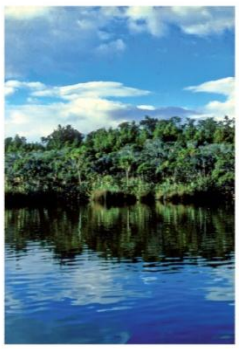

Longbush Ecosanctuary: assessment of baseline flora and vegetation by landform

Envirolink Advice Grant: 1277-GSDC108

Landcare Research
Manaaki Whenua

Longbush Ecosanctuary: assessment of baseline flora and vegetation by landform

Mark C Smale, Jacob M Overton, Robert F Price

Landcare Research

Prepared for:

Gisborne District Council

PO Box 747
Gisborne 4010
New Zealand

September 2013

Landcare Research, Gate 10 Silverdale Road, University of Waikato Campus, Private Bag 3127, Hamilton 3240, New Zealand, Ph +64 7 859 3700, Fax +64 7 859 3701, www.landcareresearch.co.nz

Reviewed by:	*Approved for release by:*
Colin Meurk Researcher Landcare Research	Bill Lee Portfolio Leader – Managing Biodiversity Landcare Research
Landcare Research Contract Report:	LC1641

Disclaimer

This report has been prepared by Landcare Research for Gisborne District Council. If used by other parties, no warranty or representation is given as to its accuracy and no liability is accepted for loss or damage arising directly or indirectly from reliance on the information in it.

ISO 14001

Contents

Summary v

1 Introduction 1

2 Background 1

3 Objective 1

4 Methods 1

4.1 Predicted pre-clearance flora and vegetation of Longbush by landform 1

4.2 Pre-clearance indigenous vegetation extant in the Waimata subdistrict 2

4.3 Baseline inventory of flora and vegetation by landform extant on Longbush and elsewhere in the Waimata subdistrict 2

5 Results 2

5.1 Physical contex 2

5.2 Biological context 3

5.3 Human context (adapted from Ecoworks 2009) 3

5.4 Pre-clearance indigenous vegetation extant in the Waimata subdistrict 3

5.5 Predicted pre-clearance indigenous vascular flora on Longbush by landform 4

5.6 Baseline inventory of surviving indigenous flora and vegetation extant on Longbush and other primary forest remnants in the Waimata subdistrict by landform 6

5.7 Relationships between flora and landform in lower Waimata Valley 7

5.8 Predicted pre-clearance indigenous vegetation on Longbush by landform 7

6 Conclusions 14

7 Recommendations 17

8 Acknowledgements 17

9 References 17

Appendix 1 – Common and scientific names of plants and animals used in text 19

Appendix 2 – Inventory of naturally occurring indigenous vascular plant species recorded from Longbush Ecosanctuary and other primary forest remnants in the lower Waimata Valley in autumn 2013 21

Summary

Project and Client

- Surviving vascular flora and vegetation were inventoried and pre-existing flora and vegetation predicted by landform in Longbush Ecosanctuary and other primary forest remnants in the lower Waimata Valley for Gisborne District Council.

Objective

- To document past and present vascular flora and vegetation by landform of the Longbush Ecosanctuary and other primary forest remnants in the lower Waimata Valley for Gisborne District Council.

Methods

- A literature search was conducted for information on the past and present indigenous flora and vegetation of similar landforms and geology in the Waimata subdistrict of the Waiapu Ecological District.
- A condensation of Dalrymple's nine-unit landform model, which relates slope form to the processes of slope formation, was used to classify landform.
- A mapping algorithm was used to predict the probability of occurrence or potential abundance of 49 species in Longbush Ecosanctuary.
- A field survey of indigenous flora and vegetation in relation to landform in Longbush Ecosanctuary and other larger primary forest remnants in the lower Waimata Valley was made in March and May 2013, and compared with the predictions.

Results

- Thirty-nine vascular native species were predicted to occur with a probability of occurrence greater than 0.1 originally in Longbush Ecosanctuary. Density predictions were made for an additional 11 species, a total of 49 species.
- A total of 100 vascular native plant species were recorded in Longbush Ecosanctuary and 129 in the wider lower Waimata Valley.
- There was a high degree of coincidence between predicted and actual occurrence of species on Longbush (73%) and in the wider lower Waimata Valley (88%).
- Three tree species not predicted to occur in the Waimata subdistrict do, in fact, occur in extant primary forest remnants there.
- Forty percent of the 129 plant species occurred on 4 or more of the 7 landform units.
- Seven forest types are predicted for 6 landforms ranging from interfluve to colluvial footslope/alluvial toeslope, 6 of them dominated by tawa and/or kohekohe and one by black beech.

Conclusions

- Before forest clearance began c. 130 years ago, the predominant natural vegetation of Longbush is likely to have been tall forest dominated by tawa and kohekohe, the composition and density of scattered emergent conifers (kahikatea most widespread) varying with landform. Other common tall canopy tree species would have been tītoki, rewarewa, and pukatea. Subcanopies are likely to have been dominated by māhoe and pigeonwood.
- Subtle shifts in composition would have reflected differences in underlying parent material and landform, with tawa more common on less fertile sandstone and kohekohe more common on more fertile mudstone. The most floristically rich communities would have been on relatively fertile colluvial toeslopes and alluvial toeslopes, the poorest on relatively infertile sandstone ridges.
- The composition of surviving primary forests, in terms of the relative abundance and even the presence of species, has been altered by a long history of direct and indirect effects of introduced mammals. Some highly palatable species, e.g. patē, have been reduced or perhaps eliminated by these influences. Intensive pest control on Longbush should help correct the imbalances caused by them. Protracted successions back to tall forest through secondary kānuka forest and the slow growth rates of some formerly important canopy species mean that restoration of the primary forest on most of Longbush will be a slow process. Most of the vascular plant component that existed before clearance has persisted, re-established naturally or been re-established by replanting.
- In the biological context, there are strong ecological synergies within suites of restored natural areas, and even beyond them. In the human context, there is already evidence of a marked conservation 'ripple effect' from the ecological restoration success evident on Longbush.

Recommendations

- Ideally, any restoration planting should mimic the predicted original flora and vegetation by landform described here.
- Ecosourcing from the Waiapu Ecological District or the wider East Coast region should be continued.
- The possible former presence of northern rātā (based on modelled predictions) raises exciting prospects for its re-introduction.
- All substantial natural areas remaining in the Waimata subdistrict should be assessed for possible inclusion in an ecological management zone around Longbush, which would enhance the restoration and maintenance of native biodiversity within Longbush itself and beyond.

1 Introduction

The pre-clearance vegetation of Longbush Ecosanctuary was predicted and the surviving flora and vegetation were inventoried by landform in Longbush and other primary forest remnants in the lower Waimata Valley for Gisborne District Council.

2 Background

The Longbush Ecosanctuary project is the largest area (110 ha) in the Tai Rawhiti district intensively managed for the preservation and restoration of rare and endangered species of indigenous plants and animals. Although an intensive weed and pest control programme is in place, existing baseline information on the indigenous flora surviving at Longbush is inadequate. A comprehensive database is an essential starting point for any restoration programme of this size, not only to identify the presence of any threatened species surviving on the property but also to avoid re-introduction and contamination of the local gene pool of more common species that may be still present. Before any major revegetation programme is undertaken, adequate baseline information on existing vegetation surviving on the property is needed to guide species selection decisions. An understanding of the natural vegetation pattern that existed on the various landforms before clearance is also necessary to guide species placement decisions. Informed species selection and placement decisions, i.e. what species are planted where, are more likely to lead to successful restoration outcomes.

3 Objective

To document past and present vascular flora and vegetation by landform of the Longbush Ecosanctuary and other primary forest remnants in the lower Waimata Valley for Gisborne District Council.

4 Methods

4.1 Predicted pre-clearance flora and vegetation of Longbush by landform

Maps of the natural distributions of native plant species were used to inform the reconstruction of the original vegetation. These maps, held in a geographic information system (GIS), predict the abundance or probability of occurrence of native plant species for all locations within New Zealand from statistical models of the abundance or occurrence of individual plant species against climate and landform variables. For locations spread on a grid within Longbush, we obtained the predicted abundance or probability of occurrence of 49 vascular plant species.

The models used abundance or occurrences of species in RECCE (Hurst & Allen 2007) or National Forest Survey plots in intact forest. The statistical models were then used to predict the natural distribution of each species across all of New Zealand, including places where forest no longer remained. Together, these provide predictions of natural forest composition

for all of New Zealand. Further information on the details of the data and models used to produce the maps of natural distributions can be obtained from Leathwick et al. (2001).

4.2 Pre-clearance indigenous vegetation extant in the Waimata subdistrict

A literature search was conducted for information on the pre-clearance indigenous vegetation of similar landforms and geology in the Waimata subdistrict of Waiapu Ecological District.

4.3 Baseline inventory of flora and vegetation by landform extant on Longbush and elsewhere in the Waimata subdistrict

A field survey of indigenous flora and vegetation surviving in Longbush Ecosanctuary and larger remnants in the Waimata subdistrict was made in March and May 2013. Species of uncertain identity were identified by staff of the Allan Herbarium of Landcare Research.

A condensed version of the landform model of Dalrymple et al. (1968) was used. This relates slope form to the processes of slope formation:

- Interfluve
- Seepage slope
- Convex creep slope
- Fall face
- Transportational midslope
- Colluvial footslope
- Alluvial toeslope.

Colluvial footslope and alluvial toeslope were combined.

5 Results

5.1 Physical context

5.1.1 Geology and topography

Longbush comprises mostly moderately steeply dissected hill country on undifferentiated, fossiliferous mudstone (*papa*) and tuffaceous sandstone of Pliocene age. Alluvial toeslopes of the Waimata River comprise Quaternary-aged fan gravels and alluvium with some tephra coverbeds on the more elevated and older surfaces that have not been inundated by flood deposits within European settlement times (Mazengarb & Speden 2000).

5.1.2 Climate

Longbush lies in a climatic region with very warm summers – occasional daytime temperatures exceed 30 °C – and moderate winter temperatures. Rainfall is markedly lower and less reliable in spring and summer than in winter.

Mean annual temperature is 14 °C. Mean midsummer (January) temperature is 18–19 °C; mean midwinter (July) temperature is 8–9 °C. Mean annual rainfall is 1200–1600 mm (New Zealand Meteorological Service 1985–1986).

5.2 Biological context

Longbush lies in the Waimata subdistrict of the Waiapu Ecological District (Leathwick et al. 1995) and the Gisborne Botanical Province (Wardle 1991). At least one of the two species centred in the province, *Jovellana sinclairii*, a small perennial herb, occurs naturally in Longbush, but none of the local endemics. The recent deforestation typical of the coastal parts of the province applies here.

5.3 Human context (adapted from Ecoworks 2009)

Until 1887, Longbush and the surrounding land were under Māori ownership in the rohe of Whānau a Iwi and the hapū of Te Aitanga a Mahaki (Jackman 1999 in Ecoworks 2009). In 1886 a local chief, Raharuhi Rukupo, contracted Henry Parker and Robert Thelwall to establish a sheep farm on what is now Longbush Ecosanctuary (Jackman 1999). In 1887, Jack Dunlop purchased the Waikereru block of c. 1330 ha (Tombleson 1997 in Ecoworks 2009), including Longbush. Henry Hegarty and son William bought the property in 1923. By this time, the land was predominately in pasture with only remnant patches of indigenous vegetation. The Hegartys were attracted to the property by natural springs that meant cattle had a year-round water supply, but farming proved difficult because of the steep topography (J. Hegarty, pers. comm.). Cattle, sheep, and finally goats were farmed before the Hegartys sold the property in the early 1990s (Tombleson 1997 in Ecoworks 2009). Dame Anne and Jeremy Salmond purchased Longbush in 2000, placing it under a Queen Elizabeth II National Trust covenant in 2002 and covenanting a further 113 ha in 2006. Unlike most other remnants of natural vegetation in the district, Longbush Ecosanctuary is being actively managed with intensive pest control and restoration planting. As a result, it now provides habitat for threatened species such as long-tailed bat and New Zealand falcon/kārearea, and for other species such as New Zealand pigeon/kererū that are now scarce in the region.

5.4 Pre-clearance indigenous vegetation extant in the Waimata subdistrict

Because the National Forest Survey (1946–1955) and later Ecological Survey (1962–1965) of the New Zealand Forest Service only sampled larger tracts of forest (>50 ha), some forest types of largely deforested districts such as Waimata that are now represented only by modified derivatives were missed. Remnants of primary forest are now rare in the Waimata subdistrict. Only four substantial Recommended Areas for Protection (RAPs) were identified

in the Waiapu PNA (Leathwick et al. 1995), and almost all the total area recommended for protection of 250 ha in one of them comprises secondary kānuka forest.

Of the three primary RAPS, Riverside Road Bush (Priority 1), now in Longbush Ecosanctuary, comprises 29 ha of primary kahikatea-tawa-kohekohe-tītoki forest on an alluvial toeslope (within Longbush Ecosanctuary) and tawa-kohekohe-tītoki forest on an adjacent lower mudstone hillslope (Rimuroa Bush: see below). The Longbush portion was fenced 10 years ago and is subject to intensive predator control. Its understorey and ground layers have shown dramatic recovery from a very degraded state in 1993 (Leathwick et al. 1995).

Waikereru Bush (Priority 1) comprises 19 ha mostly of primary tawa-kohekohe forest on upper mudstone hillslopes. Associated tall canopy species are kahikatea, mataī, pukatea, and rewarewa, with shorter canopy and subcanopy species including āmāhoe, ngaio, and kōwhai. It now lies within an exotic pine plantation so is effectively fenced, but feral goats are having major impacts on lower tiers in places.

Town Hill Bush (Priority 2) comprises 5 ha of primary black beech forest on sandstone ridge crests and primary tawa-kohekohe-tītoki forest on mudstone hillslopes. Other tall canopy species in the hillslope forest include kahikatea, mataī, rewarewa, pūriri, white maire, and hinau; shorter canopy and subcanopy species include māhoe, pigeonwood, five finger, heketara, kaikōmako, milk tree/turepo, lancewood, tree fuchsia/kōtukutuku, māpou and kōwhai (Leathwick et al. 1995). It remains unfenced and is also subject to feral goat browsing.

In addition, Rimuroa Bush (Priority 1) directly across the Waimata River from Riverside Road Bush comprises a significant tract of primary tawa-kohekohe-tītoki forest on colluvium. It was fenced 1 year ago and is already showing signs of ground layer recovery.

5.5 Predicted pre-clearance indigenous vascular flora on Longbush by landform

Thirty-nine species of native plant were predicted to occur originally in Longbush Ecosanctuary with probability of occurrence greater than 0.1 (Table 1). Density predictions were made for an additional 11 species.

Table 1 Predicted probability of occurrence and density (stems >30 cm DBH ha^{-1}) – trees only – of native vascular species in Longbush Ecosanctuary

Species	Predicted probability of occurrence	Predicted density (>30 cm DBH) ha^{-1})	Extant on Longbush	Extant elsewhere in Waimata subdistrict
		Large trees		
Kohekohe	0.28	41	Y	Y
Tawa	–	39	Y	Y
Pūriri	–	24	Y	Y
Kahikatea	–	17	Y	Y
Tōtara	–	4	N	Y
Tītoki	–	4	Y	Y
Hīnau	–	1	Y	Y
Rimu	–	1	N	N
Mataī	–	1	Y	Y
Miro	–	0.3	Y	N
Kāmahi	–	0.3	–	–
Rewarewa	0.39	N	Y	Y
Pukatea	0.26	N	Y	Y
Northern rātā	0.15	N	N	N
		Small trees		
Māhoe	0.71	5	Y	Y
Māpou	0.57	N	Y	Y
Pigeonwood/porokaiwhiri	0.45	N	Y	Y
Five finger	0.39	N	Y	Y
Lancewood/horoeka	0.34	N	Y	Y
Heketara	0.3	N	N	Y
Wineberry/makomako	0.25	N	Y	Y
Patē	0.1	N	Y	Y
		Shrubs		
Rangiora	0.39	N	Y	Y
Hangehange	0.32	N	Y	Y
Mingimingi	0.3	N	N	Y
Mānuka	0.28	N	N	Y
Kanono	0.25	N	N	N
Prickly heath	0.15	N	N	N
Coprosma lucida	0.12	N	Y	Y
Coprosma rhamnoides	0.11	0	Y	Y

		Tree ferns		
Ponga/silver fern	0.26	N	Y	Y
Mamaku	0.16	N	Y	Y
Whekī	0.14	N	N	Y
		Ferns		
Asplenium bulbiferum	0.43	–	Y	Y
Blechnum novae-zelandiae	0.34	–	Y	Y
Microsorum pustulatus	0.28	–	Y	Y
Blechnum filiforme	0.26	–	Y	Y
Asplenium flaccidum	0.22	–	Y	Y
Blechnum chambersii	0.2	–	Y	Y
Microsorum scandens	0.18	–	Y	Y
Asplenium polyodon	0.17	–	Y	Y
Asplenium oblongifolium	0.16	–	Y	Y
Blechnum discolor	0.13	–	N	Y
		Lianes		
Supplejack/pirita	0.44	–	Y	Y
Metrosideros diffusa	0.27	–	Y	Y
Kiekie	0.14	–	N	Y
Metrosideros perforata	0.11	–	N	Y
Rubus cissoides	0.11	–	Y	Y
		Herbs		
Uncinia uncinata	0.43	–	Y	Y

– = no prediction made

Y = recorded

N = not recorded, but not necessarily absent

5.6 Baseline inventory of surviving indigenous flora and vegetation extant on Longbush and other primary forest remnants in the Waimata subdistrict by landform

A total of 100 vascular indigenous species were recorded on Longbush itself; 129, including the wider Waimata subdistrict during the survey (Appendix 2). The survey was not exhaustive, and a small number of less widespread species are likely to have been missed, both on Longbush and elsewhere.

There was a high degree of coincidence between predicted and actual occurrence of species on Longbush (73%) and in the wider lower Waimata Valley (88%). Interestingly, two tree species – white maire and tree fuchsia/kōtukutuku – that are not predicted to occur in Longbush do occur in extant remnants of primary forest in Town Hill Bush in the Waimata subdistrict (Leathwick et al. 1995) and may be present on Longbush. Conversely, in some

instances species that are predicted to occur on Longbush – pūriri, tōtara, heketara, mānuka, *Blechnum discolor*, kiekie, and *Metrosideros perforata* – were not recorded there nor, in other instances – rimu, kāmahi, northern rātā, kanono, and prickly heath – anywhere in the lower Waimata Valley. Some of the latter group – rimu, miro, kāmahi, and kanono – are relatively drought-intolerant and others, such as northern rātā are highly palatable to introduced herbivores like possums.

5.7 Relationships between flora and landform in lower Waimata Valley

Fifty-two of the 129 vascular native plant species recorded in the lower Waimata Valley (40%) were widely distributed on the landscape, occurring on more than half the landform units. The relatively high nutrient status fertility of mudstone as a parent material means that fertility gradients are likely to be less pronounced than on some other substrates and thus species less clearly sorted in relation to landform.

5.8 Predicted pre-clearance indigenous vegetation on Longbush by landform

5.8.1 Interfluve (Figure 1)

Mudstone

Canopy: Tawa–kohekohe with some tītoki, rewarewa and occasional tōtara. Kānuka, lancewood/horoeka, kōhūhū, māpou, putaputawētā, and cabbage tree/tī kōuka mostly at forest margins.

Subcanopy: Pigeonwood/porokaiwhiri.

Understorey: *Coprosma rhamnoides*, *Coprosma spathulata*, hangehange.

Sandstone

Canopy: Black beech.

Understorey: *Coprosma rhamnoides*, *Coprosma spathulata*, akepiro, mingimingi, rangiora.

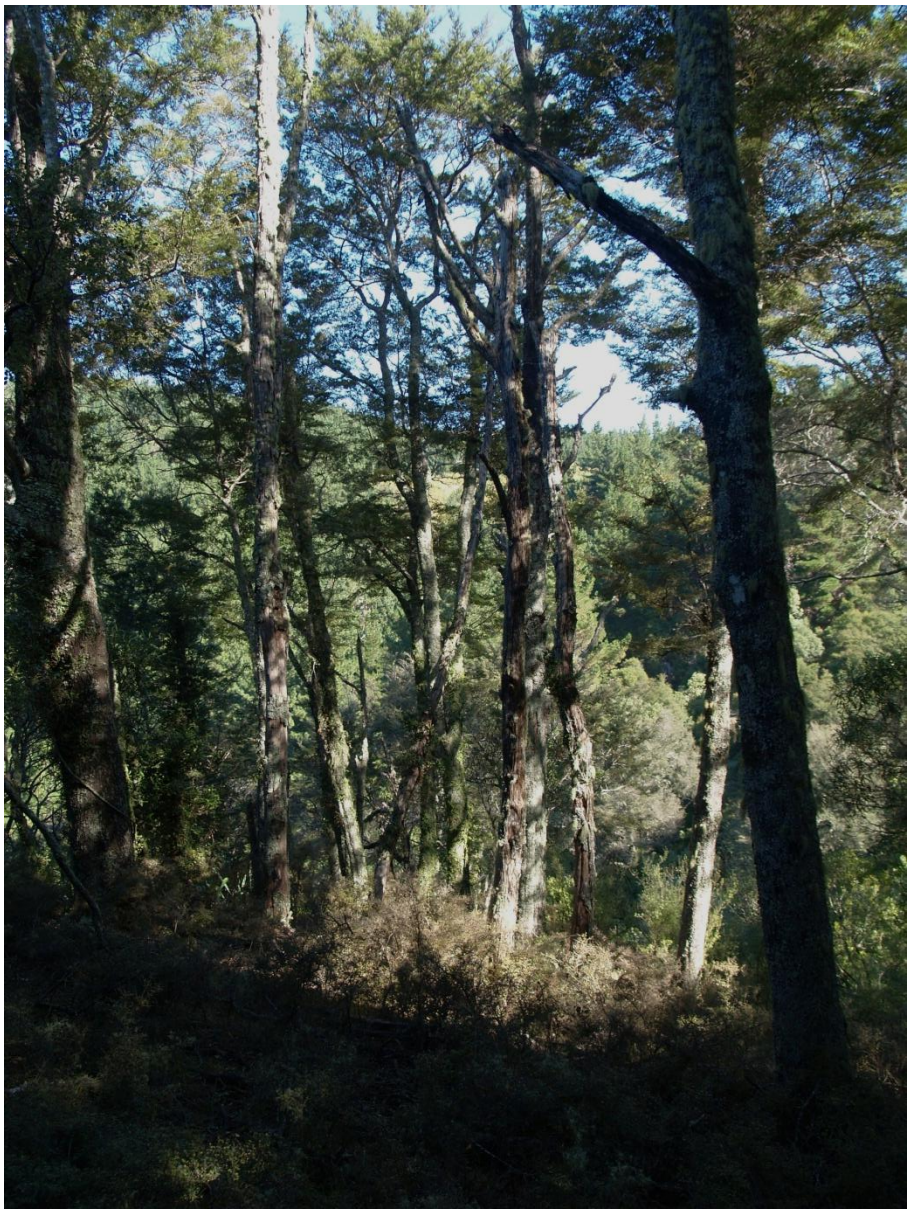

Figure 1 Best relic in the district. Primary black beech forest with a small-leaved *Coprosma* understorey on a sandstone interfluve in Town Hill Bush.

5.8.2 Seepage slope

Canopy: Kohekohe, with some kahikatea, mataī, tōtara, and pukatea.

Subcanopy: Māhoe with some milk tree/turepo and nīkau. Māpou, putaputawētā, kaikōmako, long-leaved lacebark/houhere, kānuka, rōhutu, and cabbage tree/tī kōuka mostly at forest margins.

Understorey: Kawakawa and *Coprosma rhamnoides.*

5.8.3 Convex creep slope (Figure 2)

Canopy: Kohekohe–tawa, with some tītoki, rewarewa, karaka, white maire, pukatea, pūriri, kahikatea, mataī, and tōtara.

Subcanopy: Māhoe-pigeonwood, with some milk tree/turepo and nīkau. Māpou, putaputawētā, lancewood/horoeka, kaikōmako, kōhūhū, long-leaved lacebark/houhere, kānuka, rōhutu, tree fuchsia/kōtukutuku, tree tutu, and cabbage tree/tī kōuka mostly at forest margins.

Understorey: Kawakawa, hangehange, Coprosma rhamnoides, Coprosma spathulata, mingimingi, rangiora, patē.

Figure 2 Native forest degraded. Complete removal by feral goat browsing of understorey and ground layers of primary kohekohe forest on a mudstone convex creep slope in Waikereru Bush.

5.8.4 Fall face

Canopy: Mountain flax/whaririki, with occasional trees, shrubs, other megaherbs, and ferns.

5.8.5 Transportational midslope (Figure 3)

Canopy: Tawa-kohekohe, with some rewarewa and hinau.

Subcanopy: Māhoe-pigeonwood, with some milk tree/turepo, heketara, and nīkau. Taupō kōwhai, lancewood/horoeka, putaputawētā, kōhūhū, kaikōmako, māpou, kānuka, long-leaved lacebark/houhere, tree tutu, ngaio, and cabbage tree/tī kōuka mostly at forest margins.

Understorey: Kawakawa, hangehange, *Coprosma rhamnoides*, *Coprosma spathulata*, rangiora.

Figure 3 Native forest restored. Understorey of secondary broadleaved forest on a steep mudstone transportational midslope in the northern valley of Longbush Ecosanctuary, showing understorey dominated by kawakawa and gully fern.

5.8.6 Colluvial footslopes and alluvial toeslopes (Figures 4-6)

Canopy: Tawa-kohekohe-tītoki, with some kahikatea, pukatea, rewarewa, hinau, pūriri, and karaka and occasional mataī.

Subcanopy: Māhoe-pigeonwood, with some milk tree/turepo and nīkau. Māpou, five finger, lancewood/horoeka, putaputawētā, Taupō kōwhai, kaikōmako, kōhūhū, kānuka, rōutu, whau, wharangi, long-leaved lacebark/houhere, and cabbage tree/tī kōuka mostly at forest margins.

Understorey: Hangehange, kawakawa, *Coprosma rhamnoides*, and patē, with tree tutu, koromiko, kakaramū and karamū mostly at forest margins.

Figure 4 Native forest being restored. Primary alluvial tawa-kohekohe-tītoki forest fenced 10 years ago in Riverside Road Bush in Longbush Ecosanctuary (foreground), and primary colluvial tawa-kohekohe-tītoki forest fenced one year ago in Rimuroa Bush (middle distance and background). The Waimata River is in the middle distance between Riverside Road Bush and Rimuroa Bush.

Figure 5 Native forest restored. Re-established understorey (māhoe saplings) and ground layer (common maidenhair) in primary alluvial tawa-kohekohe-tītoki forest fenced 10 years ago in Riverside Road Bush, Longbush Ecosanctuary.

Figure 6 Native forest restored. *Lastreopsis microsora* ssp. *pentangularis*, a characteristic fern of fertile alluvial soils, indicative of the recovery of the ground layer in Riverside Road Bush, Longbush Ecosanctuary.

6 Conclusions

Before forest clearance began c. 130 years ago, the predominant natural vegetation of Longbush is likely to have been tall broadleaved forest dominated by tawa and kohekohe, with the composition and density of scattered emergent conifers (kahikatea most widespread) varying with landform. Other common tall broadleaved canopy tree species would have been tītoki, rewarewa, and pukatea. Black beech stands would have occurred on interfluves. Subcanopies are likely to have been dominated by māhoe and pigeonwood/porokaiwhiri. Better-lit sites such as forest margins would have supported a variety of smaller trees such as māpou and lancewood/horoeka.

Subtle shifts in composition would have reflected differences in underlying parent material and landform, with tawa somewhat more common on less fertile sandstone and kohekohe more common on more fertile mudstone. The most floristically rich communities would have been on relatively fertile colluvial toeslopes and alluvial toeslopes, with their diverse array of smaller trees, the poorest on the least fertile sandstone ridges with floristically simple black beech stands.

The composition of surviving primary forests, in terms of the relative abundance and even the presence of species, has undoubtedly been altered by a long history of direct – for example,

herbivory – and indirect – for example, seed predation – effects of introduced domestic and feral mammals. Some highly palatable species have undoubtedly been greatly reduced – for example, tree fuchsia/kōtukutuku – or perhaps eliminated altogether – for example, northern rātā – by these influences. Fencing protects vegetation, but also increases the number of ship rats, which destroy seeds, invertebrates, and nesting birds. Maximising the biodiversity values of forest fragments therefore requires both fencing and control of ship rats (Innes et al. 2010). Both these management strategies – along with restoration planting – are being pursued vigorously on Longbush, and should help correct the imbalances caused by introduced mammals. Restoration planting can accelerate successions by enhancing current and future (via seed sources) populations of extant species or by re-introducing seed sources of lost ones.

Fragmentation alters forest interior microclimates, favouring some species, for example rewarewa, but not others, for example, tawa (Burns et al. 2011). Protracted successions back to tall forest through secondary kānuka forest (Smale et al. 1997) and the slow growth rates of some formerly important canopy species like tawa mean that restoration of the primary forest that existed until relatively recently on Longbush Ecosanctuary will be a lengthy process. Fortunately, most of the vascular plant component of the tall forest that existed before clearance on Longbush has persisted, re-established naturally or been re-established by replanting.

In the biological context, there are likely to be positive ecological interactions within suites of restored natural areas, and even beyond them, for example, the regeneration of palatable native canopy tree species within nearby plantation forest (Figure 7). In the human context, there is already evidence of a marked conservation 'ripple effect' from the ecological restoration success evident on Longbush. For instance, adjacent Rimuroa Bush was fenced recently and it is likely that Waikereru Bush will also be fenced. Other areas beside and near Longbush are now being pest-controlled. An 'ecological management zone' involving restoration of other substantial forest remnants in the Waimata subdistrict would substantially enhance the restoration and maintenance of native biodiversity both within Longbush itself and in the wider district. The Waiapu PNA only assessed larger natural areas remaining in the Waimata subdistrict, and a significant number of smaller areas of both primary and secondary forest remain to be surveyed to assess their potential for inclusion in such a zone.

Figure 7 Native forest in the making. Prolific regeneration of kohekohe and other shade-tolerant native species under radiata pine plantation surrounding Waikereru Bush, reflecting the wider-scale beneficial effects of pest (possum) control in the district.

7 Recommendations

- Ideally, any restoration planting should mimic the predicted original flora and vegetation by landform described here.
- Plantings should be ecosourced from the Waiapu Ecological District or the wider East Coast region.
- The possible former presence of northern rātā also raises exciting possibilities for its re-introduction, as has recently been trialled in Zealandia in Wellington (Burns et al. 2008).
- All substantial natural areas remaining in the Waimata subdistrict should be surveyed for possible inclusion in an ecological management zone around Longbush.

8 Acknowledgements

We would like to thank Envirolink for funding this project, Jeff Hextall and Trevor Freeman (Gisborne District Council) for facilitating and managing the contract, and Professor Dame Anne Salmond (Auckland) for her encouragement and assistance, and for providing helpful comments on a draft. Gary Hope (Gisborne), Penny Hoogerbrug (Rimuroa Station), and Warren Payne (Hikurangi Forest Farms) granted access permission to their respective properties. Dr Michael Marden (Landcare Research, Gisborne) provided geological advice. Drs Ines Schoenberger, Peter Heenan, Robin Smissen, and Aaron Wilton, and Ms Kerry Ford (Landcare Research) identified plant taxa. Dr William Lee and John Innes (Landcare Research) commented on a draft.

9 References

Burns BR, Floyd CG, Smale MC, Arnold GC 2011. Effects of forest fragment management on vegetation condition and maintenance of canopy composition in a New Zealand pastoral landscape. Austral Ecology 36: 153–166.

Burns B, Knightbridge P, Empson R 2008. Northern rātā: prospects for restoration of a once-common strangling hemi-epiphyte. Proceedings of the New Zealand Ecological Society Annual Conference, Auckland, 2008.

Dalrymple J, Long R, Conacher A 1968. A hypothetical nine-unit land- surface model. Zeitschrift für Geomorphologie 12: 60–76.

Ecoworks 2009. Opportunities for ecological restoration of Longbush Reserve and the Waikereru Hills. Gisborne, Ecoworks (NZ) Ltd.

http://longbushreserve.org/documents/SpeciesList.pdf

Hurst JM, Allen RB 2007. The RECCE method for describing New Zealand vegetation. Version 4. Lincoln, Manaaki Whenua – Landcare Research.

Innes JG, King CM, Bridgman LJ, Fitzgerald NB, Arnold GC, Cox N 2010. Effect of grazing on ship rat density in forest fragments of lowland Waikato, New Zealand. New Zealand Journal of Ecology 34: 227–232.

Leathwick JR 2001. New Zealand's potential forest pattern as predicted from current species–environment relationships. New Zealand Journal of Botany 39: 447–464.

Leathwick JR, Clarkson BD, Burns, BR, Innes JG, Smale MC 1995. Waiapu Ecological District: Survey report for the Protected Natural Areas Programme. New Zealand Protected Natural Areas Programme Series No. 31. Gisborne, Department of Conservation. 177 p.

Mazengarb C, Speden IG 2000. Geology of the Raukumara area. 1:25000. Lower Hutt, IGNS.

New Zealand Meteorological Service 1985–1986. Climatic map series of New Zealand. 1:50 000. Wellington, New Zealand Meteorological Service.

Smale MC, Mcleod M, Smale PN 1997. Vegetation and soil recovery on shallow landslide scars in Tertiary hill country, East Cape region, New Zealand. New Zealand Journal of Ecology 21: 31–41.

Wardle P 1991. Vegetation of New Zealand. Cambridge, UK, Cambridge University Press. 672 p.

Appendix 1 – Common and scientific names of plants and animals used in text

Common name	*Scientific name*
Akepiro	*Olearia furfuracea*
Black beech	*Nothofagus solandri var. solandri*
Cabbage tree/ti kōuka	*Cordyline australis*
Five finger	*Pseudopanax arboreus*
Hangehange	*Geniostoma ligustrifolium*
Heketara	*Olearia rani*
Hīnau	*Elaeocarpus dentatus*
Kahikatea	*Dacrycarpus dacrydioides*
Kaikōmako	*Pennantia corymbosa*
Kakaramū	*Coprosma lucida*
Kamahi	*Weinmannia racemosa*
Kanono	*Coprosma grandifolia*
Kānuka	*Kunzea ericoides*
Karamū	*Coprosma robusta*
Kawakawa	*Macropiper excelsum*
Kiekie	*Freycinetia banksii*
Kohekohe	*Dysoxylum spectabile*
Kōhūhū	*Pittosporum tenuifolium*
Koromiko	*Veronica stricta*
Lancewood/horoeka	*Pseudopanax crassifolius*
Long-tailed bat	*Chalinolobus tuberculata*
Māhoe	*Melicytus ramiflorus*
Mamaku	*Cyathea medullaris*
Manuka	*Leptospermum scoparium*
Māpou	*Myrsine australis*
Mataī	*Prumnopitys taxifolia*
Milk tree/turepo	*Streblus heterophyllus*
Mingimingi	*Leucopogon fasciculatus*
Miro	*Stachopitys ferruginea*
Mountain flax/whaririki	*Phormium cookianum*
New Zealand falcon/karearea	*Falco novaseelandiae*
New Zealand pigeon/kererū	*Hemiphaga novaseelandiae*
Nīkau	*Rhopalostylis sapida*
Ngaio	*Myoporum laetum*

Northern rātā	*Metrosideros robusta*
Patē	*Schlefflera digitata*
Pigeonwood/porokaiwhiri	*Hedycarya arborea*
Ponga	*Cyathea dealbata*
Prickly heath	*Leptecophylla juniperina*
Pukatea	*Laurelia novae-zelandiae*
Pūriri	*Vitex lucens*
Putaputawētā	*Carpodetus serratus*
Rangiora	*Brachyglottis repanda*
Rewarewa	*Knightia excelsa*
Rimu	*Dacrydium cupressinum*
Rōhutu	*Lophomyrtus obcordata*
Ship rat	*Rattus rattus*
Supplejack	*Ripogonum scandens*
Taupo kōwhai	*Sophora tretraptera*
Tawa	*Beilschmiedia tawa*
Tītoki	*Alectryon excelsus*
Tōtara	*Podocarpus totara*
Tree fuchsia/kōtukutuku	*Fuchsia excorticata*
Tree tutu	*Coriaria arborea*
Whau	*Entelea arborescens*
Wineberry/makomako	*Aristotelia serrata*
Whekī	*Dicksonia squarrosa*
White maire	*Nestegis lanceolata*

Appendix 2 – Inventory of naturally occurring indigenous vascular plant species recorded from Longbush Ecosanctuary and other primary forest remnants in the lower Waimata Valley in autumn 2013

Scientific name	Māori name (not necessarily Tairawhiti)	Common name	Longbush Ecosanctuary (incl. Riverside Rd Bush)	Waikereru Bush	Town Hill Bush	Rimuroa Bush
		Ferns (37)				
Adiantum cunninghamii		Common maidenhair	Y	Y	Y	Y
Adiantum viridescens			Y	–	–	–
Arthropteris tenella			Y	Y		Y
Asplenium bulbiferum	Pikopiko	Hen & chickens	Y	Y	Y	Y
Asplenium flaccidum		Hanging spleenwort	U	Y	Y	–
Asplenium hookerianum			–	Y	Y	Y
Asplenium lyallii			Y	Y	–	–
Asplenium oblongifolium			Y	–	Y	–
Asplenium polyodon		Sickle fern	Y	Y	Y	–
Blechnum chambersii	Nini		Y	Y	Y	Y
Blechnum discolor	Piupiu	Crown fern	–	Y	Y	–
Blechnum filiforme		Thread fern	Y	Y	Y	Y
Blechnum fluviatile	Kiwakiwa		–	Y	Y	–
Blechnum novae-zelandiae	Kiokio	Palm-leaf fern	Y	Y	Y	–
Cyathea cunninghamii			Y	Y	Y	Y
Cyathea dealbata	Ponga	Silver fern	Y	Y	Y	–
Cyathea medullaris	Mamaku	Black tree fern	Y	Y	Y	Y
Dicksonia fibrosa	Whekī-ponga		–	Y	–	–
Dicksonia squarrosa	Whekī		–	Y	Y	Y
Diplazium australe		Lady fern	Y	Y	Y	–
Doodia australis		Rasp fern	Y	Y	–	Y
Histiopteris incisa		Water fern	–	Y	Y	–
Hymenophyllum demissum		Filmy fern	–	–	Y	–
Hypolepis ambigua			–	Y	Y	–
Lastreopsis glabella			Y	Y	Y	–
Lastreopsis microsora ssp. pentangularis			Y	–	–	–

Microsorum novae-zelandiae			–	Y	–	–
Microsorum pustulatum		Hound's tongue	Y	Y	Y	–
Microsorum scandens	Moki	Fragrant fern	Y	Y	Y	Y
Notogrammitis pseudociliata			–	Y	–	–
Pellaea rotundifolia	Tarawera	Button fern	Y	Y	Y	Y
Pneumatopteris pennigera		Gully fern	Y	Y	Y	Y
Polystichum silvaticum			–	Y	–	–
Polystichum wawranum		Common shield fern	Y	Y	Y	–
Pteris 'macilenta'		Sweet brake	Y	Y	Y	Y
Pteris tremula		Trembling brake	Y	Y	Y	Y
Pyrrosia eleagnifolia		Leatherleaf	Y	Y	Y	Y
		Conifers (4)				
Dacrycarpus dacrydioides	Kahikatea	Kahikatea, white pine	Y	Y	Y	Y
Podocarpus totara	Tōtara	Tōtara	–	Y	Y	–
Prumnopitys ferruginea (seedlings only)	Miro	Miro	U	–	–	–
Prumnopitys taxifolia	Mataī	Mataī, black pine	Y	Y	Y	Y
		Dicot trees and shrubs (43)				
Alectryon excelsus	Tītoki	Tītoki	Y	Y	Y	Y
Beilschmiedia tawa	Tawa	Tawa	Y	Y	Y	Y
Brachyglottis repanda	Rangiora	Rangiora	Y	Y	Y	–
Carpodetus serratus	Putaputawētā	Putaputawētā, marbleleaf	Y	Y	Y	Y
Coprosma lucida	Kakaramū	Shining karamū	Y	–	–	–
Coprosma rhamnoides			Y	Y	Y	Y
Coprosma robusta	Karamū	Karamū	Y	–	–	Y
Coprosma spathulata			–	–	Y	–
Cordyline australis	Tī kōuka	Cabbage tree	Y	Y	Y	Y
Dysoxylum spectabile	Kohekohe	Kohekohe	Y	Y	Y	Y
Coriaria arborea	Tutu	Tree tutu	Y	Y	–	Y
Corynocarpus laevigatus	Karaka	Karaka	Y	–	Y	Y
Elaeocarpus dentatus	Hīnau	Hīnau	Y	–	–	–
Entelea arborescens	Whau	Whau	Y	–	–	–
Fuchsia excorticata	Kōtukutuku	Tree fuchsia	Y	–	–	–

Geniostoma ligustrifolium var. rupestre	Hangehange	Hangehange	Y	Y	Y	Y
Hoheria sextylosa	Houhere	Long-leaved lacebark	Y	Y	Y	Y
Hedycarya arborea	Porokaiwhiri	Pigeonwood	Y	Y	Y	Y
Knightia excelsa	Rewarewa	Rewarewa	Y	Y	Y	Y
Kunzea ericoides	Kānuka	Kānuka, tea tree	Y	Y	Y	Y
Laurelia novae-zelandiae	Pukatea	Pukatea	Y	Y	Y	Y
Leptospermum scoparium	Mānuka	Mānuka, tea tree	–	–	Y	–
Leucopogon fasciculatus	Mingimingi	Mingimingi	–	Y	Y	–
Lophomyrtus obcordata	Rohutu	Rohutu	Y	–	–	–
Macropiper excelsum	Kawakawa	Kawakawa	Y	Y	Y	Y
Melicope ternata (seedlings only)	Wharangi	Wharangi	Y	–	–	–
Melicytus ramiflorus	Māhoe	Māhoe, whiteywood	Y	Y	Y	Y
Myoporum laetum	Ngaio	Ngaio	Y	Y	–	–
Myrsine australis	Māpou	Māpou	Y	Y	Y	Y
Nestegis lanceolata	Maire	White maire	–	Y	–	–
Nothofagus solandri var. solandri	Tawhai	Black beech	Y	–	Y	–
Olearia furfuracea	Akepiro		–	–	Y	–
Olearia rani	Heketara	Heketara	–	–	Y	Y
Ozothamnus leptophyllus	Tauhinu	Cottonwood	Y	Y	Y	Y
Pennantia corymbosa	Kaikōmako	Kaikōmako	Y	Y	Y	Y
Pittosporum tenuifolium	Kōhūhū	Kōhūhū, black mapau	Y	Y	Y	Y
Pseudopanax arboreus	Whauwhaupaku	Five finger	Y	–	Y	Y
Pseudopanax crassifolius	Horoeka	Lancewood	Y	Y	Y	Y
Schefflera digitata	Patē	Seven finger	Y	Y	Y	–
Sophora tetraptera	Kōwhai	Kōwhai	Y	–	Y	Y
Streblus heterophyllus	Turepo	Milk tree	Y	–	Y	Y
Veronica stricta	Koromiko	Koromiko	Y	–	–	–
Vitex lucens	Pūriri	Pūriri	Y	Y	Y	–
		Dicot lianes and epiphytes (12)				
Calystegia tuguriorum			Y	Y	Y	–
Clematis cunninghamii			Y	Y	–	Y
Clematis paniculata	Puawhananga		Y	–	–	–

Metrosideros colensoi		White rātā	–	–	Y	–
Metrosideros diffusa		White rātā	Y	Y		Y
Metrosideros perforata	Akatea	White rātā	–	Y	Y	Y
Muehlenbeckia australis	Pōhuehue		Y	Y		Y
Parsonsia capsularis		Māori jasmine	Y	Y	Y	Y
Parsonsia heterophylla		Māori jasmine	Y	–	Y	–
Passiflora tetrandra	Kohīa	Native passionflower	Y	–	–	Y
Rubus cissoides	Tātarāmoa	Bush lawyer	Y	–	–	–
Rubus schmidelioides	Tātarāmoa	Bush lawyer	Y	–	–	–
Dicot herbs (12)				–	–	–
Acaena anserinifolia	Piripiri		Y	–	–	–
Euchiton audax		Cudweed	Y	–	–	–
Haloragis erecta	Toatoa		Y	–	–	–
Hydrocotyle elongata		Pennywort	Y	Y	Y	Y
Jovellana sinclairii		NZ calceolaria	Y	–	–	–
Leptinella squalida CHR 624953			–	Y	–	–
Lobelia anceps		Native lobelia	–	–	Y	–
Nertera depressa			–	Y	–	–
Oxalis exilis			–	Y	–	–
Stellaria parviflora			Y	–	–	Y
Monocot trees, lianes, and epiphytes (5)						
Astelia solandri	Kōwharawhara		Y	–	Y	–
Collospermum hastatum	Kahakaha	Tank lily	–	Y	Y	–
Freycinetia banksii	Kiekie	Kiekie	–	Y	Y	Y
Rhopalostylis sapida	Nīkau	Nīkau	Y	Y	–	Y
Ripogonum scandens	Pirita	Supplejack	Y	Y	Y	Y
Orchids (3)						
Drymoanthus adversus			Y	–	–	–
Gastrodia cunninghamii			U	–	–	–
Pterostylis banksii			U	–	–	–
Grasses (4)						
Microlaena stipoides		Meadow rice grass	Y	Y	Y	Y
Microlaena avenacea		Bush rice grass	Y	–	Y	–
Oplismenus imbecillus			Y	Y	Y	Y
Rytidosperma gracile		Danthonia	Y	–	Y	Y

Sedges (9)						
Carex geminata			Y	–	–	Y
Carex lambertiana			Y	–	–	–
Carex solandri			Y	–	–	–
Carex virgata			Y	–	Y	Y
Gahnia lacera			–	–	Y	–
Gahnia setifolia			–	–	Y	–
Isolepis distigmatosa			–	–	–	Y
Uncinia banksii		Hook-sedge	–	–	Y	Y
Uncinia uncinata		Hook-sedge	Y	Y	Y	Y
Rushes (2)						
Juncus edgariae	Wīwī		Y	–	–	Y
Juncus sarophorus	Wīwī		–	–	–	Y
Other monocot herbs (2)						
Libertia grandiflora	Mikoikoi	NZ iris	Y	Y	Y	–
Phormium cookianum	Whaririki	Mountain flax	Y	–	Y	–

Y: recorded

–: not recorded. The absence of a record does not necessarily imply absence, but if present is probably rare.

U = unspecified (http://longbushreserve.org/documents/SpeciesList.pdf).

Four records are not accepted yet: *Myrsine divaricata* (?), *Nestegis montana* (probably *N. lanceolata*), *Blechnum triangularifolium* (probably *B. novae-zelandiae*), and *Hydrocotyle moschata* (probably *H. elongata*), but cannot be ruled out.