

# Operational Forest Restoration Plan for Kukutaaruhe Gully

A client report prepared for the Kukutaaruhe Education Trust

Part 2 of 3

**ERI Report 136**

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## Executive summary

Kukutaaruhe Gully is a minor branch of Hamilton's extensive gully system, and runs from the corner of Bankwood and Clarkin Road, behind Fairfield College, connecting with Donny Park in the north and out into the Waikato River. The Kukutaaruhe Education Trust was established to support the implementation of the Fairfield Project, which is a partnership between Ngati Wairere, local community and Fairfield College. The project's goals include the establishment of an ecological and environmental education centre on the approximately 12 ha of land behind Fairfield College and restoration of the adjacent Kukutaaruhe Gully.

In 2019, the University of Waikato's Environmental Research Institute was contracted by the Kukutaaruhe Education Trust to create an Operational Forest Restoration plan for Kukutaaruhe Gully. This is one in a three-part series created together under one contract:

- Part 1 of 3 is an Overview of the Kukutaaruhe Gully Restoration Initiative
- **Part 2 of 3 is this document, the Operational Forest Restoration plan for Kukutaaruhe Gully**
- Part 3 of 3 is an Ecological Restoration Plan Template.

This operational plan is designed to support the other two parts of the report and give specific guidance as to what plant species are currently present in the gully, which are non-native weeds that require immediate management, and steps for how to conduct restoration plantings to recreate a forest ecosystem.

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## 1. Restoration goals

Restoration goals should be decided and agreed upon by the Kukutaaruhe Education Trust.

Possible goals for the Operational Forest Restoration Plan could be to:

- Reconstruct plant communities similar to those originally found in Hamilton gullies
- Create conditions where native forest plants can regenerate without human assistance
- Encourage natural processes, such as plant regeneration, succession, seed dispersal and pollination
- Attract and provide habitat for native species, including birds, insects, lizards and bats
- Extend the corridor of native vegetation, connecting with Donny Park in the north, for the dispersal of native plants and animals
- Stabilise the soil on steep gully slopes
- Provide an ‘outdoor classroom’ for Fairfield College students for hands-on environmental education
- Contribute to a local sense of wellbeing and cultural identity

## 2. Site description

### 2.1. Historic forest composition

Steep gully sides (‘hillslope’, ‘crest’ and ‘footslope’ in Figure 1 and Figure 2) are characterised by well-drained soils composed of loose rhyolitic sand and gravel from the Hinuera Formation. Clarkson, Clarkson, and Downs (2007, p. 9) describe the vegetation that would have characterised gully sides:

*“The scarps and steep gully side slopes were covered with forest dominated by totara, matai, and kowhai. Kanuka and kamahi were also present, and mahoe occurred in more poorly drained sites. The understorey included shrubs of mapou, mingimingi, and Rhabdothamnus solandri, and the ground was covered in a variety of ferns such as Blechnum chambersii, Doodia media, and Polystichum richardii. Slopes too steep for forest had herbaceous or shrubby vegetation, including Machaerina sinclairii, wharariki, rangiora, koromiko, and heketara. No intact remnants of this vegetation type remain in the Hamilton Ecological District.”*

Soils of the poorly drained gully floors ('backswamp', 'levee' and 'terrace peatland' in Figure 1, wetland in Figure 2) are composed of colluvium, rhyolitic sand, silt and gravel from the Hinuera Formation, with occasional organic material. Clarkson et al. (2007) describe the vegetation that would have dominated gully floors as follows:

*"The poorly drained gully floors and their associated backswamps were dominated by kahikatea, pukatea, swamp maire, cabbage tree and pokaka. Understorey and ground cover species included mapou, fuchsia, lancewood, pate, Coprosma rotundifolia, Cyathea cunninghamii, Astelia grandis, kiekie, and supplejack. This type is represented in a small (1 ha) remnant, Hammond Bush, located alongside the Waikato River in southern Hamilton City, and is described in detail in de Lange (1996). Kahikatea trees are absent from Hammond Bush, probably a result of the nutrient status at the site, although seedlings of this species have been found there. A larger (2.2 ha) remnant of this vegetation type is present on a private reserve near Temple View. This remnant, Koromatua Bush, is situated within two shallow gullies (de Lange 1996)."*

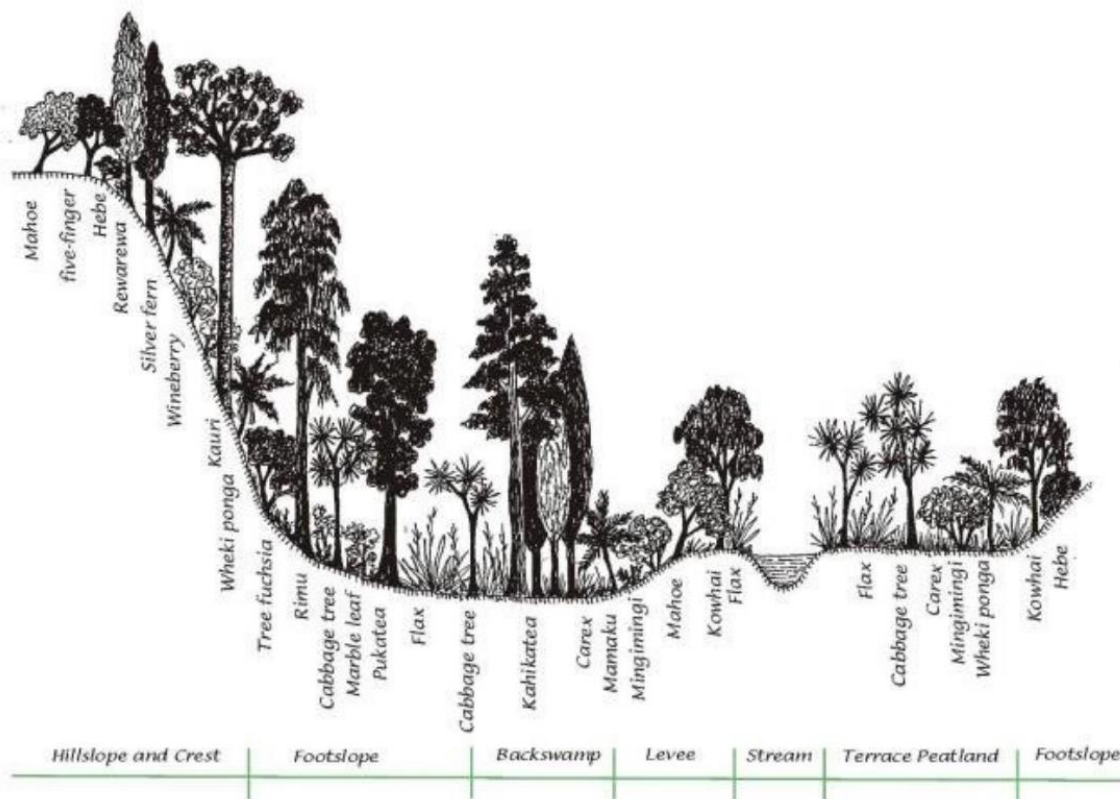


Figure 1. Example of a Hamilton gully profile showing the main topographic units and associated native plant species. From Wall and Clarkson, 2001.

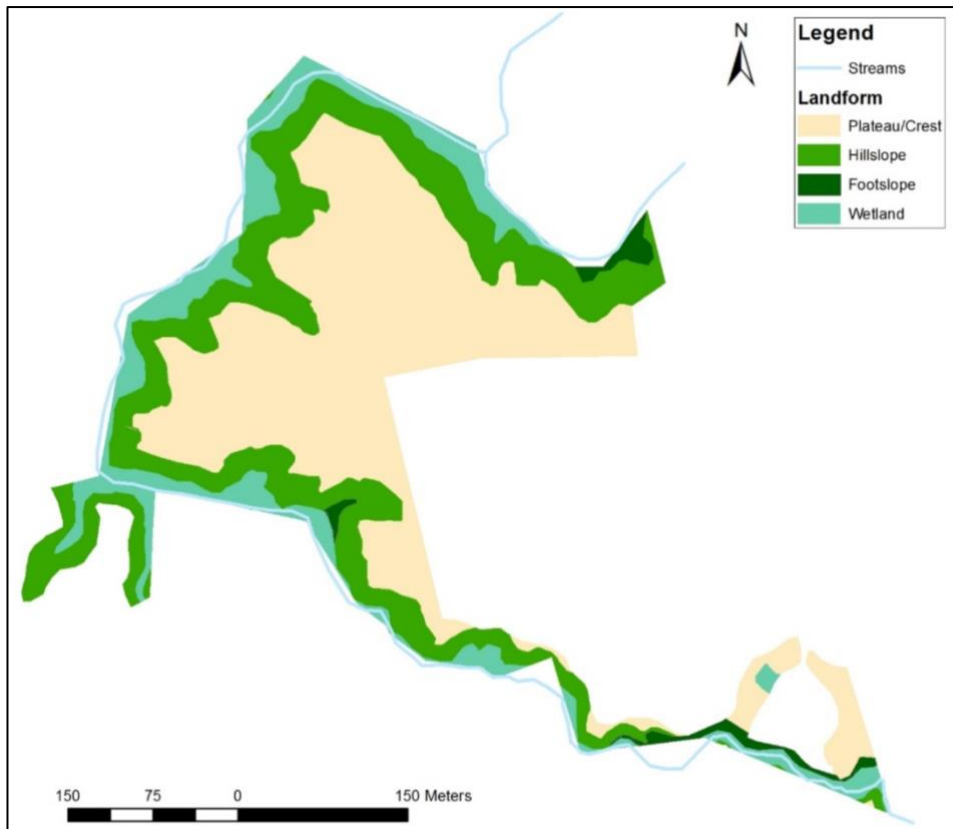


Figure 2. Landforms of Kututaaruhe Gully.

## 2.2. Current vegetation cover

Kukutaaruhe Gully currently presents a substantial restoration challenge, as the steep gully slopes are dominated by invasive vines, shrubs and trees, notably blackberry, Japanese honeysuckle, privet and gorse. Principal canopy species are primarily exotic and include willow, privet, bamboo, Taiwan cherry, oak and eucalyptus. However, pockets of native trees and shrubs persist, including kaanuka, tarata (lemonwood), maahoe, tī kōuka (cabbage trees) and tree ferns. The gully floor is largely covered in continuous carpets of the weed *Tradescantia*, with other weeds such as arum lilies, onion weed and elephant ears abundant throughout. The gully is further characterized by a depauperate epiphyte and liane community, with only two species sighted during the survey. For a full list of exotic species detected during the survey as well as a full list of native species found but not planted by the Fairfield Project, see Appendix 1 of the Overview of the Kukutaaruhe Gully Restoration Initiative (part 1 of this 3 part report series).

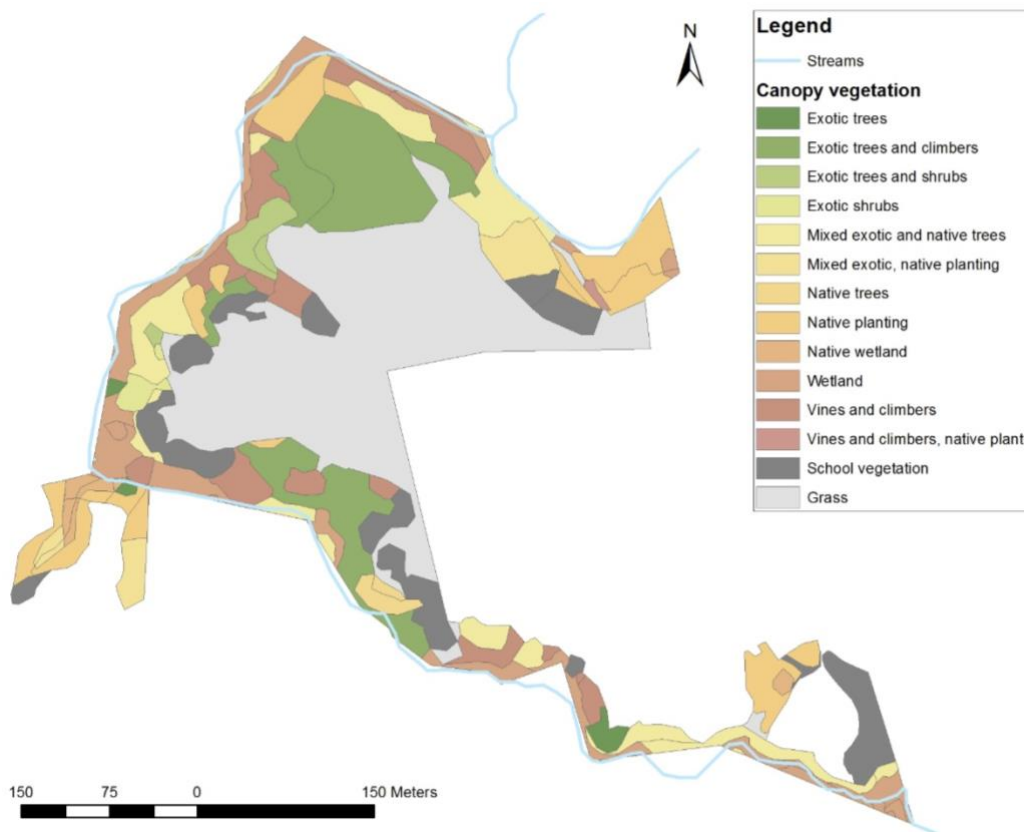


Figure 3. Current vegetation cover.

The Fairfield project organised community working bees to begin native plant restoration of the gully in 2017, with subsequent plantings in 2018 and 2019. For a list of species planted to date, see Appendix 2 of the Overview of the Kukutaaruhe Gully Restoration Initiative (part 1 of this 3 part report series). There is another small area of native plantings of unknown origin (Figure 4).

Another area in the north-western section of the gully has been planted with native vegetation (Figure 3, Figure 4 left). These plantings are older than that carried out by the Fairfield Project and have reached a good level of canopy closure to enable enrichment planting of later successional species. Native canopy species include tootara, tarata (lemonwood) and pohutukawa, while weedy canopy species include Taiwan cherry and wild cherry. Other native species planted include kowhai, tī kōuka (cabbage tree), akeake, *Pittosporum tenuifolium*, kauri, rimu, kahikatea, karaka and five-finger. Natural succession may already be occurring, with kawakawa established well in the understorey (unless these have been planted). Three species of tree fern are also present (silver fern, mamaku and *Dicksonia squarrosa*) – these probably have recolonized naturally or may possibly have been planted.



Figure 4. Left, an area of older native plantings in the north-western section of the gully. Right, example of recent native plantings on a slope.

### 2.3.1. Current ecological threats: Weeds

Kukutaaruhe Gully is dominated by invasive non-native plants that severely modify natural habitats and disrupt historic ecological processes (Figure 55). Key invasive non-native plants in the gully which are listed in the National Pest Plant Accord (NPPA) include Japanese honeysuckle, grey and crack willow, woolly nightshade, tree privet, green goddess and *Tradescantia* (for a full list of all exotic vegetation seen during the site survey, see the Appendix 3 in the Overview of the Kukutaaruhe Gully Restoration Initiative, part 1 of this 3 part report series).

There is a relatively large patch of bamboo in the western section of the gully. Bamboo is difficult to eradicate and the large clump present in the gully will require heavy machinery to remove, likely paired with application of herbicide. Blackberry and privet are starting to come up in the large field area along the north-western edge of Kukutaaruhe Gully (Figure 6). We advise quick control of this area, as weeds are easier to control when they are small. Non-native weed control should focus on:

- smothering weeds, such as Japanese honeysuckle and jasmine
- non-native fruiting species whose seeds are widely spread by birds, such as tree and Chinese privet, Taiwan cherry, evergreen buckthorn and woolly nightshade
- weeds that occupy forest margins more quickly than native plants, such as blackberry, gorse and woolly nightshade
- weeds tolerant of shade which quickly cover the forest floor, smothering native tree seedlings, such as *Tradescantia*, wild ginger, ivy and privet



Figure 5. Kukutaaruhe Gully is dominated by invasive non-native weeds such as *Tradescantia* (left), privet (upper right) and honeysuckle (bottom right), but pockets of native species such as tree ferns sometimes persist interspersed (upper right).

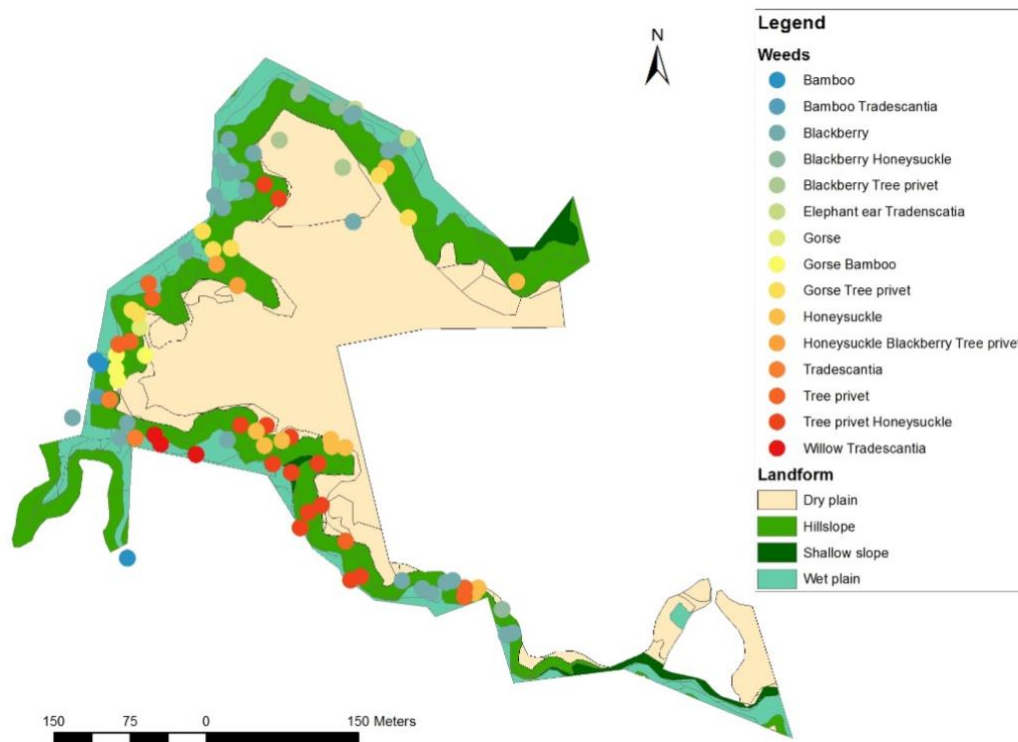


Figure 6. Current main weed species and infestation locations.

Top priority non-native weeds for control in Kukutaaruhe Gully include:

1. **Tree privet** (*Ligustrum lucidum*) and **Chinese privet** (*Ligustrum sinense*)



Figure 7. Left - tree privet, right – Chinese privet (photo: Weedbusters).

*Status:* Pest plant under Waikato Regional Council’s Regional Pest Management Strategy (RPMS). Must be removed if requested by Environment Waikato’s plant pest contractors.

*Why is it a problem?*

Privet produces many widely dispersed berries, is fast-growing and forms dense stands. Dense carpets of seedlings prevent the establishment of native plants and tree privet grows to dominate and replace native canopy trees.

2. **Woolly nightshade** (*Solanum mauritianum*)



Figure 8. Woolly nightshade (photo: Weedbusters)

*Status:* Under Waikato Regional Council’s Regional Pest Management Strategy (RPMS), landowners are required to control all woolly nightshade on their land. Woolly nightshade is also banned from being sold, propagated, distributed or included in commercial displays.

*Why is it a problem?*

Grows rapidly, forms dense stands and produces many seeds, which are widely dispersed by birds. Produces toxins that alter the soil, inhibiting regeneration of native seedlings. In some people, it can cause skin irritation and respiratory problems.

3. **Grey willow** (*Salix cinerea*) and **crack willow** (*Salix fragilis*)



Figure 9. Grey willow, left: male flower clusters. Right: Upper and lower surfaces of older leaves (photo: Trevor James).



Figure 10. Crack willow (photo: Weedbusters)

*Status:* General nuisance weed in gullies

*Why is it a problem?*

Willows exclude native plants from damp areas, form dense stands and alter the hydrological regime in streams.

#### 4. **Tradescantia** (*Tradescantia fluminensis*)

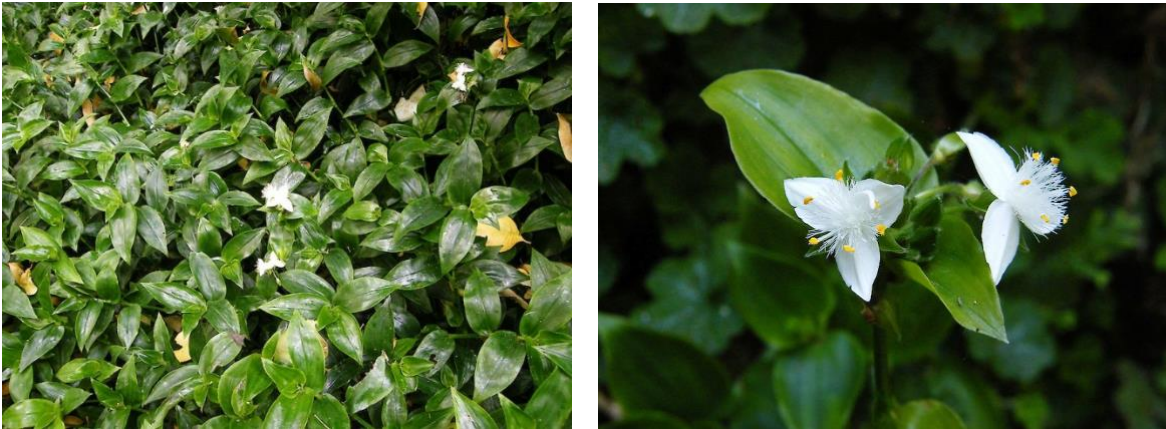


Figure 11. *Tradescantia* (photo: Weedbusters).

*Status:* General nuisance weed in gullies

*Why is it a problem?*

Rapidly forms dense mats, smothers native ground cover and prevents native seedling establishment. Very tolerant of dense shade. Presents major disposal problem as it can re-sprout from stem fragments.

#### 5. **Japanese honeysuckle** (*Lonicera japonica*)

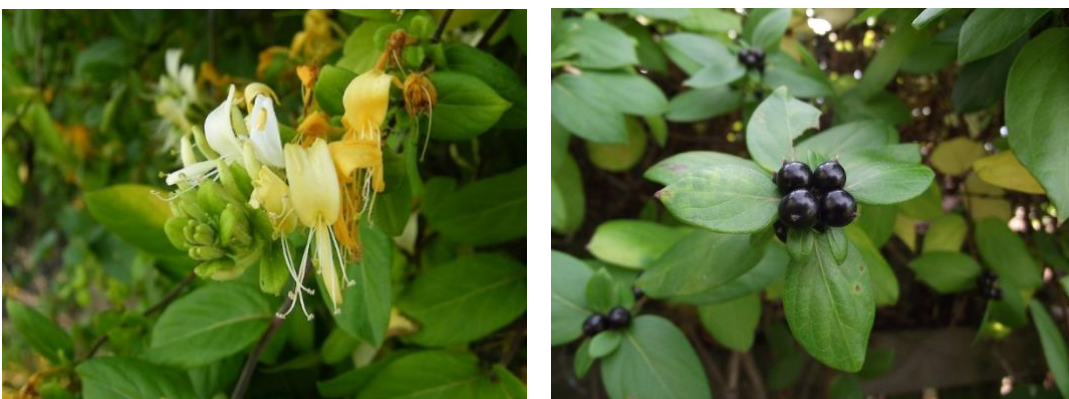


Figure 12. *Japanese honeysuckle* (photo: Weedbusters).

*Status:* banned from sale, propagation and distribution

*Why is it a problem?*

Forms dense, long-lived mats, smothers native plants and can cause canopy collapse.

6. **Blackberry** (*Rubus fruticosus*)



Figure 13. Blackberry (photo: Weedbusters).

*Status:* General nuisance weed in gullies

*Why is it a problem?*

Forms dense, long-lived clumps, smothers low-growing plants and prevents native seedling establishment. Mature plants are difficult to dig out because of extensive rhizome systems. Is intolerant of dense shade. Inhibits human use of an area.

7. **Wild ginger** (*Hedychium gardnerianum* and *H. flavescens*)



Figure 14. *Hedychium gardnerianum* (photo: Weedbusters)



Figure 15. *Hedychium flavescens* (photo: Weedbusters)

**Status:** Wild ginger is a total control plant under Waikato Regional Council's Regional Pest Management Strategy (RPMS). Landowners are required to control it on their properties. Wild ginger is also banned from being sold, propagated, distributed or included in commercial displays.

*Why is it a problem?*

Wild ginger forms dense clumps, smothers young plants and prevents regeneration of native seedlings. Wild ginger spreads from rhizomes (underground stems), and new plants can form from rhizome fragments. Causes erosion.

### **Evergreen buckthorn (*Rhamnus alaternus*)**



Figure 16. Evergreen buckthorn (photos: Weedbusters)

**Status:** Waikato Regional Council is responsible for controlling evergreen buckthorn. Landowners are encouraged to report evergreen buckthorn on their properties. Evergreen

buckthorn is also banned from being sold, propagated, distributed or included in commercial displays.

*Why is it a problem?*

Evergreen buckthorn can quickly take over stream and forest margins, forming thick stands and suppressing native plant regeneration. It is long-lived and produces many berries, which are bird-dispersed. Currently there are only a few localised infestations in the Waikato, which need to be destroyed to keep it from spreading.

### **3. Management steps for forest restoration**

#### **3.1 Selecting a working location and plants for planting**

When undertaking urban forest restoration, especially from scratch (also known as forest reconstruction), it is important to restore the area in manageable sections. Therefore, first select a specific area of the gully to focus on.

Assess the area for what stage of forest succession it is in (early, middle, late succession), as successful restoration should mimic natural forest succession (sometimes assisting to accelerate it). If there is no forest canopy present, select early successional species for planting (Appendix 1). Where there is at least 50% canopy cover or more (comprised of either native or non-native tree species) you may plant mid-successional species (Appendix 2) and 75% canopy cover or more you may plant late successional species that require the most shelter from the elements (Appendix 3).

When establishing early successional species amongst weeds we recommend planting 1 metre tall plants at a density of 1 plant per m<sup>2</sup>. Tall plants present in this high density are often required in urban settings especially, in order to outcompete heavy weed competition and reduce need for herbicide use around plantings. Be aware this results in a high number of plants for planting so be sure to select a small area when first trialling this approach (200 m<sup>2</sup> works well, which equals 200 plants). When establishing middle or late successional species they must still be at least 1 metre tall at planting to compete with weeds, but can be spaced 1 plant per 2-3 m<sup>2</sup>.

Next determine what landform type you are working within (Figure 2). The landform type will determine what plant types to select for your planting and will be one of the following:

- plateau/crest (also known sometimes as ‘ridge’)
- hillslope
- footslope (also known sometimes as ‘toeslope’)
- wetland (also known sometimes as ‘backswamp’, ‘terrace’ or ‘basin’)

Appendices 1-3 indicate what species you can include in plantings based on landform.

### **3.2 Sourcing your plants**

Given that setting up a nursery was part of the Kukutaaruhe Education Trust plan for the area, we advise beginning with this step as intended, as it will take at least 2 years from the time of seed collection for the plants to be tall enough for planting in the gully. This is also an excellent opportunity for social engagement, as the Fairfield Project can run workshops on collecting and propagating native plants from seed. We recommend advertising such workshops to properties neighbouring Kukutaaruhe Gully and Donny Park in order to encourage the cultivation and planting of native species in adjacent private properties.

To maintain genetic diversity, seeds be collected from native bush in the Hamilton Ecological District (Figure 178), with permission of the landowner or controlling authority. Seed should be collected from many individuals to ensure genetic diversity. These plants are well-adapted to the climate and soils of their region of origin, where they will grow better and produce more flowers and seeds. If a wider collection area is needed to ensure collection of seed from enough individuals than this takes priority to staying within the ecological district. Avoid using hybrids, cultivars or variegated plants, such as red flax, red cabbage tree and garden variety *Hebes*.

Seeds and plants may also be available from Wayne Bennett’s nursery *Forest Flora* (<http://www.forestflora.co.nz>) or Peter Morris’s nursery (ph 829 5763). See the Gully Restoration Guide ([http://www.gullyguide.co.nz/files/Gully\\_Guide\\_Mar07.pdf](http://www.gullyguide.co.nz/files/Gully_Guide_Mar07.pdf)) for more information on seed collection and propagation.

If plants are to be purchased from a nursery, it may be worthwhile entering into a contract with an eco-sourced native plant nursery to supply all plants for the duration of the restoration project, as this could reduce the unit cost per plant.

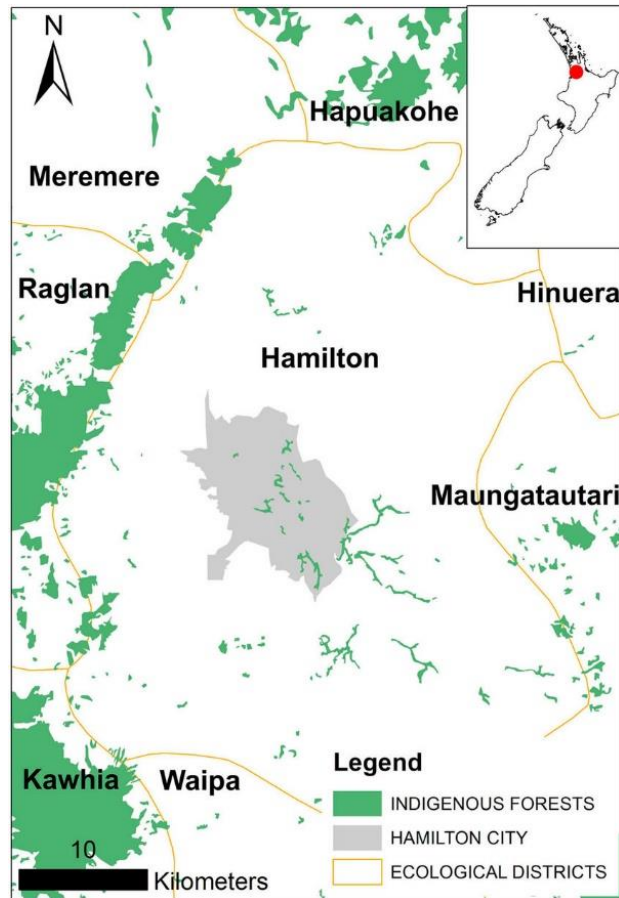


Figure 17. Boundaries of the Hamilton Ecological District. Map borrowed with permission from Wallace and Clarkson, 2019.

Whether growing one's own plants from seed or purchasing from a nursery, it is important to get the process started at least 2 years before actual planting is to commence.

### 3.3 Weed and pest control

With steep slopes currently covered in a number of weed species, Kukutaaruhe Gully poses a significant restoration challenge. Weeds compete with native plants for light, space, moisture and nutrients and weed removal is a top priority before planting can commence. Uncontrolled weeds will:

- establish rapidly, competing with native plantings for resources (e.g., blackberry and woolly nightshade)
- smother and kill growing plants (e.g., Japanese honeysuckle and jasmine)

- prevent regeneration (e.g., shade-tolerant species such as *Tradescantia*, wild ginger and ivy)

Options for weed control include hand weeding, shading, ring barking, mechanical weeding, biocontrol and the use of herbicides. Use of herbicides should be minimized, but may be necessary for larger infestations. Care must be taken as spraying can easily kill native plants. Cutting and stump poisoning allows for more precise weed removal and decreases the amount of damage to non-target plants. It is vital to discuss the options with local council to clarify if resource consents or professionals are required for any activities. If using herbicides, all instructions should be read carefully.

We recommend using Waikato Regional Council's 'Controlling weeds in riparian margins' guide ([www.waikatoregion.govt.nz/assets/WRC/Services/plant-and-animal-pests/weeds-and-riparian-margins.pdf](http://www.waikatoregion.govt.nz/assets/WRC/Services/plant-and-animal-pests/weeds-and-riparian-margins.pdf)) and the Weedbusters website ([www.weedbusters.org.nz](http://www.weedbusters.org.nz)) for information on control options for specific weed species present in Kukutaaruhe Gully. Alternatively, contact your local plant pest contractor (ph: 0800 246 732).

Start with a small, manageable patch – it is better to do a small area well than tackle a large area and lose plantings to weeds. It is important not to leave areas of soil bare for more than a week, but to quickly replant with native vegetation to keep weeds from reinvading the site, reduce erosion, and minimize soil carbon loss. Mulching with untreated sawdust or bark chips can suppress weeds until the area is ready for planting. Much of Kukutaaruhe Gully is characterised by steep banks. To minimise the risk of erosion, only clear small areas of weeds at a time, leaving the roots of dead weeds (that do not regrow from roots or rhizomes) to stabilise the soil. When ready to plant, remove all existing exotic vegetation from the patch by skimming off surface vegetation with a spade or grubber. Grasses can quickly choke out native plantings.

While non-native weeds need concerted initial effort to control, they will need to be constantly managed at a low level, especially in the first one to three years after planting. It is best to control weeds in late winter or early spring, before they grow too large. It is important not to undertake more planting than you can maintain free of weeds. For slower growing native planted species, weeding may be needed for up to three years. You will also need to replace dead plants to maintain a densely planted native area to protect against weed invasions. You may need to consider replacing with different species if most plants of a given species die. Large areas of the Kukutaaruhe Gully floor are covered in *Tradescantia*, and large areas on the

slopes are covered in Japanese honeysuckle – when planting is done adjacent to these areas, releasing native plants from these weeds will need to be done every month during the growing season. Physical weeding using hands will work best but spray guards can be installed around each plant to allow for herbicide application. If herbicide is to be used however, it's best to use before plantings are put in.

Exotic nurse plants can be left if they will not continue to spread and do not suppress planted natives. Gorse, for example, will be shaded out over approximately 10-20 years in damp environments, and in the meantime can provide shade and shelter to native species.

The best strategy to deal with the weeds in Kukutaaruhe Gully is that already being implemented by the Fairfield Project – i.e., clearing small areas completely and planting densely with hardy native species. We now recommend continued intensive management of these sites to ensure weeds do not reinvade and choke out the native plantings. Starting from the northern end of the gully is also a good approach, as it will extend the Donny Park native vegetation corridor that links up with the Waikato River. The restoration work can continue to move south along the gully as resources allow.

We recommend contacting owners of the properties adjacent to Kukutaaruhe Gully to stop the dumping of weeds into the gully. Since most weeds come from seed sources in gardens, the Fairfield Project could provide information and volunteer assistance to help remove high priority weeds and encourage the planting of native species on neighbouring properties.

Control of introduced mammals is another vital step, requiring its own operational management plan (see recommendations in the Overview of the Kukutaaruhe Gully Restoration Initiative). These animal pests include possums, rats, rabbits, cats, stoats, mice, wasps and introduced fish. Introduced pests eat leaves, fruits and seeds of native plants, compete with native animals for food and shelter, and prey on native species.

### **3.4 Planting**

For dry sites in the Waikato, e.g., the gully plateau/crest and hillslope, it is best to plant in late autumn to avoid droughts and minimise the amount of watering you have to do. Plants may need to be watered throughout the summer in their first year as they establish. Planting on gully

floors is best done in spring and autumn, as they tend to be wet and cold (i.e., frost-prone) in the winter.

When no canopy is present and the ground is exposed to the open sky plants can easily dry out. Mulching with newspaper, wet straw, bark or untreated sawdust will help plants survive on dry, open sites by trapping moisture, and will further suppress weeds. Either water plants thoroughly before mulching or wait to mulch until after a good rainfall. Clear the area of weeds and lay the mulch at least 10 cm deep, but keep it away from the stem or the stem may rot. Use organic material, as it breaks down and supplies nutrients to the soil, but do not use walnut, pine or eucalyptus as these may have allelopathic chemicals within them that inhibit other plant species' growth. Do not mulch wet areas and stream edges. Mulching should no longer be needed once the plants have established themselves and formed a closed canopy.

When no canopy is present, initial plantings should be hardy, fast-growing, early-successional species that can tolerate exposed conditions. A list of the early-successional species we recommend planting in specific gully habitats is provided in Appendix 1. Most weeds demand light and planting densely will allow native plants to establish a good canopy cover as quickly as possible, thereby shading out many weed species. These early successional species are short lived and will die back after ~20-30 years, they should only be thought of as a stepping stone in forest establishment. Mid and late successional species will therefore need to be already established by the 10-20 year mark, or else canopy collapse can occur and weeds will re-invade. Planting must be done with a long-term vision in place. Larger tree species used in enrichment plantings (addition of late successional species under a canopy) will need more room and should therefore be planted approximately 3 m apart (Table 1). A list of mid and late successional species we recommend planting can be found in Appendix 2 and 3, respectively. You can prepare for the enrichment planting stage by growing required species in the nursery 2-3 years before they need to be planted.

Planting in groups or clumps of the same species allows young trees to shelter one another from wind, frost and drought and helps with pollination and mycorrhizal associations (symbiotic soil fungus). Some species need both male and female plants to allow for natural regeneration. As it is impossible to tell male and female seedlings apart, planting in groups of four or five will increase the chances of having both sexes present.

Table 1. Suggestions for spacing of plants based on size. Data from Davis and Meurk, 2001. Urban plantings should usually be done on the denser end of the spectrum due to heightened non-native weed competition and harsher urban heat island conditions.

<b>Plant type</b>	<b>Suggested spacing</b>	<b>No. plants/ha</b>
Large canopy and podocarp trees	3-10 m	100-1000
Small trees	1-2 m	2,500-10,000
Shrubs and large tussocks	1 m	2,500-10,000
Ground cover plants and small tussocks (ferns, rushes, sedges)	0.5 m	40,000

### Planting method

- Soak plants in a bucket of water before planting, leaving them to drain out of direct sunlight
- Dig holes approximately twice the size of the plant's root ball
- The hole should be deep enough so the collar (base of the stem where the root starts) is about 1 cm below ground level, except on wet or saturated sites where it should be 1-2 cm above ground level (Figure 19)
- Score the sides and loosen the soil in the bottom of the hole to a depth of approximately half a metre to allow the new plant's roots to penetrate the soil
- Remove the plant from its container carefully, keeping as much soil around the roots as possible
- If the plant is root bound, gently untangle the roots. Root bound plants will grow more slowly and take longer to become well established. Do not do this, however, with young *maanuka*, as they have sensitive roots
- In dry areas, use the heel of your boot to press the soil down firmly around your planting, leaving a slight depression immediately around the plant stem to catch any rain or water run-off. In sites that are usually waterlogged in winter, dig a small mound and plant on top of it to encourage drainage as plants are prone to drowning in such conditions.
- In dry areas, water thoroughly
- In dry, open areas, surround with mulch to suppress weeds and keep soil moist

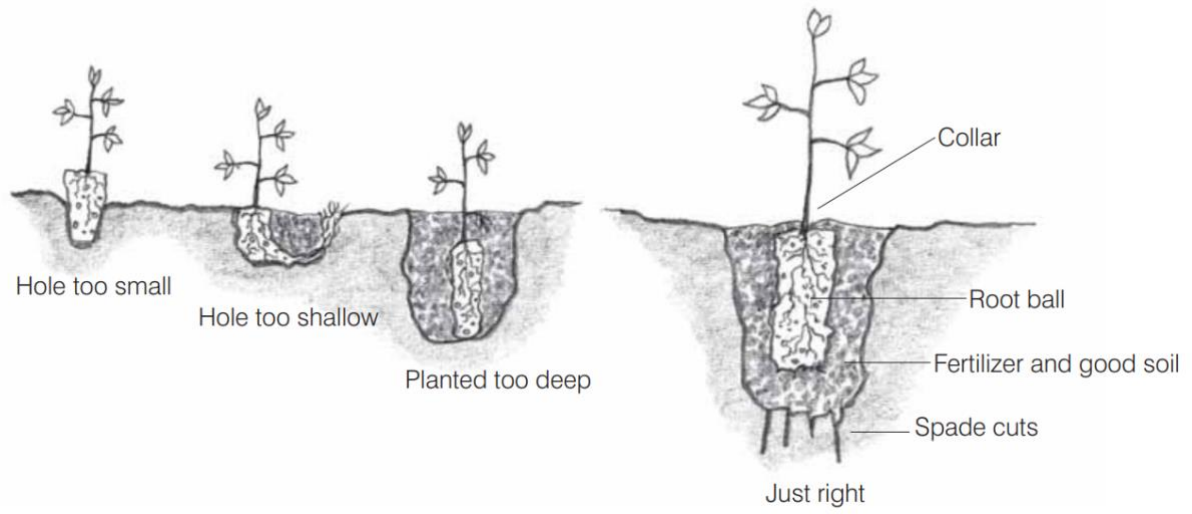


Figure 18. Ideal planting depth. Image from Davis and Meurk, 2001.

### 3.5 Monitoring and record keeping

Monitoring your restoration project will allow you to measure the success of your restoration work, learn from mistakes, identify the requirements of different species and measure the effectiveness of management techniques. Every restoration site is different you need to get to know yours by monitoring whether your work is having the effect you want. It is important to keep clearly written and organised electronic records of all your work, as key people may leave over the course of the project. We recommend storing all records in a centrally-accessible cloud like a Google Team Drive, which is always “owned” by members of it, and therefore never lost to the group even when there is some member turn over. Proper record keeping is another way to ensure your project is successful for the long-term.

Be sure to document and store the following:

- Records of plant species lists, numbers of plants planted, their sources and costs
- Locations of plantings, successional stage of those plants and years planted
- Lists of contacts for volunteers and suppliers of material
- Monitoring assessments (methods used, results, management actions decided)
- Reasons for plant death or poor establishment
- Weed management methods and regimens (dates weed control occurred)

For a simple, qualitative measure of change, take photographs from fixed points throughout the duration of your project and record the date on them. These can be useful for presentations and publications demonstrating the success of your work when applying for funding.

For a more powerful approach to monitoring, use a quantitative method for monitoring success, set up permanent vegetation plots to measure changes in, for example, plant species presence, density, native seedling regeneration and survival, leaf litter depth, canopy closure and soil properties. These plots could be used as an educational tool for Fairfield College students, and for monitoring they conduct on a yearly basis. The students can get practice basic statistics (means, densities, change in population size) in their analysis of the plants in the plots. To be comparable to other long-term forest studies currently underway in New Zealand cities, follow methods developed by the People, Cities & Nature Plantings team ([www.peoplecitiesnature.co.nz/research/plantings](http://www.peoplecitiesnature.co.nz/research/plantings)), which are based on the National Vegetation Survey (<https://nvs.landcareresearch.co.nz>) methods developed by Manaaki Whenua Landcare Research. Monitoring should commence immediately prior to planting and

then again immediately afterward in order to set a benchmark point, then completed every three years to record changes from unmanaged, weed-covered plots into native forest. Monitoring and subsequent analysis of monitoring data should be used in adaptive management, as it will reveal some management approaches that are not working. Another helpful, free resource for assessing restoration progress is the Society for Ecological Restoration's Recovery Wheel, a simple way to determine progress in all aspects of a restoration initiative (<http://seraustoralasia.com/wheel/index.html>).

### **3.6 Enrichment planting**

After approximately five-10 years since initial planting, the early successional species will likely provide suitable canopy cover (at least 50% cover required) for enrichment planting of native species that require more sheltered conditions (Appendix 2 – Mid-successional species). Early successional plant canopies can be pruned or thinned slightly to create light gaps for the later successional species. Leave pruned material on the forest floor to reduce erosion, provide important woody debris for plant seedling establishment havens, and habitat for decomposer communities. Enrichment planting can be done from autumn to spring, as the early successional species should protect the new plants from frost.

The area of older native plantings along the north-western ridge is ready for enrichment plantings of mid-successional species at the time of our survey in 2019 (map, Appendix 2).

Once you have achieved 75% or more canopy cover, you can plant ground covers, ferns and shade-tolerant, frost-sensitive species, such as tawa and other species listed in the Appendix. Epiphytes and lianes may colonize naturally once forest conditions become suitable, or if there is no natural colonisation through seed dispersal, they can be introduced once trees are large enough to host them. Ferns are likely to colonize naturally, or they can be introduced by bringing in spores. Collect fronds with fresh spores and lay them down so that the spores touch the ground. Where possible, leave dead trees to decompose naturally in the gully, as this will provide habitat for native fauna.

## **4. Summary**

The urban forest restoration recommendations provided in this management plan are based on ecological research conducted in Hamilton and other cities throughout New Zealand. We hope that by following these guidelines your team will be successful in establishing native forest that will benefit both people and Aotearoa's native biodiversity for hundreds of years to come.

## Appendix 1. Early successional forest plant species listed by their preferred landform type.

Plant at 1 metre tall and one every 1 m<sup>2</sup>. To be planted when no canopy is present. Plant classification and information sources borrowed from the Waiwhakareke planting tool and Gully Restoration Guide (both created by the Environmental Research Institute), and the Indigenous vegetation types of the Hamilton Ecological District (Clarkson 2007).

### A. Plateau: Early Successional

Scientific name	Common name	Life form	Abundance*	Bird food**	Notes
<i>Agathis australis</i>	kauri	tree	+		
<i>Alectryon excelsus</i>	titoki	tree	+	FS	frost sensitive, requires shelter
<i>Aristolelia serrata</i>	wineberry/makomako	tree		FSN	plant several individuals in clumps to ensure fruiting, frost sensitive
<i>Carmichaelia australis</i>	New Zealand broom	shrub			
<i>Coprosma arborea</i>	mamangi	tree	+		
<i>Coprosma lucida</i>	shining karamu	shrub	+++	FS	plant several individuals in clumps
<i>Coprosma rhamnoides</i>	twiggy coprosma	shrub	+		
<i>Coprosma rigida</i>	-	shrub			
<i>Coprosma robusta</i>	karamu	shrub	+++	FS	plant several individuals in clumps to ensure fruiting
<i>Cordyline banksii</i>	ti ngahere	monocot tree	+	FS	
<i>Coriaria arborea</i>	tutu	shrub			poisonous
<i>Dicksonia squarrosa</i>	wheki	tree fern			
<i>Geniostoma rupestre</i> var. <i>ligustrifolium</i>	hangehange	tree	++		
<i>Hoheria sexstylosa</i>	long leaved lacebark	tree	++		
<i>Knightia excelsa</i>	rewarewa	tree	+	N	
<i>Kunzea robusta</i>	kanuka	tree	+++		
<i>Leptecophylla juniperina</i> subsp. <i>juniperina</i>	prickly mingimingi	shrub			
<i>Leptospermum scoparium</i> (dry variety)	manuka	tree	+++		
<i>Leucopogon fasciculatus</i>	mingimingi	shrub			
<i>Libocedrus plumosa</i>	kawaka	tree			may be difficult to obtain
<i>Melicytus ramiflorus</i>	mahoe	tree	+++	FS	plant several individuals in clumps to ensure fruiting, frost sensitive
<i>Myrsine australis</i>	mapou	tree	++	FS	
<i>Phyllocladus trichomanoides</i>	tanekaha	tree			
<i>Pittosporum eugenioides</i>	lemonwood	tree		FSN	may be difficult to find eco sourced seed, plant several individuals in clumps to ensure fruiting, needs canopy gap
<i>Pittosporum tenuifolium</i>	kohuhu	tree		FSN	may be difficult to find eco sourced seed
<i>Podocarpus laetus</i>	Hall's totara	tree	+	F	
<i>Podocarpus totara</i>	totara	tree	+	FS	
<i>Pseudopanax arboreus</i>	five-finger	tree	++	FS	plant several individuals in clumps to ensure fruiting
<i>Pseudopanax crassifolius</i>	lancewood	tree	+	FS	
<i>Veronica stricta</i>	koromiko	shrub	++		quick growing may only last ten years
*(+++ use plentifully, ++ use commonly, + use sparingly)					
**fruit (F), seeds (S), nectar (N)					

## B. Hillslope: Early Successional

Scientific name	Common name	Life form	Abundance*	Bird food**	Notes
Alectryon excelsus	titoki	tree	+	FS	frost sensitive, requires shelter
Aristolelia serrata	wineberry/makomako	tree		FSN	plant several individuals in clumps to ensure fruiting
Coprosma arborea	mamangi	tree			
Coprosma lucida	shining karamu	shrub	+++	FS	plant several individuals in clumps to ensure fruiting
Coprosma rigida	-	shrub			
Coprosma robusta	karamu	shrub	+++	FS	plant several individuals in clumps to ensure fruiting
Cordyline australis	cabbage tree	monocot tree	+	FS	
Dacrydium cupressinum	rimu	tree	+	FS	plant several individuals in clumps to ensure fruiting
Geniostoma rupestre var. ligustrifolium	hangehange	tree	++		frost sensitive
Hoheria sexstylosa	long leaved lacebark	tree	++		
Knightia excelsa	rewarewa	tree	+	N	
Kunzea robusta	kanuka	tree	+++		
Leptospermum scoparium (dry variety)	manuka	tree	+++		
Lophomyrtus bullata	ramarama	tree			
Melicytus ramiflorus subsp. ramiflorus	mahoe	tree	+++	FS	plant several individuals in clumps to ensure fruiting, frost tender
Metrosideros robusta	northern rata	tree		N	
Myrsine australis	mapou	tree	++	FS	
Pittosporum eugenioides	lemonwood	tree		FSN	may be difficult to find eco sourced seed, plant several individuals in clumps to ensure fruiting, needs canopy gap
Pittosporum tenuifolium	kohuhu	tree		FSN	may be difficult to find eco sourced seed
Plagianthus regius	ribbonwood, manatu	tree			on lower parts of hillslope
Podocarpus totara	totara	tree	+	FS	
Pseudopanax arboreus	five-finger	tree	++	FS	plant several individuals in clumps to ensure fruiting
Pseudopanax crassifolius	lancewood	tree	+	FS	
Veronica stricta	koromiko	shrub	++		quick growing may only last ten years
*(+++ use plentifully, ++ use commonly, + use sparingly)					
**fruit (F), seeds (S), nectar (N)					

## C. Footslope: Early Successional

Scientific name	Common name	Life form	Abundance*	Bird food**	Notes
Aristotelia serrata	wineberry/makomako	tree		FSN	plant several individuals in clumps to ensure fruiting, frost sensitive
Carpodetus serratus	putaputaweta	tree		FSN	
Coprosma areolata	thin leaved coprosma	shrub			
Coprosma robusta	karamu	shrub	+++	FS	plant several individuals in clumps to ensure fruiting
Coprosma tenuicaulis	swamp coprosma	shrub			
Cordyline australis	cabbage tree	monocot tree	+	FSN	will tolerate peat soils
Dacrycarpus dacrydioides	kahikatea	tree		FS	
Dacrydium cupressinum	rimu	tree	+	FS	plant several individuals in clumps to ensure fruiting
Fuchsia excorticata	tree fuchsia	tree		FSN	plant several individuals in clumps to ensure fruiting, frost sensitive
Hoheria sexstylosa	long leaved lacebark	tree			
Leptospermum scoparium (wet variety)	manuka	tree			
Lophomyrtus bullata	ramarama	shrub			
Meliccytus ramiflorus subsp. ramiflorus	mahoe	tree	+++	FS	plant several individuals in clumps to ensure fruiting, frost tender
Myrsine australis	mapou	tree	++	FS	
Nestegis cunninghamii	black maire	tree			may be difficult to obtain
Pennantia corymbosa	kaikomako	tree		FN	
Phormium tenax	flax/harakeke	monocot herb	++	N	
Plagianthus regius	ribbonwood, manatu	tree			
Podocarpus totara	totara	tree	+	FS	
Prumnopitys taxifolia	matai	tree	+	F	
Pseudopanax crassifolius	lancewood	tree	+	FS	
Sophora microphylla	kowhai	tree	+	N	poisonous
*(+++ use plentifully, ++ use commonly, + use sparingly)					
**fruit (F), seeds (S), nectar (N)					

## D. Wetland: Early Successional

Scientific name	Common name	Life form	Abundance*	Bird food**	Notes
Baumea rubiginosa	baumea	sedge			
Carex geminata	cutty grass	sedge			
Carex lessoniana	cutty grass	sedge			
Carex maorica	Maaori sedge	sedge			
Carex secta	pukio	sedge			
Carex virgata	swamp sedge	sedge			
Coprosma propinqua	mingimingi	shrub			will tolerate peat soils
Coprosma rigida	-	shrub			
Coprosma rotundifolia	round-leaved coprosma	shrub			
Coprosma tenuicaulis	swamp coprosma	shrub		F	needs swampy, boggy ground
Cordyline australis	cabbage tree	monocot tree	+	FSN	will tolerate peat soils
Cyperus ustulatus	giant umbrella sedge	sedge			
Dicksonia squarrosa	wheki	tree fern			
Gahnia xanthocarpa	tupari-maunga	sedge			
Juncus edgariae	leafless rush	rush			
Leptospermum scoparium (wet variety)	manuka	tree			
Machaerina arthropophylla	-	sedge			
Machaerina sinclairii	-	sedge			
*(+++ use plentifully, ++ use commonly, + use sparingly)					
**fruit (F), seeds (S), nectar (N)					

## Appendix 2. Mid successional forest plant species listed by their preferred landform type.

Plant at 1 metre tall and one every 2 m<sup>2</sup>. To be planted only under 50% or greater canopy cover. Plant classification and information sources borrowed from the Waiwhakareke planting tool and Gully Restoration Guide (both created by the Environmental Research Institute), and the Indigenous vegetation types of the Hamilton Ecological District (Clarkson 2007).

### A. Plateau: Mid Successional

Scientific name	Common name	Life form	Abundance*	Bird food**	Notes
<i>Agathis australis</i>	kauri	tree			needs large canopy gap, frost sensitive
<i>Alectryon excelsus</i>	titoki	tree	+	FS	frost sensitive, requires shelter
<i>Alseuosmia macrophylla</i>	toropapa	shrub		FSN	may be difficult to obtain, frost sensitive
<i>Alseuosmia quercifolia</i>	toropapa	shrub			may be difficult to obtain, frost sensitive
<i>Brachyglottis repanda</i>	rangiōra	tree	+		needs canopy gap
<i>Coprosma arborea</i>	mamangi	tree	+		
<i>Coprosma grandifolia</i>	kanono	tree	+	FS	plant several individuals in clumps to ensure fruiting, frost sensitive
<i>Coprosma lucida</i>	shining karamu	shrub	+++	FS	plant several individuals in clumps to ensure fruiting, needs canopy gap
<i>Coprosma rigida</i>	-	shrub			needs canopy gap
<i>Coprosma robusta</i>	karamu	shrub	+++	FS	needs canopy gap, plant several individuals in clumps to ensure fruiting
<i>Coprosma spathulata</i>	-	shrub			frost sensitive
<i>Cordyline banksii</i>	ti-ngahere	monocot tree	+	FS	
<i>Cyathea dealbata</i>	silver fern	tree fern			frost sensitive
<i>Dacrydium cupressinum</i>	rimu	tree	+	FS	needs large canopy gap, plant several individuals in clumps to ensure fruiting
<i>Dicksonia fibrosa</i>	wheki ponga	tree fern			
<i>Dicksonia squarrosa</i>	wheki	tree fern			frost sensitive
<i>Gahnia pauciflora</i>	cutting sedge	sedge			frost sensitive
<i>Geniostoma ligustrifolium subsp. ligustrifolium</i>	hangehange	shrub	++		frost sensitive
<i>Hedycarya arborea</i>	pigeonwood/porokaiwhiri	tree	+	FS	plant several individuals in clumps to ensure fruiting, requires shelter, frost sensitive
<i>Knightia excelsa</i>	rewarewa	tree	+	N	needs canopy gap, frost sensitive
<i>Leptecophylla juniperina subsp. juniperina</i>	prickly mingimingi	shrub			
<i>Melicytus ramiflorus subsp. ramiflorus</i>	mahoe	tree	+++	FS	plant several individuals in clumps to ensure fruiting, frost sensitive
<i>Melicope ternata</i>	wharangi	tree			may be difficult to obtain, frost sensitive
<i>Myrsine australis</i>	mapou	tree	++	FS	
<i>Myrsine salicina</i>	toro	tree			frost sensitive
<i>Nestegis lanceolata</i>	white maire	tree			frost sensitive
<i>Olearia rani</i>	heketara	shrub			frost sensitive
<i>Phyllocladus trichomanoides</i>	tanekaha	tree			needs large canopy gap
<i>Piper excelsum</i>	kawakawa	shrub		FS	plant several individuals in clumps to ensure fruiting, frost sensitive
<i>Pittosporum eugenoides</i>	lemonwood	tree		FSN	may be difficult to find eco sourced seed, plant several individuals in clumps to ensure fruiting, needs canopy gap
<i>Podocarpus laetus</i>	Hall's totara	tree	+	F	needs canopy gap
<i>Pseudopanax arboreus</i>	five finger	tree	++	FS	plant several individuals in clumps to ensure fruiting
<i>Pseudopanax crassifolius</i>	lancewood	tree	+	FS	needs canopy gap
<i>Raukawa anomalus</i>	-	shrub			may be difficult to obtain
*(+++ use plentifully, ++ use commonly, + use sparingly)					
**fruit (F), seeds (S), nectar (N). Note many of these native plants will host insects which are also food for birds.					

## B. Hillslope: Mid Successional

Scientific name	Common name	Life form	Abundance*	Bird food**	Notes
<i>Alectryon excelsus</i>	titoki	tree	+	FS	frost sensitive, requires shelter
<i>Aleuosmia macrophylla</i>	toropapa	shrub		FSN	may be difficult to obtain
<i>Aleuosmia quercifolia</i>	toropapa	shrub			may be difficult to obtain
<i>Aristotelia serrata</i>	wineberry/makomako	tree	FSN	plant several individuals in clumps to ensure fruiting	needs canopy gap
<i>Brachyglottis repanda</i>	rangiora	tree	+		needs canopy gap
<i>Coprosma arborea</i>	mamangi	tree	+		
<i>Coprosma grandifolia</i>	kanono	shrub	+	FS	plant several individuals in clumps to ensure fruiting, frost sensitive
<i>Coprosma lucida</i>	shining karamu	shrub	+++	FS	plant several individuals in clumps to ensure fruiting, needs canopy gap
<i>Coprosma rigida</i>	-	shrub			needs canopy gap
<i>Coprosma robusta</i>	karamu	shrub	+++	FS	needs canopy gap, plant several individuals in clumps to ensure fruiting
<i>Coprosma spathulata</i>	-	shrub			
<i>Cordyline australis</i>	cabbage tree	monocot tree	+	FSN	will tolerate peat soils
<i>Cyathea dealbata</i>	silver fern	tree fern			
<i>Cyathea medullaris</i>	mamaku	tree fern			
<i>Dacrydium cupressinum</i>	rimu	tree	+	FS	needs large canopy gap, plant several individuals in clumps to ensure fruiting
<i>Dicksonia fibrosa</i>	wheki ponga	tree fern			
<i>Dicksonia squarrosa</i>	wheki	tree fern			
<i>Elaeocarpus dentatus</i>	hinau	tree	+	FS	may be difficult to obtain
<i>Fuchsia excorticata</i>	tree fuchsia	tree		FSN	plant several individuals in clumps to ensure fruiting, frost sensitive
<i>Hedycarya arborea</i>	pigeonwood	tree	+	FS	plant several individuals in clumps to ensure fruiting, requires shelter, frost sensitive
<i>Knightsia excelsa</i>	rewarewa	tree	+	N	needs canopy gap
<i>Leptospermum scoparium (dry variety)</i>	manuka	tree	+++		needs canopy gap
<i>Leucopogon fasciculatus</i>	mingimingi	shrub			needs canopy gap
<i>Litsea calicaris</i>	mangeao	tree	+	F	
<i>Lophomyrtus bullata</i>	ramarama	tree			
<i>Meliccytus ramiflorus subsp. ramiflorus</i>	mahoe	tree	+++	FS	plant several individuals in clumps to ensure fruiting, frost sensitive
<i>Metrosideros robusta</i>	northern rata	tree	+	N	
<i>Myrsine australis</i>	mapou	tree	++	FS	
<i>Myrsine salicina</i>	toro	tree			
<i>Nestegis lanceolata</i>	white maire	tree			
<i>Olearia rani</i>	heketara	shrub			
<i>Phyllocladus trichomanoides</i>	tanekaha	tree			needs large canopy gap
<i>Piper excelsum</i>	kawakawa	shrub		FS	plant several individuals in clumps to ensure fruiting, frost sensitive
<i>Pittosporum eugenioides</i>	lemonwood	tree		FSN	may be difficult to find eco sourced seed, plant several individuals in clumps to ensure fruiting, needs canopy gap
<i>Plagianthus regius</i>	ribbonwood, manatu	tree			on lower parts of hillslope
<i>Podocarpus totara</i>	totara	tree	+	F	needs canopy gap
<i>Prumnopitys ferruginea</i>	miro	tree	+	FS	
<i>Pseudopanax arboreus</i>	five finger	tree	++	FS	plant several individuals in clumps to ensure fruiting
<i>Pseudopanax crassifolius</i>	lancewood	tree	+	FS	needs canopy gap
<i>Raukava anomalous</i>	-	shrub			may be difficult to obtain
<i>Rhopalostylis sapida</i>	nikau	monocot tree	+	F	
<i>Schefflera digitata</i>	pate	shrub		FS	plant several individuals in clumps to ensure fruiting, frost sensitive
<i>Streblus heterophyllus</i>	turepo	tree			
<i>Weinmannia racemosa var. racemosa</i>	kamahi	tree			

\*(+++ use plentifully, ++ use commonly, + use sparingly)

\*\*fruit (F), seeds (S), nectar (N). Note many of these native plants will host insects which are also food for birds.

## C. Foothills: Mid Successional

Scientific name	Common name	Life form	Abundance*	Bird food**	Notes
<i>Alectryon excelsus</i>	titoki	tree	+	FS	frost sensitive, requires shelter
<i>Aristotelia serrata</i>	wineberry/makomako	tree		FSN	plant several individuals in clumps to ensure fruiting, needs canopy gap, frost sensitive
<i>Brachyglottis repanda</i>	rangiora	tree	+		needs canopy gap
<i>Carpodetus serratus</i>	putaputaweta	tree		FSN	needs canopy gap
<i>Coprosma areolata</i>	thin leaved coprosma	shrub			
<i>Coprosma grandifolia</i>	kanono	shrub	+	FS	plant several individuals in clumps to ensure fruiting, frost sensitive
<i>Coprosma robusta</i>	karamu	shrub	+++	FS	needs canopy gap, plant several individuals in clumps to ensure fruiting
<i>Coprosma tenuicaulis</i>	swamp coprosma	shrub			
<i>Cordyline australis</i>	cabbage tree	tree	+	FSN	will tolerate peat soils
<i>Cyathea dealbata</i>	silver fern	tree fern			frost sensitive
<i>Cyathea medullaris</i>	mamaku/black ponga	tree fern			
<i>Dacrydium cupressinum</i>	rimu	tree	+	FS	needs large canopy gap, plant several individuals in clumps to ensure fruiting
<i>Dicksonia fibrosa</i>	wheki ponga	tree fern			
<i>Dicksonia squarrosa</i>	wheki	tree fern			frost sensitive
<i>Fuchsia excorticata</i>	tree fuchsia	tree		FSN	plant several individuals in clumps to ensure fruiting, frost sensitive
<i>Hedycarya arborea</i>	pigeonwood	tree	+	FS	plant several individuals in clumps to ensure fruiting, requires shelter, frost sensitive
<i>Knightia excelsa</i>	rewarewa	tree	+	N	needs canopy gap, frost sensitive
<i>Laurelia novae-zelandiae</i>	pukatea	tree	+		frost sensitive
<i>Leucopogon fasciculatus</i>	mingimingi	shrub			needs canopy gap
<i>Lophomyrtus bullata</i>	ramarama	shrub			
<i>Melicope simplex</i>	poataniwha	shrub			frost sensitive
<i>Melicytus micranthus</i>	manakura	shrub			frost sensitive
<i>Melicytus ramiflorus subsp. ramiflorus</i>	mahoe	tree	+++	FS	plant several individuals in clumps to ensure fruiting, frost sensitive
<i>Myrsine australis</i>	mapou	tree	++	FS	
<i>Nestegis cunninghamii</i>	black maire	tree		F	may be difficult to obtain, frost sensitive
<i>Piper excelsum</i>	kawakawa	shrub		FS	plant several individuals in clumps to ensure fruiting, frost sensitive
<i>Plagianthus regius</i>	ribbonwood, manatu	tree			
<i>Prumnopitys taxifolia</i>	matai	tree	+	F	
<i>Pseudopanax crassifolius</i>	lancewood	tree	+	FS	needs canopy gap
<i>Rhopalostylis sapida</i>	nikau	monocot tree	+	F	frost sensitive
<i>Schefflera digitata</i>	pate	shrub		FS	plant several individuals in clumps to ensure fruiting, frost sensitive
<i>Streblus heterophyllus</i>	turepo	tree			
<i>Syzygium maire</i>	swamp maire	tree		F	prefers permanently damp soil, frost sensitive, will tolerate peat soils
<i>Weinmannia racemosa var. racemosa</i>	kamahi	tree			frost sensitive

\*(+++ use plentifully, ++ use commonly, + use sparingly)

\*\*fruit (F), seeds (S), nectar (N). Note many of these native plants will host insects which are also food for birds.

## D. Wetland: Mid Successional

Scientific name	Common name	Life form	Abundance*	Bird food**	Notes
<i>Carex secta</i>	pukio	sedge			
<i>Coprosma propinqua</i>	mingimingi	shrub			
<i>Coprosma rigida</i>	-	shrub			needs canopy gap
<i>Coprosma rotundifolia</i>	round-leaved coprosma	shrub			
<i>Coprosma tenuicaulis</i>	swamp coprosma	shrub			
<i>Cordyline australis</i>	cabbage tree	monocot tree	+	FSN	will tolerate peat soils
<i>Cyathea medullaris</i>	mamaku/black ponga	tree fern			
<i>Dianella haemata</i>	swamp ink berry	herb			
<i>Dicksonia squarrosa</i>	wheki	tree fern			frost sensitive
<i>Gahnia xanthocarpa</i>	tupari-maunga	sedge			frost sensitive
			+		
<i>Hedycarya arborea</i>	pigeonwood/porokaiwhiri	tree		FS	plant several individuals in clumps to ensure fruiting, requires shelter, frost sensitive
<i>Leptospermum scoparium (wet variety)</i>	manuka	tree			needs canopy gap
<i>Pennantia corymbosa</i>	kaikomako	tree		FN	frost sensitive
<i>Syzygium maire</i>	swamp maire	tree		F	prefers permanently damp soil, frost sensitive, will tolerate peat soils
*(+++ use plentifully, ++ use commonly, + use sparingly)					
**fruit (F), seeds (S), nectar (N). Note many of these native plants will host insects which are also food for birds.					

## Appendix 3. Late successional forest plant species listed by their preferred landform type.

Plant at 1 metre tall and one every 3 m<sup>2</sup>. To be planted only under 75% or greater canopy cover. Plant classification and information sources borrowed from the Waiwhakareke planting tool and Gully Restoration Guide (both created by the Environmental Research Institute), and the Indigenous vegetation types of the Hamilton Ecological District (Clarkson 2007).

### A. Plateau: Late Successional

Scientific name	Common name	Life form	Abundance*	Bird food**	Notes
<i>Alectryon excelsus</i>	titoki	tree	+	FS	frost sensitive, requires shelter
<i>Alseuosmia quercifolia</i>	toropapa	shrub			may be difficult to obtain, frost sensitive
<i>Beilschmiedia tawa</i>	tawa	tree	+	FS	frost sensitive
<i>Brachyglottis repanda</i>	rangiara	tree	+		needs canopy gap
<i>Coprosma arborea</i>	mamangi	tree	+		frost sensitive
<i>Coprosma grandifolia</i>	kanono	shrub	+	FS	plant several individuals in clumps to ensure fruiting, frost sensitive
<i>Dacrydium cupressinum</i>	rimu	tree	+	FS	needs large canopy gap, plant several individuals in clumps to ensure fruiting
<i>Freycinetia banksii</i>	kiekie	liane			
<i>Geniostoma ligustrifolium</i> subsp. <i>ligustrifolium</i>	hangehange	shrub	++		frost sensitive
<i>Hedycarya arborea</i>	pigeonwood	tree	+	FS	plant several individuals in clumps to ensure fruiting, requires shelter, frost sensitive
<i>Melicope ternata</i>	wharangi	tree		FS	may be difficult to obtain, frost sensitive
<i>Myrsine salicina</i>	toro	tree			frost sensitive
<i>Olearia rani</i>	heketara	shrub			frost sensitive
<i>Piper excelsum</i>	kawakawa	shrub		FS	plant several individuals in clumps to ensure fruiting, frost sensitive
<i>Pittosporum eugenioides</i>	lemonwood	tree		FSN	may be difficult to find eco sourced seed, plant several individuals in clumps to ensure fruiting, needs canopy gap
<i>Rhabdothamnus solandri</i>	matata	shrub		N	frost sensitive
*(+++ use plentifully, ++ use commonly, + use sparingly)					
**fruit (F), seeds (S), nectar (N). Note many of these native plants will host insects which are also food for birds.					

## B. Hillslope: Late Successional

Scientific name	Common name	Life form	Abundance*	Bird food**	Notes
<i>Alectryon excelsus</i>	titoki	tree	+	FS	frost sensitive, requires shelter
<i>Alseuosmia macrophylla</i>	toropapa	shrub		FSN	may be difficult to obtain
<i>Alseuosmia quercifolia</i>	toropapa	shrub			may be difficult to obtain
<i>Austroblechnum lanceolatum</i>	lance fern/nini	fern			
<i>Beilschmiedia tawa</i>	tawa	tree	+	FS	frost sensitive
<i>Brachyglottis repanda</i>	rangiora	tree	+		needs canopy gap
<i>Coprosma arborea</i>	mamangi	tree	+		
<i>Coprosma grandifolia</i>	kanono	shrub	+	FS	plant several individuals in clumps to ensure fruiting, frost sensitive
<i>Coprosma spathulata</i>	-	shrub			
<i>Cyathea dealbata</i>	silver fern	tree fern			
<i>Cyathea medullaris</i>	mamaku	tree fern			
<i>Dianella nigra</i>	New Zealand blueberry	herb			
<i>Dicksonia fibrosa</i>	wheki ponga	tree fern			
<i>Dicksonia squarrosa</i>	wheki	tree fern			
<i>Doodia australis</i>	rasp fern	fern			already present in the gully, can collect leaves with spores from these plants
<i>Elaeocarpus dentatus</i>	hinau	tree	+	FS	may be difficult to obtain
<i>Freycinetia banksii</i>	kiekie	liane			
<i>Fuchsia excorticata</i>	tree fuchsia	tree		FSN	plant several individuals in clumps to ensure fruiting, frost sensitive
<i>Geniostoma ligustrifolium subsp. ligustrifolium</i>	hangehange	shrub	++		frost sensitive
<i>Hedycarya arborea</i>	pigeonwood	tree	+	FS	plant several individuals in clumps to ensure fruiting, requires shelter, frost sensitive
<i>Leucopogon fasciculatus</i>	mingimingi	shrub			
<i>Litsea calicaris</i>	mangeao	tree			
<i>Meliccytus ramiflorus subsp. ramiflorus</i>	mahoe	tree	+++	FS	plant several individuals in clumps to ensure fruiting, frost sensitive
<i>Metrosideros robusta</i>	northern rata	tree	+	N	
<i>Mida salicifolia</i>	willow-leaved maire	tree			may be difficult to obtain
<i>Myrsine salicina</i>	toro	tree			
<i>Neomyrtus pedunculata</i>	rohutu	tree			may be difficult to obtain
<i>Nestegis lanceolata</i>	white maire	tree			
<i>Olearia rani</i>	heketara	shrub			
<i>Piper excelsum</i>	kawakawa	shrub		FS	plant several individuals in clumps to ensure fruiting, frost sensitive
<i>Pittosporum eugenioides</i>	lemonwood	tree		FSN	may be difficult to find eco sourced seed, plant several individuals in clumps to ensure fruiting, needs canopy gap
<i>Polystichum neozelandicum subsp. zerophyllum</i>	shield fern	fern			often sold as <i>Polystichum richardii</i>
<i>Prunnopytys ferruginea</i>	miro	tree	+	FS	
<i>Pseudopanax arboreus</i>	five finger	tree	++	FS	plant several individuals in clumps to ensure fruiting
<i>Rhabdothermus solandri</i>	matata	shrub		N	frost sensitive
<i>Rhoplostylis sapida</i>	nikau	monocot tree	+	FS	
<i>Schefflera digitata</i>	pate	shrub		FS	plant several individuals in clumps to ensure fruiting, frost sensitive
<i>Weinmannia racemosa var. racemosa</i>	kamahi	tree			

\*(+++ use plentifully, ++ use commonly, + use sparingly)

\*\*fruit (F), seeds (S), nectar (N). Note many of these native plants will host insects which are also food for birds.

## C. Footslope: Late Successional

Scientific name	Common name	Life form	Abundance*	Bird food**	Notes
<i>Asplenium bulbiferum</i>	hen and chicken fern	fern			
<i>Astelia fragrans</i>	kakaha/bush lily	monocot herb			
<i>Austroblechnum lanceolatum</i>	lance fern/nini	fern			
<i>Beilschmiedia tawa</i>	tawa	tree	+	FS	frost sensitive
<i>Blechnum novae-zealandiae</i>	kiokio	fern			
<i>Brachyglottis repanda</i>	rangiora	tree	+		needs canopy gap
<i>Coprosma areolata</i>	thin leaved coprosma	shrub			
			+		plant several individuals in clumps to ensure fruiting, frost sensitive
<i>Coprosma grandifolia</i>	kanono	shrub		FS	
<i>Cordyline australis</i>	cabbage tree	monocot tree	+	FSN	will tolerate peat soils
<i>Cyathea dealbata</i>	silver fern	tree fern			frost sensitive
<i>Cyathea smithii</i>	kaponga	tree fern			frost sensitive
<i>Dicksonia squarrosa</i>	wheki	tree fern			frost sensitive
					already present in the Gully, can collect leaves with spores from these plants
<i>Doodia australis</i>	rasp fern	fern			
<i>Freycinetia banksii</i>	kieke	liane			
					plant several individuals in clumps to ensure fruiting, frost sensitive
<i>Fuchsia excorticata</i>	tree fuchsia	tree		FSN	
<i>Geniostoma ligustrifolium</i> subsp. <i>ligustrifolium</i>	hangehange	shrub	++		frost sensitive
			+		plant several individuals in clumps to ensure fruiting, requires shelter, frost sensitive
<i>Hedycarya arborea</i>	pigeonwood	tree		FS	
<i>Laurelia novae-zealandiae</i>	pukatea	tree	+		frost sensitive
<i>Leucopogon fasciculatus</i>	mingimingi	shrub			
<i>Melicope simplex</i>	poataniwha	shrub			frost sensitive
<i>Melicytus micranthus</i>	manakura	shrub			frost sensitive
			+++		plant several individuals in clumps to ensure fruiting, frost sensitive
<i>Melicytus ramiflorus</i> subsp. <i>ramiflorus</i>	mahoe	tree		FS	
<i>Mida salicifolia</i>	willow-leaved maire	shrub			may be difficult to obtain, frost sensitive
<i>Nestegis cunninghamii</i>	black maire	tree			may be difficult to obtain, frost sensitive
					plant several individuals in clumps to ensure fruiting, frost sensitive
<i>Piper excelsum</i>	kawakawa	shrub		FS	
<i>Polystichum neozelandicum</i> subsp. <i>zerophyllum</i>	shield fern	fern			often sold as <i>Polystichum richardii</i>
<i>Rhopalostylis sapida</i>	nikau	monocot tree	+	FS	
					plant several individuals in clumps to ensure fruiting, frost sensitive
<i>Schefflera digitata</i>	pate	shrub		FS	
					prefers permanently damp soil, will tolerate peat soils, frost sensitive
<i>Syzygium maire</i>	swamp maire	tree		F	
<i>Weinmannia racemosa</i> var. <i>racemosa</i>	kamahi	tree			frost sensitive
*(+++ use plentifully, ++ use commonly, + use sparingly)					
**fruit (F), seeds (S), nectar (N). Note many of these native plants will host insects which are also food for birds.					

## D. Wetland: Late Successional

Scientific name	Common name	Life form	Abundance*	Bird food**	Notes
<i>Blechnum novae-zealandiae</i>	kiokio	fern			
<i>Coprosma rotundifolia</i>	round-leaved coprosma	shrub			
<i>Cordyline australis</i>	cabbage tree	monocot tree	+	FSN	will tolerate peat soils
<i>Dicksonia squarrosa</i>	wheki	tree fern			frost sensitive
<i>Freycinetia banksii</i>	kiekie	liane			
			+		plant several individuals in clumps to ensure fruiting, requires shelter, frost sensitive
<i>Hedycarya arborea</i>	pigeonwood	tree		FS	frost sensitive
<i>Laurelia novae-zelandiae</i>	pukatea	tree	+		frost sensitive
<i>Pennantia corymbosa</i>	kaikomako	tree		FN	frost sensitive
					prefers permanently damp soil, will tolerate peat soils, frost sensitive
<i>Syzygium maire</i>	swamp maire	tree		F	
*(+++ use plentifully, ++ use commonly, + use sparingly)					
**fruit (F), seeds (S), nectar (N). Note many of these native plants will host insects which are also food for birds.					