Some revegetation options for Lake Horowhenua, Levin

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Abstract

Three forest remnants near the shores of Lake Horowhenua were inspected to provide information for Wellington Conservancy and local people who are interested in restoring native vegetation of the lake edge. The remnants visited contained a diverse range of species and will provide excellent foci and seed sources for the proposed restoration. Several regionally rare species were noted in our brief survey, and it is suggested that more detailed survey of the area before restoration commences would be desirable in order to make full use of the botanical assets which exist there.

The steps to follow for effective restoration are outlined in sections 4 and 5 of this report, and the summary provides a handy checklist to ensure that all steps have been followed. The early successional native tree species which will be most successful for this restoration project are named, and any ecological variation which could be important is also described.

Restoration of the lake edge vegetation of Lake Horowhenua can be achieved, but is a long-term project which future generations will gain more benefit from than the current generation which has the foresight to get the restoration underway.

1. Introduction

The owners of Lake Horowhenua and much of its surrounding land wish to restore native vegetation on some parts of the property currently in pasture. Department of Conservation staff have had discussions with the owners over this proposal, and we were part of a group at an on-site meeting and inspection in May 1993. We reported independently to the Wellington Conservancy office on aspects of a proposed revegetation programme. Many aspects of what we have proposed for revegetation at Lake Horowhenua are applicable to similar projects in other places. For this reason, we have combined our separate contributions into a report for a wider readership.

2. Field inspection of Lake Horowhenua for revegetation options

On 12 May 1993, in company with representatives of the Lake Horowhenua owners and staff of Wellington Conservancy of the Department of Conservation, we inspected three forested sites near the shores of Lake Horowhenua,

Levin. These were Arawhata Bush, Hokio Bush, and Te Kowhai Bush. Although limited time precluded a detailed survey, at each site we listed vascular plant species, and made notes on the general condition of each bush patch. These remnants became the basis for our advice on restoring the remainder of the lake edge vegetation. We also identified the botanical importance of each bush remnant, and the management action required to protect or enhance each remnant. Our advice also builds from our experience with vegetation restoration in other parts of New Zealand.

3. Vegetation history of Lake Horowhenua

3.1 EARLY HISTORY

Before human presence, dry land around Lake Horowhenua was forested. However, the lake margins and other swampy ground would have had thickets of swamp shrubs, with flax, raupo and other reeds on progressively wetter sites. The forest composition would have differed from site to site, according to factors such as soil moisture and fertility, and exposure to sun and wind. Later, human disturbance had a profound effect on the distribution and types of forest. A model can be made of the previous natural vegetation cover by examining the remnants of forest, scrub and swamp near the lake and in the greater surrounding district. Historic records are also helpful, such as the summary made by Frances Duguid in her 1990 paper "Botany of the Northern Horowhenua lowlands".

A significant point made by Duguid (loc. cit.) is that "there used to be a conspicuous stand of semi-swamp forest at the northern end of the lake. In about 1931 the lake was artificially lowered, killing most of the trees. The shallow lake embayment in the vicinity has become a flax swamp with toetoe and many associated species."

3.2 RECENT SURVEYS

At least some of the area mentioned by Duguid was recommended for protection by Don Ravine, in the Department of Conservation's 1992 Protected Natural Areas programme report on the Foxton Ecological District. The area was called "Whitiki Bush and Swamp" (Recommended Area for Protection No. 15 [=RAP 15]) and was considered very important because it is the largest area of swamp forest in the Ecological District. The adjoining swamp was also recognised as having an unusually large number of native plant species. This part of the lake margin was not visited during our inspection on 12 May 1993.

One other area of forest and swamp beside the lake was recommended for protection by Don Ravine (loc. cit.), who identified it as "Lake Horowhenua

West Bush" (RAP 14). We visited this same area in May 1993, and some notes on it are given in Section 5.2, under "Hokio Bush".

Although only brief, our inspection revealed species hitherto unknown or not recently seen in the area. For example, Duguid (1990) noted that a native grass, swamp millet (*Isachne globosa*), had not been seen by her at the lake, and was last recorded there by Neville Moar in 1949. It was not recorded by Ravine (1992), but in May 1993 we saw that it is a common and conspicuous part of swamp vegetation adjoining Hokio Bush.

3.3 FUTURE SURVEYS

Our finding of a regionally rare plant on only a brief visit shows that it is important to do more botanical survey at an early stage in the programme to restore native vegetation at Lake Horowhenua. This should:

(a) give better knowledge of the species available for restoration work;

(b) identify areas with rare or threatened species (locally or even nationally) which might need special protection before and during the restoration project.

4. The restoration project

4.1 OBJECTIVES

As a result of discussions with the land owners, we concluded that they wished to restore native vegetation around the lake in order to -

(a) establish more extensive areas of native vegetation which represent that which was there before the period of extensive European clearing for farming;

(b) provide wildlife habitat (not only for birds, but also for smaller animals such as native insects; soil animal diversity will also improve under native vegetation);

(c) improve visual effects/restore 'natural' landscapes/screening of buildings and roads etc;

(d) have a greater range of species and native plant communities for educational and cultural uses;

(e) provide shelter from wind and sun;

(f) provide a buffer from noise;

(g) provide opportunities for those involved to learn tree care, especially propagation, planting and releasing of young plants;

(h) provide a more natural environment which would enhance the ecotourism potential of the lake and its surrounds;

(i) provide for easier long-term management of the land.

4.2 WHICH SPECIES?

Not all of the above outcomes can be achieved by a single revegetation programme. The choice of species will determine the eventual type of result and this choice depends upon which uses the owners/managers see as being predominant. The owners told us that they wish to restore native plant communities and species which remain now as only tiny fragments or which have gone from the area. Adherence to this principle would mean that exotic plants and species of native plants "foreign" to the Levin area (e.g., pohutukawa, karo, kauri) should not be planted. This would not rule out the possibility of using exotic plants as temporary shelter or nurseries for native species. Tree lucerne is a useful exotic tree for this purpose (see note below).

Other considerations in the choices of trees are practical ones: suitability for the site (hardiness to frost, wind, summer drought or winter water-logging of the soil), speed of growth, disease/pest resistance, potential maximum size, cost and availability.

The following planting suggestions are no more than some of the possibilities. The suggested species might be substituted by species which we have not named here, and a more detailed botanical survey of the lake surroundings would undoubtedly reveal other possibilities. Species named in this report are those which are (a) indigenous to the area, and (b) able to survive and grow in the first stages of revegetation. We are taking some guesses in this, because we visited the lake in autumn. Summer drought might be worse than we anticipate, or frost or water-logging could be severely limiting in winter. Local knowledge should be used to modify our planting suggestions.

4.3 LOCAL VARIATION WITHIN SPECIES

If an important aim of the project is to restore representative areas of Horowhenua vegetation, then not only must the "right species" be used, but also those plants must be from local genetic sources. Studies of many native species have shown variation within species from region to region.

Well-known examples include *Sophora microphylla*, the most widespread species of kowhai. It is a tree in most regions but a sprawling shrub on cliffs both sides of Cook Strait. Kowhai trees have more obviously weeping branches in some regions, and they are deciduous in some regions but not others. Young kowhai pass through a much-tangled shrub phase in only some regions, and these usually take many years to become a flowering tree. It is important to

note that these differences remain when kowhai seeds from different regions are grown side by side.

Manuka growing in wet places in Otago was shown to produce an aerating tissue under the bark, a feature not present in manuka on dry sites, and when seed from dryland manuka was grown in wet conditions it could not develop aerating tissue. Such genetically different variants of a species are termed ecotypes. Many other examples have been found among New Zealand's plants, and they include coastal ecotypes which are more tolerant of salt than inland plants of the same species. Inland plants may, however, be more frost-tolerant.

Locally-sourced plants will be adapted to local conditions, and are most likely to produce vegetation that most nearly resembles what was originally present in the area. If "outside" stock is introduced it may also interbreed with local stock (this has been termed "genetic pollution") and any distinctive features of the local stock may be lost.

There is no absolute rule about how far away the parent plants should be to be regarded as "local", though the same ecological district (ED) is sometimes used as a guide. The boundary between the Foxton ED (= sand country) and Manawatu Plains ED (= uplifted marine terrace country) is close to the eastern edge of Lake Horowhenua, so that the intended restoration plantings will be in both districts, and plants might be sourced, therefore, from both districts. On the other hand, both these EDs are very long and narrow, and we believe that it would be inappropriate to bring materials from the extreme northern (Patea) or southern (Paekakariki) ends of the EDs. We suggest that a practical limit be the Levin - Hokio area, without defining its limits too closely, but perhaps the land between the lower reaches of the Manawatu and Ohau rivers is a reasonable source area.

4.4 RIBBONWOOD AND LACEBARK

The species we recommend above all others for many of the moister sites near the lake is ribbonwood. The habitat seems ideal, and it is one of New Zealand's fastest growing native trees. It has been successfully used in revegetation projects elsewhere (e.g., Carter's Bush, near Carterton, Kitchener Park in Feilding, and a reserve at Hunterville (see 5.3.2). We did not see ribbonwood in the forest patches beside Lake Horowhenua, but there are several old trees on District Council land near the Lake Domain. Duguid (1990) states that ribbonwood was formerly common on the Horowhenua plains, but that little regeneration is now taking place. The trees we saw on council-administered land are likely to be natural relicts, and may be the closest source of ribbonwood seed for revegetation. Ribbonwood is the native tree with the most potential to give fast results on all damper sites near the lake, and in so doing will restore a forest component which has all but disappeared from the area.

Narrow-leaved lacebark is another species which has undergone a decline in the Horowhenua (Duguid [loc. cit.] says "now rare..... formerly widespread"). This lacebark grows into a larger tree than the common lacebark (houhere),

and is longer lived. It has an attractive divaricating juvenile form, growing as columnar bushes to about 3m tall, before developing a tall trunk and graceful weeping branchlets. It is almost as versatile and fastgrowing as ribbonwood. We have not seen the species close to Lake Horowhenua, but it occurs in the Koputaroa snail reserve and is probably still elsewhere. Local people, such as members of the Levin Native Flora Club, can probably advise on other locations from where plants might be propagated.

Combination plantings of ribbonwood and narrow-leaved lacebark are most striking visually and are effective forest pioneer species, if used extensively.

5. Planting

5.1 SITE PREPARATION

Provision of artificial watering and shelter could widen the range of species which might be established in the early stages. Fencing from stock is essential, but stock should be kept to control grass growth until shortly before areas are planted. To assist early establishment of trees it is necessary to 'knock-down' pasture grasses in the spots where plantings are to be done, and for the next year or two until plants are above grass level. This can be done mechanically (hard work and short-lived in effect) or chemically (generally easier, but initially more expensive; some herbicides are non-residual in the soil but will need several applications until trees can cope with the grass unaided).

5.2 PLANTING DENSITIES

Planting density depends very much on which species are chosen, but generally a faster result can be obtained by planting more densely. Trees provide mutual shelter when grown close together, and can be thinned out after several years, if desired. Obviously, more plants are needed for denser plantings.

Larger trees, such as those named in 5.3.1(b), can be planted 1-3m apart, but wider spacings should be in filled with lower growing shrubs.

5.3 SHELTERBELTS

5.3.1 Mixed species shelterbelts

Although it is possible to establish a shelterbelt as a single row of trees (as is often done with pines, eucalypts or macrocarpa), a more natural visual effect is achieved by growing several parallel but staggered rows of plants. Also, if different species are used which have different maximum heights, this will avoid a common fault of shelterbelts to be draughty. On an exposed western boundary, such a shelterbelt might be as follows -

(a) outer (western) edge: flax (harakeke) and/or toetoe (*Cortaderia toetoe*) [*Cortaderia fulvida* is also native to the district, but is smaller in stature than *C. toetoe* and grows in drier sites; the exotic pampas grasses (*C. selloana* or *C. jubata*) should not be used as they are likely to become serious weeds];

(b) inner tall trees: totara, kowhai, kanuka, ribbonwood, narrow-leaved lacebark, broadleaf, tree lucerne;

(c) intermixed smaller trees: lemonwood (tarata), taupata, karamu.

A harakeke (flax) shelterbelt is easily established by dividing large harakeke plants into their component fan-shaped tillers, then cutting off the top half to two thirds of the leaves. Plant tillers no more than 1m apart.

Apart from tree lucerne, the species named above are native to the Levin area.

5.3.2 Tree lucerne

Tree lucerne (or tagasaste) is a useful 'nursery' tree which is cheap and grows very quickly. It could be planted exclusively in the place of all those named 5.3.1 (a) and (b) above, at spacings of no more than 2m. After, say, 4-5 years, every second tree would be removed or ring-barked and then replaced with other species. Tree lucerne has been used very successfully in this way in the plantings at Hunterville, in a reserve which borders what was once the town rubbish dump. Tree lucerne is a legume and therefore supplies nitrogen to the soil. One weakness of tree lucerne is that it is highly palatable to browsing animals - rabbits or hares would be a problem, if they are present. Other exotic trees might be considered for shelterbelts, but they usually create problems of how and when to remove them later, without impacts on established native plantings.

5.4 EXISTING FOREST PATCHES

Every existing forest remnant or grove of native trees, or even patches of scrub such as manuka or gorse, is a potential nucleus for an expanded area of trees.

There are many possible ways to plant the area, depending on the resources. Grazing is the easiest way to maintain unplanted areas for future planting but good fencing will be needed to separate planted areas from those which are grazed. Where there is an existing grove of trees or shrubs on a grazed site then:

(a) fence the area

(b) start planting between and around existing trees. Shadier areas should be used for trees which need such conditions, such as karaka, titoki, mahoe, matai, lacebark (houhere). At or beyond the limit of the crowns of the canopy trees is the place for planting trees which need more

light, e.g., kanuka, ngaio, lemonwood, kowhai, totara, akeake and ribbonwood. All these trees are native to the Levin area; kanuka, in particular, is a characteristic feature of local landscapes.

(c) plant 'satellite' patch(es) of trees. Steeper slopes (terrace scarps and sides of old dunes) are suited to species which tolerate lower fertility and seasonal droughts (e.g., kanuka, akeake, ngaio, totara), while flat ground near the lake will have more fertile soils (especially near the toes of slopes) and wetter conditions. This would suit ribbonwood, narrow-leaved lacebark, lemonwood, shrub coprosmas (e.g., *Coprosma robusta*, *C. rigida*, *C. tenuicaulis*, *C. propinqua*), kahikatea, ti kouka, harakeke and toetoe.

As with shelterbelt plantings, it is better to concentrate a limited number of shrubs in small, well-managed patches rather than disperse them over a larger area. Again the spacing of plants depends upon the species, but 1-2 m is suggested.

(d) as an alternative to parts of (a) and (b) above, tree lucerne could be used to establish a quick tree cover (see 5.3.2).

Once established, planted trees and shrubs will shade out grasses and other pasture plants. They then provide habitat for their own natural spread and for the establishment of other species that arrive by wind or birds. At this stage, some of the district's rarer canopy trees, or species needing more shelter than the pioneer plants, could be planted. Unfortunately, some of the new arrivals may be potentially serious weeds such as old man's beard and blackberry; a watch should be kept for these.

5.5 SOURCES OF PLANTS

There are many commercial nurseries which can supply appropriate species, and some would probably offer discounts for bulk purchases. However, such nurseries are unlikely to have plants of local genetic origin in stock; they would need seed or other propagating materials to be collected locally, then a year or two in order to grow the plants for local use.

An alternative for at least some species is to propagate plants locally. Propagating advice might be obtained from the horticultural unit of the Manawatu Polytechnic which is based in Levin, and there is a Levin Native Flora Club. It may be possible to get a work-skills group, such as Task Force Green, to set up a propagation unit. Seed-planting and pricking out are useful skills to learn, and species such as akeake, ribbonwood and kowhai give quite rapid results.

5.6 SUMMARY OF STEPS NEEDED TO RESTORE NATIVE VEGETATION

1. Use only seeds and cuttings from plants of local provenance.

2. Use plants which are appropriate for the habitat being restored.

3. Plant early successional species in the first instance.

4. Propagate some of the later successional species for planting into earlier plantings once these have grown for several years. These act as seed sources in addition to the remnants in the area.

5. Plant in small groups which act as nuclei for expansion through natural regeneration.

6. Specific sites

6.1 "ARAWHATA BUSH", HOKIO BEACH ROAD

6.1.1 Description

This remnant is a short distance from the lake, but is on a drier site than Hokio Bush (see below). It has a protection covenant, is effectively fenced, and is owned by Landcorp. The forest canopy is dominated by titoki and tawa with some mahoe. Pukatea is locally common and there are scattered cabbage trees. The main understorey tree is karaka, with shorter-stature kawakawa. Apart from ferns, the dominant ground cover in places is the weed wandering Jew. Our list of plants includes the trees matai, lemonwood (tarata), kahikatea, ngaio, broadleaf, swamp maire (=maire tawake), the shrubs *Coprosma areolata*, *C. rigida* and turepo (small-leaved milktree), and the lianes climbing fuchsia and kiekie.

6.1.2 Weeds

Within the forest by far the worst weed is wandering Jew. As mats of this plant expand across the forest floor they effectively prevent regeneration of almost all other species, and if plantings are done on adjoining land which is currently unforested, wandering Jew will also invade these as a shade cover begins to establish. At present it would not require a great effort to eradicate the weed, either with herbicide alone, by hand-weeding or raking, or by a combination of hand-weeding and herbicide. More abundant than wandering Jew, at present, is the small shrub weed, Jerusalem cherry. This shrub may inhibit some native regeneration but it is more a visual nuisance and impediment to people's use of the forest. Hand weeding and grubbing are recommended, because to eradicate Jerusalem cherry with herbicide would cause too much other destruction.

Small amounts of boxthorn, blackberry and water celery were noted.

6.1.3 Extending the forest

Within the fenced boundary of the forest there are areas of mostly rank pasture grasses and weeds. Other land adjoining the forest on its north-west side is currently grazed by cattle, but it is apparently available for planting in forest trees.

We recommend that enrichment planting be undertaken within the fenced area first. Planted specimens will need to be quite tall to cope with the rank grasses, but could be shorter if patches for planting are sprayed with a knockdown herbicide first. Spot spraying of areas before planting, then the use of a mulch such as wood or bark chips over old newspaper will help suppress grasses until trees become established. Plants chosen should be tolerant of well-lit sites (i.e., trees such as karaka or tawa would not be suitable), and could include non-forest species such as flax, toetoe and *Coprosma rigida*, and trees which are currently rare in the forest patch (e.g., lemonwood, ngaio, matai, swamp maire). The site seemed quite poorly drained, and may be suboptimal for species such as ngaio and matai. If so, it would probably be unsuitable for other species of well-drained sites, such as totara and kanuka.

Ribbonwood should be ideal for this site, perhaps with narrow-leaved lacebark as well (see 4.4).

6.2 "HOKIO BUSH", BESIDE HOKIO STREAM

6.2.1 The forest

Hokio Bush lies on the shore of the lake, at the source of the Hokio Stream. It extends as a strip along the true right of the stream for perhaps 300 m. Of the three remnants visited, Hokio Bush is the most intact and has the greatest diversity of vascular plant species. It is a most striking piece of forest, considering its small area.

The forested part is dominated by kahikatea, with pukatea, karaka, mahoe, ti kouka and titoki as the other major tree species. Notable in the remnant are a few stunted swamp maire which seem to be surviving in an environment which is now too shaded for them. This species was almost certainly more common around the lake in the past.

6.2.2 The wetland

Wetland adjacent to the forest is dominated by raupo and harakeke with occasional swamp coprosma and ngaio. One of the characteristic plants of the swamp fringe is the large tussock-sedge, makura or purei. This is a common host plant for the regionally local fern, *Hypolepis distans*. Makura is also a prime nesting habitat for several native birds of wetlands. These birds include the seldom seen spotless crake and marsh crake, which suspend their nests under the weeping foliage. Australasian harriers often nest on the crowns of makura.

Between the makura tussocks is swamp millet, a native grass which is rare in the southern North Island and seemingly last reported at Lake Horowhenua in 1949 (see 3.2). Climbing fuchsia scrambles over and through the makura. The summer-green, tall sedge, kukuraho is another locally common plant in this swamp fringe. We saw that young trees have established in what was reed swamp, probably a result of lowering the lake level (see 3.1). Dead "trunks" of makura were found within the bush, again indicating that higher water levels existed in the past.

6.2.3 Protection and future use

As stated in Section 3.2, Hokio Bush was identified in the PNAP survey report for Foxton Ecological District (Ravine 1992) as a Recommended Area for Protection (RAP 14), because it is a particularly rich and vigorously regenerating area of swamp forest which grades into swamp scrub, flax and reeds. Although this bush is a narrow ribbon of forest it has a fair amount of regeneration, good ground cover with deep litter, and an excellent forest/wetland boundary.

Hokio Bush is mostly fenced, though the fence is in urgent need of repair. The effects of stock on this kind of forest are vividly illustrated here because the remnant is divided by a fence, and stock graze a small part of the bush at the upstream end. The grazed part has almost no ground cover, no litter, and no small shrubs, and it is possible to see right through it. Some adventive species are present but in small enough numbers to make eradication feasible. These are boxthorn, bittersweet and gorse.

Aside from providing a valuable local source of a wide range of species, an additional value of this site is its potential educational use. Natural forest/wetland margins of this sort are very rare in the Wellington region and the recent history of the site is well portrayed in the vegetation - both wetland and forest.

The lack of potentially invasive weeds is a pleasing feature of Hokio Bush.

6.3 "TE KOWHAI" BUSH, NEAR LAKE DOMAIN

6.3.1 Description

This area of privately owned forest has been protected from grazing for many years. It is very near the lake edge, by the boating club. The forest canopy is dominated by titoki, with some mahoe, and the understorey is largely karaka with shorter-stature kawakawa. Unfortunately, the ground has extensive carpets of wandering Jew (see 6.1.2). Perhaps because this remnant is on uniformly flat terrain it has a rather small range of plants, but past grazing and, probably, timber removal, would have depleted the variety of native plants. The dense understorey of karaka also provides heavy shade, which may be limiting the range of plants able to occupy this forest. We noted several large cabbage trees, one matai (plus three more matai, possibly planted, beside the entrance driveway), one ngaio (and several others on the forest edge), and

one lemonwood tree. The understorey had several specimens of *Coprosma areolata* and turepo.

Despite its small range of indigenous plants, Te Kowhai bush is still a potentially important seed source to other areas through bird dispersal, and for sources of propagating material.

6.3.2 Kowhai at "Te Kowhai"

Although the homestead beside the bush is known as "Te Kowhai", the only kowhai trees seen were close to the driveway, where they may have been planted. Duguid (1990) noted kowhai in several places in the district, and raised doubts about the natural origin of trees north of Otaki. She seemed to accept specimens "on stony land beside Lake Horowhenua" (maybe = "Te Kowhai"?) as being natural to the area.

Kowhai has obvious uses in the revegetation programme for Lake Horowhenua, and Te Kowhai may be the only nearby source. However, Duguid noted that there is kowhai "on a sand ridge in the Hokio dune forest", and further botanical survey may reveal other kowhai near the lake. A close comparison should be made of any such plants with those at Te Kowhai, before growing more plants from Te Kowhai's specimens. It is likely that kowhai sourced from the dunes will be less well-suited to lake-edge planting (see 4.3).

6.3.3 Giant maidenhair fern

The presence of giant maidenhair fern in Te Kowhai bush is of interest, because it has a nationally threatened status of "rare". However, it is not known to be native to the Levin area and was apparently planted at Te Kowhai from where it has spread into the forest patch. Giant maidenhair fern was noted here by Duguid (1990).

7. Conclusions

We compliment the owners of Lake Horowhenua and its surrounds for their vision of a restored natural area. The long-term results of their efforts will be a lake which will be substantially cleaner and a better habitat for native wildlife than it is now, a lake which will be fringed with a range of native wetland plant communities which are home to the diminishing wildlife of such habitats, a lake which is set in a wider landscape of the different kinds of native forest which once dominated the district.

The challenge is how to make this vision real. Those involved need to understand that there will a lengthy time before conspicuous results come from their efforts. Many of the benefits will be seen only by future generations. However, early successes can be achieved by working with natural vegetation fragments which have survived to the present day. Early efforts should be

concentrated rather than dispersed. These successes should then be an inspiration and stimulus for more resources and ever-increasing successes.

8. References

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9. Acknowledgements

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APPENDIX 1: Formal names of plants named in the text

* species not indigenous to the Lake Horowhenua area

akeake	*Dodonaea viscosa*
**bittersweet*	*Solanum dulcamara*
**blackberry*	*Rubus fruticosus* agg.
**boxthorn*	*Lycium ferocissimum*
broadleaf	*Griselinia littoralis*
cabbage tree (ti kouka)	*Cordyline australis*
climbing fuchsia	*Fuchsia perscandens*
**eucalypt*	*Eucalyptus* spp.
flax (harakeke)	*Phormium tenax*
**giant maidenhair fern*	*Adiantum formosum*
**gorse*	*Ulex europaeus*
harakeke (flax)	*Phormium tenax*
houhere (lacebark)	*Hoheria populnea* var. *(H. sexstylosa)*
**Jerusalem cherry*	*Solanum pseudocapsicum*
kahikatea	*Dacrycarpus dacrydioides*
kanuka	*Kunzea ericoides*
karaka	*Corynocarpus laevigatus*
karamu	*Coprosma robusta*
**karo*	*Pittosporum crassifolium*
**kauri*	*Agathis australis*
kawakawa	*Macropiper excelsum*
kiekie	*Freycinetia baueriana* ssp. *banksii*
kowhai	*Sophora microphylla* var.
kukuraho	*Bolboschoenus fluviatilis*
lacebark (houhere)	*Hoheria populnea* var.
lemonwood (tarata)	*Pittosporum eugenioides*
**macrocarpa*	*Cupressus macrocarpa*
mahoe	*Melicytus ramiflorus*
maire tawake	*Syzygium maire*
makura (purei)	*Carex secta*
manuka	*Leptospermum scoparium*
matai	*Prumnopitys taxifolia*
narrow-leaved lacebark	*Hoheria angustifolia*
ngaio	*Myoporum laetum*
old man's beard	*Clematis vitalba*
**pampas grass*	*Cortaderia selloana, C. jubata*
**pine*	*Pinus* sp.
**pohutukawa*	*Metrosideros excelsa*
pukatea	*Laurelia novae-zelandiae*
purei (makura)	*Carex secta*
raupo	*Typha orientalis*
ribbonwood	*Plagianthus regius*
small-leaved milk tree (turepo)	*Streblus heterophyllus*
swamp maire (maire tawake)	*Syzygium maire*

swamp millet	*Isachne globosa*
tarata (lemonwood)	*Pittosporum eugenioides*
taupata	*Coprosma repens*
tawa	*Beilschmiedia tawa*
ti kouka (cabbage tree)	*Cordyline australis*
titoki	*Alectryon excelsus*
toetoe	*Cortaderia toetoe* (except where otherwise specified)
totara	*Podocarpus totara*
tree lucerne	*Chamaecytisus palmensis*
turepo (small-leaved milk tree)	*Streblus heterophyllus*
**wandering Jew*	*Tradescantia fluminensis*
**water celery*	*Apium nodiflorum*

APPENDIX 2: Lists of plants for three forest remnants at Lake Horowhenua

1. HOKIO BUSH

Ferns

Asplenium flaccidum
Asplenium polyodon
Blechnum filiforme
Blechnum minus
Dicksonia squarrosa
Diplaziun australe
Hypolepis ambigua
Hypolepis distans
Pneumatopteris penniger
Pteris macilenta auct NZ

Trees, shrubs and lianes

Alectryon excelsus
Calystegia sepium
Coprosma areolata
Coprosma grandifolia
Coprosma propinqua
Coprosma propinqua x *C. robusta*
Coprosma tenuicaulis
Cordyline australis
Corynocarpus laevigatus
Dacrycarpus dacrydioides
Freycinetia baueriana var. *banksii*
Fuchsia perscandens
Geniostoma rupestre var. *ligustrifolium*
Griselinia lucida
Laurelia novae-zelandiae
Leptospermum scoparium
Meticytus ramiflorus
Metrosideros perforata
Myoporum laetum
Myrsine australis
Pittosporum tenuifolium
Ripogonum scandens
Syzygium maire

Grasses, sedges, and other herbaceous plants

Bolboschoenus fluviatilis
Carex geminata
Carex lambertiana
Carex lessoniana
Carex secta

Carex virgata
Collospermum hastatum
Cortaderia toetoe
Eleocharis acuta
Hydrocotyle novae-zeelandiae
Isachne globosa
Phormium tenax
Typha orientalis
Urtica linearifolia [P de Lange, pers. comm.]

Adventive species

Isolepis sepulcralis
Lycium ferocissimum
Solanum dulcamara
Ulex europaeus

2. ARAWHATA BUSH

Ferns

Asplenium flaccidum
Asplenium oblongifolium
Blechnum sp. (unnamed, *B. capense* agg.;
lowermost pinnae progressively shorter)
Blechnum filiforme
Dicksonia squarrosa

Trees, shrubs and lianes

Alectryon excelsus
Beilschmiedia taws
Calystegia septum
Carpodetus serratus
Coprosma areolata
Coprosma grandifolia
Coprosma rigida
Cordyline australis
Corynocarpus laevigatus
Dacrycarpus dacrydioides
Freycinetia baueriana var. *banksii*
Fuchsia perscandens
Griselinia lucida
Laurelia novae-zelandiae
Melicytus ramiflorus
Muehlenbeckia australis
Myoporum laetum
Myrsine australis
Parsonsia heterophylla
Passiflora tetrandra

Ripogonum scandens
Solanum aviculare
Streblus heterophyllus

Grasses, sedges, etc.

Some present, but none recorded

Adventive species

Apium nodiflorum
Berberis glaucocarpa
Lycium ferocissimum
Rubus fruticosus agg.
Solanum pseudocapsicum
Tradescantia fluminensis

3. TE KOWHAI BUSH

Trees, shrubs and lianes

Alectryon excelsus
Coprosma areolata
Cordyline australis
Corynocarpus laevigatus
Macropiper excelsum
Melicytus ramiflorus
Myoporum laetum
Parsonsia heterophylla
Pittosporum eugenioides
Prumnopitys taxifolia
Streblus heterophyllus

Indigenous ferns

Arthropteris tenella
Pyrrosia eleagnifolia

Adventive species

Adiantum formosum [see text]
Euphorbia lathyris
Tradescantia fluminensis