Manaaki Whenua
Landcare Research

Transitioning from exotic to native forest through natural regeneration: benefits and risks

Envirolink Grant: 210-HBRC249

Prepared for: Hawke's Bay Regional Council

February 2020

Transitioning from exotic to native forest through natural regeneration: benefits and risks

Contract Report: LC3676

Suzanne M Lambie, Michael Marden

Manaaki Whenua – Landcare Research

Reviewed by:
Robyn Simcock
Researcher
Manaaki Whenua – Landcare Research

Approved for release by:
Chris Phillips
Portfolio Leader – Managing Land & Water
Manaaki Whenua – Landcare Research

Contents

Summary

Project and Client

- In some steepland areas, there are increasing concerns about harvesting of exotic forests and accelerated erosion and slash impacts on waterways. Landowners are increasingly seeking information from Councils on best practices to transition from exotic to indigenous forest. However, there is little data on the benefits and risks associated with conversion strategies.
- Maungataniwha Pine Forest is currently undergoing post-pine-harvest natural regeneration using several approaches. It is a potential case study for Hawke's Bay Regional Council (HBRC) to provide data on the viability of several conversion techniques. This information would enable HBRC to advise land managers on which conversion strategy would minimise erosion and/or maximise other environmental benefits.
- HBRC engaged Manaaki Whenua – Landcare Research (MWLR) to advise on the viability of collection information on restoration strategies at Maungataniwha Pine Forest.

Objectives

- Hold a joint visit with HBRC to Maungataniwha Pine Forest to discuss conversion strategy success or failure with Peter Shaw (Forest Lifeforce Restoration Trust)
- Gather information on the spatial distribution of harvest dates and post-harvest treatments undertaken, including any data on native and non-native tree species and growth collected, and the possibility of installing permanent sampling plots for data collection.
- Assess Maungataniwha Pine Forest for suitability to inform how natural reversion contributes to erosion mitigation and carbon sequestration.

Outcomes

- A joint meeting was held between Peter Shaw, MWLR, HBRC and Forbes Ecology on 30 September 2019.
- Timelines and maps for forest harvest and conversion treatments (e.g. spraying) are not currently available for Maungataniwha Pine Forest.
- Maungataniwha Pine Forest is a complex landscape with varying forest covers that reflect the ease of reversion to native forest. Competition from *Pinus radiata* wildings was the main threat to successful conversion and governed the restoration strategy used at a specific site. Strategies include:
    - Harvest of pines → no spray applied → successful native regeneration
    - Harvest of pines → Meturon spray → successful native regeneration
    - Harvest of pines → wilding pine re-population → repeated manual removal → successful native regeneration
    - Harvest of pines → wilding pine re-population → abandonment (no further control measures)

    - Harvest of pines → Meturon spray → dense wilding pine re-population → glyphosate spray with desiccant → plantation mānuka (which will progress to broadleaf-podocarp forest naturally in the future)
    - Mature pines remaining to be harvested, decisions pending on the regeneration strategy to be used
    - Retention forestry, mature pines not to be harvested but left standing for native understory development
- No tree growth or species distribution data have been collected at Maungataniwha Pine Forest. Such data are not included in goals of the Forest Lifeforce Restoration Trust (FLRT), who manage the land and restoration projects.
- Establishment and measurement at Maungataniwha of Permanent sampling plots (PSP), with the addition of information on tree below-ground parameters, would be a viable way to determine when and how natural reversion mitigates erosion, accrues biomass and sequesters carbon if a map of pine harvest and subsequent spray/planting treatments was done.

Recommendations

- A map and timeline of harvest and treatment schedules for the various regeneration strategies at Maungataniwha is needed to underpin site management post-harvest. This would ensure the Trust has a written record of their efforts which contributed to the various forest outcomes.
- Following this, the implementation of PSP plots would supply HBRC with valuable information with respect to erosion mitigation and viability of conversion strategies from pine plantation to native forest via natural regeneration.

1 Introduction

Trees play a vital role in mitigating erosion (Marden & Rowan 1993; Marden et al. 1995; Philips et al. 2015). It is important that erosion-prone land remain in forested land-uses to reach and/or maintain acceptable water quality (Calder 2007; Yao et al. 2014). There has been an increasing interest in conversion of exotic forest to native forest by natural regeneration (Marlborough District Council et al 2016). Maungataniwha Pine Forest is an ideal case study of a first-rotation production forest post native forest removal. The forest has not been in pasture and has a high anticipated regeneration potential and close proximity to established native forest. Regeneration of native vegetation can occur with, or without, plantation harvesting; the latter is termed 'retention forestry' and is emerging as a key practice for erosion mitigation as well as biodiversity enhancement (Peterson & Hayman 2018). Where harvesting occurs, there is limited information on the species distribution and growth potential which effects the provision of erosion mitigation services by native regeneration (Lambie et al. 2018).

Maungataniwha Pine Forest was a first-rotation 6,294-hectare *Pinus radiata* forest planted between 1981 and 1985 (A Fleming, pers. comm., 18 September 2019). The forest is situated between the Mohaka and Waiau Rivers in the Hawke's Bay Region (Fig. 1) and is bordered to the north by Maungataniwha Native Forest, which links Te Urewera and Whirinaki Conservation Forest. The property was purchased by Simon Hall in 2006, and 3,582 hectares were under the management of Matariki Forest Company until January 2018 (Shaw 2019). Both the Maungataniwha Native and Pine Forests are currently managed as part of the Forest Lifeforce Restoration Trust (FLRT; https://www.forestlifeforce.org.nz/), the goal of which is habitat provision for native bird species.

Figure 1. Location of Maungataniwha pine forest (Shaw 2019).

The site was podocarp/kamahi-beech forest (Hashiba et al 2014; Fig. 2) before being progressively logged in the 1980's (Fleming, pers. comm., 2019). The land was cleared by burning. Some areas were subsequently sprayed with herbicide which mostly likely consisted of Atrazine WP or Actzaine 5A and Gesaprim 500FW both with Dalapon and Amitrole added (Gous 2003) before radiata pine was planted (Fleming, pers. comm., 2019). Mature radiata pines were harvested between 2007 and 2017. Harvesting did not follow a consistent pattern but was driven by demand from mills for particular products (Fleming, pers. comm., 2019). Some pockets of mature pine trees remain on the property (Shaw 2019). The conversion of Maungataniwha is the largest natural regeneration post pine harvest restoration project in New Zealand (Forest Lifeforce Restoration Trust 2020b).

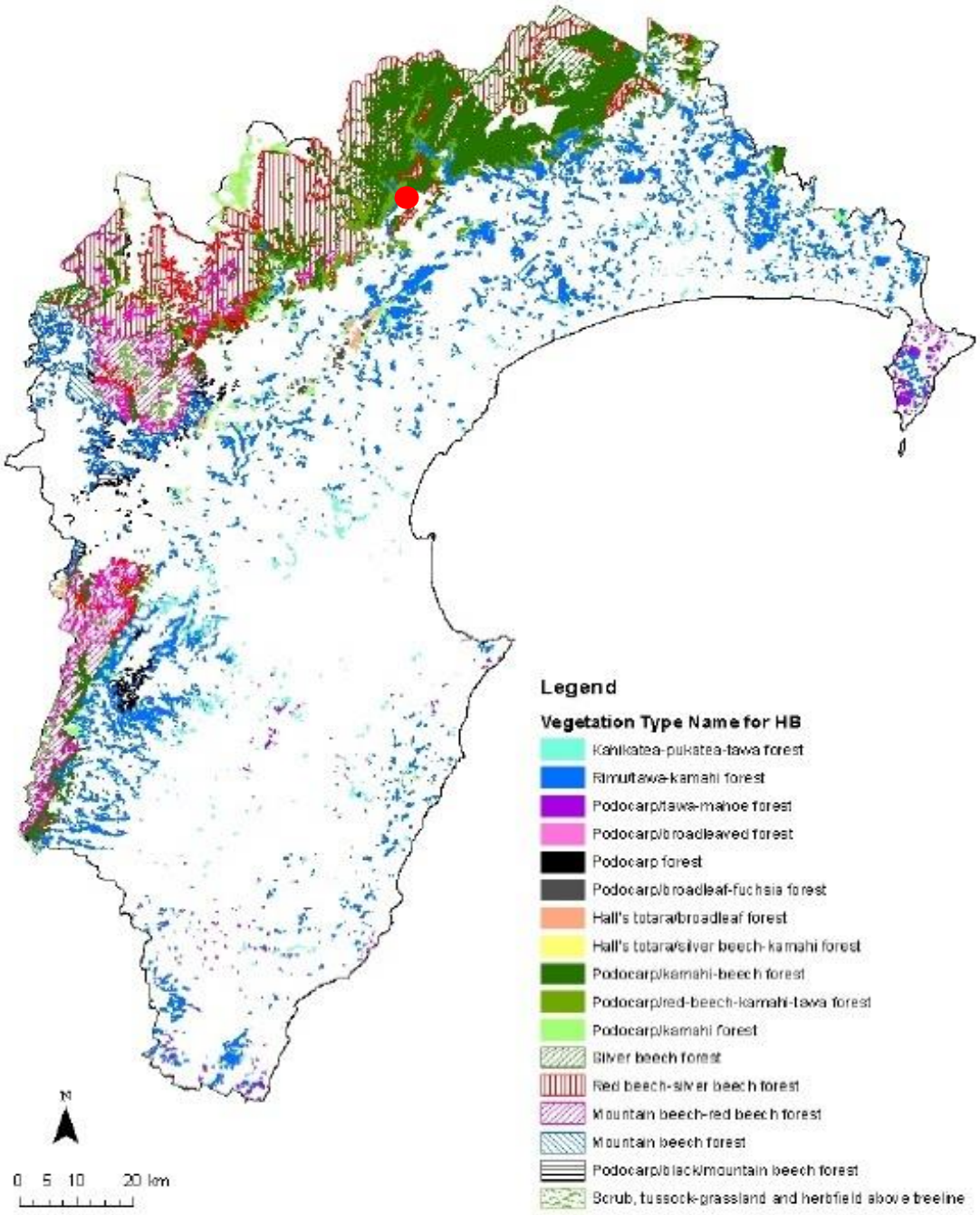

Figure 2. Extent of native forest and scrub cover in the Hawke's Bay (Hashiba et al. 2014). The red dot indicates Maungataniwha Pine Forest.

Maungataniwha Pine Forest lies on mudstone geology, with minor limestone and tuff of Miocene/Pliocene age (New Zealand Geological Survey 1958). The moderately steep to steep slopes (10–55°) are classified as Land Use Capability Class 7 (National Water and Soil Conservation Organisation 1976) and are representative of erosion-prone, soft-rock hill country found throughout much of the North Island.

The soils have developed in airfall tephra that is susceptible to a range of different erosion processes, but particularly shallow landslides. Soils across the site reflect the extent and type of erosion processes including soils on stable ridges with little erosion which are largely undisturbed Typic Orthic Allophanic Soils (Hewitt 2010). These are silt loams

consisting of an A-horizon containing Taupo ash (erupted ~1850 years BP) underlain by a B-horizon of Waimihia Lapilli (erupted ~3280 years BP), and older finer-grained tephra of mid-Holocene age (Eden et al. 1993). Soils are free draining with tunnel gullies forming within the Waimihia Lapilli. In contrast, where slopes are steepest, extensive landslides have stripped much of the original cover-bed materials, resulting in thin Typic Orthic Recent Soil typically associated with land that has been eroded or has received sediment as a result of slope processes (Hewitt 2010), and correlate with the Inceptisols of Soil Taxonomy (Soil Survey Staff 1992). The extensive landslides were initiated by storm events (Glade 1996), with most failures coinciding with the colluvium-bedrock contact. The region is regularly subjected to heavy, intense rainfall events resulting in considerable loss of soil from the steeper slopes.

The primary land use strategy for progressing from exotic pine to native forest at Maungataniwha is natural regeneration, however, success has been erratic. Trial-and-error has led to several regeneration strategies being adopted at Maungataniwha. This range of treatments and ages since restoration at Maungataniwha present opportunities to assess the viability of various restoration strategies. Hawke's Bay Regional Council (HBRC) is seeking advice from Manaaki Whenua – Landcare Research (MWLR) on what information from Maungataniwha Forest could inform conversion strategies for erosion mitigation on similar properties.

2 Objectives

The objectives of this work were to visit Maungataniwha Pine Forest with site manager/Trustee Peter Shaw and HBRC staff to discuss how conversion from pine to native forest has been undertaken. Further, to gather information on the spatial distribution of harvest dates and post-harvest treatments undertaken, on any data on native and non-native tree species and growth collected, and on the possibility of installing permanent sampling plots (PSPs). The Forest will be assessed for suitability to investigate the benefits and costs of regeneration strategies for erosion mitigation using PSPs and collection of data for below ground tree parameters and carbon sequestration.

3 Outcomes

Maungataniwha Pine Forest was visited on 30 September 2019 with Mark Mitchell and Tim Norris (HBRC) and Adam Forbes (Forbes Ecology).

3.1 Forest harvesting information

Determining the time of harvest for the various pine forest compartments was completed will potentially be difficult (Fleming, pers. comm., 2019). The variable tree harvest pattern and the lack of recorded data means mapping of harvest timing may not be possible. Matariki Forests generated annual 'hand-back maps' for the landowners of Maungataniwha forests, but MWLR has not been able to access these. Key information is the season of harvesting, as this impacts pine regeneration (Marlborough District Council

et al. 2016), and the method of harvesting (e.g. ground-based skidder with whole-stem or stem-only removal, feller-buncher or hauler). Large areas of radiata pines were harvested between January 2016 and February 2017 and again before October 2018, with harvesting completed in November 2018 (Forest Lifeforce Restoration Trust; Fig. 3).

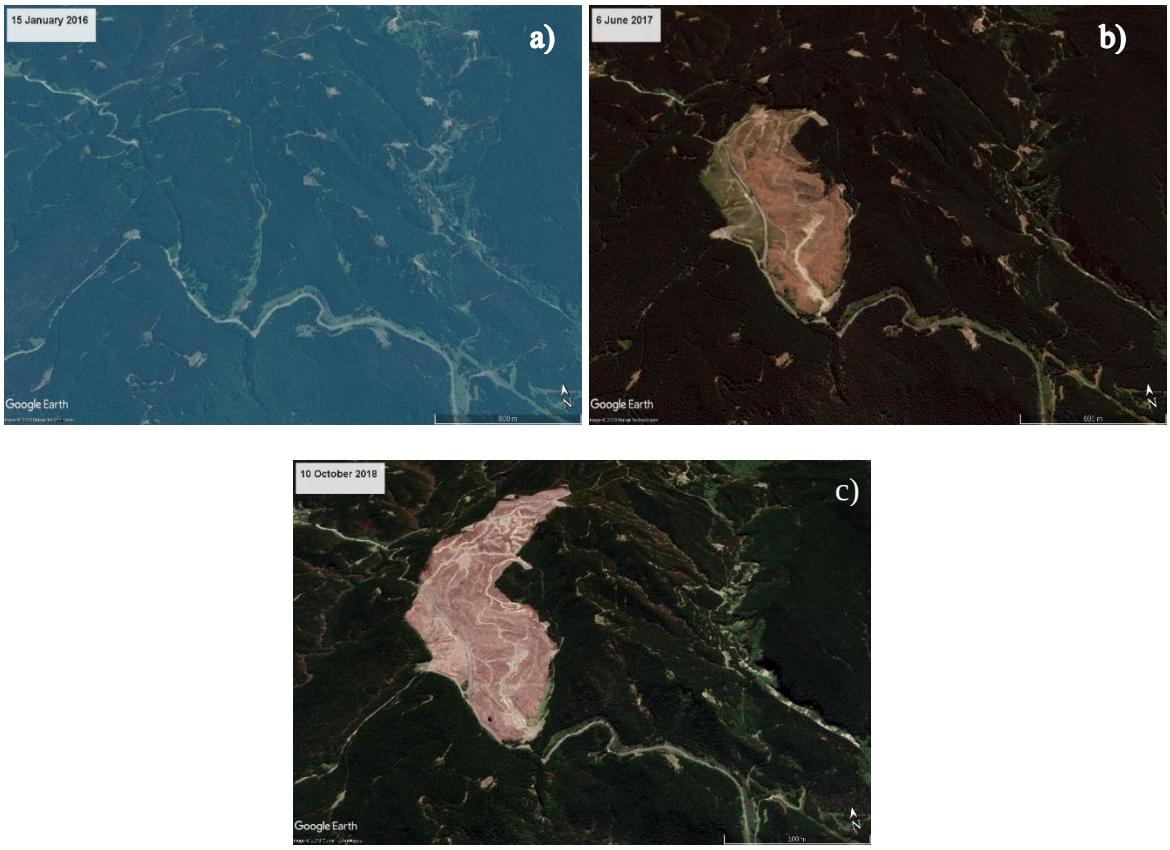

Figure 3. Areas and timing of some areas in Maungataniwha Pine Forest (Google Earth 2019).

3.2 Wilding pine control

The predominant limitation to native regeneration has been wilding pines, which have densely re-populated some areas post-harvest (Fig. 4). Wilding pines were removed using aerial spraying of dense, and/or difficult to access areas and manual removal in sparsely populated areas (Appendix One).

Figure 4. Dense wilding pine re-populated area post harvest at Maungataniwha Pine Forest (outlined in red).

In 2019, nearly 600 hectares were aerial sprayed to remove wilding pines from areas of regenerating native forest (Shaw 2019). Meturon (Mesulfuron-methyl) with Organosilicone was sprayed with increasing concentration in response to greater pine density (Shaw 2019). The control of wilding pines is a major cost for FLRT at ~$163 k or around $292/hectare (Shaw 2019). The control strategy used for wilding pines has evolved over the last 3–4 years, with increasing concentrations of herbicides (combined with increasing flying time) increasing costs, for example spray costs were $207/hectare in 2015–2016 (Shaw 2019).

Aerial spraying of wilding pines with high rates of Meturon may kill the first flush of native species to germinate. At Maungataniwha, native grasses, including hook grass (*Uncinia uncinate)* and toetoe (*Austroderia* spp.), are the first to regenerate, followed by small shrubs or small trees, including māhoe (*Melicytus ramiflorus)* and makomako *(Aristotelia serrata)*. These in turn, are succeeded by mountain cabbage-tree (*Cordyline indivisa),* kānuka (*Kunzea eroicoides*), and kōtukutuku (*Fuchsia excorticata*). Spraying probably alters the eventual species distribution in the post-spray second flush of native forest regeneration, in particular, by removing broader leafed species, and species without waxy cuticles (Marlborough District Council et al. 2016). However, Marlborough District Council et al. (2016) found putaputaweta *(Carpodetus serratus*), mānuka (*Leptospermum scoparium)*, tauhinu *(Ozothamnus leptophyllus*), māhoe, and makomako survived Meturon spraying at concentrations of 200 g/ha (~$150–250/ha). At high rates of herbicide

application (500 g/ha; 250–$400/ha), grass was sometimes all that remained; however, in Marlborough grass supresses wilding pines and acts as a nurse crop for kānuka.

Areas with low densities of wilding pine often have successful native regeneration to fuchsia (Fig. 5) or mānuka/kānuka shrubland. In these areas manual removal of pine trees has been successful for wilding control, but repeated visits are required every few years to prevent pine re-establishment and light suppression of the slower-growing natives. Manual (ground) control costs $500/ha, with a 70% kill rate of initial clearances of 1800–3000 wilding pines/ha, and a second pass within 2–3 years of initial control (Forest Lifeforce Restoration Trust 2019a).

Figure 5. Regenerating *Fuchsia excorticata* intermixed with wilding pines at Maungataniwha Pine Forest.

Marlborough District Council et al. (2016) report that pine wildings had greater density in drier areas with greater extents of harvesting disturbance; however, this has not been confirmed at Maungataniwha.

3.3 Regeneration strategies

HBRC is interested in outcomes of different conversion strategies at Maungataniwha, particularly with respect to best practice, biodiversity improvement, and costs. Density of *Pinus radiata* wildings has determined the regeneration interventions at Maungataniwha Pine Forest. The regeneration strategies are as follows:

- Harvest of pines → no spray applied → successful native regeneration
- Harvest of pines → Meturon spray → successful native regeneration
- Harvest of pines → wilding pine re-population → repeated manual removal → successful native regeneration
- Harvest of pines → wilding pine re-population → abandonment (no further control measures)
- Harvest of pines → Meturon spray → dense wilding pine re-population → glyphosate spray with desiccant → plantation mānuka (which will progress to broadleaf-podocarp forest naturally in the future)
- Mature pines remaining to be harvested, decisions pending on the regeneration strategy to be used
- Retention forestry, mature pines not to be harvested but left standing for native understory development

Successful native regeneration is defined as restocking of forest cover with native species from existing seed sources.

FLRT have partnered with ProLife, a multi-national food production company based in Hamilton, New Zealand, to establish plantation mānuka at Maungataniwha Pine Forest. Benefits for the Trust are: 1) ProLife pay for site treatment costs such as aerial herbicide spraying; 2) mānuka honey income to support restoration initiatives; and 3) plantation mānuka may act as a nursery crop for broadleaf-podocarp secondary forest development. Mānuka/kānuka shrubland is often the first phase of native forest development and podocarp-broadleaf forest develops under mānuka/kānuka canopy about 80 years after shrubland establishment (Bergin et al. 1995). Due to close proximity of large tracts of mature native forest (Maungataniwha Native in Fig. 1) it is likely that this strategy will be successful over the long term if wilding pines that emerge in the plantation mānuka are removed and risk of fire is reduced. Mānuka is highly flammable, but the fire risk can be mitigated by the implementation of 'green firebreaks' using other native species with low flammability, including karamū (*Coporosma robusta*), karaka (*Carynocarpus laevigatus*), kohekohe (*Dysoxylum spectabile*), five-finger (*Pseudopanax arboreus*), hangehange (*Geniostoma ligustrifolium*) and kōtukutuku (Wyse et al. 2016).

3.4 Data collection

FLRT collect data on predator control, wilding pine control (but not pre- or post-control density or height), native bird counts, rare native tree/shrub species (notably mistletoes (*Peraxilla* spp and *Alepis flavida*) and kakabeak (*Clianthus* spp)) and are particularly active in monitoring and re-introducing kiwi (Shaw 2019). The goal of FLRT is habitat provision predominantly for bird species, so their focus has not been measuring tree parameters or

assessing native plant species in successful or unsuccessful areas of regeneration. No data have been collected at Maungataniwha Pine Forest that are relevant to native or wilding pine tree species distribution or growth. FLRT do not have the capacity required to collect data recommended to assess erosion mitigation, plant biomass and biodiversity outcomes of the various regeneration strategies. Additional resourcing would be required.

Establishment of permanent sampling plots (PSPs) at Maungataniwha could inform land management and forest conversion strategy information for HBRC. PSPs are permanent 20 x 20 m plots that have been historically used in New Zealand to determine changes in forest structure, species composition, and growth parameters (Allan 1993; Hurst & Allen 2007). Additional data on the below-ground parameters, such as rooting depth and horizontal spread, would also need to be collected adjacent to PSPs. Collection of plant growth parameters can inform the Landuse and Carbon Analysis system (LUCAS; New Zealand's carbon accounting system) and the carbon economy (EBEX) of the possible monetary value of regenerating forests. Enviro-link 2039-HBRC252 'Site-based (Tier 2) terrestrial biodiversity' is focusing on the design and placement of a PSP network in the Hawke's Bay and will also inform PSP installation at Maungataniwha.

Maungataniwha Pine Forest has the unique advantage of a range of natural regeneration strategies and a range of forest covers at different ages applied at a large scale. Maungataniwha Pine Forest also has the added benefit of being first-rotation pine post-native forest clearance, rather than post-pastural grazing, being adjacent to mature native forest with an abundance of bird life and active pest control (Shaw 2019). The Trust would support the implementation of PSPs but could not contribute to the cost of installation, maintenance or monitoring (Peter Shaw, pers. comm.).

4 Recommendations

Maungataniwha Pine Forest covers a complex landscape with a variety forest covers developing after pine harvesting. Information on the spatial distribution, timing of harvesting, and the methods and timing of conversion strategies is greatly needed. This information has not yet been comprehensively recorded, and remains predominantly in the recollections of Peter Shaw. MWLR could not legally access information from Matariki Forests; in particular, the hand-back maps were not supplied by LFRT, so information on harvesting could not be collected within the framework on this Enviro-link. Compilation of these data is therefore, a first vital step in assessing the relative effectiveness of conversion strategies at Maungataniwha Pine Forest. This data compilation, including its presentation in maps, would also provide the Trust with a record of how their efforts have contributed to the various forest cover outcomes. It would be useful to supplement information provided in hand-back maps and by Peter Shaw with aerial imagery and high-definition aerial photos over the time of plantation harvesting, the latter which is held by HBRC.

Maungataniwha Pine Forest is a suitable study site to assess when, and how, natural reversion will mitigate erosion post pine harvest. PSP plots are the best way to collect relevant information, using a well-established methodology. They could also be used to quantify biomass accumulation (by repeat visits to permanent plots over time) and therefore carbon sequestration rates under the various vegetation covers and restoration

strategies. The cost involved in establishing, maintaining and monitoring PSP sites is considerable, but may be funded through central or local government or research initiatives.

5 Acknowledgements

Peter Shaw for sharing his invaluable knowledge and time to discuss the goals and strategies for converting Maungataniwha Pine forest to native forest via natural regeneration. Thanks to Barry Lynch, Mark Mitchell, and Tim Norris (HBRC), Adam Forbes (Forbes Ecology), and James Powrie (RedAxe Forestry Intelligence) for their valued input into discussions on this kaupapa.

6 References

Allen RB 1993. A permanent plot method for monitoring changes in indigenous forests: a manual. Lincoln, NZ, Manaaki Whenua – Landcare Research. 24 p.

Bergin DO, Kimberley MO, Marden M 1995. Protective value of regenerating tea tree stands on erosion-prone hill country, East Coast, North Island, New Zealand. New Zealand Journal of Forestry Science 25(1): 3–19.

Calder IR 2007. Forests and water – ensuring forest benefits outweigh water costs. Forest Ecology and Management 251: 110–120.

Eden DN, Frogga, PC, Trustrum NA, Page MJ 1993. A multiple source Holocene tephra sequence from Lake Tūtira, Hawke's Bay, New Zealand. New Zealand Journal of Geology and Geophysics 36: 233–242.

Forest Lifeforce Restoration Trust 2019a. Battle of the pines. Retrieved 16 January 2019, from, updated 22 August 2019: https://www.forestlifeforce.org.nz/post/battle-of-the-pines.

Forest Life Force Restoration Trust 2019b. Forest Conversion. Retrieved 15 January 2020, from https://www.forestlifeforce.org.nz/forest-conversion.

Glade TW 1996. The temporal and spatial occurrence of landslide-triggering rainstorms in New Zealand. In: Mäusbacher R, Schulte A eds Beiträge zur Physiographie. Festschrift für Dietrich Barsch. Heidelbetg Geogr. Arb: 104: 237–250.

Gous S 2003. Overview of the use of agri-chemicals and alternatives to control competition vegetation in forestry. Report prepared for the New Zealand Management COOP. 47 p.

Hashiba K, Wade O, Hesketh W. 2014. Hawke's Bay Biodiversity Inventory: current state of knowledge. HBRC Report Rm13/23-4454.

Hewitt AE 2010. New Zealand Soil Classification. Landcare Research Science Series No. 1. Lincoln: Manaaki Whenua Press.

Hurst JM, Allan RB 2007. A permanent plot method for monitoring indigenous forests: field protocols. Lincoln, NZ: Manaaki Whenua – Landcare Research. 66 p.

Lambie SM, Marden M, Kirschbaum M, Soliman T, Walsh P 2018. SLMACC 405415: Best options for land use following radiata harvest in the Gisborne District under climate change: Literature review. MPI Technical Report No: 2018/46.

Marlborough District Council, Department of Conservation, Marlborough Sounds Restoration Trust 2016. Guidelines for converting pine plantations to native vegetation in the Marlborough Sounds. 11 p.

Marden M, Rowan D 1993. Protective value of vegetation on tertiary terrain before and during Cyclone Bola, East Coast, North Island, New Zealand. New Zealand Journal of Forestry Science 23: 255–263.

Marden M, Rowan D, Phillips C 1995. Impact of cyclone induced landsliding on plantation forests and farmland in the East Coast region of New Zealand: a lesson in risk management? In: Proceedings of the 20th IUFRO World Congress, Technical Session on 'Natural disasters in mountaineous areas', 7–10 August 1995, Tampere, Finland. Pp. 133–145.

National Water and Soil Conservation Organisation 1975. New Zealand Land Resource Inventory worksheets. Wellington, New Zealand: New Zealand Government Printer.

New Zealand Geological Survey 1958. Geologicical Map of New Zealand, 1:2 000 000 scale. Welligton, New Zealand: Department of Scientific and Industrial Research.

New Zealand Soil Bureau 1963. Soil map of the North Island of New Zealand. Welligton, New Zealand: Department of Scientific and Industrial Research.

Peterson P, Hayman E 2018. Conserving indigenous fauna within production forestry landscapes. Manaaki Whenua – Landcare Research Contract Report LC3216. Envirolink Grant: 1854-GDDC150 June 2018.

Phillips C, Marden M, Basher L 2015. Forest and erosion protection: getting to the root of the matter. New Zealand Journal of Forestry 60(2): 11–15.

Shaw P 2019. Annual Report 2018-2019 prepared for Lifeforce Forest Restoration Trust. 76 p.

Soil Survey Staff 1992. Keys to soil taxonomy. SMSS Technical Monograph no 19. Blacksberg. VA: Pocahontas Press Inc. 556 p.

Wyse SV, Perry GLW, O'Connell DM, Holland PS, Wright MJ, Hosted CL, Whitelock SL, Geary IJ, Maurin KJL, Curran TJ 2016. A quantitative assessment of shoot flammability for 60 tree and shrub species supports rankings based on expert opinion. International Journal of Wildland Fire 25: 466-477.

Yao RT, Scarpa R, Turner JA, Barnard TD, Rose JM, Palma JHN, Harrison DR 2014. Valuing biodiversity enhancement in New Zealand's planted forests: socioeconomic and spatial determinants of willingness-to-pay. Ecological Economics 98: 90–101.

Appendix One – Excerpt from Marlborough District Council et al. (2016).

The Forest Lifeforce Restoration Trust is restoring more than 4000 ha of radiata pine in northern Hawke's Bay to regenerating native forest. Three-quarters has been logged by Rayonier NZ, which owns the cutting rights.

Harvested hill country at Maungataniwha forest, Hawke's Bay.

Regenerating native vegetation in a moister gully at Maungataniwha.

The approach is to do nothing for at least three years after harvesting, leaving a mosaic of different intensities of wilding pine. The densest wilding areas are then boom-sprayed by helicopter with metsulfuron herbicide plus penetrant. In gullies and other areas where natives predominate, experienced ground crews with chainsaws manually fell pines and chemicals are not used.

Some, but not many, native species survive spraying but regeneration has been rapid from seed left in the soil and spread by birds from surrounding native bush. Native grasses are the first to establish, suppressing pines and creating a nursery for shrubs and small trees like māhoe and wineberry then cabbage trees, kānuka and native fuchsia.

Dry areas are colonised by pines at the highest densities, especially where logging has disturbed the ground creating a seedbed. Adult pines on poor sites become stressed and produce the most seed. About 1170 goats have been shot in the forest since the project began in 2008.

Forest Lifeforce land manager, Pete Shaw, expects the next step to be spot-spraying treated blocks by helicopter using a directional boom. By then, native ground cover should be dense and high.

"It can be tempting to go light on control to save natives but this will cost time and money in the long-term," says Pete. "Don't worry when the site looks dreadful after spraying as this'll be temporary."

He recommends that when there's the option, mature pines be poisoned standing rather than harvested, making native restoration cheaper and easier. Felled trees damage any native undergrowth and spread their cones to seed again.