: Erosion: Forestry:	 Not suitable unless planted as part of a group of trees with shelter. Not suitable. Not suitable - unless grown as interplanted species in existing erosion control forest areas. High potential for long-term forestry - but will need strategically timed thinning to maximise growth rates and quality.
TREE MANAGEMENT: Planting spacing: Pruning: Final stocking:	 Needs to be established in 'light wells' within existing cover. Can grow at very close spacing up to 10 years, but will then require gradual thinning. Tends to develop multiple leaders in an open situation. Suggested stocking rates at 1100 sph or greater in conjunction with nurse crop. Response to pruning is not benecial unless it is in a site that encourages apical dominance. For a 100+ year cycle, the trees will require considerable room- possibly 100 to 150sph in a pure stand.
GENERAL COMMENTS: **FURTHER INFORMATION:** **EXAMPLES IN HAWKE'S BAY:**	Rimu will survive in a suppressed state for 20-30 years, then respond well to releasing. Rimu timber is becoming restricted in supply as sustainable harvesting is only allowed on private properties. Present customer demand ensures a very valuable timber. 'Indigenous Forestry- Sustainable Management', Ministry of Forestry/NZ Farm Forestry Association (1998); 'The Native Trees of New Zealand', J.T. Salmon (1980); 'New Zealand Timbers', N.C. Clifton (1991); 'What's New in Forest Research?' No. 173 & No. 243.'Maraetara' - Seafield Rd; • Ball's Clearing Reserve - Puketitiri; • 'Gwavas Station' - Tikokino; • Holt Forest Trust - Waikoau.

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Table 100

BOTANICAL NAME: **COMMON NAME:**	Dacrycarpus dacrydioides (dakri' kahpus) Kahikatea, white pine
ORIGIN: **FORM:** **POTENTIAL HEIGHT:** **GROWTH RATE:** **MATURITY TO HARVEST:** **TIMBER QUALITIES and UTILISATION:**	New Zealand. Apical dominant, evergreen conifer. 60 metres. Medium on favourable sites, very slow on hard sites. 100+ years. The heartwood is non-durable, of a pale to bright yellow in colour, with the abundant sapwood being creamy white. Sapwood is prone to borer and fungal attack. The timber is completely odour and taste free, hence its suitability for use in association with food. Used for painted finishing - window sashes, weather boarding and boat building.
SITE PREFERENCES: Soils: Cold tolerance: Wind tolerance: General:	 On a sheltered forest site, rimu seems to tolerate a wide range of soils - all soils except Gley, Organic, Podzol, and Raw. Occurs in most parts of NZ. Susceptible to frost when young. Intolerant to wind exposure until mature. Susceptible to drought, therefore will need careful siting for Hawke's Bay conditions. Can be dicult to grow in the open.
RISKS: Animal pests: Insect pests: Diseases: General:	 Once established, it copes well with most grazing animals. Cicadas damage many seedlings.
PURPOSE: Amenity: Shelterbelt: Erosion: Forestry:	 Suitable for planting near wetlands or in gully sites. Not suitable. Suitable for gullies, but not those actively eroding. Good potential on favourable sites, otherwise it will be very slow or will fail.
TREE MANAGEMENT: Planting spacing: Pruning: Final stocking:	 Naturally good form. Does not require competition and benets from an open 'light well' site. Suggest 800 sph. This rate can be reduced in a gully when indigenous cover is present at planting. Some form pruning may be required. Clear pruning is untested and may be of little benet. Growing in a conventional forest regime will be rare. More likely to be planted into existing indigenous growth. Will survive very high stocking rates, but this will restrict diameter growth.
GENERAL COMMENTS: **FURTHER INFORMATION:** **EXAMPLES IN HAWKE'S BAY:**	Very good choice for permanently wet sites. 'The Native Trees of New Zealand', J.T. Salmon (1998); 'New Zealand Timbers', N.C. Clifton (1991); 'Indigenous Forestry - Sustainable Management', Ministry of Forestry/NZ Farm Forestry Association (1998); 'What's New in Forest Research?' - No. 173 & No. 243. • 'Falomai' - Patoka; • Ball's Clearing Reserve - Puketitiri; • Holt Forest Trust - Waikoau;

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Table 101

BOTANICAL NAME: **COMMON NAME:**	Fagus sylvatica (fae' gas) English Beech, European beech
ORIGIN: **FORM:** **POTENTIAL HEIGHT:** **GROWTH RATE:** **MATURITY TO HARVEST:** **TIMBER QUALITIES and UTILISATION:**	Europe and southern England. Deciduous, round-headed tree, with silky-haired young foliage. Autumn foliage is an attractive gold/orange/brown. 40 metres. Slow to start, then medium. It's hard and strong timber has been prized in Europe for furniture, indoor nishing and ooring. Is not durable when exposed to the weather.
SITE PREFERENCES: Soils: Cold tolerance: Wind tolerance: General:	 Prefer lime-rich, well drained soils, with adequate available water into which the roots can extend - Melanic, Pallic mid slope, Recent alluvial, Brown, and possibly Allophanic. Hardiness 5 - 8. Within primary shelter, it is capable of withstanding considerable wind. Good survival on gravels as a shelter belt at Rissington
RISKS: Animal pests: Insect pests: Diseases: General:	 Prized as a specimen tree, with F. sylvatica var. 'Purpurea' (copper beech) being spectacular. With permanent trunk protection, this species will make excellent shade if pruned to allow light under the tree. Needs a sheltered paddock site. Marginal use due to slow growth. Given time, will perform well as it handles trimming. Not suitable. No known examples in Hawke's Bay.
PURPOSE: Amenity: Shelterbelt: Erosion: Forestry:	 Suitable for planting near wetlands or in gully sites. Not suitable. Suitable for gullies, but not those actively eroding. Good potential on favourable sites, otherwise it will be very slow or will fail.
TREE MANAGEMENT: Planting spacing: Pruning: Final stocking:	
GENERAL COMMENTS: **FURTHER INFORMATION:** **EXAMPLES IN HAWKE'S BAY:**	There are some spectacular, high-trimmed, pure beech or copper beech shelterbelts in England that are quite old. (One planted at the time of the 'Battle of Colloden'.) 'What tree is that?' S. Macoboy (1979); 'The Trees of New Zealand - Exotic Trees: The Broad/eaves', J.T. Salmon (1999). • Frimley Park - Hastings (for F. sy/vatica and F. sy/vatica var .'Purpurea'); • 'Eland' driveway - S.H.5; • Ridgemount Road - Tutira.

"O leave this barren spot to me!
Spare, woodman, spare the beechen tree."

Thomas Cambell 1777-1844
(The Beech Tree's petition)

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Table 102

BOTANICAL NAME: **COMMON NAME:**	Ginkgo biloba (gin' koh) Ginko, Maidenhair tree, Duck's foot tree
ORIGIN: **FORM:** **POTENTIAL HEIGHT:** **GROWTH RATE:** **MATURITY TO HARVEST:** **TIMBER QUALITIES and UTILISATION:**	China. Deciduous conifer, pyramidal shaped, spreading tree with spectacular, golden autumn foliage. 40 metres in a warm climate. Medium - believed to survive for over 1000 years.
SITE PREFERENCES: Soils: Cold tolerance: Wind tolerance: General:	 Tolerates a range of soils and seems to survive on exposed dry sites - Pallic, Allophanic, Pumice, Melanic, Brown, Recent alluvial and steeplands. Hardiness 3-10, withstands severe cold, but thrives in summer heat. Seems to tolerate moderate levels of wind without suering branch damage. Better in sheltered sites or where wind is buered by primary shelter. Withstands pollution in cities and tolerates a fair degree of salt wind. Male trees do not produce pungent fruits (Ginkgo biloba var. 'Fastigiata' is an erect male variety).
RISKS: Animal pests: Insect pests: Diseases: General:	
PURPOSE: Amenity: Shelterbelt: Erosion: Forestry:	 Attracts over-wintering Monarch butteries in Cornwall Park, hastings A spectacular specimen tree for its shape, foliage and hardiness in the open. Suited to many conditions as an amenity tree. Under-rated. The more erect forms could be a good contrast in mixed species, multi-row shelterbelts. Unknown qualities but could be suitable for a dicult, not actively eroding, site. Not suitable.
TREE MANAGEMENT: Planting spacing: Pruning: Final stocking:	 There is little experience to date with on-farm planting - but it has good potential. If using it for erosion control work, then suggest 400 sph (5m by 5m). Cost may be prohibitive.
GENERAL COMMENTS: **FURTHER INFORMATION:** **EXAMPLES IN HAWKE'S BAY:**	Fossil records show this species existed across the northern hemisphere some 200 million years ago. It was thought by the western world to be extinct until 1730, when it was brought out of China. Its tolerance to such a wide range of conditions, and its beauty, make it a choice worth including on any property. The leaves and fruit do have medicinal properties, but the market for these is untested in New Zealand. The products derived from gingko are a huge worldwide industry. 'What tree is that?' S. Macoboy (1979); • Cornwall and Frimley Parks - Hastings; • Puketapu Park - Puketapu; • Latham Street, Napier.

Table 103

BOTANICAL NAME: **COMMON NAME:**	Juglans nigra (joo' glans) Black walnut
ORIGIN: **FORM:** **POTENTIAL HEIGHT:** **GROWTH RATE:** **MATURITY TO HARVEST:** **TIMBER QUALITIES and UTILISATION:**	Eastern North America. Deciduous, tall, domed crown on a straight trunk. 35 metres. Medium/fast in good conditions. 40-50 years. Heartwood varies from light to dark brown in colour. Excellent for furniture, carving, gunstocks and for sliced veneer.
SITE PREFERENCES: Soils: Cold tolerance: Wind tolerance: General:	 Fertile, well drained soils. Pumice, mid slope Pallic, Recent alluvial, Allophanic, Brown, and Melanic. Hardiness 4-10. Susceptible to out of season frosts. Best in sheltered sites. Is one of the most dicult trees to correctly site to obtain good performance for timber.
RISKS: Animal pests: Insect pests: Diseases: General:	 Magpies and possums may break leaders and young branches. Fungal infection from large pruning wounds.
PURPOSE: Amenity: Shelterbelt: Erosion: Forestry:	 An impressive, large specimen if plenty of space is available in suitable conditions. Not suitable. Not suitable. A potentially valuable timber in the long term, but must be very carefully sited to perform. To obtain a straight trunk, it is essential to obtain a good seed provenance.
TREE MANAGEMENT: Planting spacing: Pruning: Final stocking:	 Early competition is required to encourage form and height growth, possibly with another species in the short term e.g. poplar, alder. Suggest about 600 sph. Form and clear pruning will be required to control the tree's tendency for heavy branch spread. To provide the space required for this long-term tree, nal stocking may need to be about 100 sph or less on dry sites.
GENERAL COMMENTS: **FURTHER INFORMATION:** **EXAMPLES IN HAWKE'S BAY:**	If the initial plantings do not grow with good form, they can be felled and the stumps will coppice - usually with much straighter stems. There have been many attempts to grow this variety in Hawke's Bay with minimal success. Juglans regia Is much easier, has valuable, edible nuts and quality timber in time. 'New Zealand Timbers', N.C. Clifton (1991); 'What tree is that?' S. Macoboy (1979); 'The Trees of New Zealand - Exotic Trees: The Broadleaves', J.T. Salmon (1999). • Downstream from White Pine Bush Scenic Reserve - S.H.2 Tutira; • 'Maraetara' - Seafield Road; • 'Omatua' - Rissington; • Lake Tutira rest area - S.H.2 Tutira.

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Table 104

BOTANICAL NAME: **COMMON NAME:**	Juglans regia (joo' glans) Common walnut, European walnut
ORIGIN: **FORM:** **POTENTIAL HEIGHT:** **GROWTH RATE:** **MATURITY TO HARVEST:** **TIMBER QUALITIES and UTILISATION:**	Persia, southeast Europe. Deciduous, large, wide spreading tree with a round crown. 30 metres. Medium. 50-80 years. NZ grown timber is as good a quality as European with the same density. Heartwood is variable grey-brown with very dark streaks, sapwood is near white. Easily worked wood with a good nish, suitable for carving and turning, cabinet making and gunstocks.
SITE PREFERENCES: Soils: Cold tolerance: Wind tolerance: General:	 Fertile, well drained soil. Pumice, mid slope Pallic, Recent alluvial, Allophanic, Brown, and Melanic. Hardiness 4-10. Relatively sheltered site.
RISKS: Animal pests: Insect pests: Diseases: General:	 Fungal infection from large pruning wounds. If you want to retrieve the walnuts, the race is on against rooks, possums, rats and pigs!
PURPOSE: Amenity: Shelterbelt: Erosion: Forestry:	 An impressive, large, multi-purpose tree, which does not have much autumn colour. Provides shade, nuts and beauty. Not suitable. Not suitable. Has excellent, long-term timber potential.
TREE MANAGEMENT: Planting spacing: Pruning: Final stocking:	 Early competition is required to encourage form and height growth, possibly with another species in the short-term e.g. poplar, alder. Suggest about 600 sph. Form and clear pruning will be required to control the tree's tendency for heavy branch spread. To provide the space required for this long-term tree, nal stocking may need to be about 100 sph or less on dry sites.
GENERAL COMMENTS: **FURTHER INFORMATION:** **EXAMPLES IN HAWKE'S BAY:**	During pruning, particular care must be taken to not damage the branch collar, which can be quite extended on this species. It is important that wound healing is as rapid as possible to guard against infections. Is well suited as a shade tree around stockyards - animals nd the bark unpalatable. 'New Zealand Timbers', N.C. Clifton (1991); 'What tree is that?' S. Macoboy (1979); 'The Trees of New Zealand - Exotic Trees: The Broadleaves', J.T. Salmon (1999). • 'Washpool Station' -Valley Road; • 'Oakmere' - Te Pohue; • 'The Horseshoe' - Tukituki.

Table 105

BOTANICAL NAME: **COMMON NAME:**	Knightia excelsa (nai' teea) Rewarewa, New Zealand honeysuckle
ORIGIN: **FORM:** **POTENTIAL HEIGHT:** **GROWTH RATE:** **MATURITY TO HARVEST:** **TIMBER QUALITIES and UTILISATION:**	New Zealand - North Island and northern South Island. Evergreen with glossy foliage that readily forms a straight, clear trunk when grown in a forest. 30 metres. Medium. 50+ years. Pale reddish/pinkish brown wood is spectacularly gured with medullary rays and is prized for furnishing and inlay woodwork. The heartwood produces a ne nish but is not durable for exterior use. The core wood is defective and should be cut out on milling.
SITE PREFERENCES: Soils: Cold tolerance: Wind tolerance: General:	 Tolerates a wide range of soils that are well drained - Pumice, Allophanic, Brown, and Pallic slopes. Naturally occurs up to 850 metres above sea level in the North Island and Marlborough Sounds. Susceptible to out-of-season frosts. Appears to be good, but may not perform well in the open when it is young. Moderately drought tolerant. Prefers high levels of overhead light and is best planted in established cover.
RISKS: Animal pests: Insect pests: Diseases: General:	
PURPOSE: Amenity: Shelterbelt: Erosion: Forestry:	 Its narrow form with a clear base makes it a good choice for a shade tree, but it may be dicult to achieve this in the open. Should be grown in a group of trees. Possible in a mix for secondary shelter. Not suitable - unless grown as interplanted species in existing forest area. One of the shortest rotation length indigenous species with potential for timber.
TREE MANAGEMENT: Planting spacing: Pruning: Final stocking:	 Needs competition to encourage a straight clear trunk - 'light well' situation. Suggested stocking rates over >1100 sph in conjunction with a nurse crop. Will need form pruning. Timber quality and yield will benet from clear pruning. Unknown yet. Will probably handle close nal spacing >350 sph.
GENERAL COMMENTS: **FURTHER INFORMATION:** **EXAMPLES IN HAWKE'S BAY:**	Could be expensive on a per hectare basis to establish, particularly when including a nurse crop. Despite this, this beautiful tree is well worth planting. 'Indigenous Forestry- Sustainable Management', Ministry of Forestry/NZ Farm Forestry Association (1998); 'New Zealand Timbers', N.C. Clifton (1991); "The Trees of New Zealand - Exotic Trees: The Broadleaves', J.T. Salmon (1999). 'What's New in Forest Research?', No. 173 & No. 243. Naturally occurring trees at: • 'Longridge' - Patoka; • 'Raumati' - Patoka; • Tangoio Scenic Reserve - S.H.2; • Mohaka Forest - Kotemaori;

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Table 106

BOTANICAL NAME: **COMMON NAME:**	Larix decidua (la' riks) Larix kaempferi European larch Japanese larch
ORIGIN:	Southern and Central Europe to Romania. Central Japan (The following information refers directly to L. decidua as most early Hawke's Bay experience is with this variety. But many attributes of L . kaempferi are similar.)
FORM:	Deciduous conifer, apical, with slightly drooping older branches. Has attractive yellow/orange autumn foliage. These two varieties will hybridise readily.
POTENTIAL HEIGHT:	36 metres.
GROWTH RATE:	Medium. Typically 0.5 - 1.0 m per year when young, slowing later.
MATURITY TO HARVEST:	In excess of 50 years to obtain the best quality timbers.
TIMBER QUALITIES and UTILISATION:	The heartwood is a yellowish brown to brick-red colour, with prominent growth rings while the sapwood is a pale brown. Its strength is good, with medium density, often erected 'green' into framing. Has been utilised for log houses. Sapwood can be preservation treated. Attractive structural or appearance grade timber.
SITE PREFERENCES:	
Soils:	Prefers deep, well drained, but moist soil (especially in the spring) - Pumice, Brown and Allophanic. Best in areas with >1400 mm rainfall.
Cold tolerance:	Hardiness 4-9. Will not tolerate out-of-season frosts. Does not like hot, dry sites.
Wind tolerance:	Does not perform well in persistent wind or sea winds due to foliage damage.
General:	Deep rooting, wind-stable trees. Unlikely to topple but may have some branch breakage and stem distortion.
RISKS:	
Animal pests:	
Insect pests:	
Diseases:	Susceptible to leaf cast and canker problems.
General:	It has a moderate wilding risk so be careful of planting in very high wind zones.
PURPOSE:	
Amenity:	Soft, green spring foliage and yellow autumn foliage.
Shelterbelt:	An option in east to west running shelterbelts, as it is deciduous.
Erosion:	Where other species cannot grow due to cold, slope planting is ideal as long as the erosion is not severely active.
Forestry:	Larch is an option on cold sites.
TREE MANAGEMENT:	
Planting spacing:	Requires close initial planting to restrict branching -1000-1200 sph.
Pruning:	Traditionally not pruned, but knots need to be small for quality structural timber.
Final stocking:	Strategically thin to maintain diameter growth. Depending on rotation length, a nal stocking of 300-400 sph.
GENERAL COMMENTS:	A very popular choice in NZ 100 years ago, but is no longer commercially planted. Larch varieties are a specialist commercial option, but are worth considering for attractive diversity. Larch are a 'low ammability' species, so could be used near buildings or on boundaries. The mature heartwood is stunning as exposed beams. L kaempferi is a popular choice for its attractive, orange coloured autumn foliage. It will withstand drier and warmer sites than L decidua.
FURTHER INFORMATION:	'New Zealand Timbers', N.C. Clifton (1991); 'The larches', K. Miller (1988).
EXAMPLES IN HAWKE'S BAY:	• Near Te Pohue settlement by Ohurakura Road junction; • Paterson's, Hendley Road, Patoka; • S.H.2 near the 'Devil's Elbow'; • Kereru Station terraces facing Mangleton Road; • Makahu Station, Pakaututu.

Table 107

BOTANICAL NAME: **COMMON NAME:**	Metasequoia glyptostroboides (me ta see kwoy' a) Dawn redwood, water larch, water fir
ORIGIN: **FORM:** **POTENTIAL HEIGHT:** **GROWTH RATE:** **MATURITY TO HARVEST:** **TIMBER QUALITIES and UTILISATION:**	Hupeh Province, China. strongly apical, deciduous conifer, with the branches angling upwards. 35 metres (as yet only planted post-1948 in NZ). Medium/fast on good sites. Low density wood, otherwise unknown as yet.
SITE PREFERENCES: Soils: Cold tolerance: Wind tolerance: General:	 Soils retaining adequate moisture throughout the year - Recent alluvial, Pallic and Brown on lower slope, Pumice, but not Gley soils with anaerobic conditions. Hardiness 5-10. Generally wind tolerant and holds good form, however the branches will distort away from strong wind. Most suited to sheltered, lower valley slopes or ats.
RISKS: Animal pests: Insect pests: Diseases: General:	 Possums will ring bark smaller branches. Need to protect the trunk from stock damage at all times - especially cattle.
PURPOSE: Amenity: Shelterbelt: Erosion: Forestry:	 An attractive, deciduous conifer with colourful spring and autumn foliage. Erect form and deciduous character provide summer shade. Not suitable. Suitable for lower slope and gully erosion control, but not actively eroding sites. Currently not an option.
TREE MANAGEMENT: Planting spacing: Pruning: Final stocking:	 If using the tree for erosion control work or gully planting, follow the Sequoia recommendations, perhaps using a wider spacing to reduce costs.
GENERAL COMMENTS: **FURTHER INFORMATION:** **EXAMPLES IN HAWKE'S BAY:**	 'The redwoods', K. Miller (1993). • 'Te Motu' - Waihau Rd; • 'Langridge' - Patoka; • 'Maraetara' - Seafield Road; • Frimley Park - Hastings.

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Table 108

BOTANICAL NAME: **COMMON NAME:**	Metrosideros excelsa (metrohsi' duros) Pohutakawa
ORIGIN: **FORM:** **POTENTIAL HEIGHT:** **GROWTH RATE:** **MATURITY TO HARVEST:** **TIMBER QUALITIES and UTILISATION:**	Coastal northern half of the North Island and associated islands. Wide spreading, evergreen tree with gnarled branches. Profusion of crimson owers in summer. 20 metres. Medium. Heartwood is a rich, reddish brown colour. Timber is heavy, strong and durable. It is rare to find many straight trunks growing naturally, so there has been limited experience using the wood.
SITE PREFERENCES: Soils: Cold tolerance: Wind tolerance: General:	 Can withstand very exposed sea-edge sites, sometimes producing aerial roots to gather moisture - Recent alluvial, Melanic, Allophanic, Pallic, Brown, coastal Pumice and Raw sand. Can be successfully grown on inland sites that have a low-frost risk. Resistant to strong winds, except if heavily laden with salt which 'cuts' the foliage.
RISKS: Animal pests: Insect pests: Diseases: General:	 Foliage is palatable to all animals.
PURPOSE: Amenity: Shelterbelt: Erosion: Forestry:	 Magnicent choice for shade, beauty and benet to birds and bees. It has been grown successfully in shelterbelts but can be slow and requires trimming to control branches. Untried, but as there are few coastal species that thrive, ii has potential. Not in wet or actively eroding sites. Considered to have a fast growth rate for an indigenous species, has a valuable timber, but dicult to grow straight.
TREE MANAGEMENT: Planting spacing: Pruning: Final stocking:	 Its timber potential is often discussed, but getting the tree into a forestry system has been untried. There are straight trees on Mayor Island and they need to be sourced for seed. If you want to try a hectare then high stocking would be needed, suggest >1600 sph, possibly 2000. The reason ii doesn't grow straight has something to do with its ancestry; has a predisposition to grow lateral branches.
GENERAL COMMENTS: **FURTHER INFORMATION:** **EXAMPLES IN HAWKE'S BAY:**	If it can be grown in your area, is well worth establishing due to its many benets - nectar for birds and bees, beauty, resistance to insect and disease, suitability for trimmed shelter and a possibility of gaining some valuable timber in future generations. The sawdust and shavings can be used for smoking bacon and sh. It is an easy plant to establish from seed. Yellow and white owering strains are available. There is a beautiful pohutukawa forest on Mayor Island. 'The Native Trees of New Zealand', J.T.Salmon (1998); 'New Zealand Timbers', N.C.Clifton (1991); 'Indigenous Forestry- Sustainable Management', Ministry of Forestry/NZ Farm Forestry Association (1998) • 'What's New in Forest Research?' No. 173 & No. 243. • Corner of Juli and Carnell Streets - Napier; • Marine Parade - Napier; • Marine Parade - Wairoa.

Table 109

BOTANICAL NAME: **COMMON NAME:**	Nothofagus fusca (nothoh fae' gus) Red beech, Tawhairaunui
ORIGIN: **FORM:** **POTENTIAL HEIGHT:** **GROWTH RATE:** **MATURITY TO HARVEST:** **TIMBER QUALITIES and UTILISATION:**	New Zealand's cooler areas. Erect form developing a straight trunk. The leaves of juveniles are bright red in winter, greening in maturity. On mature trees, old leaves fall as the spring leaves emerge. 42 metres. Medium/fast. 50 - 70 years. Heartwood is light to medium reddish-brown and is the most durable and stable wood of our beeches. Mainly used for furniture, turning and joinery. The wood corrodes iron in moist situations. Can be dicult to mill and season, with 'quarter-sawing' being best for stability.
SITE PREFERENCES: Soils: Cold tolerance: Wind tolerance: General:	 Requires better soils than the other beech species, with good drainage - Pumice, deep Brown, Allophanic (upland sites), Podzol and Melanic. Requires du (forest oor litter) as part of the mulch in which it is planted. Unknown on the hardiness scale, but would be expected to cope with fairly high level considering current growing range. Not very tolerant of wind, so requires a relatively sheltered environment. The most site demanding of all the indigenous beeches. Reports of sun burning on the foliage of older trees - could be a problem on hot and exposed sites in Hawke's Bay.
RISKS: Animal pests: Insect pests: Diseases: General:	 Cambium and stem borer, especially if under stress and as the trees age. Dicult to establish in the open and subsequently requires low levels of competition for good growth.
PURPOSE: Amenity: Shelterbelt: Erosion: Forestry:	 Not suitable unless they are common in your area - try black beech. In cold areas, this may be a good choice (also consider the hardier black or silver beech). Suitable if your options for other species are limited by growing environment i.e. high altitude, very cold - only for east-west direction. Planted as shelter running north to south will be too windy and exposed for them to perform well. Slow growing and so not suitable for actively eroding sites. Establishment dicult, best interplanted with other species. High potential for cooler climates with the management and market already established.
TREE MANAGEMENT: Planting spacing: Pruning: Final stocking:	 Establishment in the open is reported to be dicult, so companion plant or use a 'light well' system in existing cover, suggest >600 sph including nurse crop. Seedlings are poor competitors, but have good apical dominance. Need to remove branches for clearwood and for health purposes - reduce pinhole borer attack. Become large crowned trees on maturity, so may require nal stocking of around 150 sph.
GENERAL COMMENTS: **FURTHER INFORMATION:** **EXAMPLES IN HAWKE'S BAY:**	Establishment for forestry in open ground needs care, but the potential in growth rate and timber quality is high. N. menziesii (Silver beech) is slower, has poorer form and is prone to borer attack. N. solandri (Black beech) wood is not as durable but the tree is hardier in the open. 'The Native Trees of New Zealand', J.T.Salmon (1998); 'New Zealand Timbers', N.C.Clifton (1991); 'Indigenous Forestry - Sustainable Management', Ministry of Forestry/NZ Farm Forestry Association (1998); 'What's New in Forest Research?' No. 173 & No. 243. 'The redwoods', K. Miller (1993). • 'Oakmere' - Te Pohue; • Ball's Clearing Reserve - Pukelitiri; • Kaweka and Ruahine Ranges.

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Table 110

BOTANICAL NAME: **COMMON NAME:**	Picea sitchensis (pai' see a) Sitka spruce
ORIGIN: **FORM:** **POTENTIAL HEIGHT:** **GROWTH RATE:** **MATURITY TO HARVEST:** **TIMBER QUALITIES and UTILISATION:**	North-western North America. Evergreen conifer with a narrow apical form. 65 metres. Medium. 40 - 50 years. Light coloured heart and sapwood, non-durable, medium density wood. Its high strength-to-weight ratio makes it suitable for specialist uses including gliders and musical instruments (good resonance). Used extensively for pulp and building in North America and Europe.
SITE PREFERENCES: Soils: Cold tolerance: Wind tolerance: General:	 Moist, well drained site, with >1200 mm rainfall - Pumice, Brown, upland Allophanic, and Recent alluvial. Hardiness 4-8. Late season frosts and 'cold ponding' areas can be fatal. Dislikes persistent and severe winds. Seems to be very site sensitive. However, ii has been reported to tolerate some salt wind that may reduce the eect of aphids. Prefers to have its stem in permanent shade on a cool site.
RISKS: Animal pests: Insect pests: Diseases: General:	 Very prone to aphid attack, especially if on a warm, humid site (slows growth dramatically). The benecial variety of Mycorrhizae (root fungi) has not yet been identied for NZ introduction.
PURPOSE: Amenity: Shelterbelt: Erosion: Forestry:	 An attractive tree when in a healthy state, which is more likely to occur when space planted. Not suitable. Possibly some gully sites but is hindered by frost vulnerability. Not suitable for actively eroding sites. It is not considered a commercial option because of slow growth and no signicant timber qualities, plus its susceptibility to aphid attack. However, some enthusiasts plant it for diversity
TREE MANAGEMENT: Planting spacing: Pruning: Final stocking:	 Requires sucient numbers for mutual competition to control branch size - at least 800 sph. Very dicult to prune with numerous prickly branches and a tendency to grow epicormics. Best to maintain a high stocking to ensure small branches. Once a good stem with small branches has been established, thinning can occur to allow incremental growth of the trunk. Final spacing is possibly around 250 sph.
GENERAL COMMENTS: **FURTHER INFORMATION:** **EXAMPLES IN HAWKE'S BAY:**	P. sitchensis was chosen for this guide due to its popular recognition. Some of the other Picea varieties may be better suited to Hawke's Bay conditions - although little local evidence is available. P. smithiana (West Himalayan spruce) is performing very well at Holt Forest Trust, Waikoau. 'The spruces', K. Miller (1989). • 'Trelinnoe' - Te Pohue; • 'Makahu' - Pakaututu; • Dean's- Nuhaka.

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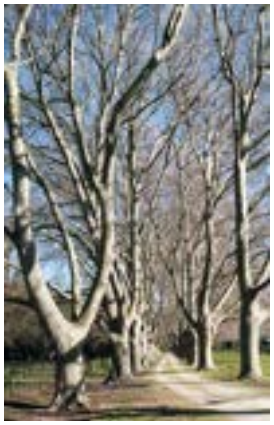
Table 111

BOTANICAL NAME: **COMMON NAME:**	Platanus acerifolia (syn hispanica) (pla tan' us) London plane tree
ORIGIN: **FORM:** **POTENTIAL HEIGHT:** **GROWTH RATE:** **MATURITY TO HARVEST:** **TIMBER QUALITIES and UTILISATION:**	A hybrid between the American P. occidentalis and the European P. orientalis. Deciduous, with wide-spreading branches, developing a rounded crown. 44 metres. Medium, although fast in the rst few years. 50+ years. Pale brown coloured, stable timber, attractive very ne 'medullary ray' eect similar to the native rewarewa. The wood nishes well but is non-durable. It is mainly used for decorative purposes as a solid wood or veneer.
SITE PREFERENCES: Soils: Cold tolerance: Wind tolerance: General:	 Withstands a wide range of soils and can tolerate low moisture levels once established - Pallic, Allophanic, Pumice, Brown, Melanic, and Recent steepland and alluvial soils. Hardiness 4-9. Surprisingly good for a large-leafed tree. Severe wind slows the growth rate and causes form distortion. An incredibly hardy tree as proven in cities around the world, with street surfacing right up to the trunk and regular topping to control the branches creating a 'pollard' (see Glossary).
RISKS: Animal pests: Insect pests: Diseases: General:	 Susceptible to fungal invasion on wounds - a reason why HBRC does not grow poles from stools in its nursery.
PURPOSE: Amenity: Shelterbelt: Erosion: Forestry:	 Excellent shade tree, makes an impressive ornamental, but requires plenty of room. Excellent choice planted individually or as a mixed species shelterbelt if it is regularly side-trimmed. May be a substitute for traditional species in some medium moist sites - the stumps readily coppice. It is much slower growing than poplar and willow and would not suit actively eroding sites. It is not identied as a strong candidate for forestry, but would be a great choice for growing in a farming/woodlot system.
TREE MANAGEMENT: Planting spacing: Pruning: Final stocking:	 If planting for erosion control use 8 - 10 metre spacing (100 to 156sph). If for forestry then 4.5m by 3.5m (634sph) possibly inter-planted with a companion species to encourage form. Plant rooted material. Corrective pruning is essential to maintain good form, plus clear pruning to a desirable height. Require plenty of space to 'express' their potential. Uneven competition will deform the trunk creating timber stresses.
GENERAL COMMENTS: **FURTHER INFORMATION:** **EXAMPLES IN HAWKE'S BAY:**	The Platanus species deserve much more attention. On one site, a number of young London plane trees are growing with their trunks unprotected in an intensive bull beef system, without suering any bark damage. They can be managed under power wires by 'pollarding' for fodder and rewood. Easily propagated from cuttings and possible to establish from poles in ideal conditions. A tip for pole planting - pour some potting mix around the pole to provide a good rooting medium. 'Meetings with Remarkable Trees', Thomas Pakenham (2002); 'What tree is that?', Stirling Macoboy (1979); 'The Trees in New Zealand - Exotic Trees: The Broadleaves', J. T. Salmon • 'Longridge' - Patoka; • Farndon House - Clive (avenue); • Cornwall Park - Hastings; • Lake Tutira rest area - S.H.2 Tutira; • On the streets of Hastings and Napier, plane trees show their tolerance to the • extremes of abuse with vehicle pollution and tarseal !



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BOTANICAL NAME: **COMMON NAME:**	Podocarpus totara (poh' doh kah pus) Totara
ORIGIN: **FORM:** **POTENTIAL HEIGHT:** **GROWTH RATE:** **MATURITY TO HARVEST:** **TIMBER QUALITIES and UTILISATION:**	New Zealand - from North Cape to Stewart Island, but most abundant in central North Island. A spreading, bushy tree in the open, but a narrow form with a clear trunk if grown in competition. It will grow to massive dimensions in time. 40 metres. Slow in the natural competitive habitat - untested in plantation regimes. 50+ years if plantation managed. Possibly longer to be assured of natural timber durability. A soft, but very durable, red-brown coloured wood, for in-ground and water purposes. Being very stable when seasoned, it is easily worked for carving, joinery and furniture. Straight grain enables easy splitting, but the heartwood is quite brittle. Natural oils in the wood make it hard to coat with paint or oils.
SITE PREFERENCES: Soils: Cold tolerance: Wind tolerance: General:	 Suited to Pallic, Brown, Pumice, Allophanic, Melanic , and Recent steeplands/alluvial. Intolerant of poorly drained, badly aerated Gley and Podzol soils. Hardiness 9-11. Naturally occurs up to about 480 metres above sea level, where in some areas it gives way to P. hallii - a smaller, but hardier variety. Tolerant of wind, but this may cause poor tree form. "Need a moist season to establish successfully in a scrub environment" - John Dean, Nuhaka. Tolerant of dry soils and seasonal drought. Very under-rated as a timber tree.
RISKS: Animal pests: Insect pests: Diseases: General:	 A 'smut fungus' can occur and cause severe malformation - more common on Hall's totara.
PURPOSE: Amenity: Shelterbelt: Erosion: Forestry:	 Has potential as shade tree. It is common in Hawke's Bay, and is robust. Would require pruning to allow light under trees to maintain grass cover. Established as a shelterbelt, it is a hardy tree that withstands stock around the base and has unpalatable foliage. Could provide timber option, certainly rewood. Suitable for erosion control work although not on actively eroding sites . As yet untested as an intensively managed timber tree. From observing naturally occurring trees in Hawke's Bay, ii is apparent that seed source and growing regimes need to be given serious thought.
TREE MANAGEMENT: Planting spacing: Pruning: Final stocking:	 To ensure good stem form, suggest planting at 3m by 3m on open sites or 5m by 5m in light wells or with companion species. Worthwhile to achieve maximum clearwood, but avoid restricting tree growth by over pruning. If planted as a dense stand, which is its natural growing situation, let ii self prune over time. Form pruning is necessary to remove double leaders. Observation of tree growth will dictate when and to what degree thinning operations need to occur over the long growing cycle till harvest.
GENERAL COMMENTS: **FURTHER INFORMATION:** **EXAMPLES IN HAWKE'S BAY:**	Totara has a high potential for farm forestry use, especially for timber or as a secondary long-term shelter species. The timber of old trees competes with any other species for natural durability. 'The Native Trees of New Zealand', J. T. Salmon (1980); 'New Zealand Timbers', N.C. Clifton (1991); 'Indigenous Forestry - Sustainable Management', Ministry of Forestry/NZ Farm Forestry Association (1998); 'What's New in Forest Research' - No. 173 & No. 243; 'Totara: establishment, growth and management', D. Bergin (2003). • 'Gwavas Station' - Tikokino; • Glenross Farm - Gunson's, Glenross Road; • 'Monkton's Reserve' - Makaretu; • 'Gallen's Bush' - Ohurakura Road; • Holt Forest Reserve - Waikoau.

Table 113

BOTANICAL NAME: **COMMON NAME:**	Pseudotsuga menziesii (sur doh soo' ga) Douglas r, Oregon Pine
ORIGIN: **FORM:** **POTENTIAL HEIGHT:** **GROWTH RATE:** **MATURITY TO HARVEST:** **TIMBER QUALITIES and UTILISATION:**	Western North America. Evergreen conifer with strong apical growth of relatively narrow form. 100 metres - that is probably at 400 years. Medium on good sites, slow but steady in very cold areas. Could be as soon as 30 years, but maintains its growth rate and timber quality improves with increasing age, thus the optimal time may be 50 - 70 years. Reddish brown heartwood, most suited to use out of the weather. A strong, stable structural timber highly regarded in the Northern Hemisphere. It is non-durable in the ground, but is durable for interior uses. Commonly used for exposed beams.
SITE PREFERENCES: Soils: Cold tolerance: Wind tolerance: General:	 Well drained soils, receiving >1200mm rainfall on cooler southerly and easterly aspects, upland Allophanic, Pumice, Brown, Podzol, Recent steepland. Hardiness 4-9, frost tolerant to-16° but out-of-season frosts, especially in 'cold ponding' areas, can be fatal. Branches deform, with severe wind restricting growth rate still performs reasonably well. Prefers higher altitude (up to 900m asl) in the North Island where rainfall is more reliable and temperatures cooler. Is intolerant of salt-laden wind and heavy clay soils. Tolerates shading and close competition. It will also grow well on cool sites at lower altitudes if the roots have a reliable water source, but not what would be considered a wet site.
RISKS: Animal pests: Insect pests: Diseases: General:	 Deer will cause damage through browsing and rubbing on young trees. Possums are a serious problem. A number of insects browse but seldom cause any serious problems. 'Swiss needle cast' fungus appears to be a problem in trees stressed by inappropriate siting or overcrowding. Roots interact with neighbouring trees, so do not poison trees or stump regrowth. Trunks exposed to the sun on hot, dry sites distort and bleed. Has a relatively high wilding risk so care is needed for windy sites.
PURPOSE: Amenity: Shelterbelt: Erosion: Forestry:	 Stately conifer if plenty of space is available. Can be successfully side-trimmed into a dense hedge. Suitable on slopes that have the potential to erode. Very high value crop, especially in a long rotation of 50+ years. Productivity peaks at age 60-90 years! Ideal for colder areas.
TREE MANAGEMENT: Planting spacing: Pruning: Final stocking:	 Requires close initial planting to provide early branch growth restriction-1200 to 1600 sph. Traditionally not pruned, but knots need to be less than 40 mm for quality structural timber. Strategically thin over the years to maintain diameter growth. Depending on rotation length, a final stocking of 400-600 sph. Will stand closer spacing than many other species and continue to perform well for at least 100 years! Crops respond well to delayed production thinning (around 25 years of age). 'Wind -throw' is a risk if thinning is too dramatic at one ti me.
GENERAL COMMENTS: **FURTHER INFORMATION:** **EXAMPLES IN HAWKE'S BAY:**	Provenance trials (1958 on) show a consistently higher performance from seedlots of the California and Oregon 'fog bells' (low altitude coastal areas). From these, an intensive improvement-breeding programme is continuing. 'Fort Bragg' and 'Bertaleda' origin seedlots are a good Hawke's Bay choice. 'New Zealand Timbers', N.C. Clifton (1991); 'Douglas r', K. Miller (1994); New Zealand Farm Forestry Association - Information Leaflets; 'Green Solution' evaluation program - NZ Farm Forestry Association. • 'Gwavas Forest' provenance trials; • 'Raumati' - Patoka; • Te Waka Forest - Te Pohue (high altitude); • Holt Forest Trust - Waikoau.

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BOTANICAL NAME: **COMMON NAME:**	Robinia pseudoacacia (roh bin'ee a) Black locust, false acacia
ORIGIN: **FORM:** **POTENTIAL HEIGHT:** **GROWTH RATE:** **MATURITY TO HARVEST:** **TIMBER QUALITIES and UTILISATION:**	Appalachian Mountains, eastern USA. Usually seen as a wobbly-stemmed, deciduous, round headed tree. There are now improved straight-stem strains available. 30 metres. Medium. 25 - 30 years on good sites. Very dense, strong and durable, medium golden -brown coloured heartwood. Used for many exterior purposes. Suitable for untreated posts or poles. Tough enough for tool handles.
SITE PREFERENCES: Soils: Cold tolerance: Wind tolerance: General:	 To achieve good growth rates, deep, imperfectly drained sites are best - lower slope for Pallic, Pumice, Brown, Allophanic, Melanic, and Recent alluvial soils. Hardiness 3-9. Intolerant to strong wind that can break branches and leaders, deforming the trunk. Leguminous species, capable of growing in, and rejuvenating, nutrient starved sites such as erosion scars.
RISKS: Animal pests: Insect pests: Diseases: General:	 The puriri moth may be a problem in some areas. This thorny species suckers prolically. Be careful where you plant it!
PURPOSE: Amenity: Shelterbelt: Erosion: Forestry:	 Has an interesting character, but undesirable habits - thorns and suckers. Not suitable. Suitable for lower slope and gully sites. Widely used for erosion control because of its aggressive root system and suckering habit. Some Hungarian strains are showing promise of straight form and rapid growth. If durability is required, this variety is well worth trying.
TREE MANAGEMENT: Planting spacing: Pruning: Final stocking:	 Grown in a nurse crop (e.g. tagasaste, alder) it responds well by producing a tall and straight log. Suggest planting about 600 sph. Requires pruning and early correction of strong apical branches. There is limited forest experience in Hawke's Bay to date, but management is probably similar to Acacia species, with a nal stocking rate of about 250 sph.
GENERAL COMMENTS: **FURTHER INFORMATION:** **EXAMPLES IN HAWKE'S BAY:**	Very good nectar source for bees. 'New Zealand Growing Today', June 2002; 'New Zealand Timbers', N.C. Clifton (1998); The Trees in New Zealand - Exotic Trees: The Broadleaves', J. T. Salmon (1999). • 'Glenlands' - Eskdale; • Jack Kirk's - S.H.5 just after 'Marshalls' bridge; • 'Kopanga Station' - Havelock North; • Paterson's - Bridge Pa.

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BOTANICAL NAME: **COMMON NAME:**	Sequoia sempervirens (see kwoi' ya) Redwood, Californian redwood, Coast redwood
ORIGIN: **FORM:** **POTENTIAL HEIGHT:** **GROWTH RATE:** **MATURITY TO HARVEST:** **TIMBER QUALITIES and UTILISATION:**	Coastal California, USA. Evergreen conifer with strong apical dominance, acknowledged as the tallest conifer in the world. 120 metres. Fast when juvenile. 50 - 80 years - maintains signicant incremental growth to at least 100 years! Possible at 30 years, but it is unlikely to be very durable at this age. Traditional use for water tanks where no taint is important. Low density, stable, moderately durable, red-brown heartwood, pale sapwood with darker growth veins. Contains high levels of tannin. Not ideal for structural use (brittle), but used for joinery, interior and exterior cladding. Slow seasoning reduces warping and checking.
SITE PREFERENCES: Soils: Cold tolerance: Wind tolerance: General:	 Soils retaining adequate moisture throughout the year- Recent alluvial, Pallic and Brown on lower slope, Pumice, and Gley soils, but not Organic (wet) soils. Hardiness 8-10. Young growth can be damaged by below-9 °C frosts, especially late frosts. Severe winds tend to distort branch growth and break tip growth, causing multiple leaders. Likes reasonably sheltered sites. Will not tolerate salt laden winds in our dry Hawke's Bay climate. Is very shade tolerant.
RISKS: Animal pests: Insect pests: Diseases: General:	 The foliage is palatable to animals. Possums can ring-bark, and magpies can break the growing tip causing double leaders. The 'NZ drywood termite' can penetrate to the heartwood via dead branches. Occasional canker fungus damage to trunk especially susceptible under stress.
PURPOSE: Amenity: Shelterbelt: Erosion: Forestry:	 'Cathedral-like' atmosphere under mature groves. Foliage is a minor problem in long wool. Not suitable in Hawke's Bay. The stumps coppice, so the roots do not die on harvesting. Good for moist, sheltered sites. Suitable for really wet gullies with inlled oors and Gley soils, marginal for severely eroding gullies. Very high timber potential on selected moist, reasonably sheltered sites.
TREE MANAGEMENT: Planting spacing: Pruning: Final stocking:	 Apical dominance reduces need for competition; suggest planting 600 sph to provide selection. Closer planting would require early thinning and cause problems with coppice growth. Can be interplanted with a companion species to provide the necessary early competition. For timber- dead knots degrade the timber and can introduce borer insects, so ideally prune to 8-10 metres, maintaining a small defect core. Can stand fairly close spacing dependent on soil moisture levels and tree size. 300- 500 sph seems to be a sound aim, but will require monitoring. Has a remarkable ability to accelerate growth when provided with space, even after 200 years!
GENERAL COMMENTS: **FURTHER INFORMATION:** **EXAMPLES IN HAWKE'S BAY:**	Due to traditional demand in the Western USA, which is in short supply due to conservation, there is serious overseas investment in establishing commercial forests in NZ. Extensive eld trials of clonal material are being established throughout NZ. Like Douglas r, redwood experiences signWicant incremental growth from age 30. Timber durability is greater with age, so 50 plus year harvest rotations seem to be desirable. The bark and crowns are highly re resistant. Consider companion planting with Alnus spp. 'NZ Redwood Grower's Handbook'. Wade Cornell (2002); 'New Zealand Timbers', N.C. Clifton (1991); NZFFA Sequoia Action Group - Russell Coker 03 358 7211 Email: russell.coker@xtra.co.nz 'The redwoods', K. Miller (1993). • Holt Forest Trust - Waikoau; • Te Mata Park - Havelock North; • 'Te Motu' - Waihau Rd; • 'Maraetara' - Seafield Road; • Ted Bibby - Onga Onga.

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BOTANICAL NAME: **COMMON NAME:**	Sequoiadendron giganteum (see kwoi ya den' dran) Wellingtonia, Californian big tree, giant redwood
ORIGIN: **FORM:** **POTENTIAL HEIGHT:** **GROWTH RATE:** **MATURITY TO HARVEST:** **TIMBER QUALITIES and UTILISATION:**	Central California, USA. Evergreen conifer, with strong apical growth and dense foliage - acknowledged as the largest, by volume, tree in the world. 94 metres. Medium. 50 - 80 years - will maintain steady growth indenitely. Wood contains high levels of tannin. Low density, durable, reddish-brown heartwood (darker and coarser than Sequoia sempevirens). Marketed as redwood.
SITE PREFERENCES: Soils: Cold tolerance: Wind tolerance: General:	 Is intolerant of permanently wet sites - Gley soils, but suits Pumice, Pallic, Brown, Allophanic, Melanic and Recent steepland and Recent alluvial that is well drained. Hardiness 6-10 - withstands regular -20 °C frost in Europe. Good - very stable in high winds. Withstands some salt winds. Originates from higher altitudes than Sequoia sempevirens. More site tolerant than redwood.
RISKS: Animal pests: Insect pests: Diseases: General:	 Foliage is generally unpalatable, but animals may strip the bark. Canker will sometimes appear on the trunk, causing a top 'blow-out'. More susceptible under stress. It is becoming very prevalent in lowland environments. Seed source is crucial as inbreeding greatly inhibits the potential.
PURPOSE: Amenity: Shelterbelt: Erosion: Forestry:	 If plenty of room is available, it is an impressive ornamental choice with good form. A slow, but eventually impressive shelter tree for very cold sites. Little is known, however it would be suitable for slope and some gully sites. In very cold areas, it would be a good long-term choice for a durable decorative limber.
TREE MANAGEMENT: Planting spacing: Pruning: Final stocking:	 Not trialled in New Zealand, but management probably similar to Sequoia sempevirens. Note: Tom Hartree at 'Te Motu' has a small block of pruned trees that are shaping up well.
GENERAL COMMENTS: **FURTHER INFORMATION:** **EXAMPLES IN HAWKE'S BAY:**	Not commonly planted, but has more potential than is currently recognised. Some trial work is proceeding in the South Island high country. The bark and crowns are highly re-resistant. Has been successfully used, untreated, for above ground deer fence battens. 'The redwoods', K. Miller (1993); 'What tree is that?' Stirling Macoboy (1979). • 'Te Motu' - Waihau Rd; • Corner of Rissington/Soldiers Settlement Rd; • Cornwall and Frimley Parks - Hastings; • Ridgemount Road - Tutira.

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BOTANICAL NAME: **COMMON NAME:**	Taxodium distichum (taks oh' dee am) Swamp cypress, bald cypress
ORIGIN: **FORM:** **POTENTIAL HEIGHT:** **GROWTH RATE:** **MATURITY TO HARVEST:** **TIMBER QUALITIES and UTILISATION:**	Central/Southern USA, Mississippi River. Broadly conical, deciduous conifer, with haphazardly drooping branches. Has a wide buttressed base in swampy conditions, but in well-drained conditions has a steady taper. Attractive, soft green foliage in the spring and summer, then rust-brown late autumn colours. 35 metres. Medium rate when young, slows as it ages. The heartwood is dark coloured, low density and lightweight, but is very durable in the ground.
SITE PREFERENCES: Soils: Cold tolerance: Wind tolerance: General:	 Withstands wetter conditions than most other trees- to the extent that it will form 'knees' for the underwater roots to breath. Once established it will grow in water. Recent alluvial, Organic, lower slope waterlogged Pumice and Gley. Hardiness 6-10. Suers from severe wind damage due to brittle branches. It will also grow well away from water, particularly in well drained but moist soils (lower slope Pallic). Intolerant of drought if the soils dry out too much.
RISKS: Animal pests: Insect pests: Diseases: General:	 Very palatable foliage
PURPOSE: Amenity: Shelterbelt: Erosion: Forestry:	 A very attractive ornamental in moist soil conditions. Not suitable. Suitable for gully planting, particularly where soils are wet, but not actively eroding gullies as it would be too slow growing. Not considered a commercial forestry choice, but the wood is very durable with age, so has a potential for exterior uses.
TREE MANAGEMENT: Planting spacing: Pruning: Final stocking:	 The form is not naturally straight, so if you expect timber, plant them close (suggest >1000 sph), or preferably interplant with species that will encourage better form (e.g. Alnus spp.). Most planting will be in small lots. If planting in a gully, then plant at 3m by 3m. At maturity they require space possibly down to <200 sph.
GENERAL COMMENTS: **FURTHER INFORMATION:** **EXAMPLES IN HAWKE'S BAY:**	T. ascendens (pond cypress) has similar properties, growing to 18 metres in a narrower ascending branch form. Its foliage colours later- extending the autumn eect. This is considered by some to be of better potential than T. distichum. T. mucronatum (Montezuma cypress) is also similar. One specimen in Tule, Mexico, has an irregular trunk of 57 metres in girth - reputed to be the largest of any single tree in the world. 'The redwoods', K. Miller (1993); 'Remarkable Trees of the World', Thomas Pakenham (2002). • 'Te Motu' - Waihou Road; • Anderson Park- Greenmeadows (with 'knees'); • Dean's - Nuhaka; • Whararangi Lawn Cemetery- Poraiti; • Windsor and Cornwall Parks - Hastings; • Lake Tutira rest area - S.H.2 Tutira.

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BOTANICAL NAME: **COMMON NAME:**	Thuja plicata (thoo' ya) Western red cedar
ORIGIN: **FORM:** **POTENTIAL HEIGHT:** **GROWTH RATE:** **MATURITY TO HARVEST:** **TIMBER QUALITIES and UTILISATION:**	Western North America. Evergreen conifer with strong apical dominance and aromatic dark green foliage. 60 metres. Slow/medium. 40-50 years. Very light, low density but strong. Heartwood is variable dark brown to pinkish brown. Durable for above ground use such as exterior cladding and split shingles. Good for carving, joinery and panelling.
SITE PREFERENCES: Soils: Cold tolerance: Wind tolerance: General:	 Moist, well drained soils with high rainfall >1400 mm/yr. It will survive on waterlogged and/or impoverished sites- upland Pumice, Allophanic, Brown, Gley, and Recent steepland. Hardiness 5-11 - grows best in cool conditions, suering severely in hot/dry climates. Strong wind creates stress, particularly in dry conditions, leading to other serious problems. Tolerates shading well- has been recorded emerging through bracken after a number of years.
RISKS: Animal pests: Insect pests: Diseases: General:	 Bark is susceptible to damage at all ages. Possums are a problem at all times. Borer insects are a serious problem in some areas, particularly the native 'two-toothed longhorn' beetle, which gains entry to the heartwood via dead branches or damaged bark. Fungal rot in the stem is quite common and can be serious enough to be fatal. Severe trunk uting in NZ is detrimental for timber production - may be seed source or siting that is responsible.
PURPOSE: Amenity: Shelterbelt: Erosion: Forestry:	 Generally not used for stock shade, but may be suitable around buildings. There are many cultivars of Thuja available. Suitable in the right site which is very limited in Hawke's Bay. Not suitable. To date, the Hawke's Bay experience has been disappointing with severe problems with borer, excess uting, non-durable heartwood timber with dead knots unless it has been intensively pruned.
TREE MANAGEMENT: Planting spacing: Pruning: Final stocking:	 Needs competition to restrict branch size, especially on fertile sites. Suggest planting at 1000 sph. Essential to produce a clearwood product. A multi-visit pruning programme will be required. Readily produces epicormic regrowth in the open or over-pruned situation. Tolerates shading well, but will progressively need space to maintain diameter growth. Final stocking of about 250-300 sph.
GENERAL COMMENTS: **FURTHER INFORMATION:** **EXAMPLES IN HAWKE'S BAY:**	This species is not recommended for Hawke's Bay. There are few sites where ii will do well as the species is intolerant of the extremes of moisture and temperature. 'New Zealand Timbers; N.C. Clifton (1991); 'Cryptomeria, Thujaand Tsuga', K. Miller (1997). • 'Rangiora' - Patoka; • 'Mahoe' - Patoka. (Both examples have recent infestations of borer which are causing die- back and breakages.)

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BOTANICAL NAME: **COMMON NAME:**	Ulmus procera (ul' mas) English elm
ORIGIN: **FORM:** **POTENTIAL HEIGHT:** **GROWTH RATE:** **MATURITY TO HARVEST:** **TIMBER QUALITIES and UTILISATION:**	England and north-west Spain. A deciduous, straight-trunk tree with a narrow form, said to be a 'gure-of-eight' shape. 40 metres. Medium. 50+ years. Sapwood is pale, heartwood is a dull brown. Wood is medium density, of a coarse texture and is not durable except if in constant running water. Is an excellent tough timber for furniture, boat building and wood turning.
SITE PREFERENCES: Soils: Cold tolerance: Wind tolerance: General:	 Tolerates a range of soils- Recent alluvial, Organic, Allophanic, Pallic, Melanic, Pumice and deep Brown. Hardiness 4-9. Withstands wind well, but older branches are prone to breakage. Will tolerate soils that are periodically waterlogged in winter. Under-rated tree for Hawke's Bay.
RISKS: Animal pests: Insect pests: Diseases: General:	 Bark beetles spread the 'Dutch elm' fungal disease. Dutch elm disease has devastated the Northern Hemisphere, but is contained in New Zealand. The prolic suckering needs to be considered - it may be an advantage, or a problem if not grazed by cattle. Old trees can unexpectedly drop branches.
PURPOSE: Amenity: Shelterbelt: Erosion: Forestry:	 A good choice for stock shade and amenity as it is a handsome tree with impressive yellow autumn foliage. Once mature, the bark is not at risk from most livestock. A good option for a mixed species secondary shelter. Highly suitable. The extensive root system will sucker prolically and will endure if the parent is harvested. Might be dicult to get established in an actively eroding site, but worth trying. Highly desired traditional timber, with naturally straight form and reasonably fast growth. There is the possible risk of 'Dutch elm disease'.
TREE MANAGEMENT: Planting spacing: Pruning: Final stocking:	 Early competition is required to encourage form and height growth, possibly with another species in the short term e.g. poplar, alder. Suggest about 600 sph. Form and clear pruning will be required to control the trees' tendency for heavy branch spread. To provide the space required for this long-term tree, nal stocking may need to be about 100 sph or less.
GENERAL COMMENTS: **FURTHER INFORMATION:** **EXAMPLES IN HAWKE'S BAY:**	Sets no fertile seed, so is propagated from cuttings or suckers. Foliage has been a preferred fodder for cattle in past history. For single specimens, grafted non-suckering plants are available. 'New Zealand Timbers, N.C. Clifton (1991); 'What tree is that?' Stirling Macoboy (1979); 'The Trees of New Zealand- Exotic Trees; The Broadleaves; J. T. Salmon (1999). • Rissington settlement area; • Te Aute settlement area; • Old 'Rawhiti Settlement'-Glengarry Road; • Hastings/Havelock North Road (planted in late 1800s); • Gilbertson's - Patangata.

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BOTANICAL NAME: **COMMON NAME:**	Vitex lucens (vai'teks) Puriri
ORIGIN: **FORM:** **POTENTIAL HEIGHT:** **GROWTH RATE:** **MATURITY TO HARVEST:** **TIMBER QUALITIES and UTILISATION:**	New Zealand subtropical/temperate coastal areas to about mid North Island. Wide-spreading, evergreen tree with glossy leaves, producing attractive red/pink owers and berries almost all year round. 20 metres. Medium. 50 years. Reddish-brown colour, heavy and dense, great strength and durability. The grain is irregular and uneven, making it dicult to work. Used extensively in the past for in-ground purposes. Takes a very high polish.
SITE PREFERENCES: Soils: Cold tolerance: Wind tolerance: General:	 Dry to moist soils, not wet - Pallic, Recent alluvial and slope, coastal Pumice. Will not tolerate frosts, requires protection during its juvenile years. Relatively safe in coastal Hawke's Bay. Reasonably tolerant of wind. Withstands sea exposure. Requires strong overhead sunlight when growing in a canopy. Can be planted out in the open.
RISKS: Animal pests: Insect pests: Diseases: General:	 Puriri moth (Hepialis virescens) often bores into the trunk, spoiling some of the timber.
PURPOSE: Amenity: Shelterbelt: Erosion: Forestry:	 If not too cold, it is a very attractive shade choice producing fruit for birds most of the year. In coastal situations, it is suitable for mixed species shelterbelts. Suitable for slope erosion control and gully areas as long as frosts are light e.g. Mahia Peninsula. Not suitable for actively eroding sites. High potential on warm, frost-free sites.
TREE MANAGEMENT: Planting spacing: Pruning: Final stocking:	 Requires close competition to encourage a single stem form, suggest 1100 to 1600 sph in a pure stand. Could be more cost eective to use a nurse crop, lowering sph requirements of the tree. Will probably need some form and clear pruning to increase timber yield, and will possibly reduce the risk of puriri moth infection if the wounds heal quickly. As it has a similar shape and habit to A. melanoxylon, nal stocking may be about the same - around 200 sph.
GENERAL COMMENTS: **FURTHER INFORMATION:** **EXAMPLES IN HAWKE'S BAY:**	The greatest risk is from the larvae of the puriri moth, especially if the trees are under stress. 'Indigenous Forestry- Sustainable Management', Ministry of Forestry/NZ "j_ Farm Forestry Association (1998); 5":; 'The Native Trees of New Zealand', J. T. Salmon (1998); 'New Zealand Timbers', N.C. Clifton (1991); 'What's New in Forest Research?' No. 173 & No. 243. • 'Maraetara' (Kipper & Esther Reserve) - Seafield Rd; • • Scattered examples in Havelock North.

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Further Reading

- Bergin, D. (2003) Totara: establishment, growth and management, New Zealand Indigenous Tree Bulletin, No. 1. Forest Research, Rotorua.
- Charlton, J.F.L. (ed) 2003 Using Trees on Farms.
- Clifton, N.C. (1991) New Zealand timbers: the complete guide to exotic or indigenous woods.
- Cornell, Wade (2002) New Zealand redwood growers' handbook.
- Macoboy, Stirling (1979) What tree is that?
- Miller, K. (1989) The larches. FRI Bulletin No. 124 – Part 3. 17pp.
- Miller, K. (1989) The spruces. FRI Bulletin No. 124 – Part 6. 20pp.
- Miller, K. (1989) The silver firs – Abies spp. FRI Bulletin No. 124 – Part 7. 20pp.
- Miller, K. (1993) The redwoods. FRI Bulletin No. 124 – Part 13. 31pp.
- Miller, K. (1994) Douglas fir. FRI Bulletin No. 124 – Part 14. 38pp.
- Miller, K. (1996) The cypresses. FRI Bulletin No. 124 – Part 9. 33pp.
- Miller, K. (1997) Cryptomeria, Thuja and Tsuga. FRI Bulletin No. 124 – Part 16. 30pp.
- Miller, K. et al (2000) Ash Eucalypts. FRI Bulletin No. 124 – Part 18. 58pp.
- Ministry of Forestry/New Zealand Farm Forestry Association (1998) Indigenous forestry – sustainable management.
- Pakenham, T. (1996) Meetings with remarkable trees.
- Pakenham, T. (2002) Remarkable trees of the world.
- Salmon, J.T. (1998) The native trees of New Zealand.
- Salmon, J.T. (1999) The trees in New Zealand: exotic trees – the Broadleaves.
- Snook, L.C. (1986) Tagasaste/Tree Lucerne – high production fodder crop.

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Farm Forestry
Tree Establishment and Management

In previous chapters, we have outlined the farm forestry zones of Hawke's Bay, with their unique combination of geology, soil types and climate, and have provided detailed information on the specific tree species and the suitability of each of these within each planting zone.

This chapter provides advice on the planting and the management of your trees. If you want further advice or information you can always come along to farm forestry field days. The local branch currently has an appropriate field day annually looking at the basic principles of planting, species selection, and tree management. Join the New Zealand Farm Forestry Association. Membership entitles you to a very informative magazine called "Tree Grower" that is produced four times a year.

Pre-plant preparations

Fencing

Prior to planting, it is important to ensure fencing is stock-proof. With electric fences, the risk of stock invasion tends to be greater than with standard fences due to electric current failure, especially when the vegetation becomes long and wet. The fencing may need to occur some years in advance, particularly if you are intending to plant a nurse crop of trees for a later planting of another variety. For example, a tagasaste nurse crop for later planting of puriri and totara.

Ordering seedlings

Order tree seedlings early to ensure you obtain quality stock. This is essential with Special Purpose Species (SPS), as nurseries usually have limited numbers of these higher value seedlings. Some of these take two or three seasons to prepare for sale. For bulk orders, a deposit and staged payments may be required. If you are ordering indigenous species, try to get PB3 size or larger if you can afford it, particularly if you expect a low rainfall in spring and summer. They have more resilience and are easier to see above the grass when you need to release spray or hand release.

Pest and weed control

Control of rabbits, possums, goats, deer and hares needs to be completed before, and maintained during, the establishment phase. See later in this chapter for more detail on the control of mammal and insect pests.

Pre-plant weed control of woody weeds is essential for successful tree establishment. Some of this must be done well in advance, up to two years for blackberry and gorse. In this case, it is not only essential to enable the permanent removal of the woody species but it also ensures there are no residual chemical effects on the newly planted trees. Due to limited chemical choices, most SPS seedlings are difficult to effectively weed release after planting. Therefore, pre-plant spraying with a suitable chemical to kill pasture is the best option. This can have the additional benefit of reducing moisture and nutrient competition at planting and afterwards. However, when digging a hole, it may be necessary to shift to another spot due to rocks, roots etc. making re-spraying of the site necessary following planting. In this case, clear the ground around the seedling to one metre in diameter.

Chemicals respond differently to soils, climates, and seasons. Expert advice must be obtained on the use of chemical sprays or, if this is unavailable, treat a trial plot and observe the effects on your site. The good thing about pre-plant spraying is that you can see where to plant and can direct your workers accordingly. For more information on weed control, see the section on Release Spraying later in this chapter.

Obtain quality advice.

Sequoia sempervirens planted into pre-sprayed spots, 2003. Source: ***Susan Mackintosh***

Tips :

1. EscortTM herbicide must be kept away from all Eucalyptus species and Cedrus deodara once planted (However, it can be used up to 6 weeks prior to planting). In dry climates, EscortTM should be kept away from all trees. This is unfortunate, as it is a very effective chemical on blackberry!
2. You can use GardoprimTM (in pellet or spray form) for a pre-plant knockdown as it is very effective. However, the chemical is a residual and you will need to scarf the site and throw away the dead turf. Take about an inch of soil away to remove any potential chemical left in the soil. This in turn may allow aggressive weeds to regrow and compete requiring follow up treatment.

Be carefull when spraying weeds around the base of trees using herbicide chemicals that can move from one plant to another through the roots or soil. Source: ***Kevin Thomsen***

Seed source - genetics

Genetics is one of the critical factors in successful forestry. We tend to accept the plants that are available without question, even though the trees from that particular seed source may not be ideally suited to our conditions. The breeding history influences every aspect of the tree's potential – frost tolerance, form, insect and disease resistance, growth rate, timber qualities and, therefore, profitability.

A good example of this can be seen at Gwavas Forest. In the late 1950s, a provenance trial of Douglas fir was established, with the seed originating from various altitudes in California, USA. Today, the trees that originated from lower altitude sites (Bertaleda and Fort Bragg) are of a harvestable size, whereas the neighbouring trees from alpine sources are still only thin stems.

By initially planting high numbers, you improve the final selection that suits your growing conditions through thinning of the poorer quality trees. With indigenous species, it is generally not critical that the species are seed-sourced locally, what we call 'eco-sourced'. But, as we learn more about our indigenous species and further our aims at protecting the remaining biodiversity of areas, it becomes more reasonable and responsible to try and source your plants from local seed sources.

Nursery practices and tips

Forest species for timber and shelter belts

Many forest species can be supplied as one year old plants, for example, Pinus radiata, Cupressus, Eucalyptus and Acacia spp. Other species, such as Sequoia sempervirens, Cedrus deodara, Larix spp. and Pseudotsuga menziesii, are supplied as two year olds due to their slower nursery stage growth.

The bulk of forest species are grown in nursery beds and are supplied as 'bare rooted' (open ground grown) plants. This means that they are supplied with their roots free of soil. Some species of trees and some situations make it desirable to grow and supply the plants in containers.

Desirable factors to consider when ordering and collecting forest species plants:

- Stem diameter/height ratio – A minimum factor of 1:60 is used. This means a minimum stem diameter of 5 mm for a plant height of 300 mm.
- Root mass – The tap root must be cleanly cut without sweep and be callused over (this shows sufficient pre-transplant preparation), with numerous lateral roots all trimmed to a root:shoot balance of 1:3, i.e. one-third roots, two-thirds stem and foliage. This is important because during early establishment, the roots have to be able to keep up with the evapotranspiration from the foliage, especially in a hot, dry, windy spring season. Trials have indicated this ratio provides the necessary root mass.

Examples of good balance between the roots and the foliage of a 'bare-rooted' plant, Cupressus lusitanica, well prepared by the nursery for successful planting. Source: ***Kevin Thomsen***

- Mycorrhiza – This is a beneficial fungal growth attached to the plant's roots and visible as root nodulations and sometimes as fluffy filaments. Mycorrhizae are effectively extensions of the plant's root system and are essential to plant health and nutritional status.
- Stem stiffness – This is an indicator of adequate pre-transplant conditioning. The stem should not be limp, as this indicates juvenile growth. Instead it should be woody and rigid.
- Handling and storage – Plants will be packaged in cartons or polybags. Neither of these should be stored in the wind, sun or in hot areas such as a hot shed or vehicle. Keep in a cool, sheltered, shaded but not dark situation, and make sure the roots are not allowed to dry out. Properly packaged and carefully treated seedlings can be stored safely for a few days, but the sooner they are planted the better. Nurseries should provide handling recommendations.
- Topping – This is a routine nursery practice with some species (e.g. P. radiata, Cupressus, Eucalyptus, Acacia spp.) to encourage stem stiffness, stem diameter, plant balance and assist in conditioning the plant for transplanting. Although this results in multiple-leader regrowth, one shoot rapidly becomes dominant (apical dominance).

Amenity/shade plants

Amenity or shade plants can be up to four years old before planting. They should have had regular root-trimming to ensure safe transplanting with minimal stress. In general, amenity species are more likely to be deciduous than evergreen. If the plants are evergreen, the broad principles and recommendations in the forestry section will apply.

Local nurseryman Bill Lawrence advises "The bigger the plant – the bigger the risks. The smallest size that conditions allow you to plant is best, maintaining roots in balance with the top. Transplant risk increases with age."

Though deciduous species are leafless in the winter, they are not lifeless. Care must still be applied to their handling. Again, 'big is not necessarily beautiful' applies as there is great risk in transplanting unbalanced (root:shoot) trees in drought-prone Hawke's Bay.

Container grown plants

Many nurseries and garden centres present plants in some form of container. There is a risk of holding plants too long within a container as they can stagnate, a state from which they will struggle to recover. In round plastic containers or polybags, roots circle and, unless these are cut or straightened, natural root development will be hampered once transplanted. Root-trainer type containers train the roots into a good structure that encourages the correct development of roots after transplanting.

Before planting container grown seedlings, soak them thoroughly by immersing in a trough until bubbles stop rising. This loads the root mass with water, making it less susceptible to stress from evapotranspiration. The addition of mulching material around the base of the tree can be of significant benefit.

'Paddockwood'. Bill and Margaret Lawrence's mixed species nursery in early autumn. Source: **Kevin Thomsen**

Heeling in

If you are unable to immediately plant barerooted seedlings, dig a trench in the vegetable garden or some other well cultivated soil, spread the plants out along the trench and fill it in, compacting the soil around them so that no air pockets remain around the roots. Even under soil, air pockets can result in the roots drying out. Be cautious about leaving bundles of plants tied when heeled in the ground. Keep the soil moist. If plants are 'content' in this heeled-in situation, you will notice on lifting that some will have developed new root shoots. Therefore, it is important not to leave plants too long otherwise they will move out of the semi-dormant state for which the pre-transplanting conditioning in the nursery has prepared them.

Plant spacing

Plant spacing refers to the planting density required for your trees. It varies greatly, particularly with indigenous species and Special Purpose Species where the purpose of the trees is not geared towards a commercial forest or woodlot situation. Overplanting is common and this can cause problems, such as over-competition, which can result in trees becoming deformed or dying. Check the spacing guide in Appendix V to identify the numbers required at different plant spacings.

Commercial forest/woodlot

Points to keep in mind when deciding on the spacing between trees at establishment are:

- Farm plantings need to be considered differently from traditional forest situations. In most cases, farmed land has a history of fertiliser application plus livestock fertility transfer. This fertilizer can have a detrimental affect on tree growth and form. The trees will grow fast, but usually with a distorted form and they have a high potential for toppling in the first few years. Planting high numbers of trees can reduce these problems.
- Smaller blocks of trees have a greater proportion of edge trees. The form of these trees will suffer from the effects of wind, unrestricted light and space. Edge trees require closer planting to provide extra competition to reduce the above effects.
- Individual tree species have different requirements for space, light, and competition, so quality guidance needs to be obtained.
- Genetics has a dramatic effect on both the growing requirements and the end result. Selected seed sources or cutting grown seedlings can have significant benefits, despite the extra cost per unit. These benefits include improved form, growth rate, timber qualities and disease resistance.
- Landowners can use their knowledge of microclimates to effectively vary the planting rate. A sound recommendation with most conifers is to plant using a high stocking rate on fertile, windy sites (up to 1500 sph) and reduce to lower rates on sheltered, medium-low fertility slopes or valley bottoms (down to 600 sph).
- Consider the size and natural form of the species being planted. With some Special Purpose Species, final spacing may be similar to the establishment spacing, as their natural form will provide the timber requirements you are looking for. This spacing may seem an enormous distance initially, but it will reduce establishment costs and remove the need to cull expensive trees at a later date.

An alternative is to plant a 'companion' nurse crop (e.g. tagasaste) or trees can be inter-planted, (e.g. Alnus rubra) providing competition to encourage good form plus shelter, ground cover, nitrogen, firewood, bee and bird food. Another option is to plant sacrifice trees, such as poplar or pine – but be aware of the risk of domination and the physical difficulties of later removal.

There is information on plant stocking rates in the Pinus radiata species guide (Chapter 3) that is applicable to many other forest species. Many of the other species guides also have general recommendations for plant spacing.

An example of companion planting (nurse crop) where Tagasaste (Chamaecytisus palmensis) has been planted amongst red oak Quercus rubra. Source: ***Kevin Thomsen***

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Eucalypts are very susceptible to bending away from competition, as graphically shown in this photo. To avoid this, thin them evenly. Source: ***Kevin Thomsen***

Shade/Amenity Trees

Shade/amenity trees have been identified because of their ability to grow well in an open situation. However, be aware that trees grown in the open develop a different form from those close planted. Poor form and heavy branching can result. Protection from animals is of primary concern, but any protection for a young tree from severe wind and its related stress is also beneficial.

Shelterbelts

Strategic placement for maximum primary shelter sometimes uses highly productive land. However, the benefits from a narrow single or double row (4-5m wide) shelter strip are dramatic and have been well documented from trials.

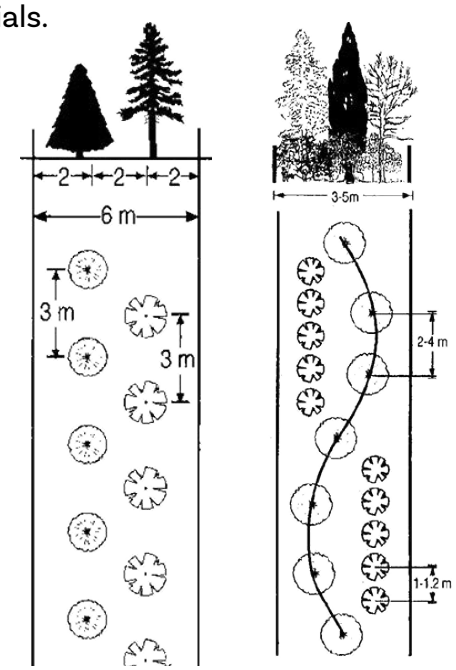


Figure 42 : Shelterbelt options

Erosion Control

Erosion control is generally achieved through poplar and willow plantings on targeted sensitive areas. A number of varieties and methods are used, with tree spacing being dependent on the type of erosion and level of risk. There is more information on poplar and willow in their respective species guides (Chapter 3). Contact the Hawke's Bay Regional Council for specific advice and assistance.

Lombardy poplars space planted on Kitchin's property, Kahuranaki Road, Tukituki valley. Source: ***Garth Eyles***

Riparian protection

Plant spacing is generally controlled by the species and their effect on neighbouring plants and the waterway. Most native trees and shrubs will form a canopy within three to five years when planted at spacing of 1.5–2 metres. Natives spaced further apart may never form a continuous canopy, in which case weeds will proliferate. The space requirements of mature trees should not govern the spacing used at planting time, as during their growing time span, many species grow faster and taller when in close company with other plants. Natural competition will gradually favour the most vigorous growers.

An example of two year old indigenous species planted at 2m spacing at Lake Tutira Country Park. Excellent pre-plant pasture control with spray and good sized plants has enabled a good growth rate and a successful result. Source: ***Garth Eyles***

Planting times

Bare-root seedlings (Open ground grown)

In Hawke's Bay, mid-June to mid-August is recommended for planting bare-rooted seedlings depending on soil moisture, wind exposure, frost risk and species choice. Get advice from your nursery supplier and from experienced locals.

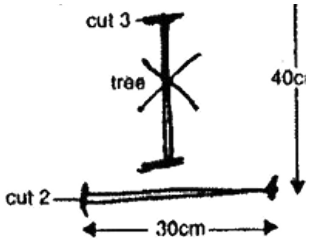
Container grown seedlings

There are definite benefits in using containers because the roots are undisturbed at planting. This suits sensitive, hard to transplant species, frost susceptible varieties (allowing later spring planting), and hard, dry sites.

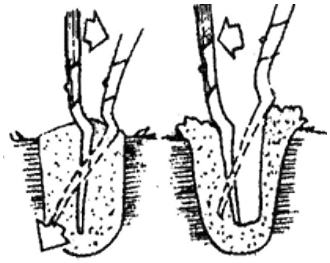
Planting methods

Basically there are two methods of planting trees:

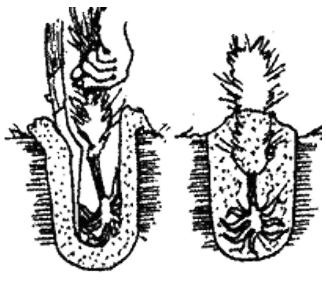
1. **The Forestry Technique.**
   This method is used for planting many forestry species in a quick and efficient way. The following diagram shows this classic 'forestry technique'.



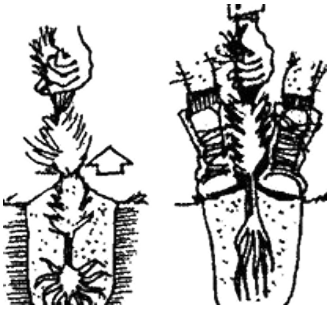
1. Orientation of the three spade cuts and final location of the tree.



2. Use the first two cuts to cultivate.



3. Place the tree in the third cut, and fill with soil.



4. Pull up and firm.

2. **The Traditional Technique**
   Many species do not suit the forestry technique. They require the digging of a more traditional hole. The soils will dictate just how much digging is required to break up your planting site. With large ornamental seedlings, you will need to dig a large hole and remove all of the soil, carefully replacing it amongst the roots (leaving no air gaps) and firming, slightly lifting the seedling to straighten the roots as you do so.

A well planted Sequoia sempervirens; pre-sprayed site, hole dug and bare-rooted specimen carefully planted using the traditional technique with the soil replaced and firmed.
Source: ***Susan Mackintosh***

Container grown seedlings must have their very porous root medium (similar to a potting mix soil) covered to prevent it acting like a wick and evaporating moisture into the air. When firming into the ground, do not crush and damage the roots or stem.

A well planted Podocarpus totara: pre-sprayed site with area scarfed to remove chemical, hole dug, tree planted carefully and soil replaced and firmed.
Source: ***Simon Stokes***

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Transpiration stress (the plant's inability to draw up from the undeveloped roots as much moisture as is being evaporated from the leaves) can be fatal, particularly in hot, windy conditions. Plants with a lot of foliage – especially evergreen species – may benefit from topping or side trimming while at the nursery or at planting time.

Post-plant management

Release spraying

Release spraying is the practice of spraying the area over the top and or around the recently established plant. It is the easiest method of weed control, with many effective herbicide sprays and granules containing residual properties available. Residual chemicals remain on the soil surface and inhibit the germination of weed seeds. However, this method is suitable for only a few species other than P. radiata and you need to find out which species these are from the chemical manufacturer or representative, experienced nursery staff, planting contractor, or farm foresters. Container grown seedlings of any species are more susceptible to residual chemicals due to the porosity of the root medium. Uptake of the residual chemical may not kill the tree seedling, but it could seriously affect its growth.

How a post-plant release spray should look in November after planting. Source: ***Simon Stokes***

There are three methods of applying release chemicals:

1. Spraying over the top of the recently planted tree. For Special Purpose Species there are some combinations of non-residual chemicals that can be safely applied in this way (at the correct concentrations). The application of these chemicals over some tree species has not been officially tested by the manufacturers, therefore specific recommendations are not available. You need to treat a test plot to check the results.
2. Spraying around each seedling - carefully! While this would be a timid option for P. radiata, it is the safest option for many other species. This should only be carried out in calm weather. Some tree growers go to the trouble of fashioing a shield from a plastic container, attaching this to a stick and moving it around the tree as they spray. Warning: non-selective sprays may kill the wrong plant if they come in contact with only a small portion of it, including green stems.
3. Using a wick type weed wiper. If used carefully, this is a satisfactory method of applying herbicide, especially if the weather is windy.

There are many variables affecting the results from chemical application. For example:

- spray equipment must be properly calibrated to apply an accurate rate. If using a knapsack, the equipment must be calibrated for each person as everyone has a different walking rate and therefore a unique spray coverage rate. Keep in mind that the terrain will also affect how quickly you can move and cover the individual spots. A good idea is to count the number of spots you spray with a full knapsack to check how much chemical is being applied to each square metre (refer to Appendix III for instructions on calibration of a knapsack).
- the speed of movement for application must be even, especially for over the top spraying. See ('Calibration' appendix 3)

Caution: There are some traps waiting for the unwary in the plant world. Many desired tree species are in the leguminosae (Acacia, kowhai and many others), compositae (daisy type e.g. olera, etc.) & umbelliferae families.

These are susceptible to sprays used to control broadleaf weeds and clovers. Some species of trees or desirable plants are in the grass family (cabbage tree, toi toi etc) and are therefore susceptible to sprays that control grass species.

It is strongly recommended that before using herbicides around trees, advice be sought from experienced farm foresters or specialist chemical retailers.

Post-plant spraying with knapsack and mini-boom on mixed ornamentals using "Been There" marker dye. Source: ***Beverley Thomsen***

Hand Releasing

Hand releasing and mulching are probably the only options with some species, but this is time consuming. Hand releasing means physically pulling weeds out. This pulled foliage, plus bark or straw can be laid around the base of the tree to inhibit weed growth. A number of HBFFA members very successfully mulch around indigenous seedlings, which replaces the need for weed control sprays plus helps to retain moisture in the root zone. The use of old carpets, sacking or weed matting as mulch is also of great benefit to the establishing plant. Do not use polythene sheeting, as it sheds water away from the limited root zone.

Tip: If you have planted indigenous species, you may have to use hand releasing or other weed controlling techniques for up to two years after planting.

Animal pests

Each pest species presents different problems for newly established trees. Possums, rabbits and hares can be devastating to seedlings. The best remedy is eradication before planting! Since this does not always occur, there are some effective spray-on repellents commercially available (e.g. Plantskydd), or you can make up your own brew using egg and acrylic paint or kerosene and fat. This can keep pests away from eating your tree.

Hares are serious trouble. They can slice the tops off many young trees in a single night, returning a few nights later to eat the wilted foliage, which is more palatable by then. Hares

are very hard to poison and not easy to shoot as they are a very alert animal.

Rabbits often dig around newly planted tree roots, resulting in the roots drying out, causing stress or death. Rabbits can ring-bark trees, particularly in the autumn period when the bark is more palatable. Poison bait pellets or shooting are the best control options.

An example of two year old indigenous species planted at 2m spacing at Lake Tutira Country Park. Excellent pre-plant pasture control with spray and good sized plants has enabled a good growth rate and a successful result. Source: ***Garth Eyles***

Possums are now the easiest pest to control with a number of effective poisons available. Possums are browsing animals and are very selective ofthe species they choose to eat. Damage can be severe on the preferred plants.

Goats and deer do not respect fences. Do not underestimate the level of damage goats can create if they access a block of trees. As with sheep and cattle, damage occurs not only when the trees are young; ring-barking and rubbing damage can seriously reduce timber quality or even kill older trees. For information about Animal Pests contact the Hawke's Bay Regional Council.

Grazing stock (sheep, goats, horses, deer and cattle) must be controlled depending on the tree species. Some tree blocks may be grazed safely at an early age, while others are always at risk from cattle ring-barking. Few trees will withstand horses!

Tree protection

If amenity trees are planted in grazed areas, they will need reliable protection, particularly during the establishment years. Some trees require protection all of their life (e.g. Castanea sativa – Sweet chestnut), while others are resistant from an early age (e.g. Platanus spp.) Generally, the worst animals are the adolescents – they get bored and will try just about anything! There is also a seasonal variation, with autumn usually being a time of greatest risk, due to the sap rise increasing the palatability of the stem. Winter is also a time of risk, with animal diets less balanced and females possibly under pregnancy stress.

Types of tree protection range from the well-known plastic netting or smooth sleeves used for poplar and willows, to elaborate post and rail fences. For information and supply of sleeves, contact the Hawke's Bay Regional Council.

Stock damage by Friesian bulls to a shelterbelt of P. radiata. Source: ***Simon Stokes***

Electric fences come in many designs and are excellent when they are working properly, but useless when the power is off or 'shorting out'. Electric wires are great for defence against cattle, horses and deer, though not so effective against woolly sheep with their in-built insulation blanket.

Physical barriers are effective protection against sheep. A successful method for early establishment protection is to use old 200 litre steel drums with the ends removed, supported with two or three stakes. Ensure that the previous contents of the drums are not toxic! An advantage of steel drums is the protected microclimate they provide for the small tree. Extra height may be required later as animals can reach the top of a drum to browse the foliage. The drums must be lifted off before the tree gets too big, and they can be re-used a number of times. Similarly, 120 cm high galvanised weld-mesh, shaped into suitable sized rings and fixed to battens both looks tidy and is re-usable. Preferably use wooden stakes or battens, as they are kinder on chainsaws than metal standards that may have been encapsulated in the trunk! The weld-mesh is

easy to remove at any stage unless the tree trunk has captured it!

Insect Pests and diseases

Insects are often a special concern after planting when the tree has a small leaf area but generally, infestations are not fatal. However, an infestation may deform the shape of the tree limiting timber potential. Often, the damage from insects decreases with the increasing numbers of similar trees planted in a block. Damaging insects include grass grub beetle, manuka beetle, psylids and many others. Spraying can control them, but this is generally not practical or desirable on a large scale. You will need to consider these when choosing your tree species.

There is a constant immigration of undesirable insects that are potentially disastrous for our trees – a good reason to plant a diversity of species to spread the risk.

Most tree species are susceptible to some diseases but their effects are usually minimal. However, canker in C. macrocarpa in Hawke's Bay can be disastrous.

Insect attack is always a possibility – leaf miner damage seen here on some Eucalyptus species.
Source: ***Kevin Thomsen***

Cupressus macrocarpa is extremely susceptible to canker infection in Hawke's Bay. Source: ***Kevin Thomsen***

The individual tree species guides (Chapter 3) have notes on the known serious pest or disease problems that restrict their potential. As these are always changing, it is impossible to ensure that this information is complete and up-to-date, so keep asking questions.

Fertiliser

The need for fertiliser is often ignored when planting trees. While P. radiata nutrient requirements are well understood, little research has been conducted on the needs of Special Purpose Species. Fortunately, most farm soils have adequate nutrients for successful tree establishment, but like pasture and crops, trees will respond to suitably balanced applications of fertiliser. Fertiliser should only be applied in conjunction with soil and foliage analyses that identify deficiencies. Certain tree species such as Eucalyptus require additional nitrogen if the soils are deficient, in their first one or two seasons. Care must be taken not to apply too much nitrogen, or apply it too close to the plant, as this could be fatal. A useful guide is 20-40 grams of urea in a spade slit 250 mm on the lower side of the plant.

Specially formulated, slow release fertilisers (e.g. 'Agroblen'™ encapsulated granules) are available that will release over a period of 6-12 months, depending on soil temperatures, and can be safely applied at planting time.

Do not apply immediately next to the tree roots! .

Trace element deficiencies do occur – Boron is probably the most common and can be identified by foliage sampling then remedied by aerial application. Conversely, too much existing, or added, fertiliser can seriously harm a tree's performance by causing imbalances in growth between roots and foliage. The results can be severe distortion of the tree's form or, at worst, death due to wind-throw. These effects can be reduced by planting high numbers of trees to provide competition.

Some laboratories can test foliage and soil samples, then provide recommendations for a balanced nutrient application. Laboratories include:

- Analytical Research Laboratories Ltd, 890 Waitangi Road, Awatoto. (06) 835-9222.
- Forest Research 'The Forest Nutrition Laboratory', Private Bag 3020, Rotorua. (07) 343-5899

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Tree silviculture

'Silviculture' is literally "the culture of wood", and refers to the management of the growing trees. In New Zealand, the word tends to be restricted to the thinning and pruning phases of a crop rotation (Maclaren, 1993).

Pruning Guidelines

The **branch collar** at the junction of a branch where it joins the tree trunk **must be protected** when pruning. This collar is where the tree defends itself from the invasion of pathogens and where the healing (occluding) of the pruning wound originates. Each species has a different shaped collar. In some instances, it extends out from the trunk along the branch some distance as a tapered swelling (e.g. *Acacia* and *Quercus species*).

If the pruning cut has been made correctly, preferably when the branches are not too large, the occluding of the wound will be rapid and even. This diminishes the risk of harmful pathogens penetrating the wood and causing decay. A neat cut, carried out in dry conditions, is the best defence for the patient. The application of various fungicidal paint treatments has been demonstrated to give only minimal extra protection.

Form pruning is the name given to the shaping of a young tree. Many timber trees and ornamental varieties will require some level of form pruning (also known as preemptive pruning). If this is undertaken while the tree is young, hand secateurs will be quick and easy to use and the effect will not be too obvious. However, if left until past the optimum time and you need a chainsaw for the job, the visual effect and the stress on the tree will be harsh. In the first few years, double leaders and heavy branching need correction. This can be achieved by complete removal of the culprit or by reducing the size of the branch to restore the balance of the tree. If 50% of a large branch is removed, it slows the branch diameter growth at the trunk while the remaining foliage continues to assist in the growth of the tree. Care needs to be taken not to unduly stress the tree by removing too much foliage as this can force 'compensatory growth' on the remaining branches – thus creating a repeat of the problem.

Even healing occurring after a skilfully perfomed pruning cut. Source: ***Kevin Thomsen***

Branch collar location and the cut line for pruning. Source: ***Kevin Thomsen***

Stability pruning: In any windy and fertile site with fast growing and/or shallow rooting species, the 'sail area' of the foliage in relation to the root anchor can be out of balance and may result in toppling. This often occurs with young conifers in a farm forestry situation. Where the tree is growing in soft, fertile soil with weed competition sprayed out, so has no need to spread its roots to achieve successful growth with plenty of foliage. At age 2-4 years, these trees can be at high risk from strong wind, particularly after a rainfall event that has saturated the soil.

To reduce this risk, a method of branch reduction is employed using secateurs (or a 'scrub-cutting' machine if there many branches). The largest branches are cut back by up to 50% of their length so that the bulk of foliage is reduced, giving the tree a narrower form and therefore reducing the likelihood of wind toppling.

An example of a double leader in Eridano poplar that has been left too long and if not pruned soon it will cause splitting. One leader needs to be removed.
Source: ***Simon Stokes***

Other methods of reducing the risk of wind toppling are planting high initial stocking rates or using physiologicallyaged cuttings (those taken from three or four year old parent material which will take on the growth habits of that age, i.e. will be less bushy). Primary shelter is necessary on windexposed sites to reduce growth problems and promote the growth of high quality timber.

Pruning for clearwood: Pruning to produce high value clearwood is still the best option for a farm forester wanting to maximise cash returns because:

- without the economies of scale that large forestry companies have, there is a need to maximise the value of the crop on a per tree basis;
- small blocks of trees have a high proportion of edge trees, whose branches will require mechanical control by pruning as they are not restricted by competition and will grow exuberantly;
- high levels of soil fertility from many years of fertiliser application and from stock grazing, with inherent livestock camps, creates problems in varying growth and form;
- some species are known to self-prune. This process mostly occurs in dense stands and requires time for the dead branches to detach. If the aim is to produce clearwood, then assistance is required to remove the branches (unless you intend to leave harvest for 50 to 100 years!).
-

Timber Quality Issues

In our Pinus radiata industry there is an increasing pressure from the marketplace to produce high quality timber. The technology is developing to readily assess this. In this handbook, we refer to the pruned log that produces a substantial premium over sawlogs. The margin between high quality pruned and unpruned logs is presently somewhere around $100 per tonne. (The same principles apply to many other timber species.)

Density is one of the key quality factors. It is influenced by genetics, site and age. A longer harvest rotation of 28 to 30 years will improve timber quality. However, some climate and/or soil conditions may restrict the economic rotation to a shorter period. For example, in parts of the Tukituki valley, due to the dry climate, tree growth slows dramatically at about age 23 making it desirable to harvest and replant at that stage. Therefore, to obtain high value timber, it is necessary to grow high-density wood in the early years. New seed selections now on the market will provide plants with a potential for growing the higher wood density in those early years.

An example of well-tended Pinus radiata after two pruning lifts. Source: **Jonathan Barran**

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Size is crucial to obtaining the best returns from the forest. Clearwood from a 'butt-log' contains the highest value product from a forest, as long as it has the required dimensions of maximum LED (large end diameter) and minimum SED (small end diameter) measurements. It is possible, in the right growing conditions, to achieve these dimensions beyond the first log, making it economic to prune above the normal 6 - 6.5 metre height. However, the rotation may need to be longer than usual.

Pruned clearwood is potentially high value timber as long as it is not spoilt by growth defects like spiral grain or resin pockets that will destroy its finished appearance (these are not confined to the core). It is important to grow an adequate clearwood sheath over the defect core to produce marketable sized boards. The defect core includes the (sometimes wandering) pith and pruned branch stubs.

If high quality timber is required for speciality purposes, many Special Purpose Species may fulfill the role. The choice of suitable species for the site and the management of the tree is much more difficult and specialised.

Milling elm (Ulmus procera) on Carney's property, 2000. Perry King and Josh Bell in photo. Source: ***Alec Olsen***

Record keeping

It is important to keep thorough and accurate records on all aspects of your farm forestry operation. Some of these are listed below:

- **Seed source/provenance information** this may not seem important at the time of planting, but after a few years you realise how variable trees are within a species, depending on their seed source. P. radiata is well tested and tolerant of variable sites, so this section refers primarily to Special Purpose Species. A range of important tree growth factors are involved: frost tolerance, growth rate, form, insect and disease resistance, and timber properties. If you are familiar with the qualities of your chosen plants, you will have a valuable head start. However, it is probable that the species has not been tested in your immediate area and you are doing the pioneer work. Therefore, for good or for bad, you need to know the seed source to enable you to either repeat or avoid that provenance in the future.The nursery supplying the plants should be able to provide details of the seed source including a provenance number which refers to the exact geographical location of the parents.
- **General notes:** these include time of planting, presentation of plants, weed control methods, fertiliser applications, and weather conditions during the first season (e.g. a drought caused 20% death rate in February 2000). Any important general observations such as pest or disease attacks, severe wind storms causing damage etc. need to be recorded.
- **Silvicultural practices:** record dates of form pruning, first to last pruning lifts, thinning operations.
- **Forest measurement**: The method of doing this involves using a system of Permanent Sample Plots (PSP). These are small plots of trees selected randomly throughout the forest block to give a fair representation of the overall growth rate. A suitable age to start measurement is about seven years. Within each plot, the trees are marked and numbered, and their measurements taken at one or two year intervals, but within the same month each time. Measurements taken include: age of the stand at measurement, the tree height (m), the diameter (cm), final pruned height (m), and its stocking rate (sph). From the measurements at around 10-12 years of age, plus the previous stocking history, a '300 index' can be established. This is an estimate of the productive capacity of the site, closely linked to the 'site index', and is standardised so that data from many sites can be compared and used for computer simulated growth calculations. Computer growth models are available for Pinus

radiata, Pseudotsuga menziesii and some Eucalyptus species. The first two are included in the 'Green Solution' programme, which is available from the New Zealand Farm Forestry Association. Without the need to use a computer program, you can use the measurements to assist with decisions on when to perform thinning operations. Too soon and branches may get large, too late and tree growth slows down rapidly. Each PSP may indicate different thinning times and that different final tree stocking rates are desirable in sections of the forest due to varying fertility, light conditions or, most importantly, soil moisture availability.

- **Pruned stand certification:** This is a system established by Forest Research to provide an official, verified record of the silvicultural practices that have occurred within a forest. The pruning operations are measured and assessed by a trained and registered consultant, with the records being stored by Forest Research. The New Zealand Farm Forestry Association – Information Leaflets have information on setting up PSP and on pruned stand certification.

Thinning operations

"Forestry is very largely the art of thinning": quote from 'The Trees of Britain and Northern Europe' (Mitchell & Wilkinson, 1989).

It is necessary to restrict the size of the branches above the pruning level, through tree competition. The aim is to finely balance the number of trees per hectare with the ability of each tree to achieve adequate trunk diameter increments. This can be achieved by a series of judicial thinnings, either to waste or production thinning, depending on access and market prices. Timing depends on the species, soils, fertility, moisture and sunlight. A practice of multiple production thinnings may be well suited to many farm sites where access is easy and growth rate is variable. This improves timber quality and assists with cash flow (a method successfully practised by Denis Hocking, an experienced farm forester in the Bulls district).

Safety issues

Strict rules and guidelines govern contract forestry work standards. Many of these are relevant to the farm forester and are covered in numerous publications. Most of the important safety issues are covered by OSH on their website: www.osh.dol.govt.nz/order/catalogue/index.shtml#fe Another useful reference is the Department of Labour's (1999) 'Approved code of practice for Safety and Health in Forest Operations'.

These 20-year-old pine trees do not show much potential for a profitable timber crop, due to the lack of any silviculture management. Source: ***Kevin Thomsen***

Sole Operator

In many instances, the farm forester is working alone using a chainsaw and/or a ladder. While it is ideal to have a work buddy, it is not always practical. However, some sensible precautions can be taken to minimise risk:

- Notify someone of where you will be working and when you expect to return.
- Always practise safe procedures.
- Attach a basic First Aid kit to your belt.
- If your work area has coverage, attach a mobile phone to your belt.
- Use a safety harness when pruning above three metres.
- Use Hi Viz clothing.

Chemical Use

Chemicals can be dangerous to the operator and to the environment if not handled with care. 'Growsafe', operated by the New Zealand Agricultural Chemical Trust, run courses providing basic training and awareness of the risks of chemical use, and the considerations required for the safe handling and application of chemicals.

There is an increasing requirement by local and national government authorities for landowners to have proof of their expertise in performing tasks. Chemical handling and application are considered high-risk tasks and despite the possibility that the operator may have years of practical experience, some form of accepted certification is required to satisfy the requirements of regulations. Check the Grow Safe website www.growsafe.co.nz for more information.

Ladders

There are many designs of pruning ladders available. They come in different lengths for the various stages of pruning. Talk to a few experienced pruning contractors and farm foresters about their preferences. The ladder must be light, strong, with good 'feet' to hold the ladder steady on uneven slopes, and a shaped top to rest against the curved tree trunk. The top step must be safe to stand on for the bulk of the pruning work. The majority of pruning accidents occur as the user is climbing up or down the ladder. If the base of the ladder is not evenly secure on, or in, the ground, it will easily twist around the tree trunk while the user is climbing. Conventional ladders are dangerous to use for pruning!

Safety Harness

The harness is not just a valuable restraint to protect you from falling – it is also a tool that makes the task of pruning much easier. When you accept the need for and become confident using a harness, the job of pruning will be easier and less stressful on the body and mind. Both hands will be free for the operation without relying on one leg hooked around the tree trunk to hold you up. A harness is even more essential when chainsaw pruning where it is desirable to keep body parts away from the business end of the saw.

1. Helmet & ear muffs
2. Safety goggles
3. Hi-Viz vest
4. Pruning ladder
5. Chainsaw holster
6. Safety harness to tree
7. Bar guard
8. Safety trousers (padded infront of leg)

Kevin Thomsen demonstrating pruning safety with all the necessary equipment. Source: ***Beverley Thomsen***

Chainsaws

Chainsaws are the most useful piece of equipment available for managing a forest. They must always be respected and handled correctly. As one safety trainer said: "Chainsaws are not the danger – it is the operator". If you are inexperienced in using chainsaws, obtain training from an experienced operator or a qualified trainer. Always check the operator's handbook that comes with the chainsaw for safe operation advice.

The Industry Training Organisation (ITO), based in Rotorua, produces documents and training programmes for forest industry safety. They maintain a list of certified Regional Training Advisors. Their website is www.itf.org.nz , or phone 04 894 3190.

The equipment required for safe chainsaw operation includes:

Helmet: Essential for anyone working in a forest. Even a falling pinecone can kill! The helmet should be a 'Hi-viz' colour for maximum visibility. Helmets have a limited life span due to ultra violet light causing the plastic to gradually become brittle. All helmets are stamped with the date of manufacture and no helmet is deemed safe to use after three years from the time of purchase. Some forest companies restrict the time to three years from the date of manufacture.

Ear protection: When using a chainsaw, good quality ear protection is essential – Grade 4 or 5 earmuffs clipped on to the helmet are the best as they can be swung out of the way when temporarily not required.

Eye protection: Unfortunately, both goggles and visors will allow irritating dust to get to the eyes, but prevention of larger chips penetrating the eye is desirable.

- **Safety glasses/goggles** suit some users but tend to fog up. At some angles, they can reflect sunlight, partly obscuring vision. Some styles are light-enhancing, which can be of benefit in gloomy situations underneath a tree canopy.
- **Safety mesh visors** attached to the helmet are the most common method of protection with the advantage of pivoting up out of the way when not required.
- Gauze goggles (nicknamed 'Flies' eyes') are preferred by some chainsaw pruners. They are less bulky than visors and are made with finer gauze.

Leg protection: Essential for any chainsaw use, they protect the user by utilizing a layer of fibres that bind up and quickly halt the chain in the event of a mishap.

Two styles are available:

- **Chaps** are the most popular as they can be clipped into place over existing clothes and footwear.
- **Trousers** are comfortable, especially when chainsaw pruning, helping to keep sawdust out of boots and giving some cover to the back of the leg, but are hotter to wear.

Footwear: Steel-capped boots are mandatory with chainsaw use. Purpose-made protective boots containing an in-built layer of fibres further protect the upper foot and lower leg.

High-Viz clothing: This is a necessary 'fashion accessory', especially when working with other operators. It is not easy to identify someone in a block of trees if they are wearing clothes that blend in with their surroundings. Vests that go over existing clothing are cheap and effective.

Fire extinguisher: Available from forestry shops.Standard compression bandage: Available from forestry shops.

Drinking water: to minimise dehydration which impairs judgement and reduces strength.

1. Helmet, Ear muffs & Visor
2. Hi-Viz clothing
3. Leather hand guard
4. Chaps
5. Steel toe hard boots

First Aid Kit also necessary

Simon Stokes demonstrating full chainsaw safety gear for working on the ground. Source: ***Simon Stokes***

Chainsaw pruning

Chainsaw pruning is becoming more popular, particularly on farm forestry blocks where the branches tend to be a larger diameter. With a suitable chainsaw, it is no problem to make two cuts on a large branch – the first a distance out from the trunk, removing the weight, with the second cut made neatly beside the branch collar. This reduces the risk of tearing a strip of bark down the trunk. An undercut on the first cut may be necessary with some branches.

OSH was opposed to the use of chainsaws for pruning at first but now accepts that there are fewer injuries from **correct chainsaw use** than from the use of loppers and handsaws (causing back strain and 'repetitive use syndrome').

For pruning, the chainsaw should be a lightweight, top handled saw with a short bar (300 mm) using either low profile chain or ¼ inch chain. The bar must be fitted with a special protective guard to reduce the chain exposure, thus protecting both the operator and the tree trunk from damage. Get advice on the correct method of sharpening so a quality cut is achieved, thus maximising the clearwood by avoiding feathering at the end of each cut. ***In the hands of an expert, the cut is as clean as if loppers were used***

Extra equipment recommended for chainsaw pruning is listed below:

- **Chainsaw holster:** A useful accessory for chainsaw pruning is a holster that attaches

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to the safety harness or a belt, on which the chainsaw can be placed when not in use. For example, between finishing high pruning on one tree and the start of high pruning on the next tree, the holster allows the farm forester to move more safely on the ladder, to attach the safety harness to the next tree, and allows easier shifting of the ladder.
- Safety harness: As mentioned previously, this makes the job easier, safer and faster. Most importantly, it allows two hands to be used on the chainsaw which reduces stress and accident risk.

Hand Pruning Tools

Secateurs may be used for form pruning and some epicormic or light branch removal. Not a high usage tool, but good to have available.

Loppers are the most used tool in any managed forest. They are available in many styles that vary in their ability to handle different branch sizes. For ease and speed of operation it is necessary to have the right type. If the loppers are light in construction, they may be very quick and manoeuvrable for small branches, but on larger branches the cutting action is laborious and the blades are likely to break. For large branches, heavy duty, double-action, wide jaw loppers will be easier to operate and withstand the stress of the job without breakage. It is important for the operator's health and the quality of the cuts that the tool is well matched to the job. It is hard work anyway, without making it harder!

Handsaws may be necessary to cut the very large branches. The older type jacksaw has been used in the forest industry for a long time. It is now superseded by double-action (cutting as you push and as you pull) sickleshaped saws. These are easier to use on difficult angled branches and make a very clean and fast cut.

An epicormic knife is used to remove the stubborn shoots sprouting out from the tree trunk so there is a clean bole left as you prune. Most epicormic shoots can be rubbed off by a gloved hand, or possibly by a length of nylon fishing line with two toggle handles. An epicormic knife can be purchased or you can make your own from an industrial hacksaw blade, ground sharp, with a piece of polythene pipe sleeved over one end as a handle. Remember, these are very sharp instruments and will damage the tree bark and the operator if not used with care.

Further Reading

- Department of Labour (1999) Approved code of practice for safety and health in forest operations.
- Maclaren, J.P. (1993) Radiata pine growers' manual. Forest Research Institute Bulletin No. 184. New Zealand Forest Research Institute Ltd., Rotorua.
- Milne, P. (2003) Growing radiata clearwood. In: New Zealand Tree Grower, February 2003, page15.
- Ministry for the Environment (2001) Managing waterways on farms: a guide to sustainable water and riparian management in rural New Zealand. Ministry for the Environment, Wellington, New Zealand.
- Mitchell, A. & Wilkinson, J. (1989) The trees of Britain and Northern Europe.
- New Zealand Farm Forestry Association Information Leaflets.
- NIWA (2003) Assessing Hawke's Bay's frost risk. NIWA Client Report: AKL2003-128.
- Olykan, Sonya (2002) Forest nutrition – nitrogen. In: New Zealand Tree Grower, May 2002, page 31.
- Olykan, Sonya (2003) Nitrogen nutrition of some nonradiata forest tree species. In: New Zealand Tree Grower, February 2003, page 16.
- Palmer, H., Gardner, B., Hislop, M. & Buttery, N. (2003) Trees for shelter – basic principles revisited. In: New Zealand Tree Grower, February 2003, page 38.
- Park, J. (1999) Tuning the pruning on a fertile site. In: New Zealand Tree Grower, May 1999, page 39.
- Ridley, G.S. & Dick, M.A. (2001) The diseases of forest and amenity trees in New Zealand. Shigo, A., Vollbrecht, K. & Hvass, N. (1987) Tree biology and tree care: photo guide.
- Smail, P. (1997) Shelter required to increase production. In: New Zealand Tree Grower, November 1997, page 4.

Appendix I : Soils of Hawke's Bay

Introduction

Across Hawke's Bay, many different types of soils have evolved. A knowledge of these soils is critical to understanding the growing environment for your trees, crops and pasture. While soils are complex, there are some basic things you need to understand.

These are:

- physical soil characteristics, type, and general location in the landscape;
- soil drainage (linked to providing a soil water balance);
- soil moisture availability (linked to providing a soil water balance);
- potential rooting depth.

1. **Physical soil characteristics** are important as they affect the growth of plants and trees. Two major components are:

- soil texture, which influences the availability of plant nutrients, the development of the soil structure, and the ease with which a soil can be cultivated; and
- soil structure, which describes the way the soil is held together.

Combined, they provide an indication of soil porosity (pore space), bulk density (compactibility), and consistency (plasticity). Knowledge of these will help with making management decisions on issues such as erosion control, trace element and nutrient deficiencies, and stock-grazing regimes. Remember, the soils will vary across your property.

2. Soil drainage refers to how quickly water is removed from a soil. This is dependent upon the position of the soil within the landscape. Soil drainage is determined by four factors:

- inputs comprising rainfall, irrigation, seepage, and run-off;
- the flow of water through the soil;
- outlet from the soil; and
- the level of compaction that has occurred.

Soil colour is a good indicator of soil drainage patterns. For example, poorly drained soils have grey subsoils, whereas well drained soils have brownish or orange subsoils. Table 121 shows the five natural drainage classes demonstrating water table depth and depth after drainage.
Find the drainage class from your soil order.

3. Soil moisture availability is complex. Put simply, the soil has capacity to store water within the potential rooting depth, where the moisture level can vary. Soil moisture availability is affected by soil depth, climate, slope and aspect. As the land steepens, the soils generally become shallower, and soil moisture retention capacity reduces, particularly if the slope is facing north or west. Moisture availability is important if you live in drought prone areas, and will determine your selection of tree species.

4. Potential rooting depth relates to the available depth of soil in which trees grow. It is important for species selection. Topsoil depth is particularly important, as this is the main growing environment. On some sites, soils are too shallow for successful planting.

Table 121 : *Natural Drainage Classes. Source: "Soils of the Heretaunga Plains" by E. Griffiths*

	Natural drainage class if moderate permeability	Depth to water table after wet period (cm)	Period water table stays at depth shown, if soil is drained.
1	Very poor	0	2 month
2	Poor	1-30	1 month
3	Imperfact	30-45	3 weeks
		45-60	2 weeks
4	Moderate	60-75	1 week
		75-90	4 days
5	Well deained	90-120+	2 days

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Soil Orders

The soils of Hawke's Bay are grouped into ten orders based on the New Zealand soil classification system. The "old classification" soil groups such as 'yellow grey earth' and 'yellow brown earth', together with common soil names, are included.

Table 122

New Soil Order classification	**Pumice** A Pumice soil must have at least 60 cm of volcanic material aged from 3500 to 700 years B.P., from Ruapehu, Ngauruhoe, Kaharoa, Taupo, and Waimihia eruptive phases.
Old Soil Group classification	Yellow brown pumice.
Common names associated with this Soil Order	Taupo, Waikoau, Tutira, Puketitiri, Te Pohue, Titiokura, Kaweka type, Gisborne, Mohaka, Waihua, Tuai, Hangaroa, Tiniroto, Ruakituri, Mahia, Pakarae, Kakenui.
Physical characteristics	• Naturally low fertility with low nutrient reserves, particularly potassium, magnesium, sulphur, phosphorous, nitrogen, and calcium. • Trace elements are likely to be deficient - such as copper, cobalt, boron, and selenium. • Naturally low levels of organic matter. These may increase following farming activity; care must be taken to maintain this build-up. • Low clay content (<10%)- if present, it is allophane clay. If the Waimihia and Taupo material is not present, but other ashes are, the (clay) allophane level increases, as does the phosphorous retention ability of the soil. • Generally coarse in texture, sandier if coarse, but grading to silty sand where ashes dominate, structurally weak. • Highly susceptible to erosion. • Low bulk density -therefore high resistance to compaction .
Drainage and moisture availability	• Well drained, very high macroporosity. However, there is a high available water content, ranging from 20-30% of soil volume. • Rapid drainage of excessive water but is still capable of storing large amounts of water for plants. • Well-aerated soil. • Where compaction occurs, drainage may be impeded. (Can be identified by mottling in the upper proles.) • North and west facing slopes are more drought-prone .
Rooting depth	• Excellent. Soils are consistently deeper than 60 cm. Allows trees to tap the deeper nutrient reserves and moisture zones. As slopes steepen, the soils become shallower and less suitable for planting.

Taupo sandy loam. Source: ***Simon Stokes***

Puketitiri sandy loam.Source: ***Simon Stokes***

Table 123

New Soil Order classification	**Recent - alluvial and steepland** Occur throughout the region in young landscapes, including alluvial oodplains, unstable steep slopes and slopes mantled with very young volcanic ash (less than 700 years BP).
Old Soil Group classification	Recent.
Common names associated with this Soil Order	• On oodplain areas - Waipaoa, Waihirere, Esk, Tuki Tuki, Pakowhai, Twyford, Flaxmere, Omaranui, Argyll, Omahu, Ngatarawa, Havelock, Karamu, Ormond, Kaiti, Upokororo, Mangateretere. • On steepland areas - Mahoenui, Whangamomona, Waikaremoana, Moumahaki, Mokamoka, Kidnappers, Pahiatua, Wharerata, Taihape, Silver, Tutamoe, Aramoana, Mangatoro, Vernon, Olrig, Whangaehu, Waitaha.
Physical characteristics	• Located in valley oors, river terraces, or very steep slopes where weathering of the bedrock is still the dominant soil forming process. Colluvial material could be added as it is eroded soil from up slope deposited on existing soils in the footslope area. • Variable texture, due to location and source of soil forming material, generally silty . • Structurally weak . • High natural fertility . • Higher clay content - this is dependent on the source of the parent material. • Susceptible to change from further deposition or erosion .
Drainage and moisture availability	• Soils will have a good to imperfect drainage pattern, depending on location. • There are two basic types: low lying alluvial landforms will be well to imperfectly drained, while slopes will be well drained. • Recent steepland soils will have rapid gravity drainage and be very prone to moisture deciencies.
Rooting depth	• Excellent on the oodplain soils where depths greater than 60 cm will consistently allow trees to tap the nutrient reserves and moisture zones. • Limiting on steepland soils. • When soil depth is 45 cm or less (Recent steepland soils), rooting depth can severely limit tree growth unless roots are able to penetrate fractured bedrock.

Recent alluvial silts on Tutaekuri floodplain. Source: ***Simon Stokes***

Recent steepland soil development on sandstone in the Mangapoike River catchment, Wairoa. Note how shallow it is. Source: ***Simon Stokes***

Recent steepland soil development on mudstone near Atua Road, Elsthorpe. Soil developing on an old eroded site. Note the lack of topsoil. Source: ***Simon Stokes***

Table 124

New Soil Order classification	**Pullic** Occur where there is a water decit in summer and surplus in winter (<1000 mm/yr).
Old Soil Group classification	Yellow grey earths and associated intergrades with yellow brown earths.
Common names associated with this Soil Order	Matapiro, Waipukurau, Crownthorpe, Tangoio, Kopuawhara, Atua, Te Apiti, Wanstead, Mangatarata, Waipawa, Raukawa, Elsthorpe, Mangalahi, Waiwhare, Otamauri, Poporangi, Waikonini, Mangatewai, Horoeka, Tikokino, Mokapeka, Ngaumu, Whetukura.
Physical characteristics	• Naturally quite fertile - magnesium levels high, but sulphur low. • Can be deficient in molybdenum and selenium. • Occur where there is a summer moisture deficit (<1000 mm/yr), but where no subsoil pan has developed. • Weakly to moderately developed. • Texture is mostly silty with 20-30% clay content. • Medium bulk density - halfway between a Pumice and Gley. • Organic matter levels are moderate to low. • Moderate to high water erosion potential.
Drainage and moisture availability	• Poorly drained, due to dense subsoils. This is indicated by mottling throughout the prole. However, topsoils are considered well drained. • A wet winter, then dry spring and early summer - or longer- affects plantings, as the topsoils lose soil moisture levels quickly. While there is moisture at a lower level in the prole, if it becomes dry too quickly, young roots, in particular, will suer. • This drying effect also shrinks the soil, loosening ii around plants, causing a drying effect in the root zone that can kill the plant. • Moderate to high plant-available water in the topsoil (18-30% of volume), but availability drops away to very low in the subsoil.
Rooting depth	• When soil depth is 45 cm or less, rooting depth can severely limit tree growth unless roots are able to penetrate fractured bedrock. This can lead to toppling if extreme wind occurs.

Wanstead soil, clay dominated Pallic soil. Source: ***Simon Stokes***

Matapiro soil, shallow ash with loess and duripan at 50cm. Source: ***Simon Stokes***

Table 125

New Soil Order classification	**Raw** Raw soils lack a distinctive topsoil, are uid at a shallow depth, and occur where it is rocky, has active erosion or deposition, or is a raw volcanic landscape.
Old Soil Group classification	This is a new grouping of soils and is related to weakly developed Recent soils.
Common names associated with this Soil Order	Whakaki, Opoutama, Waipaoa, Washpool, Kuripapango, and very shallow versions of the Kaweka and Ruahine.
Physical characteristics	• The Raw soils are mostly located on coastal dunes, mountainous screes, and tidal estuaries. • Structure is weak and unaggregated. • No B horizon, (sub-soil layer) with very shallow topsoils, if any. Highly susceptible to erosion, generally located in a long-term unstable environment. • Low natural fertility, particularly nitrogen, low organic matter levels.
Drainage and moisture availability	• Mostly well drained and drought-prone, but can also be very wet and poorly drained. • Moderate plant-available water in the topsoil (16-20% of volume), becoming very low in the subsoil. Low-lying spots will show mottled prole and will show Gley-type characteristics.
Rooting depth	• Excellent. Soils are consistently deeper than 60 cm. Allows trees to tap the nutrient reserves and moisture zones. • Use caution with locations of increased wetness, as this limits root development.

Table 126

New Soil Order classification	**Allophanic** Occur in soils with a strong link to allophane clay - usually volcanic in origin.
Old Soil Group classification	Yellow brown loams, some red and brown loams and upland yellow brown earths.
Common names associated with this Soil Order	Patoka, Takapau, Kopua, Dannevirke.
Physical characteristics	• Occur in volcanic ash, where weathering has provided a high level of allophane clay. • Dominated by allophane clay, which causes high to very high P retention . • Erosion is minimal unless it is disturbed, then severe wind and sheet erosion will occur . • Low natural fertility . • Low bulk density, therefore resist compaction . • Fine sandy loam with a strongly developed nutty structure . • Can be deficient in cobalt, magnesium, or potassium. Respond to lime .
Drainage and moisture availability	• Well drained, very high macroporosity allowing for rapid water through-flow (permeability). • High moisture retention, allowing reasonable available water content of 15--25% of soil volume. • A well aerated soil.
Rooting depth	• Excellent, soils are consistently deeper than 60 cm. Allows trees to tap the nutrient reserves and moisture zones.

(Table 125)Washpool soil, found on sand dunes on floodplain. Source: ***J Watt***

(Table 126) Beautiful, deep topsoil on ash on loess, Patoka soil. Source: ***Simon Stokes***

Table 127

New Soil Order classification	**Brown** Occur where summer dryness is uncommon and where soil is not waterlogged in winter.
Old Soil Group classification	Yellow brown earths, yellow brown sands, and intergrades between yellow brown earths and yellow grey earths.
Common names associated with this Soil Order	Matamau, Makaretu, Kaweka, Ruahine, Gwavas, Waimarama, Maraetotara.
Physical characteristics	• Occur where summer droughts are uncommon. • Located on the greywacke rocks in the foothills of the Ruahine and Kaweka Ranges (and the farmed edge of the Urewera National Park). • Low to moderate natural fertility. • Predominantly silt loam texture with friable topsoils. Well developed nutty and granular structure. • Moderate P retention in topsoils increasing in the subsoils to 60-90%. Reducing if the allophane clay content increases. • Can suffer from leaching due to high, constant rainfall. • Can be acidic <5.5 ph.
Drainage and moisture availability	• Well drained. • Moderate to low macroporosity level (amount of large pore spaces) . • Available water content is high in the topsoils at 25-30% of soil volume but this reduces rapidly in the subsoils to less than 15%. • Not drought-prone as soils rarely dry out.
Rooting depth	• Excellent. Soils are consistently deeper than 60 cm. Allows trees to tap the nutrient reserves and moisture zones. • When soil depth is 45 cm or less, profile depth can limit tree growth over its lifetime.

Ruahine soil, Makaretu. Source: ***SimonStokes***

Matamau soil, Makaretu. Source: ***Simon Stokes***

Table 128

New Soil Order classification	**Podzol** Occur in areas of high rainfall and are associated with forest species which produce acid litter.
Old Soil Group classification	Podzols and some Podzolised yellow brown earths.
Common names associated with this Soil Order	Waikaremoana, Ruakituri steepland, Matawai, Kaweka and Ruahine type.
Physical characteristics	• Acidic soil. • Linked to upland volcanic locations. • Low levels of biological activity . • Very high ratio of carbon/nitrogen . • Low nutrient content and infertile, require phosphorous, potassium, nitrogen, and lime. • Very wet climate.
Drainage and moisture availability	• Imperfectly to poorly drained. • Can have a pan or compacted layers.
Rooting depth	• Shallow rooting depth. • Limited by acid condition or aluminium toxicity, or by pans.

Table 129

New Soil Order classification	**Gley** Poorly to very poorly drained, oxygen limitations are high and colour is greyish.
Old Soil Group classification	Gley or Gleyed Recent.
Common names associated with this Soil Order	Ahuriri, Awamate, Makauri, Pukehou, Okawa, Raumati, Hastings, Kaiapo, Irongate, Willowbrook, Taniwha, Te Awa, Otane, Mateo, Meeanee.
Physical characteristics	• Strongly affected by waterlogging, have been chemically reduced. • Located where watertable is seasonally high or where drainage is impeded by a pan. • Colluvial sites could be included in this group. Eroded soil from up slope deposited on existing soils in the footslope area with humps and hollows. • High clay content ranging from 20-80% . • High bulk density - very susceptible to compaction and traffic. • Organic matter levels usually high. • Highly anaerobic - low aeration.

(Table 128) Matawai soil on the top of Whakapunake, Te Reinga, Wairoa.
Source: ***Simon Stokes***

(Table 129) Okawa soil. Source: E.Griffiths

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Table 130

New Soil Order classification	**Organic** Occur in wetland sites, as peat or forest litter.
Old Soil Group classification	Organic
Common names associated with this Soil Order	Rotoatara, Poukawa, Pongakawa, Farndon, Turamoe.
Physical characteristics	• Very rare for farm forestry to occur on these sites - 'needs' are amenity trees, wetland development or protection, possibly shelterbelt. • Special landscape site, often drained, originally wetland environment. • Very low bulk density, has low bearing strength, therefore roads need foundation design. • High shrinkage potential when dry. • Low pH, acidic. • Low natural soil nutrient status with potential deficiencies in potassium, nitrogen, sulphur, and phosphate, and trace elements selenium, copper, and molybdenum. Respond well to lime. • Natural fertility is related to hydrology e.g. higher fertility, Organic soils are reliant on groundwater bringing in nutrients from surrounding mineral soils.
Drainage and moisture availability	• Very poorly drained with low aeration. • Plant-available water ranges from moderate to high.
Rooting depth	• Excellent. Soils are consistently deeper than 60 cm. Allows trees to tap the nutrient reserves and moisture zones.

Table 131

New Soil Order classification	**Melanie** Occur on limestone or basalt bedrock.
Old Soil Group classification	Rendzina and intergrades of yellow grey earths and yellow brown earths.
Common names associated with this Soil Order	Bluff, Te Mata, Te Aute, Te Onepu, Tirohia, Awatea, Kairakau.
Physical characteristics	• Naturally fertile. • Highly exchangeable base of calcium and magnesium and generally plenty of lime so a low pH. • Can have a high shrink/swell capacity making them sticky. Structurally very resilient to cropping and other pastoral use. • High biological activity
Soil drainage and moisture availability	• Very similar to the allophanic soil characteristics listed previously.
Rooting depth	Excellent. Soils are consistently deeper than 60 cm. Allows trees to tap the nutrient reserves and moisture zones.

(Table 130) Rotoatara soil.
Source: ***Dan Bloomer***

(Table 131) Te Onepu soil, Te Aute Road.
Source: ***Simon Stokes***

Appendix II : Hawke's Bay Species Survey Results

(compiled 2004)

Personal comments from some of Hawke's Bay's experienced tree planters. Taken from survey form returns: a selection of Hawke's Bay's experienced farm forestry practitioners were asked to nominate and comment on the species they had grown that had been successful (or otherwise). These were species specifically grown for the provision of shelter, shade, timber and land stabilisation.

CONTRIBUTING FARM FORESTER DETAILS
(Species comments follow)

Farm forester	Location	Altitude (metres)	Rainfall (mm)	Climate/soils
Robin Hilson	Takapau, 'One Stop Ram Shop'	180	1200	Hot dry summers, cool winters (frosts). Windy spring and summer equinox. Shallow, light soils.
Robin Hilson (High alt.)	Takapau, 'Tarata'	300-730	1500	Cool, maybe windy in spring. Few (if any) frosts. Heavy rain often at night. Snow never lies.
Steve Wyn Harris	'Marlow Hill', Hatuma	200-300	850 summers	Summer dry (usually). Frosts light (30-40 pa). No snow. Wind. Heavy soils - clays wet in winter, dry in
Ewan McGregor	Waipawa	100-200	800	Hot, dry summer. (normally). Some sharp frosts in winter. Clay soils. No snow.
Willie Peacock	Waipukurau	100-300	850	Some frosts. Summer dry. Severe spring/autumn westerlies.
Hugh McBain	'Kahotea Farm', Te Aute	90-450	830	Frosty particularly on ats. Hills dry out very quickly with westerly winds.
David Bryant	Kereru	240-550	1150	Can get very dry (summer). Frosts on lower country. Snow on higher country, but doesn't last long.
Vin Merwood	'Kereru Stn.', Kereru	330-550	1000	Can be very dry. Windy extreme. Very little snow, but occasional falls.
Helen Swinburn	'Hinerua', Tikokino	200-300	900-1200	Very hard frosts. Wind and gales.
David Rumbal	Mathieson Rd Tikokino	274	825	Down to -8°C frosts. Strong equinox winds. Summer temperatures not as hot as Hastings.
Michael & Carola Hudson	'Gwavas', Tikokino	200-340	1050	Takapau loam. Snow very rare now. A lot of frosts. A lot of westerly wind.
Malcolm & Rohan O'Dwyer	'Morning Star', Tikokino	330-400	1050	Cold, wet winters. Dry springs. Warm summer - thunderstorms frequent. Wet or dry autumn - warm. One snow (Aug. '90), frosts (0° to - 6° C).
John Russell	'Washpool', Maraekakaho	240-370	1000	Summer dry. Windy. Some frost, occasionally heavy. Snow once every 3-5 yrs, but lies no more than half day.
Garry Glazebrook	'Tuna Nui', Sherenden	50-150	700	Frosts down to -5° C.
Tom & Dora Hartree	'Te Motu', Waihau	220-240	1050	Frosts and prone to drought. Mild climate with winter growth.
Chris McGillivray	Maraetotara	230-490	1800	Snow and frosts.
Peter & Elizabeth Ormond	Kahuraniki Road, Tukituki	60	560	Min. 4 C° – max. 34° C. Area lies from SW to NE. Free draining. Average to poor fertility.
Michael & Helen Halliday	'Raumati', Patoka	275-460	1400-1500	Annual snowfall. Heavy frosts in pockets. Prone to cyclonic rainfall and long periods of anticyclonic drizzle.

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Farm forester	Location	Altitude (metres)	Rainfall (mm)	Climate/soils
Kevin & Bev Thomsen	'Longridge', Patoka	367	1350	Very free-draining soils. Occasional very light snow. Light/medium frosts. Normally summer green. Strong NW winds (mainly Aug. – Nov.) - greatest inhibitor!
Bill Whittle Mark Whittle	Puketitiri	600-900	1400	Severe frosts in valleys. Snow lies in winter.
Jack & Agnes Nicholas	'Makahu Stn.', Puketitiri	550-800	1650-1900	Cool, moist summers. Cool/cold moist winters. 4-6 falls of snow annually (25 - 150 mm).
Philip & Robyn Holt	'Maraetara', Seaeld Rd	0-300	800	Some frost June/July.
Alec Olsen	'Valhalla', Glengarry Rd	200-230	1100	Loess soils with hard pan. Heavy frosts on ats and valleys. Rare snowfalls. Destructive NW winds.
Joe Devonport, HBRC Soil Conservation Reserve	Tangoio	50-400	1500	Good summer rain. Dry N-NW faces. Snow very rare. Frost 20 days min./yr.
Hans & Jenny Weichbrodt	'Hinterland', Tutira	200-250	1000-1200	Typical max./min. gradient = 20° C. Typical summer daily max. around 30° C. Typical winter min. around 0° C. Max. frosts = -5° C to -7° C
Ross & Margaret Haliburton	Kotemaori	200-300	1350	Some frosts, especially valley oors. Snow possible on tops once or twice a year. Exposed to most winds, especially nor'west.
Graham & Susan Mackintosh	Putorino	150-370	1250	2-3 light snowfalls each year. Heavy frosts in sheltered valleys. Some NW faces which dry out in wind.
Peter Manson HBRC	Wairoa		1300+	My notes are observations of trees mainly on other people's properties. (e.g. McRae Trust)
Geoff Prickett	Morere	50-150	2000	Occasional frosts. Wet winters. Often dry summers. Little wind.
John & Heather Dean	Nuhaka	15-200	2000	Frost in valleys. Cold SE winds. Subject to coastal rainfall.

Species comments

Pinus radiata Radiata pine		
Farm forester	**Location**	**Comments**
Robin Hilson	'Tarata' & 'OSRS', Takapau	Grows well and fast. For shelter primarily, and secondly for cash crop. Protable. The "best" initial shelter.
Bill Whittle	Whittle Road, Puketitiri	Used in timber blocks and in single row shelter. Single row inter-planted with flax or pampas to create ground shelter.
Kevin & Bev Thomsen	Hendley Road, Patoka	Variable planting (600-1200 sph) depending on wind/ fertility factors which can cause severe growth distortion. Maintain high stocking rate (particularly on edge trees) to control upper branches and reduce log taper. Aiming for multi-production thinning. Recommend bare-root seedlings.
Graham & Susan Mackintosh	Putorino Station Rd.	The only site which has not excelled for us is an exposed ridge at 370 metres asl.
Steve Wynn Harris	'Marlow Hill', Hatuma	What can I say? Most reliable species for shelter and timber. Still doesn't like the wind on the edges though, so it's not perfect.
Ewan McGregor	Hautope Road, Waipawa	Planting a range for ornamentation. Showing good growth in rst year. How about P. ponderosa? .... But nothing compares with radiata - forget it!

Pinus radiata Radiata pine		
Farm forester	**Location**	**Comments**
Hugh McBain	'Kahotea Farm',Te Aute	The obvious tree for our dry limestone country. Need to plant in July and be very careful to get releasing done correctly. Advisable to plant at higher density on ridges.
Helen Swinburn	'Hinerua', Tikokino	Are giving good shelter at 2000 feet on the Ruahine foothills
David Rumbal	Mathieson Road, Tikokino	You know most of the comments! Good tree stocks and handling are essential. 5 mm stem diameter, 6 mm preferable & berous root system. Topped trees on hard sites. If maintained, is good shelter.
Mike & Carola Hudson	'Gwavas', SH 50	Planted on various sites. Rabbits wiped out two seasons of planting. Obtained locally. Growing well.
Mike & Helen Halliday	'Raumati', Patoka	A very important 'bread & butter' tree! Creates a very real income stream, which is important for ongoing family farms for succession and farm development such as water reticulation (so that waterways may be rtired).
Malcolm & Rohan O'Dwyer	'Morning Star', SH 50 Tikokino	Plant 3x3 m spacing. Release six weeks after planting with 'Velpar' #3 High Spread. East and south slopes/poor soils. Shoot magpies!
John Russell	'Tuna Nui', Sherenden	The most successful species - No doubt you know this!
Philip & Robyn Holt	'Maraetara', Seaeld Road Bay View	For us radiata is a commercial tree that grows where it's planted and lives happily ever after. However on our dry areas the population density has to be carefully managed to suit the prevailing moisture levels.
Tom & Dora Hartree	'Te Motu', Waihau Road	Grows well on our slump shingle country where there is no pan. (Our bread and butter tree.) Must have a good infrastructure like roads, and water for fire-fighting. Find it is better in a forest situation compared to single or triple rows. Wind stress and resin pockets occur in smaller plantings that are exposed. We only plant on our inferior land. Dierent pruning and stocking densities on dierent sites, e.g. northern and southern faces.
Vin Merwood	'Kereru Station', Kereru	Grows like a weed. Used extensively in shelter belts, mainly for its quick establishment.
Jack & Agnes Nicholas	'Makahu Stn.', Puketitiri	Virtually all sites successful. Possums and deer can be very hard on pine if they're not controlled.
Joe Devonport	Tangoio Soil Conservation Reserve	Grows anywhere but subject to mineral deciencies with limestone holding some minerals. Yellow patches common where limestone close to surface.
Willie Peacock	Peacock Road Waipukurau	Grown on light argillite. Good, rm and deep rooting. Good density and form. Must thin aggressively for protable nal crop growth.
Alec Olsen	'Valhalla' Glengarry Road	The most useful farm tool - after getting all the non-wood values such as shelter, erosion control and water management - all you get is money! Note: The better the management, the better the money.

Cedrus deodara/atlantica/libani Himalayan, Atlantic & Lebanese cedar		
Farm forester	**Location**	**Comments**
Alec Olsen	'Valhalla', Glengarry Road	Our cedars are tolerant of hot and cold, and exposed and windy aspects. Will tolerate moist conditions (but not too wet) and are not bothered by very dry situations and poor soil. Possums don't seem to like cedars. One-year seedlings can often struggle to get ahead of the grass, even with post-plant spray. Two-year trees are best. Valuable timber!
Robin Hilson	'One Stop Ram Shop', Takapau	Dicult to establish. Once established they thrive, but may blow over.
Bill Whittle	Whittle Road, Puketitiri	For shelter or timber. Showing great promise in Puketitiri climate.
Mike & Helen Halliday	'Raumati', Patoka	So tolerant of the extremes that we get - hot, cold, dry and wind. They're as tough as goats' knees, and make brilliant shelter that can be side trimmed and generally mutilated, and then bounce right back. However, in droughts, it is possible to lose them in their rst year when planted in dry pumice or ash.
Kevin & Bev Thomsen	Hendley Road, Patoka	Excellent apical dominance. Retains good form at wider spacings. Sensitive to some weed sprays - can refoliate afterwards. Requires up to two years weed release. Hardy to dry and cold. Dislikes wet soils.Bare root seedlings best.
Hans & Jenny Weichbrodt	'Hinterland', Tutira	Responds well to better soils and a bit of moisture. Need a lot of early releasing. Better to plant 2 or 3 year stock.
Ewan McGregor	Hautope Road, Waipawa	Very slow to start, but great tree eventually. Stands hard conditions.
Hugh McBain	'Kahotea Farm', Te Aute	Brilliant tree for shelter and amenity in our summer dry situation. Correct releasing is vital.
David Bryant	Salisbury Road, Kereru	Agree that they're a great species for exposed and dry conditions, but would add that they have quite a slow growth rate.
Helen Swinburn	'Hinerua', Tikokino	Have grown well in red metal and have now been planted quite extensively on HW50. They are thriving on dry red-metal banks.
Garry Glazebrook	'Washpool', Maraekakaho	Dislike wet feet in clay. Drought resistant. Reasonable growth in our rainfall.
John Russell	'Tuna Nui', Sherenden	Tough for wind and dry. Seem to eventually beat grass even if we forget to release. Slow until 5 or 6 yrs. Used here for shelter on tough spots.
Peter Ormond	Kahuraniki Road, Tukituki	Cedrus libani, var. atlantica, var. deodara Tolerant of wind. All do well in dry, as to be expected.
Philip & Robyn Holt	'Maraetara', Seaeld Road Bay View	Deodar copes with wind, hot and cold, and can grow on very dry sites. We believe that it has very good timber potential. Excellent shelter tree. Note! Beware of hormone sprays.
Vin Merwood	'Kereru Station', Kereru	Yes, I agree that cedars are great for coping with wind and dry, and make excellent shelter on dicult sites.
Geo Prickett	Morere	Tough tree for dry and wind. Slow starters. Need plenty of releasing. Not too fussy about site. Once established, are trouble free.

Cedrus deodara/atlantica/libani Himalayan, Atlantic & Lebanese cedar		
Farm forester	**Location**	**Comments**
John & Heather Dean	Nuhaka	C. atlantica: Blue needled strains are best for salt wind sites. C. deodara suers worst from salt winds. C. deodara can have coarser timber than the other cedars. (This was originally brought to my notice by Meyric Williams). All cedars are slow starters. C. deodara seems to be the fastest growing but some C. libani strains seem to be just as quick and better ultimate trees. C. libani grows totally dierent in NZ to British Isles and is probably the best cedar for form and timber in NZ. Clones of cedars vary enormously in growth rates, selection of good strains is most important. Timber soft at milling, hardens with age, very durable, scent benets asthma patients, is carcinogenic so nose masks should be worn during processing. Uses: besides construction and panelling, any use that needs durability and quality appearance but it is not a furniture timber. Cedar prunings have been known to last 20 years on the ground before rotting.
Jack & Agnes Nicholas	'Makahu Stn.', Puketitiri	Very hardy and probably one of the most versatile trees.
Joe Devonport	Tangoio Soil Conservation Reserve	Very small number growing well in a sheltered valley bottom - up slopes 20+m above stream. Loess soil with little limestone.

Cupressus lusitanica Mexican cypress		
Farm forester	**Location**	**Comments**
Jack & Agnes Nicholas	'Makahu Stn.', Puketitiri	Prefers cool southerly slopes.
Robin Hilson	'Tarata' Takapau	Grows well, but establishment is dicult.
Kevin & Bev Thomsen	Hendley Road, Patoka	Medium moisture soils. Distorted by severe winds. Requires competition to restrict branches, plus needs numbers for selection due to genetic variability (1000 sph). Final spacing still undecided (±350 sph ?). Bare-root seedlings best.
Mike & Helen Halliday	'Raumati', Patoka	Cypresses are generally great for our country, but lusitanica is clearly the best 'money tree' of the species.
Hans & Jenny Weichbrodt	'Hinterland', Tutira	Prefer 2yr bare-rooted stock. Choose southerly aspect against canker. Best on medium-fertility site with medium moisture. Releasing essential. Reasonably wind-tolerant.
Alec Olsen	'Valhalla', Glengarry Road	Seems to be the best cypress for our area. Good growth rates and little canker damage. Plant plenty to give some power of selection, and be prepared for a lot of branches to prune. The timber is worth the eort.
Steve Wynn Harris	'Marlow Hill', Hatuma	C. lusitanica seems to be doing well on shady/cool faces. Little canker.
Ewan McGregor	Hautope Road, Waipawa	If canker can be avoided, good growth, but heaps of bloody branches! (General comment for all Cupressus species)
Willie Peacock	Peacock Road, Waipukurau	Grows well on free-draining argillite. Slow on heavy clay south/west facing slopes. Good form. No sign of canker (yet). Trees have improved rapidly with time.
Helen Swinburn	'Hinerua', Tikokino	Has been good in the damper areas.
David Rumbal	Mathieson Road, Tikokino	Prefers sheltered sites, not too dry. Form aected by winds.

Cupressus lusitanica Mexican cypress		
Farm forester	**Location**	**Comments**
John & Heather Dean	Nuhaka	C. ovensii and C. lusitanica have grown fast with us, but we will not be planting any more as the timber is inferior to C. macrocarpa. They cost more to prune as they have more (and harder to prune) branches, grow slower, topple easier. C. lusitanica branches break easily with wind and generally have no timber merit or market - compared to C. macrocarpa.
Ross & Margaret Haliburton	Haliburton Road, Kotemaori	Pre-plant spray of pasture. Tolerate hot or cold but some wind-throw on exposed sites. Considerable variation - best on more fertile soils.

Cupressus torulosa West Himalayan cypress		
Farm forester	**Location**	**Comments**
Hugh McBain	'Kahotea Farm', Te Aute	Advised by one of our eminent farm foresters 30 yrs ago that this was the cypress most suited to our conditions. I have been a slow learner! Slow growing, good form and no canker.
Ewan McGregor	Hautope Road, Waipawa	If canker can be avoided, good growth, but heaps of bloody branches! (General comment for all cypresses)
David Bryant	Salisbury Road, Kereru	Grow in similar conditions to C. deodara. Excellent in shelter belts. Have found Gibbs Nursery have by far the best trees.
Helen Swinburn	'Hinerua', Tikokino	Have done well in red-metal, and with their conical shape are being planted more for single-row shelter.
Garry Glazebrook	'Washpool', Maraekakaho	Very drought resistant. Will survive grass closure when young. Dislikes wet feet on heavy clay country. Be sure to determine seed source for good shape.
John & Heather Dean	Nuhaka	Cupressus torulosa needs to be grown in a plantation with our strain, otherwise it does not have good apical growth and has heavy side branches.

Cupressus macrocarpa Monterey cypress		
Farm forester	**Location**	**Comments**
Robin Hilson	Paget Road, Takapau	Dicult to establish. Shallow rooting has led to large-scale windthrow. Excellent timber, but if only would not blow over.
Jack & Agnes Nicholas	'Makahu Stn.', Puketitiri	Prefers cool southerly slopes, but grows most areas. Some canker.
Bill Whittle	Whittle Road, Puketitiri	Block grown for timber. One-year plants easy to establish rather than 2-3 yr. A little canker noted in 20 yr trees.
Alec Olsen	'Valhalla', Glengarry Road	Canker has destroyed or deformed about 80% of our recent plantings. Will not plant any more.
Joe Devonport	Tangoio Soil	North east slopes, 40-50 yrs old. Grew well. Now being harvested. Shallow Conservation Reserve soils - loess, but obviously handled it well. Replant will be C. lusitanica.
John Russell	'Tuna Nui'	Some species that do not seem happy here are: Thuja plicata, Sherenden Larix, C. macrocarpa (do well until they get canker).
Mike & Carola Hudson	'Gwavas', SH 50	Grow very big. No recent plantings because of abortion in cattle.

Cupressus macrocarpa Monterey cypress		
Farm forester	**Location**	**Comments**
John & Heather Dean	Nuhaka	'Kukupa' and 'Longwood' have been disastrous on the East Coast – because of canker. 'Faulkner Strain' probably has some hybridisation, but the Colin Hair selections of the Faulkner Strain are the best we have grown. These are from three generations of selection from the Faulkner strain and without doubt the form of these trees is the best I have seen. In my opinion, this strain is the only C. macrocarpa for growth rate and type, being relatively canker free. All C. macrocarpa get canker unless grown in association with other trees.

Other cypresses		
Farm forester	**Location**	**Comments**
Robin Hilson	Paget Road, Takapau	Chamaecyparis lawsoniana All trees start well, but ultimately succumb to canker and die. Many planted 20 yrs ago now look horrible. NOT worth planting at all.
Jack & Agnes Nicholas	Puketitiri 'Makahu Stn.'	C. goveniana (3 yr) Looking good. Cupressocyparis leylandii Fast growing and free of canker (here).
Joe Devonport	Tangoio Soil Conservation Reserve	Chamaecyparis lawsoniana Southerly face - 50 yrs old. Very variable in diameter growth. Seems to need even spacing as height is fairly uniform.
Vin Merwood	'Kereru Station' Kereru	Cupressocyparis leylandii ' Naylor's Blue' Grow extremely well here.
Helen Swinburn	'Hinerua', Tikokino	Cupressus arazonica Planted on top of a high red-metal river bank. Have done well. Some blew over in the wind - were milled and some of the timber used for panelling.
David Rumbal	Mathieson Road, Tikokino	Cupressocyparis leylandii 'Leighton's Green', Fast growing. Less canker eect than C. macrocarpa. Good/excellent shelter if trimmed top and root ripped. Possible timber. Other Leylands better I hear.
Garry Glazebrook	'Washpool', Maraekakaho	Cupressus chengiana Hu (Cheng cypress) Have young trees 5 yrs. Seems very drought resistant on gravel and good form. No canker so far.
Philip & Robyn Holt	'Maraetara', Seaeld Road	C. benthamii 'Grey leaf' - only one suitable on dry areas. - Otherwise wouldn't plant.
John & Heather Dean	Nuhaka	We have a strain of Cupressus sempervirens that came as a seedling from the Circle by the Theatre area of Eastwood Hill. It has a good central stem and very light side branches and seedlings come true to form. Although it is slower to gain diameter and needs wind protection, it is a very good strain. It has very good growth habits and is reputed to have very high timber quality. I am giving seed away and encouraging others to plant it. Also, it is relatively canker free, compared to the other two Italian cypress strains we have planted. It is over 30 m tall and is taller than its parent trees at the same age. Cupressus glabra has better form and is a better tree on our property than Cupressus torulosa. Cupressus cashmeriana is growing well. I do not know its timber quality.

Sequoia sempervirens Redwood		
Farm forester	**Location**	**Comments**
Robin Hilson	Paget Road, Takapau	They just cannot stop growing. Not good for farm shelter (or wood) but thrive in gardens and sheltered sites.
Mike & Helen Halliday	'Raumati',, Patoka	Great tree in the right place, but very site specic. When planted in the right place, growth rates are comparable with P. radiata.
Jack & Agnes Nicholas	'Makahu Stn.', Puketitiri	Good growth, but likes a deep moist soil. Sheltered site. Possums and deer - oh dear!
Bill Whittle	Whittle Road, Puketitiri	Block grown for timber. Some possum damage to crowns. Frost tolerant. Showing promise.
Kevin & Bev Thomsen	Hendley Road, Patoka	Moist soils (not wet). Sheltered from severe wind. Fast growth. Prone to tip Patoka breakage (wind and magpies), causing double leaders. Prune to max. height. Coppices readily from stump (erosion control?). Bare-root seedlings best.
Hans & Jenny Weichbrodt	'Hinterland', Tutira	Do well in moist sheltered soils, but not wet. Any well-drained soils. Plant at least two year stock, or release for first two years.
Joe Devonport	Tangoio Soil Conservation Reserve	Two areas: 1. 50 yr old westerly face growing well but not as well as in silty bottom. 2. 10 yr old southerly face - very patchy due to slip scars. Very slow here.
Ewan McGregor	Hautope Road, Waipawa	Fine tree. Good form. Good growth rates in deep moist soil.
Hugh McBain	'Kahotea Farm', Te Aute	A tree that is good for the summer dry conditions if kept on valley oors. Easy to establish.
David Bryant	Salisbury Road, Kereru	Best in valley oors. Keep out of wind.
Vin Merwood	'Kereru Station', Kereru	Seems to handle whatever the climate - dry, windy, and damp but not boggy sites.
David Rumbal	Mathieson Road Tikokino	Few examples on this property. Have not competed with larch well. Has huge potential as timber tree.
Alec Olsen	'Valhalla', Glengarry Road	In a sheltered site, they are truly impressive. Fast growth rate, valuable timber, few problems and so nice to be near.
Garry Glazebrook	'Washpool', Maraekakaho	Excellent when grown on deep soil in sheltered valley. 25 m in 11 years!
John Russell	'Tuna Nui', Sherenden	Has been very successful, especially in wet places. Planted to dry up wet spots, for shelter, timber, amenity. Has succeeded with minimum attention.
Tom & Dora Hartree	'Te Motu', Waihau Road	Love river terraces and deep-soiled creek beds. We plant in gorge areas with little wind and small terraces. Hate possums breaking their growing tops. Will then possibly send up double leaders. Will grow over a metre a year. Enjoys a moist root run. Will regrow from the stump when harvested. Must be grown within a forest situation as it will grow epicormics if trunk gets too much sun. We have found that growing *Cedrus deodara* as a surrounding tree stops this regrowth. Have harvested timber from trees 30 yrs old. We prune to 10 metres
Geo Prickett	Morere	Prefer good sites. Great form and growth rates.
John & Heather Dean	Nuhaka	Needs moist sites, free from salt winds (except for the blue leaved form). Does not like competition from Kanuka. Grows well with us but very site seletive.
Ross & Margaret Haliburton	Haliburton Road, Kotemaori	Likes deep fertile soil on sheltered, but frost-free, sites. Some possum control needed to prevent damage to growing tips. Rapid growth.

Pseudotsuga menziesii Douglas fir		
Farm forester	**Location**	**Comments**
Robin Hilson	Paget Road, Takapau	Excellent wood. Pretty slow. Many have been killed by possums. Slower annual growth than I would have expected.
Jack & Agnes Nicholas	'Makahu Stn.', Puketitiri	Cool southerly slopes. Slower growing on westerly areas. Deer are a major pest with Douglas Fir.
Bill Whittle	Whittle Road, Puketitiri	Block grown for timber. Frost tolerant.
Joe Devonport	Tangoio Soil Conservation Reserve	Very small number growing well in a sheltered valley bottom - up slopes 20m+ above stream. Loess soil with little limestone.
Mike & Helen Halliday	'Raumati', Patoka	Very site specic, but very high dollar returns from the right seed source, and planted in the right place. They need a sheltered site.
Ewan McGregor	Hautope Road, Waipawa	Too dry here, but has ornamental value on cooler southern slopes.
David Bryant	Salisbury Road, Kereru	Best on cold south faces.
Vin Merwood	'Kereru Station', Kereru	Seems to handle whatever the climate - dry, windy, and damp but not boggy sites.
John Russell	'Tuna Nui', Sherenden	Southerly slopes. Moderately successful. Planted for timber. Not very quick compared with pines.
Tom & Dora Hartree	'Te Motu', Waihau Road	Altitude and rainfall a little low here, but have produced trees harvestable at 40 years. Don't handle drought well. Like a moist root run.
John & Heather Dean	Nuhaka	We have only grown two trees to try the species - they have grown well. Bob Berry informs me that Douglas r grows from Canada to Mexico and therefore we need the southern strains that are not readily available in NZ. I attribute the better growth rate of our trees to wider spacing.
Ross & Margaret Haliburton	Haliburton Road, Kotemaori	Pre-plant spray of pasture. Southerly/sou'esterly aspect. Two year stock for best results. Rapid growth. Timber crop expected 40 years.

Acacia melanoxylon Australian blackwood		
Farm forester	**Location**	**Comments**
Jack & Agnes Nicholas	'Makahu Stn.', Puketitiri	Needs deep moist soil, subject to damage by caterpillar at the crown. Subsequent leader damage. Doesn't like hard frosts.
Hans & Jenny Weichbrodt	'Hinterland', Tutira	Moist and sheltered site preferred. Consider high-density planting (2000/ha) or pine nurse crop a year later. Constant form pruning of leader necessary for first 10 years.
Joe Devonport	Tangoio Soil Conservation Reserve	Grows well in valley bottoms, but has form problems.
Ewan McGregor	Hautope Road, Waipawa	Overrated. Not a goer here.
Hugh McBain	'Kahotea Farm' Te Aute	Frost is the main limiting factor that has prevented the successful Te Aute establishment of enough trees for successful timber production. Form not good, but grow well once established.
David Bryant	Salisbury Road, Kereru	Grows well, but must be careful to get good stock.
Vin Merwood	'Kereru Station', Kereru	Stock we used was poor and if growing them again would try and source better material.

Acacia melanoxylon Australian blackwood		
Farm forester	**Location**	**Comments**
Malcolm & Rohan O'Dwyer	'Morning Star' Tikokino	Release with low dose 'Gardoprim'. Needs shelter. Hard to keep form. Try damp end of a pine plantation, or right in the middle!
Peter Manson	Wairoa (McRae Trust)	Rapid growth rate on moist, well drained sites, but poor where drier. Many trees only have 3-4 metres (or less) useful trunk, but great diamete growth.
Alec Olsen	'Valhalla', Glengarry Rd.	Grows well in valley bottoms, but has form problems.
Geo Prickett	Morere	Inclined to poor form, especially forking, but not fussy for site. Best grown on steep southern faces here.

Acacia dealbata Silver wattle		
Farm forester	**Location**	**Comments**
Hugh McBain	'Kahotea Farm' Te Aute	Easy to grow. Great firewood tree.
Robin Hilson	'Tarata' and 'OSRS', Takapau	All (Acacia) have grown easily, then mature and fall down! Very attractive. (General comment for all cypresses)
Mike & Helen Halliday	'Raumati', Patoka	This tree has a great future! Management is very important: Keep them out of the wind and plant a high density. It's a short-life tree, so grow them quickly. Ground disturbance at logging will ensure future generations of seedlings.
David Bryant	Salisbury Road, Kereru	Kereru Grows well, but must be careful to get good stock.
Alec Olsen	'Valhalla', Glengarry Rd.	A fast-growing source of very decorative timber, but get the right strain and sound management advice.
David Rumbal	Mathieson Road, Tikokino	Hardy tree. Have established on shingle river-ats. Perform remarkably on alluvial soil types. Weed control absolutely necessary otherwise complete failure (Terbuthylazine). Few insect predators. Cold tolerant (frosts).

Larix decidua/kaempheri European / Japanese larch		
Farm forester	**Location**	**Comments**
Robin Hilson	Paget Road, Takapau	Easy to establish. Easy to grow. Strong, colourful, and have produced attractive timbers.
Hans & Jenny Weichbrodt	'Hinterland', Tutira	L. decidua: Plant on southerly aspect on most soils. Tolerates dry conditions temporarily. Likes cooler climates. L. kaempferi: Do not like it too hot or dry, but do well once established.
Joe Devonport	Tangoio Soil Conservation Reserve	L. decidua: Southeast face - 40+ yrs. Growing very slowly. Good form but small size.
Ewan McGregor	Hautope Road, Waipawa	On cooler slopes. Form oers contrast. Yellow colour contrasts with Douglas fir. Grows well.
Vin Merwood	'Kereru Station', Kereru	L.decidua grows well here. I enjoy their autumn colours.
David Rumbal	Mathieson Road, Tikokino	L. kaempferi: Grows well on moist sites. Growth rates on right site very good. Great autumn colour.
John & Heather Dean	Nuhaka	L. eurolepsis is the only good larch with us, but some of the American and Oriental larches may be satisfactory.

Thuja plicata Western red cedar		
Farm forester	**Location**	**Comments**
Robin Hilson	Paget Road, Takapau	Brilliant initially but after 10-15 yrs and they were ruined by borer. Shelter was excellent, but now not worth planting.
Hans & Jenny Weichbrodt	'Hinterland', Tutira	Moist, sheltered fertile sites. Plant minimum 1 metre tall stock into sprayed pots. Release them for rst two years. Good form.
John Russell	'Tuna Nui', Sherenden	Some species that do not seem happy here are: Thuja plicata, Larix, C. macrocarpa (do well until they get canker).
Chris McGillivray	Maraetotara	Fell over due to rot at 25 yrs. Poor timber here. Have spoken to a miller at Rataehi who sends the graded product to US and prospers.
John & Heather Dean	Nuhaka	With us it seems to prefer moister sites and resents competition from kanuka. Good growth rates are being achieved. Pruning seems to promote growth. Strain selection is needed. We are surprised that this tree has timber potential with us, as we only thought it had shelter belt value when we planted it.

Cryptomeria japonica Japanese cedar		
Farm forester	**Location**	**Comments**
Robin Hilson	Paget Road, Takapau	Do not like the wind.
Kevin & Bev Thomsen	Hendley Road, Patoka	Med/moist soils. Med/fast growth. Withstands reasonable winds. Can be side trimmed for shelter or clear pruned for timber. Does not require competition to maintain good form. Very light timber. Branchlets and cones stick in wool. Bare-root seedlings best.
Hans & Jenny Weichbrodt	'Hinterland', Tutira	Moist, sheltered fertile sites, but not wet. Go for 2 year bare-rooted stock with good form. Plant into spray spots made one month in advance using a knockdown herbicide.
Geo Prickett	Morere	Strong growing. Like our conditions - hillsides, ash on papa. Excellent form.
Alec Olsen	'Valhalla', Glengarry Rd.	In sheltered places grows straight and true with few vices. Have observed its ability to poke through a kanuka canopy with little abrasion.
John & Heather Dean	Nuhaka	These trees do very well here but it is a great pity that the seed gets in sheep wool. The 'Maihi' strain of Cryptomeria japonica, is the one we grow and is probably one of the best timber strains to come to NZ. Japanese cedars are one of the best trees for ood prone areas as they will shoot new roots out of old bark if the trees are part buried by oods. Some strains stand salt wind. This tree is very wind hardy. Japanese Cedars are very variable as to what size they will grow to, so strain selection is most important. Releasing is needed if you want the trees to grow fast. They take some time to grow heartwood (the sap wood is not lasting like C.awsoniana sapwood). The Japanese do not want fast grown Japanese cedars and prize timber with close growth rings, and trees that have been very high pruned. The timber is worth ten times the value of P. radiata in Japan. The oldest use is in Japanese temples built thousands of years ago. The timber is preserved by rubbing with persimmon juice! Cryptomeria sinensis: we have only grown two trees but it seems to be quicker growing than Japanese cedar and is of good form.

Eucalyptus species		
Farm forester	**Location**	**Comments**
Robin Hilson	Paget Road, Takapau	Mountain ash (E. regnans) grow well once established. Many died with balled roots. Hard to establish, but will grow into huge trees from self-sown plants. Planted only in selected sites.
Robin Hilson	'OSRS ', Takapau	All grow well and become huge trees. Many have been utilised for timber with varied success. Good fast shelter. Once aged they drop branches daily.
Jack & Agnes Nicholas	'Makahu Stn.', Puketitiri	E. regnans, E. delegatensis , E. obliqua Fast growing on southerly slopes. Will stand wind fairly well. E. johnsonii, E. youmanii 1-3 yrs, E. blaxlandi . These three Eucs are looking promising and are growing well. Northerly slope. Deep pumice soil.
Bill Whittle	Whittle Road Puketitiri	E. delegatensis block grown for timber. Frost tolerant. Used in single row shelter belts with C. lawsoniana (1 for 1). Puketitiri grown, does not mill very well.
Kevin & Bev Thomsen	Hendley Road, Patoka	**Shelter**: E. fraxinoides Must not get wet feet at any stage. Withstands severe wind. Tolerates side trimming with branches retaining growth low down. Form poor for timber unless grown in woodlot competition. Root trainer seedlings best. **Timber**: E. nitens Very fast (30m @ 15 yrs, 50 cm DBH ave). Medium density wood. Good for re wood from thinnings. Apical shape allows nal spacing at ±160 sph. Must remove branches to achieve max clearwood. Root trainer seedlings best. **Timber**: E. regnans Very fast (30m @ 16 yrs). Low density wood - still makes good, easy splitting rewood from thinnings. Apical form allows nal spacing of ±160 sph. Must remove branches to maximise clearwood. Bare root or root trainer. In rst 12 mths, apply nitrogen as a side dressing if it is apparent that the soil is decient (urea @ 20 gms in spade slit, 200 mm away on lower side). Weed control essential in the rst season!
Graham & Susan Mackintosh	Putorino	E. nitens Have planted for firewood, timber and also on erosion sites. Very good growth rates. Hope the timber options will improve. E. saligna Originally as a rewood crop, but have thinned and retained a final crop for timber. Really straight meaty trunks. Medium dry site.
Hans & Jenny Weichbrodt	'Hinterland', Tutira	Eucalyptus sp. Cultivate soil before planting - NO GRASS! Prefer barerooted 2 yr stock. No root-trainers! First year releasing is essential. Species choice very difficult.
Steve Wyn Harris	'Marlow Hill', Hatuma	E. nitens Grow like weeds in any conditions. Tolerate wet and frosty conditions.
Mike & Helen Halliday	'Raumati', Patoka	Eucalypts Reasonably reliable for shade and shelter. Maybe OK for timber. Fraxinoides (shelter) and regnans best two for us. E. obliqua Possibly more tolerant of various sites than other Eucs. on thisproperty. Timber has been milled and used for 50 years on Raumati (heartwood only). E. obliqua battens have survived more than 50 years in places. E. regnans Compared to E. obliqua and E. fastigata, has been disappointing. Has been dicult to get good form and growth rates.
Ewan McGregor	Hautope Road, Waipawa	Eucalypt species Get the right ones and growth rates are excellent. Still learning here. Must plant more.

Eucalyptus species		
Farm forester	**Location**	**Comments**
Willie Peacock	Peacock Road, Waipukurau	E. saligna Growing well on dry sunny NW slope – 200m a.s.l. E. delegatensis Growing well on dry sunny NW slope – 200m a.s.l. E. botryoides Likes wetter sites - 150m a.s.l. E. cifolia 200m a.s.l. E. regnans Magnicent growth. Free-draining N slope - 200m a.s.l. E. fastigata Growing OK.
David Bryant	Salisbury Road, Kereru	E. delegatensis, regnans, fraxinoides & nitens All seem to grow well in this area.
Vin Merwood	'Kereru Station', Kereru	E. nitens, regnans & meliodora have survived. E. rosea in very sheltered spots - but not easy to get going.
Helen Swinburn	'Hinerua', Tikokino	E. ovata Have done well in the wet and dry areas of HW50. E. nitens & nicholii Are also doing well.
David Rumbal	Mathieson Road, Tikokino	E. obliqua Hardy eucalypt. Good form on sheltered site. Frost susceptible in first year. Responds well to nitrogen applications. E. ovata Fast growing, with attractive foliage. Good for birds. Good rewood. Possible timber for rails etc. Form initially poor (not straight). Brookeriana better. E. regnans Grows well. Good form. Timber quality debatable. E. nitens Rapid growth in cooler areas. Wind tolerant.
Mike & Carola Hudson	'Gwavas', SH 50	E. fastigata Good. E. delegatensis Lost in drought at 15 yr old. E. fraxinoides Lost with bark split in frosts. E. regnans Not drought tolerant. E. nitens Slow, but still with us!
Malcolm & Rohan O'Dwyer	'Morning Star', Tikokino	E. fastigata Fast growing. Prune early. Handles wind. Spacing 2x3 m. Thin to 6x6 m. Not in low areas - frost. E. ovata Swamp gum Plant in wet area and watch them grow. Useful for winter rewood (keep power bill down). Good form in sheltered places.
Garry Glazebrook	'Washpool', Maraekakaho	E. melliodora Successful over gravel or clay. Very durable and really great firewood. E. saligna Has made good growth when holes bored through hard pan. Good seed strain essential. Good timber. E. citriodora When stems protruded from frost? First 3 years, has made very good growth. Very decorative, and nice smell in summer. E. bosistoana (Coast grey box, Bosisto's box) Grown on gravel. Milled at 80+ years. No twist or cracking. Has made very good furniture - indoors and outdoors.
John Russell	'Tuna Nui', Sherenden	E. saligna, regnans & botryoides Limited experience. Doing well so far (15 yrs). Ripped pan before planting, but have had limited post-planting attention.
Alec Olsen	'Valhalla', Glengarry Road	E. saligna & botryoides Attacked by myriad pests, and have had many failures, but milling that rich red timber seems to make it all worthwhile. When growing Eucs you have to be prepared for surprises, both good and bad.
Tom & Dora Hartree	'Deep Creek', Puketitiri	E . fastigata (Brown barrel) Grown in pumice country at Puketitiri. Have Puketitiri produced excellent sheep-yard rails. Could be used for flooring.

Eucalyptus species		
Farm forester	**Location**	**Comments**
Chris McGillivray	Maraetotara	E. muelleriana Evaluated more than any other. The Field Bros. in the 1920s on the Waimarama Road planted 22,000 eucalypts. There were only unfortunately a few E. mulleriana. Some were milled in the early 50s and cattle yards built on the roadside. When I inspected them a few years ago, they were still sound. The limbs were used as posts. So the group bought a tree (the only one left) for $300, carried it 15 miles to our local mill and sold it at mate's rates to members. We put $500 in the bank after all expenses. A member went up to Davies-Colleys' mill in Northland and found they got 35% yield from their E.muelleriana. We got 60% plus. Even the core was quite acceptable for farm usage, as were the slabs. To say that sale was a critical factor is too bold perhaps but I do think it is relevant. This timber is usable from shingles to piles. The miller said it milled easily and true.
Philip & Robyn Holt	'Maraetara', Seaeld Road	E. fastigata, saligna, pilularis, botryoides, obliqua, microcorys, muelleriana & fraxinoides. Need well drained soils. Little frost. Plant away from frost pockets. Plant November. Small seedlings. Timber: hope will be valuable.
Peter Manson	(McRae Trust) Wairoa	E. regnans Exceptional growth on good soils. Great form but high death rate Wairoa after severe drought (15 yr old trees). E. saligna Rapid diameter growth but lots of wind damage resulting in short logs. E. botryoides Slow diameter growth - nothing special.

Quercus Oaks		
Farm forester	**Location**	**Comments**
Robin Hilson	'Tarata', Takapau 'OSRS ', Takapau	Oak, larch & European ornamentals Easy to establish. Easy to grow. Strong, colourful, and have produced attractive timbers. Walnut, chestnut & oak. Thrive & fruit well. Some problems establishing in open pasture. Wonderful timber. Trees grow fast and have not been aected by wind.
Jack & Agnes Nicholas	'Makahu Stn.', Puketitiri	Quercus All species thriving, but, like Betula, subject to damage by the Puriri moth caterpillar.
Steve Wyn Harris	'Marlow Hill', Hatuma	Quercus Best in gullies. Don't like our winds in exposed places. Plenty of potential, and they are stunning at the moment (autumn). Not sure which are best for timber, but excellent amenity species. We grow palustris, robur, coccinea plus two other varieties.
Mike & Helen Halliday	'Raumati', Patoka	Quercus Oaks have good potential here. Have planted robur x petraea, and they show good growth rates and apical dominance.
Ewan McGregor	Hautope Road, Waipawa	Quercus Wide range of species. Like my clay soils. Drought tolerant. 'English' most robust but 'American' better form and autumn colour - timber.
Hugh McBain	'Kahotea Farm' Te Aute	Quercus Several oak species have proved that they are excellent trees for our conditions. As an amenity tree, they withstand the dry and the leaves look good even in the windiest season.
David Bryant	Salisbury Road, Kereru	Q. coccinea Great autumn colour. Will stand dry conditions. Slow growing.

Quercus Oaks		
Farm forester	**Location**	**Comments**
Alec Olsen	'Valhalla', Glengarry Road	Quercus I had not realised just how tough these trees are. Will be planting many more.
Vin Merwood	'Kereru Station', Kereru	Q. palustris No 1. Grow in whatever conditions. Planted 128 in lane 4 yrs ago and every one grew. Grass grub beetle damage in spring to leaves.
Mike & Carola Hudson	'Gwavas', SH 50	Quercus: Species planted out in last 15-20 years with the minimum of SH 50 attention have mainly been for aesthetic purposes. Quercus being the most tenacious and successful. All resilient when established. Q. robur Groups out on farm over 100 yrs old now. Q. acutissima Good in drought. Q. ilex Good in wind. Q. rubra Q. erect 2 - 3 yr seedlings grow here No weed control or watering. Full exposure. Protected at planting from rabbits and possums.
Garry Glazebrook	'Washpool', Maraekakaho	Q. canariensis Has made very good growth under all conditions. Goodlooking oak.
John Russell	'Tuna Nui', Sherenden	Q. cerris Possibly next toughest. Similar conditions to cedar. We grow for Sherenden shade, shelter, duck food and amenity. Q. robur & palustris All seem to be pretty tough, especially now we have fewer possums, they are doing well.
Peter Ormond	Kahuraniki Rd., Tuki Tuki	Quercus All that I have tried do well including Q. palustris.
Philip & Robyn Holt	'Maraetara', Seaeld Road	Oaks: Algerian and Turkey Easy to grow - seeds or transplant when 1-2 yr old. Quick growing, food source, shade.
Helen Swinburn	'Hinerua', Tikokino	Quercus ilex Have been a very useful medium-height shelter. Some blew down in an unusually erce wind but are uprising again.

Alnus Alder		
Farm forester	**Location**	**Comments**
Robin Hilson	Paget Road Takapau	All do well, even in exposed sites. One of the best shelter trees possible. A. cordata = fruit salad to possums. If the site is wrong, they fail.
Hans & Jenny Weichbrodt	'Hinterland'' Tutira	Tolerate wet conditions, except A. cordata. Good form. Leaves liked by grass grubs (bronze beetle).
Hugh McBain	'Kahotea Farm' Te Aute	A. cordata - Excellent tree for shelter in wide range of conditions. Good for shelter on cropping flats.
David Rumbal	Mathieson Rd., Tikokino	A. cordata - Fast growing deciduous shelter. Not as much a spreading/competitive root system.
Peter Manson	Wairoa	A. acuminate (own property - at): Very fast growth on top-quality soils. Growth rate drops away even with a slight change in soil moisture. Brittle branches, trims well and massive diameter growth.
Geo Prickett	Morere	A. rubra: (Red alder) Great soil rejuvenators via mulch and nitrogen. Will grow on hardest sites. Good nurse tree for natives.

Alnus Alder		
Farm forester	**Location**	**Comments**
John & Heather Dean	Nuhaka	A. rubra is the best alder for timber according to my reading. It is the most successful tree we have found for growing on raw mudstone or papa slips. As these trees x nitrogen, the slips heal much quicker beneath these red alders. In our biggest planting we only lost three trees out of 500, in spite of planting them on the worst slips with a drought during the following summer. There is more work to be done in nding other good alders for our coast. Uses: heartwood red alder is said to be equivalent to rimu in use. Grow very big. No recent plantings because of abortion in cattle.
Mike & Helen Halliday	'Raumati', Patoka	A. cordata: Great east/west shelter, especially when mixed with poplars or similar.

Populus Poplar		
Farm forester	**Location**	**Comments**
Robin Hilson	'Tarata', Takapau	Do not grow well at this altitude (700m). Possums damage poles. Trees do not thrive. Very extensive pole planting was 90% failure.
Robin Hilson	'OSRS ', Takapau	From Lombardy to all modern species, these trees grow extremely well. Matsudana (willow) excellent. Possums enjoy these species but the trees appear to cope well.
Mike & Helen Halliday	'Raumati', Patoka	Kawa shines out as our best. Stands the wind, with only slight possum Patoka damage. Grows protective bark quickly. The reason one plants poplars is to stop erosion, so keep heavy cattle out of the area for 4-5 years as they damage both the young trees and the fragile soils.
Jack & Agnes Nicholas	'Makahu Stn.', Puketitiri	Most species do well, but like to be out of the wind. Tolerate most soils and Puketitiri moisture. Possums prey on some species.
Alec Olsen	'Valhalla', Glengarry Road	The most under-rated and versatile tree for farm planting. In the right place, it does everything well - shelter, shade, fodder, timber and beauty.
Graham & Susan Mackintosh	Putorino Stn. Rd., Putorino	Poplars: Toa, Kawa & Eridano - Have had good results with all three, but have planted mainly where there is moisture. Must watch sleeves of these and the willows, as they grow so fast.
Steve Wyn Harris	'Marlow Hill', Hatuma	Best in gullies. Don't like our winds in exposed places. Plenty of potential, and they are stunning at the moment (autumn).
Ewan McGregor	Hautope Road, Waipawa	Mainstay! I keep these up the slopes on poor ground, but they still are far more robust than other genuses. Brilliant yellow colour with the rust-resistant varieties. (I favour Veronese & Kawa) Excellent form. Grow anywhere.
Willie Peacock	Peacock Road, Waipukurau	Poplars: Kawa hybrid: Good form and growth. Draw up well amongst pines. Good stock fodder. Possum resistant. P. deltoides: Grow fast and huge. Break and snap in wind. Big shade area. P. italica (Lombardy): Good erosion control. Small shadow area. Gets rust but still survives. P. yunnanensis (Chinese): Grow huge and reasonably wind resistant. Big shade area. Sucker - good erosion control.
Hugh McBain	'Kahotea Farm' Te Aute	Great for valleys and peat ats. Require releasing and/or irrigation once we get off the ats or valley oors. Kawa particularly good - no possum problems and not too brittle.

Populus Poplar		
Farm forester	**Location**	**Comments**
David Bryant	Salisbury Road, Kereru	Kawa poplar: Prefers slightly moist areas. Good spring and autumn colours. Makes great timber if pruned.
Helen Swinburn	'Hinerua', Tikokino	K. van Kraaynod's hybrid poplars: Are good shelter. The ones most prone to rust have either become partly resistant or died. Poplar Argyle: Planted in a fan pattern. Have been prone to breaking o the trunk, mainly, I think, because the sleeves were kept on too long. The trunks developed roots and became like a soft root. They are still in the experimental stage.
Mike & Carola Hudson	'Gwavas', SH 50	Poplars (Modern var): Poles out with protective sleeves. Haven't had a drought yet!
Malcolm & Rohan O'Dwyer	'Morning Star', Tikokino	Poplar Kawa: Good in pine blocks to dry out wet areas. Plant as wands (1m). No release. OK for cattle year 6. (After pines had 1st prune) Poplar Toa: Sheltered moist areas. Prune from 4th year. Good for feeding stock.
John Russell	'Tuna Nui', Sherenden	Poplars: deltoides & Balsam - Have withstood possums and succeeded in damp gullies. Planted for variety and amenity plantings.
Philip & Robyn Holt	'Maraetara', Seaeld Road	Will only be successful on southern slopes and ats. Do not like it dry. We love the leaf litter and colour!
Peter Manson	Wairoa	Populus Kawa: (Waihua Hill on SH2) These are doing very well on hill country where there is sucient soil depth and moisture. They do not perform well on harder sites. Very straight stems but some breakage in windier sites. Populus Crows nest: (numerous sites) High survival rate in drier seasons. Outperforming even willows in some areas. Very straight stem, many branches, looks great.

Castanea sativa Sweet chestnut		
Farm forester	**Location**	**Comments**
Robin Hilson	'OSRS ', Takapau	Thrive & fruit well. Some problems establishing in open pasture. Wonderful timber. Trees grow fast and have not been aected by wind.
Hugh McBain	'Kahotea Farm' Te Aute	Easy to establish and do surprisingly well in dry conditions.
Mike & Carola Hudson	'Gwavas', SH 50	Very good foliage. Slow to nut.
Mike & Helen Halliday	'Raumati', Patoka	We like using the timber and eating the nuts! Another great shade tree. Has very palatable bark - KEEP STOCK OUT FOREVER!

Juglans Walnut		
Farm forester	**Location**	**Comments**
Robin Hilson	'OSRS ', Takapau	Thrive & fruit well. Some problems establishing in open pasture. Wonderful Takapau timber. Trees grow fast and have not been aected by wind.
Joe Devonport	Tangoio Soil Conservation Reserve	J. nigra - Established well but very slow growth. Form appears to be a problem. (Block across the creek from White Pine Bush carpark.)

Juglans Walnut		
Farm forester	**Location**	**Comments**
Robin Hilson	'OSRS ', Takapau	Thrive & fruit well. Some problems establishing in open pasture. Wonderful Takapau timber. Trees grow fast and have not been aected by wind.
Joe Devonport	Tangoio Soil Conservation Reserve	J. nigra - Established well but very slow growth. Form appears to be a problem. (Block across the creek from White Pine Bush carpark.)
Steve Wyn Harris	'Marlow Hill', Hatuma	Not where wet feet. Valuable for shade, shelter & nuts.
David Bryant	Salisbury Road, Kereru	Handy - good shade trees.
Alec Olsen	'Valhalla', Glengarry Road	J. nigra has been a disaster, but J. regia (common walnut) has proved to be a very useful shade tree, especially in the sheep yards. The bark seems unpalatable to stock and the nut crop is an added bonus. The rooks have established trees throughout the farm.
Geo Prickett	Morere	J. nigra: Black walnut - Good sites only. Great growth. Need good releasing. Unlike many (most) northern hemisphere deciduous species, are all immune to Puriri moth damage.

Platanus Plane		
Farm forester	**Location**	**Comments**
Kevin Thomsen	Hendley Road, Patoka	Grows readily from cuttings. Plant out as rooted small poles. Excellent shade tree pruned up (some form-pruning required). Wind tolerant. Bark unpalatable to sheep and cattle (including bulls!). Med-fast growth except on dry or low
Mike & Helen Halliday	'Raumati', Patoka	We like the timber - good form, and a great shade tree.
Alec Olsen	'Valhalla', Glengarry Road	The Plane has so much to oer pastoral farmers. Easy to establish, good growth rate, very compatible with pasture & stock, excellent timber and can be pruned, pollarded or coppiced to suit the need.
Ewan McGregor	Hautope Road, Waipawa	Good form/timber. Reasonably tough. Poor autumn colours. Soft green in leaf burst.
Garry Glazebrook	'Washpool', Maraekakaho	Make excellent shade trees and decorative avenues. Drought resistant once Maraekakaho established on gravels.

Taxodium distichum Swamp cypress		
Farm forester	**Location**	**Comments**
Ewan McGregor	Hautope Road, Waipawa	Not as good form as Dawn redwood but otherwise similar. Better autumn colours. Stand real wet.
David Bryant	Salisbury Road, Kereru	The wetter the better. Great autumn colour. Good for around dams etc. as they have a knobbly root system that goes right into the water
Vin Merwood	'Kereru Station', Kereru	Grows in wet areas and springs.
John & Heather Dean	Nuhaka	We grow T. distitchum, mucronatum and Ascendens (nutans). They all grow well for us and seem to prefer warm wet sites. T. ascendens Nutans is growing well on drier sites in spite of being called 'Pond cypress'! A wonderful erosion control tree, not very palatable to animals, other than goats.

Appendix III : Knapsack Sprayer Calibration

Calibration is very important for application of residual herbicides or for any 'over the top of the tree' spraying. It is not so critical if you are pre-plant spraying using non-residual herbicides (apart from the fact that you may be wasting chemical by excessive application.)

Few farm foresters take the trouble to calibrate their knapsack for their spraying operations. This is mostly because they do not have clear instructions on the method required to perform this task. The only reason operators avoid damaging results from imprecise application is the wide tolerances of the trees to the herbicide chemicals used. However, many failed or poor performing young trees may be a result of an excess of herbicide – especially 'residual' type chemicals that work through the soils.

General

Knapsack sprayers vary considerably in their rate of application.

Factors affecting this are:

- Each individual operator's speed of movement and evenness of application (probably the greatest variation).
- Working pressure: This can be adjusted by the operator to suit the spraying task and conditions by changing the setting of the pressure release valve. Use a short and steady pumping action on the handle to maintain an even nozzle pressure. Nozzles are available in different 'flow rate' and spray pattern configurations. For spot spraying over or around trees, a 'wide-angle fan' type nozzle is best to cover a sufficient area of 1.5-2.0 m2.
- Spray pattern: Do not spray around a tree in a circular sweep, as this will concentrate the chemical on or around the base of the tree. Use two parallel sweeps, one on each side of the plant, avoiding too much overlap. The best system is to use a 'mini-boom', which is a 'T' shaped wand with two nozzles about 50 cm apart. This allows a single pass, covering about 1.5 m in width, which makes the operation fast and even.
- Working height: This is controlled by the height of the weeds, or by the height of the young tree if you are spraying over the top of it. The higher you spray above the ground, the wider the coverage of the spray pattern, but less spray mix is applied per square metre unless the movement rate is slowed down. Also, the risk of spray drift is increased, which will reduce the concentration on the desired spot. About 50 cm above the weed foliage is an effective working height.
- Knapsack care: Cleaning the knapsack container and nozzles is essential if it has been used for other purposes, e.g. spraying blackberry or gorse! Use clean water with ammonia product (household bleach) added to neutralise any toxic residues that may contaminate the mix and harm the trees. Then flush well with clean water, checking that the filters and nozzles are clean.

Calibration

Set up the knapsack as you intend to use it for the 'release spraying' operation.

1. Add water up to an easily identified level (e.g. the 5 litre mark).
2. Begin spraying over a measured 100m distance on a hard surface (gravel or tar seal), holding the nozzle about 50 cm above the ground, moving forwards at the rate you expect to cover over the trees, pumping steadily and evenly.
3. Now measure the amount of water required to refill the knapsack up to the previously identified mark.
4. Divide this quantity by 100, if the spray coverage is about one metre wide using a single nozzle, or by 150, if using a 'mini-boom' covering about 1.5 m wide.
5. The resulting figure is the rate of spray being applied 'per square metre'
6. A comfortable 'fill' in a knapsack for rough terrain is 10litres, so divide this (i.e. 10,000 ml) by the above 'per square metre' rate. The result is how many square metres that each 10 litre knapsack 'fill' will cover = (A).
7. If you are covering 2 m2 per tree (i.e. 1.4m wide by 1.4m long), the number of trees this mix should treat is half of the above figure.

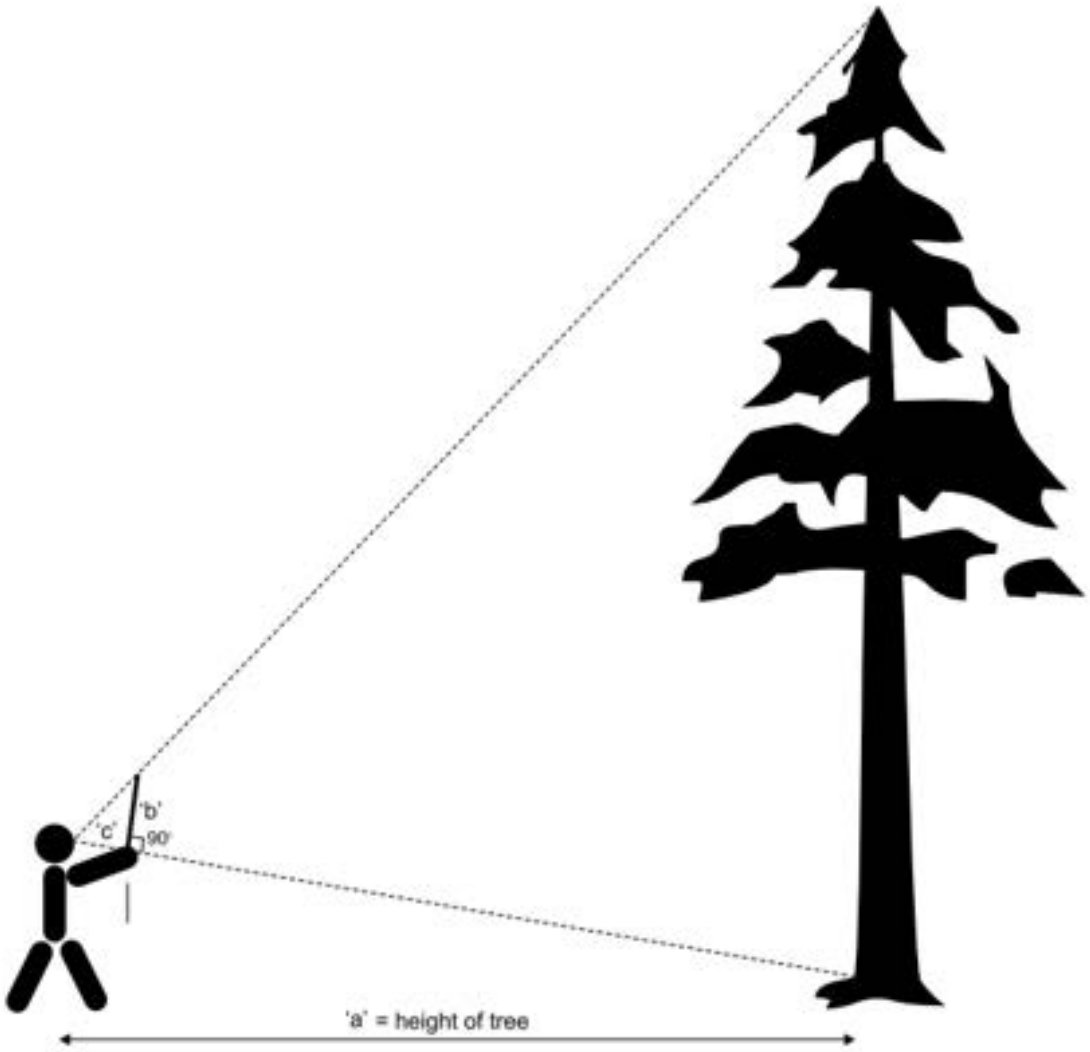
Calculating the rate of herbicide chemical to add to a mix.

1. Usually, the recommended chemical application rate is given on a 'per hectare rate'. Divide this rate by 10,000 to obtain the 'per square metre rate' (B).
2. Now use this result (B) and multiply it by the 10 litre 'knapsack fill rate' (A). The result is the amount of chemical to be added in to each fill of 10 litres.
3. If more than one chemical is needed in a mix, repeat this calculation for each one.

Finally, as a double check on the accuracy of the calibration, count the number of trees that you treat with the first knapsack fill and compare it with the expected rate. If there is a difference, vary the speed of application or adjust the chemical concentration.

Note: As a general guide, 10 litres in a knapsack should provide a 'spray coverage rate' of between 250 and 350 trees. There is no need to apply a heavy concentration of spray to each spot if the correct chemical mix is being used.

Appendix IV:
Calculating the Height of a Tree



Length of 'b' = length 'c' The length of the measure stick from the hand to the top end must equal the distance the hand is held away from the eye.

Calculating the height of a tree

There are scientific methods using hypsometers or inclinometers and tape measures or very expensive but effective laser instruments.

The simplest method is to obtain a straight length of wood or stick, longer than your arm (possibly a convenient branch). Hold one end to your eye, stretch the other arm out and grasp the stick with that hand. Now rotate the stick up vertically (thus creating a right angle triangle from the eye). Walk backwards from the tree to be measured until the tip of the tree lines up with top of the measure and the base of the tree with the hand. Try to stay on the same contour as the base of the tree to improve the accuracy. Measure the distance from your feet to the base of the tree, this equals the height. ('a'= height of tree)

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Appendix V:
Stem per Hectare Chart

The following chart is a tree spacing and stocking guide. Stocking is usually expressed as the number of stems/ha = sph. For example 1ha = 10,000m^2. If planting is at 4 x 2m, this is 8m^2/tree, and stocking is 10,000 divided by 8 which = 1250sph. If spacing is 4 x 3m, stocking is 10,000 divided by 12 which = 833sph, (NZFFA Tree Information Leaflets, 2002).

Table 132 : Tree spacing and stocking guide

Stems per hectare

Distance Between Trees	1.0	2.0	2.5	3.0	3.5	4.0	4.5	5.0	6.0	7.0	8.0
2.0	5000	2500	2000	1667	1429	1250	1111	1000	833	714	625
2.5	4000	2000	1600	1333	1143	1000	889	800	667	571	500
3.0	3333	1667	1333	1111	952	833	741	667	556	476	417
3.5	2857	1429	1143	952	816	714	635	571	476	408	357
4.0	2500	1250	1000	833	714	625	556	500	417	357	313
4.5	2222	1111	889	741	635	556	494	444	370	317	278
5.0	2000	1000	800	667	571	500	444	400	333	286	250
5.5	1818	909	727	606	519	455	404	364	303	260	227
6.0	1667	833	667	556	476	417	370	333	278	238	208
6.5	1538	769	615	513	440	385	342	308	256	220	192
7.0	1429	714	571	476	408	357	317	286	238	204	179
7.5	1333	667	533	444	381	333	296	267	222	190	167
8.0	1250	625	500	417	357	313	278	250	208	179	156
9.0	1111	556	444	370	317	278	247	222	185	159	139
10.0	1000	500	400	333	286	250	222	200	167	143	125

Source : New Zealand Farm Forestry Association Information Leaflets 2002

Appendix VI: Durable Timber Species

Farm foresters refer to durable species as those producing wood that can last in the ground or are used for outdoor use. There are a number of Special Purpose Species that may be grown in selected microclimates with varying degrees of durability. However, a number of references indicate that durability in many species has a direct association with age. While a species may be able to reach a harvestable size within 30 years, the tree may not contain a high proportion of naturally durable heartwood. This has been significant with Sequoia sempervirens in 'new growth forests' in California USA. The trees may be up to 90 years of age but do not compare for durability with 'old growth forests' that were hundreds of years old.

The following information on New Zealand grown timbers, tested for in-ground durability, is mostly extracted from 'New Zealand Timbers' (Clifton, 1991). Many of these timbers will last longer if used indoors, or outdoors but above the ground. Some of these tree species may well be required to replace chemically treated pine in vineyards or other sites where leaching could enter groundwater.

Very durable (will last longer than 25 years in the ground)

- Castanea sativa — sweet chestnut
- Catalpa speciosa — western catalpa
- Eucalyptus cladocalyx — sugar gum
- Eucalyptus microcorys — tallowwood
- Eucalyptus bosistoana — coast grey box
- Eucalyptus melliodora — yellow box
- Robinia pseudoacacia — black locust
- Podocarpus totara — totara
- Lagarostrobus colensoi — silver pine

Durable (will last 15 to 25 years in the ground)

- Durable (will last 15 to 25 years in the ground)
- Eucalyptus amygdalina — black peppermint
- Eucalyptus botryoides — southern mahogany
- Eucalyptus globoidea — white stringybark
- Eucalyptus muelleriana — yellow stringybark
- Eucalyptus obliqua — Tasmanian oak, stringybark
- Eucalyptus pilularis — blackbutt
- Eucalyptus saligna — Sydney bluegum
- Nothofagus truncata — hard beech
- Nothofagus solandri var cliffortioides — mountain beech
- Nothofagus fusca — red beech
- Metrosideros robusta — southern rata

Moderately durable (will last 10 to 15 years in the ground)

- Eucalyptus globulus — Tasmanian bluegum
- Eucalyptus radiata — narrow-leaved peppermint
- Eucalyptus sieberi — silver top ash
- Nothofagus menziesii — silver beech
- Sequoia sempervirens — redwood
- Cupressus macrocarpa — Monterey cypress
- Cupressus lusitanica — Mexican cypress
- Chamaecyparis lawsoniana — Lawson cypress
- Picea sitchensis — sitka spruce
- Libocedrus bidwillii — kaikawaka
- Phyllocladus trichomanoides — tanekaha

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Appendix VII:
Fast Find to Species Suitability

BOTANICAL NAME	DETAILS FOUND ON PAGE ?	COMMON NAME	POTENTIAL HEIGHT (IN METRES)	GROWTH RATE	SOIL MOISTURE TOLERANCE	COLD TOLERANCE	FOLIAGE FORM	SHADING TOLERANCE	WIND TOLERANCE	RISKS
			Optimum on ideal sites, sometimes with great age.	s = slow m = medium f = fast	w = wet m = moist g = good drainage d = dry	Refer to the Plant Hardiness Zones on page ?	d = deciduous e = evergreen	Scale 1 - 5 1 = intolerant 5 = very tolerant	Scale 1 - 5 1 = intolerant 5 = very tolerant	
Acacia dealbata		Silver wattle	20	f	g	8-11	e	1	1	stock & wind
Acacia melanoxylon		Australian blackwood	35	m / f	m / g	8-11	e	3	3	form / siting
Agathis australis		Kauri	50	m	g	10-11	e	2	3	frost
Alnus rubra / cordata / glutinosa		Red/Italian/black alder	25	f	m / g / d	6-9	d	3	3	
Araucaria heterophylla		Norfolk Island pine	60	m	d	10-11	e	1	5	frost
Castanea sativa		Sweet chestnut	35	m	g / d	5-9	d	1	3	palatable bark
Cedrus deodara		Himalayan cedar	60	s / m	d	7-10	e	3	5	bark damage
Chamaecytisus palmensis		Tagasaste	4-5	f	g / d	9-11	e	2	3	palatable
Cryptomeria japonica		Japanese cedar	40	m	m	7-11	e	3	2	foliage in wool
Cupressocyparis leylandii		Leyland cypress	35	f	g / d	5-10	e	3	4	canker
Cupressus lusitanica		Mexican cypress	35	m / f	g	7-9	e	3	2	cattle abortion
Cupressus macrocarpa		Monterey cypress	30	m / f	g	6-9	e	3	2	cattle abortion
Cupressus torulosa		Bhutan cypress	50	s / m	d	7-9	e	2	3	
Dacrydium cupressinum		Rimu	60	s	w / m / g	7-10	e	4	1	
Fagus sylvatica		English beech	40	m	m / g	5-8	d	2	3	
Ginkgo biloba		Maidenhair tree	40	m	g / d	3-10	d	2	3	female tree fruit!
Juglans nigra		Black walnut	35	m	g	4-10	d	2	1	Magpies
Juglans regia		Common walnut	30	m	g	4-10	d	2	3	
Knightia excelsa		Rewarewa	30	m	m / g	6-9	e	3	3	
Larix decidua		European larch	36	m	g / d	4-9	d	3	2	leaf cast
Larix kaempferi		Japanese larch	36	m	g	4-9	d	2	2	leaf cast
Metasequoia glyptostroboides		Dawn redwood	35	m	m / g	5-10	d	2	2	
Metrosideros excelsa		Pohutukawa	20	s / m	g / d	10-11	e	2	5	frost
Nothofagus fusca		Red beech	42	m / f	m / g	6-9	e	3	2	pinhole borer
Picea sitchensis		Sitka spruce	65	m	g	4-8	e	4	3	Aphids
Plantanus acerifolia		London plane	44	m	g	4-9	d	1	3	
Podocarpus dacrydioides		Kahikatea	60	s	w / m / g	7-10	e	3	3	
Podocarpus totara		Totara	40	s / m	g / d	9-11	e	3	4	
Pseudotsuga menziesii		Douglas fir	100	m	m / g	4-9	e	4	3	deer
Robinia pseudoacacia		Black locust	30	m	g / d	3-9	d	3	2	thorns, suckers
Sequoia sempervirens		Redwood	120	m / f	m / g	8-10	e	4	2	possums
Sequoiadendron giganteum		Wellingtonia	94	m	g / d	6-10	e	3	5	
Taxodium distichum		Swamp cypress	35	m	w / m	6-10	d	2	2	
Thuja plicata		Western red cedar	60	s / m	m / g	5-11	e	4	3	stem borers!!
Ulmus procera		English elm	40	m	m / g	4-9	d	3	4	suckers
Vitex lucens		Puriri	20	m	m / d	10-11	e	2	4	Puriri moth,frost
The details on the following families of trees are covered separately as they each have a range of species or varieties to suit many sites:										
Eucalyptus **species**		Eucalypts								
Pinus **species**		Pine								
Populus **varieties**		Poplars								
Quercus **species**		Oaks								

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Glossary of Forestry Terms

Apical dominance
A genetic characteristic of a tree species to have a single leading stem.

Butt-log
This is the first length of the tree from ground level (usually accepted as being 6 m long) that if pruned, and of a suitable diameter, is likely to be the highest value part of the tree.

Callus
The hardened and thickened scab on a cut root.

Clearwood
The sheath of defect-free wood grown on the outside of the defect core. Linked to PLI.

Colluvium/colluvial
Soil material deposited on the lower part of a slope that has been eroded from the upper slope.

Conifer
A tree bearing its seed in the form of a cone.

Coppicing
The cutting of the trunk or stems near ground level, allowing regrowth from that point. This can be very efficient, but subsequently the plants need full protection from grazing animals to re-establish their greenery e.g. Eucalyptus ovata, Sequoia sempervirens.

Crown
The spreading mass of a tree's branches.

Crown lightening
The practice of reducing the foliage bulk on a young tree (3-5 year old) to reduce the risk of wind toppling. Large branches are either pruned off, or cut back 50%, so foliage remains for growth.

Deciduous
A tree which sheds all leaves at one time.

Defect core
The centre of the trunk that contains pruned stubs and the most juvenile wood.

Dehisce
To naturally die back and degrade, sometimes detaching from the trunk. Occurs on many species of tree (e.g. eu -calypts), but it takes more time to occur than is ideal for quality timber production.

DBH
Diameter at Breast Height – the diameter of the tree 1.4 m up the trunk. Special tapes are available to make this measurement. A close calculation can be made by dividing the circumference by three.

DOS
Diameter Over Stubs – the diameter measurement over the largest whorl of branch stubs within the pruned lift. Taken on a random sample of 25 trees in each hectare and recorded after each pruning lift is performed.

Endemic
Native to a particular restricted area.

Epicormic growths
Small branches that develop from stem needles or buds and reduce the pruned area with regrowth.

Evergreen
Having foliage that remains green throughout more than one growing season.

Fan prune
A pruning technique that removes branches that grow outwards, particularly in a shelterbelt, allowing remaining branches to run parallel to other trees.

Feathering
The remaining splinters of wood and bark, mostly at the bottom of the chainsaw cut. If excessive, it can decrease the clearwood sheath.

Fertility transfer
Occurs as animals graze pasture in paddocks, then defacate in resting areas.

Frost tender
Refers to a fleshy plant that may be destroyed when the unprotected sap is frozen.

Genus (pl. genera)
A group of plants within a family, closely connected by common characteristics. The genus is divided into species. The generic name (with a capital initial) and the species name together constitute the scientific/botanical name (e.g. E. quadrangulata).

GF rating
G = growth – indicating the speed of growth, F = form – indicating good tree shape for timber production. A system devised by P.radiata tree breeders to rank the genetically improved seed lines. More recently, the term 'GF Plus' has been added which includes factors such as

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wood density, dothistroma resistance etc.

Hybrid
The progeny resulting from the crossing of two unrelated parents, usually of different species.

Juvenile
The second leaves to appear from seedlings, often varying markedly from the leaves of an adult plant.

Kino
A dark gum exudate that often impregnates the dead bark or creates pockets within the wood.

LED
Large End Diameter – when measuring a log from any section of the tree, this is the measurement at the 'butt end' and determines the grade and market.

Legume
A plant that produces pea-type seeds in a pod.

Loess
Aerially (wind) deposited silt and light sand, and sometimes volcanic material.

Multi-visit/multi-lift
The practice of "visiting" a tree a number of times (up to 5), to prune.

Needle
A specialized, elongated leaf, as in many conifers.

Pair planting
The technique of pairing trees either side of a gully or waterway to create a root matt between the trees.

Perch
Term used where water perches or sits on a layer in the subsoil which it cannot penetrate.

PLI
Pruned Log Index – a measurement of the amount of clearwood that can be cut from a pruned log. While every mill's requirements, and therefore yields, will differ, this is a composite 'average' from a mixture of sawing studies and simulations.

Poodle prune/Poodle cut
A method of protecting the tree trunk from damage by grazing animals. The first metre or so of branches are left on the trunk with the tips pruned to reduce branch diameter growth.

Pollard
The topping of a tree and regular removal of the regrowth above animal height (approximately 2m). Traditionally practised with basket willows to provide canes and also to enable stock grazing around the trees. Can be seen in our city streets on plane trees to prevent them becoming too large.

Pseud- or Pseudo-
A prefix meaning false or atypical.

PSP
Permanent Sample Plot – a calculated selection of the forest that is regularly measured and assessed.

Resin pockets
Appearance-damaging imperfections occurring where the tree is grown under moisture and wind stress. Known as 'Kino' in Eucalyptus species.

Scarf/scarfing
Removal of turf, so weed competition to the planted tree is temporarily removed. Also known as the action of removing a wedge of wood to aid in the directional felling of a tree.

SED
Small End Diameter – this is usually the most critical measurement for determining the grade and market of the log. If there is a lot of taper in a log, the SED dictates how much timber can be cut from the log.

Shrub
A woody plant, generally lower growing than a tree, and with multiple trunks (a very generalized term).

Species
The basic unit of classification that usually refers to one or several groups of plants or other living organisms that interbreed and maintain their distinctive identity through successive generations.

SPH
Stems Per Hectare – the standard means of expressing the number of trees in an area. If the trees are at an average of 3m apart, there are 1111 (sph) trees in one hectare. (One side of one hectare is 100m, divided by 3 = 33.33, multiplied by 33.33 = 1111). Or, in a final thinned stand, at an average of 6m apart, there are 278 sph (100 divided by 6 = 16.66 multiplied by 16.66 = 277.77).

SPS
Special Purpose Species – the range of specialist timber producing tree species.

Stem
The main leaf or flower-bearing axis of a plant.

Stock camp
An area in a paddock where animals often rest, resulting in higher soil fertility levels. The greatest effect is from high levels of nitrogen from the dung and urine. This creates an unbalanced, accelerated tree growth rate in the establishment years, often causing stem deformity and large branches.

Sub species
A major subdivision of a species.

Subtropical
A plant native to areas outside the true tropics, but not able to survive cold winters.

Sucker
A stem that emerges from an underground root.

Temperate
A mild, very often coastal, climate.

Toppling
(see wind-throw)

Transpiration
Perspiration of a plant's foliage followed by the evaporation of that moisture.

Variety
One of two or more forms of a species with minor shape, colour or form distinctions.

Wind-throw
The blowing over of a tree at any stage of its life, but more likely in the first five years.

Whorl
A circle of three or more leaves, flowers or branches appearing around a stem, branch or trunk at the same position or level.

Bibliography

Barr, N. (1996) Growing eucalypt trees for milling on New Zealand farms. New Zealand Farm Forestry Association. 140 pages.

Beazley, Mitchell (1976) The International book of wood. Mitchell Beazley Publishers. London, England. 276 pages.

Bergin, D. (2003) Totara: establishment, growth and management. New Zealand Indigenous Tree Bulletin, No. 1. Forest Research, Rotorua. 40 pages.

Brailsford, Stephen (1999) The Cypress Growers' Handbook: growing quality timber. Brailsford Forestry Management Ltd., Christchurch. 31 pages.

Charlton, D. (2003) Coppice blocks for stock feeding. In: New Zealand Tree Grower, February, 2003, page 24.

Clifton, N. C. (1991) New Zealand timbers: the complete guide to exotic and indigenous woods. GP Publications, Wellington. 170 pages.

Cornell, Wade (2002) New Zealand redwood grower's handbook. Diversified Forests Ltd., Henderson, Auckland. 54 pages.

Dallimore, W. & Jackson, A.B. (1961) A handbook of Coniferae and Gingkoaceae. Edward Arnold Ltd., London. 729 pages.

Department of Labour (1999) Approved code of practice for safety and health in forest operations. 135 pages.

Ell, Gordon (1981) Encouraging birds in the New Zealand garden. Bush Press, Auckland. 96 pages.

Ell, Gordon (1995) Enjoying nature in the New Zealand garden, attracting birds and butterflies, planting a nature garden and many more home projects. Bush Press, Auckland. 144 pages.

Hanna, Matt (2000) Forestry rights in New Zealand. New Zealand Farm Forestry Association, Waikato. 56 pages.

Hawke's Bay Regional Council/Department of Conservation (2000) Planting native plants in Hawke's Bay. Hawke's Bay Regional Council, Napier. 26 pages.

Hosking, Joll (1999) Farm forestry – the first 50 years. New Zealand Farm Forestry Association, Wellington. 404 pages.

Krussmann, Gerd (1985) Manual of cultivated Conifers. Timber Press, USA. 361 pages.

Maclaren, J.P. (1993) Radiata pine growers' manual.NZFRI Bulletin No. 184. 140 pages.

Maclaren, J.P. (1996) Environmental effects of planted forests in New Zealand. New Zealand Forest Research Institute. 180 pages.

Macoboy, Stirling (1979) What tree is that? Crescent Books, New York. 367 pages.

Maxwell, E. (1930) Afforestation in southern lands. Whitcombe and Tombs, Christchurch. 315 pages.

McWilliam, E., Barry, T., Kemp, P., & Cameron, P. (2002) Feeding willow and poplar to boost lambing. In: Using trees on Farms. Ed Charlton, J. (2003). New Zealand Grasslands Association Publishers, Wellington. 124 pages.

McWhannell, F.B. (1960) Eucalypt for New Zealand farms, parks, and gardens. Paul's Book Arcade, Hamilton, New Zealand. 226 pages.

Miller, J.T. & Knowles, F.B. (1989) Introduced forest trees in New Zealand: recognition role and seed source. Part 3: The larches. NZFRI Bulletin No. 124 Series. 17 pages.

Miller, J.T. & Knowles, F.B. (1989) Introduced forest trees in New Zealand: recognition role and seed source. Part 6: The spruces. NZFRI Bulletin No. 124 Series. 20 pages.

Miller, J.T. & Knowles, F.B. (1989) Introduced forest trees in New Zealand: recognition role and seed source. Part 7: The silver firs – Abies s pages. NZFRI Bulletin No. 124 Series. 20 pages.

Miller, J.T. & Knowles, F.B. (1989) Introduced forest trees in New Zealand: recognition role and seed source. Part 9: The cypresses (third edition). NZFRI Bulletin No. 124 Series. 33 pages.

Miller, J.T. & Knowles, F.B. (1993) Introduced forest trees in New Zealand: recognition role and seed source. Part 13: The redwoods. NZFRI Bulletin No. 124 series 31 pages.

Miller, J.T. & Knowles, F.B. (1994) Introduced forest trees in New Zealand: recognition role and seed source. Part 14: Douglas fir. NZFRI Bulletin No. 124 Series. 38 pages.

Miller, J.T. & Knowles, F.B. (1997) Introduced forest trees in New Zealand: recognition role and seed source. Part 16: Cryptomeria, Thuja and Tsuga. NZFRI Bulletin No. 124 Series. 30 pages.

Miller, J.T., Hay, A. E. and Ecroyd, C.E. (2000) Introduced forest trees in New Zealand: recognition, role and seed source. Part 18. Ash Eucalypts. NZFRI Bulletin 124 Series. 58 pages.

Milne, P. (2003) Growing radiata clearwood. In: New Zealand Tree Grower, February 2003 Issue, page 15.

Ministry for the Environment (2001) Managing waterways on farms: a guide to sustainable water and riparian management in rural New Zealand. Ministry for the Environment, Wellington, New Zealand. 209 pages.

Ministry for the Environment (2001) Soil conservation technical handbook. Ministry for the Environment, Wellington.

Ministry of Forestry/New Zealand Farm Forestry Association. (1998) Indigenous forestry – sustainable management. Ministry of Forestry, Wellington. 212 pages.

Ministry of Forestry/New Zealand Forest Research Institute Ltd. (1995) Special purpose timber species. Ministry of Forestry, Wellington. 69 pages.

Mitchell, A. & Wilkinson, J. (1989) The trees of Britain and Northern Europe. Harper Collins Publishers, London. 288 pages.

Mollon, L. (1988) The living mantle - sails of the New Zealand landscape. Mallinson Rendel Publishers Ltd. Wellington. 253 pages.

Mortimer, John & Bunny (1984) Trees for the New Zealand countryside: a planters' guide. Silverfish, Auckland. 272 pages.

Mortimer, John (2003) A selection of alternative timbers. Taitua Books, Hamilton, New Zealand. 72 pages.

Nicholas, I & Brown I (2002) Blackwood – A handbook for growers and end users. Forest Research Bulletin No 225. Forest Research, Rotorua. 95 pages.

New Zealand Farm Forestry Association – Information Leaflets, 2002. New Zealand Farm Forestry Association publication.

Olykan, Sonya (2002) Forest nutrition – nitrogen. In: New Zealand Tree Grower, May 2002, page 31.

Olykan, Sonya (2003) Nitrogen nutrition of some nonradiata forest tree species. In: New Zealand Tree Grower, February 2003, page 16.

Paddison, V. & Bryant, G. (2001) Botanica's trees and shrubs. Randon House, Auckland. 928 pages.

Pakenham, Thomas (2002) Remarkable trees of the world. Norton & Co., USA. 192 pages.

Pakenham, Thomas (1999) Meetings with remarkable trees. Random House, USA. 191 pages.

Palmer, H., Gardner, B., Hislop, M. & Buttery, N. (2003) Trees for shelter – basic principles revisited. In: New Zealand Tree Grower, February 2003, page 38.

Park, J. (1999) Tuning the pruning on a fertile site. In: New Zealand Tree Grower, May 1999, page 39.

Poole, A.L. & Adams, N.M. (1980) Trees and Shrubs of New Zealand. Manaaki Whenua Press, Wellington. 256 pages.

Porteous, Tim (1993) Native forest restoration: a practical guide for landowners. Queen Elizabeth National Trust. 184 pages.

Ridley, G.S. & Dick, M.A. (2001) The Diseases of Forest and Amenity Trees in New Zealand. NZFRI Bulletin No. 220. 110 pages.

Salmon, J.T. (1998) The native trees of New Zealand. Reed Publishing (NZ) Ltd., Wellington. 384 pages .

Salmon, J.T. (1999) The trees in New Zealand - exotic trees: the Broadleaves. Reed Publishing (NZ) Ltd., Auckland. 372 pages.

Salmon, J.T. (2000) The trees in New Zealand – exotic trees: the Conifers. Reed Publishing (NZ) Ltd., Auckland. 159 pages.

Shigo, A., Vollbrecht, K. & Hvass, N. (1987) Tree biology and tree care: photo guide. Shigo and Trees Associates, New Hampshire. 140 pages.

Simmonds, J.H. (1927) Trees from other lands for shelter and timber in New Zealand - Eucalypts. The Brett Printing & Publishing Company, Auckland. page 164.

Smail, P. (1997) Shelter required to increase production. In: New Zealand Tree Grower, November 1997, page 4.

Snook, L.C. (1986) Tagasaste – high production fodder crop. Shepparton (Australia): Night Own Publishers. page 102.

Sustainable Farming Fund (2002) Lower North Island group for drought relief from feeding poplar/willow. Sustainable Farming Fund Grant No. 01/208, Farmer Case Studies.

Tombleson, J., Moore, I. & Moore, R. (1995) Agroforestry on Te Rakau dairy farm. In: New Zealand Tree Grower, February 1995, page 18.

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