Waiwhakareke Restoration Plantings:
Re-measurement of Monitoring Plots 2007/08

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1. Introduction

Waiwhakareke Natural Heritage Park consists of a 60ha farmland site, which is being converted into native lowland and ecosystems representative of the Waikato region. The Park falls within Hamilton cities north-west boundary and includes a peat lake (Horseshoe Lake) with a surrounding swampy area and low rolling hills typical of the Hamilton Basin. The reconstruction of the native ecosystem is being lead by the Hamilton City Council in partnership with local research organisations and community groups (Grove *et al.*, 2006; McQueen 2005; McQueen & Clarkson 2003).

Replanting of native vegetation around the lake began in September 2004. Successive plantings have taken place over the years and at present a 30m+ band of vegetation encompasses the lake. This area has been fenced off from stock since 2005.

This document describes the ongoing monitoring of plots within these initial plantings. Monitoring will provide both short-term and long-term feedback to aid management decisions regarding planting maintenance and future plantings.

2. Aim

In this report we present our assessment of vegetation growth in marked baseline monitoring plots, two years after establishment. Additionally, we have established a new monitoring plot in a previously unsampled vegetation type planted in 2006. These plots are sited randomly throughout planting zones and thus allow assessment of plant health and survivorship, animal browsing impacts, reproductive output of plants, groundcover composition and canopy closure and cover.

3. Method

Initial monitoring plots were established between November 2005 and January 2006 in four plantings of varied ages, as described by Grove *et al.* (2006). These plots were re-measured in December 2007. In June 2008 an additional monitoring plot was established in a new planting zone and plot length and width was measured (Table 1). All plots are indicated on a map of the Park (Appendix 1) Plots were permanently marked with orange spray-painted wooden stakes in the ground with white metal labels on top indicating plot number and corner (Grove *et al.,* 2006).

Table 1: *Planted areas and monitoring plot sizes.*

Planting zone	**Area (m^2)**	**Date of planting**	**Plot number**	**Plot dimensions (m^2)**	**Plot size (m^2)**
A	359	Sep 2004	1	10 x 11.5	115
B	2,592	May 2005	2	5 x 18	90
C	1,944	June 2005	4	10 x 29	290
K	14,159	June 2005	3	5 x 40	200
K	14,159	June 2005	5	5 x 32	160
I	856	June 2006	6	12 x 15	180

Morphological data was collected for plot plantings. We recorded had height, width and depth of all plantings within plots. Presence or absence of browse was noted, as was presence or absence of flowers and fruits. We scored presence of live or dead weeds at the base of plantings and planting health (dead, poor or good). Canopy percent cover was calculated for each plot using the measures of width and depth covered by each plant.

In 2006 ground cover was assessed in plots using a point height intercept method. Ground cover species were identified at 25cm intervals along transects. An assessment of whether any recent spraying had occurred was made at each intercept. A minimum of 125 points were used to gather data from each plot. However in 2008 in the newly established plot, ground cover was recorded as a percentage.

Visual comparisons were made by comparing photos from 2006 photopoints at plot corners in all plots with corresponding 2008 photos and are shown in Appendix 2. Additional photopoints for existing and new plots were added to supplement these.

4. Results

Canopy cover

Canopy cover has increased exponentially over time ($p < 0.01$) (Figure 1). Total canopy cover was greatest in plot one and least in plots three and four. All re-measured plots show an increase from 2005 measurements.

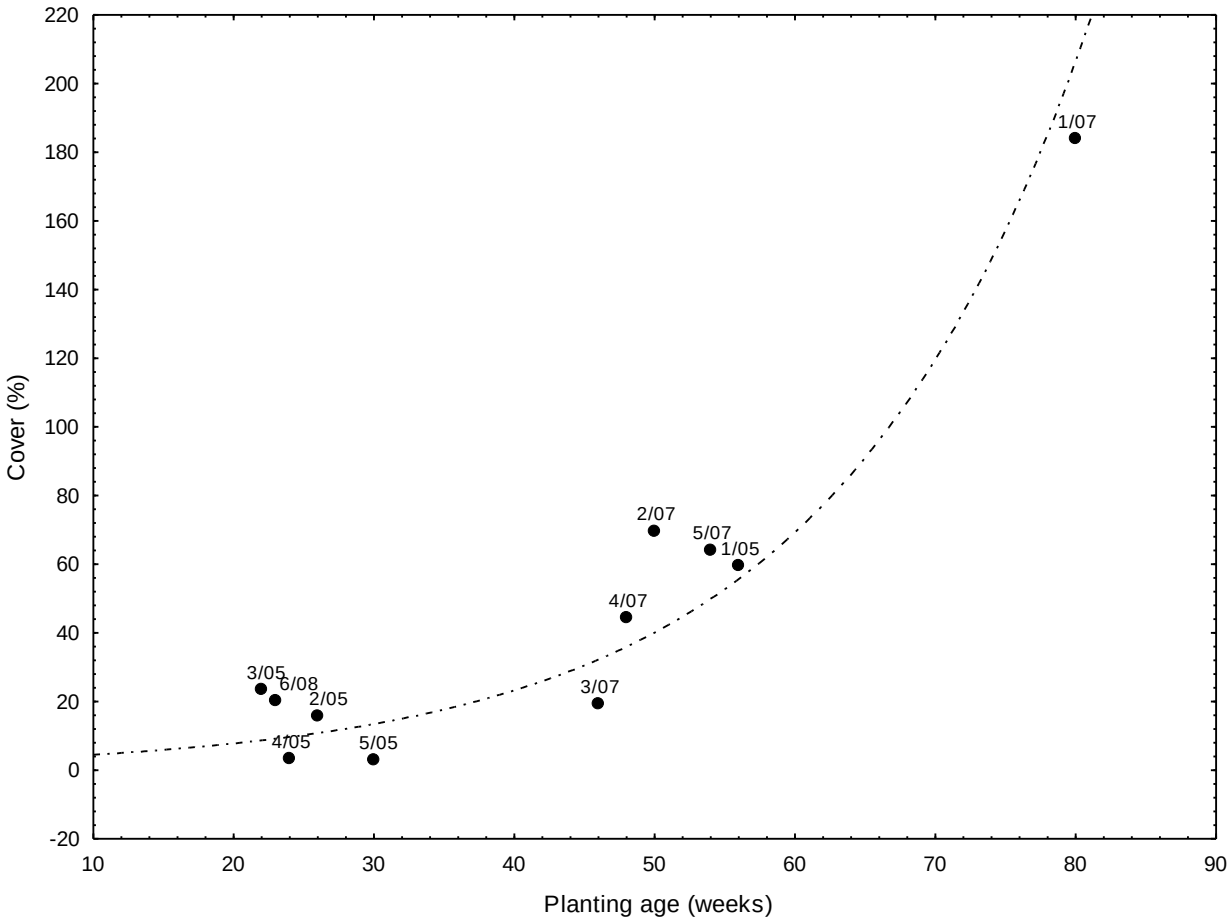

Figure 1: *Percentage of canopy cover vs planting age for all plots. Plot codes are plot number/year measured*

All plots decreased in plant density from 2005 to 2007 (Figure 2). However, initial plant densities are likely to have been modified from those planned. Grove *et al.* (2006) noted that a higher initial density of planting occurred in plot one, planting zone A. Similarly in both 2005 and 2007, plot two had a higher plant density than the proposed initial planting density. Plant densities of the plot five 2005 measurement were higher than planned initial planting densities in the planting zone but have now dropped under the initial planting density.

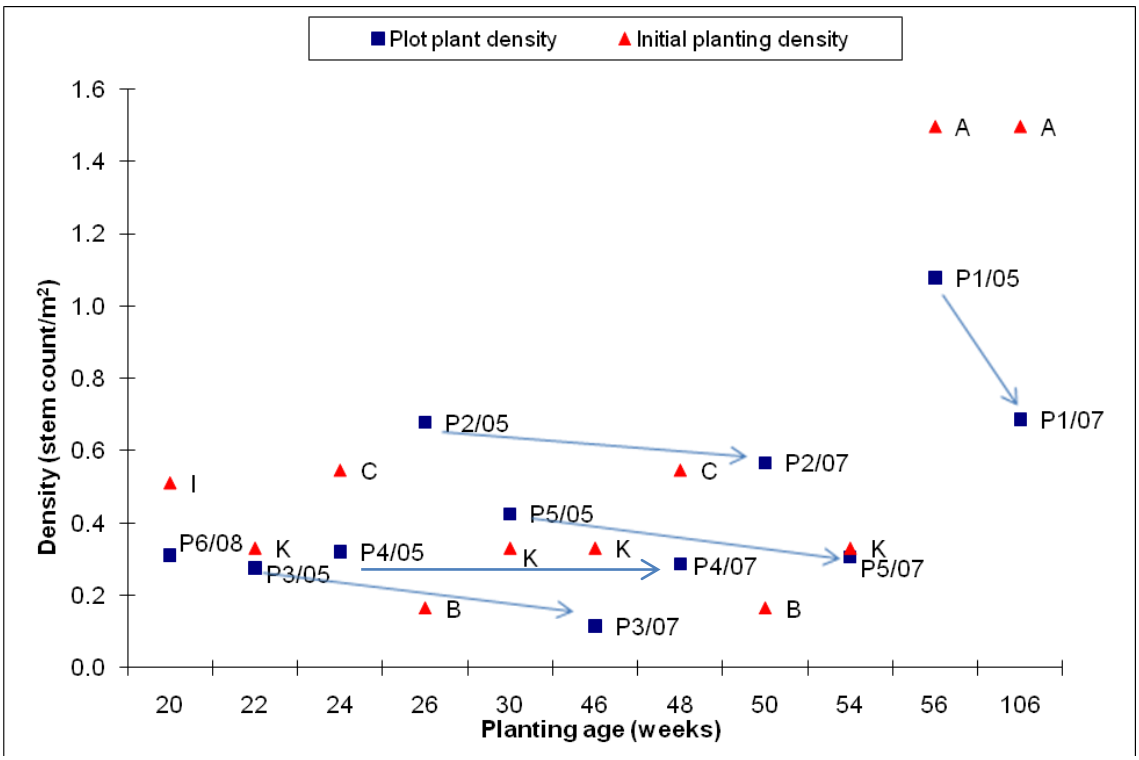

Figure 2: *Plant density recorded for each plot in comparison to initial planting zone densities. Letters A-K represent planting zones from Table 1. Plot codes are plot number/year measured*

Health and mortality

There was an increase in the quantity of *Carex secta* and *Carex virgata* (*Carex* spp.), *Leptospermum scoparium* (manuka) and *Coprosma tenuicaulis* (swamp coprosma) from 2005 measurements (Figure 3). Plot six, which was first measured in 2008, contained manuka, *Dacrycarpus dacrydioides* (kahikatea), *Phormium tenax* (flax), *Coprosma propinqua x robusta* and swamp coprosma. There was a higher percentage of species in good condition compared to 2006 measurements, with more than 80% of plants in healthy condition. Fewer plants were classed as in poor condition (44 in 2005 compared to 11 in 2007) with no particular plots having more deaths or dead species (72 individuals in 2005 compared to four in 2007) over all the plots. No *Syzygium maire* (swamp maire) survived from initial plantings. The only *Coprosma propinqua x robusta,* measured in plot six, was dead.

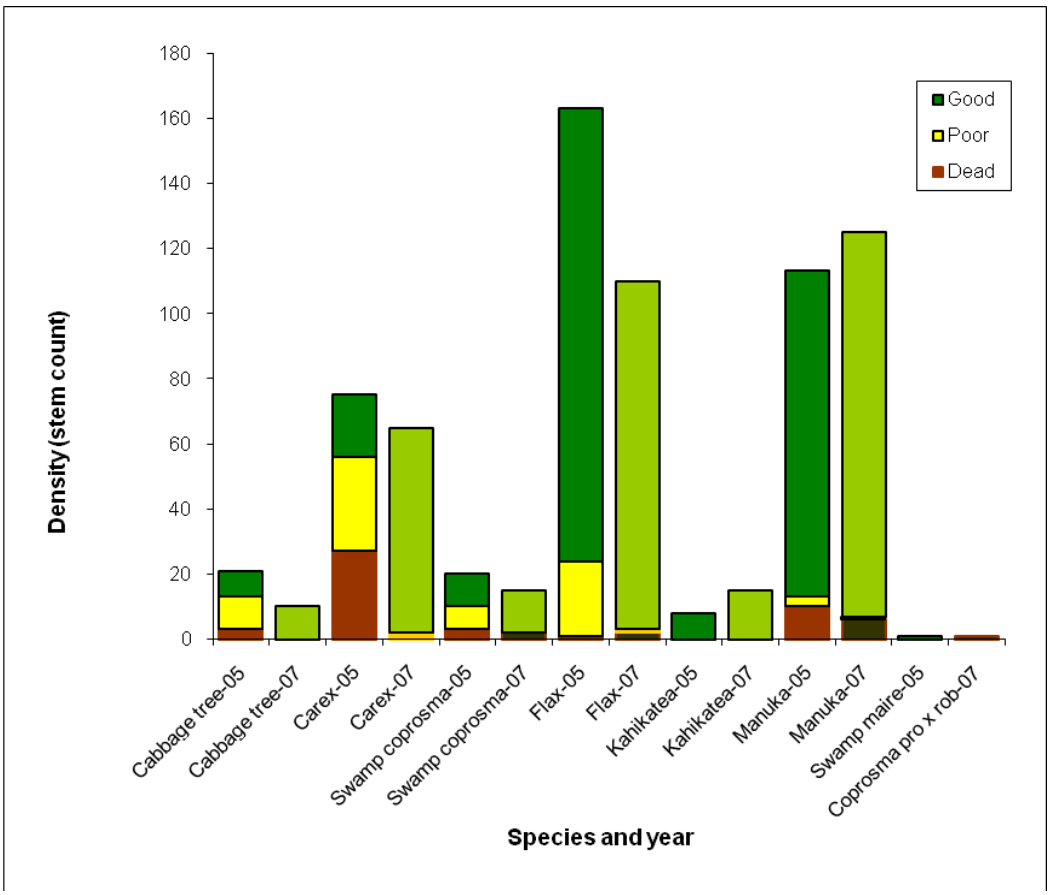

Figure 3: *Health assessment for all individual plants in plots, classified by species, in 2005 and 2007/8.Coprosma prox rob = Coprosma propinqua x robusta.*

Even though plot three had the lowest density, all were in good condition. Plot two had the highest number of poor condition plants. Although plot four had the highest mortality it also contained the greatest density of plants in good condition (Figure 4).

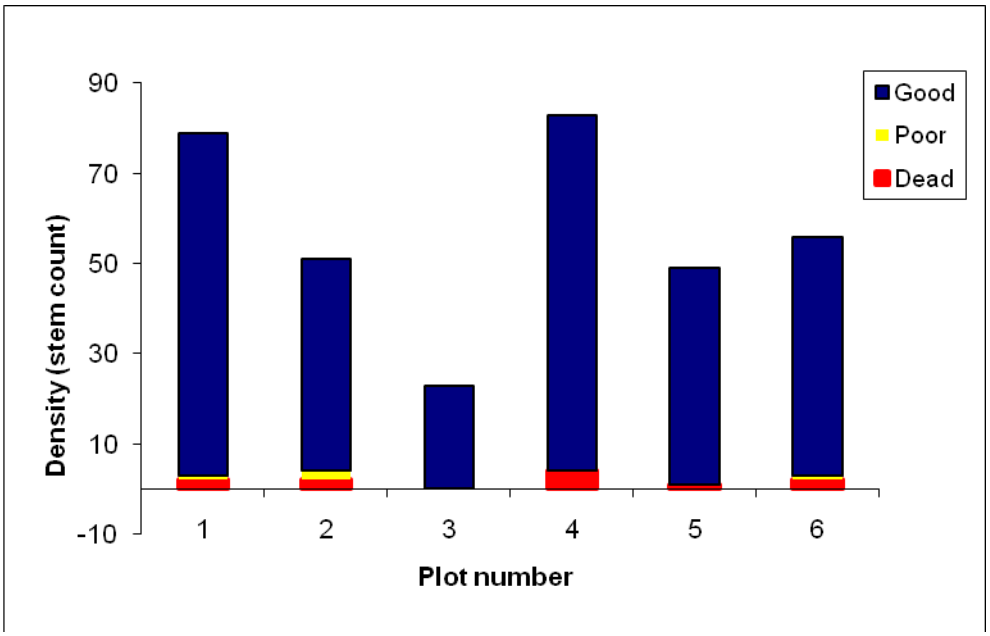

Figure 4: *Health assessment of plants by plot.*

Browse impacts

Browsing was recorded on planted *Carex* spp., swamp coprosma, flax, and *Cordyline australis* (cabbage tree) in 2005 but only on *Carex* spp. in 2007 (Fig. 5). *Carex* spp. was browsed in three plots; plot one (60%), plot two (78.5%) and plot 4 (96.8%).

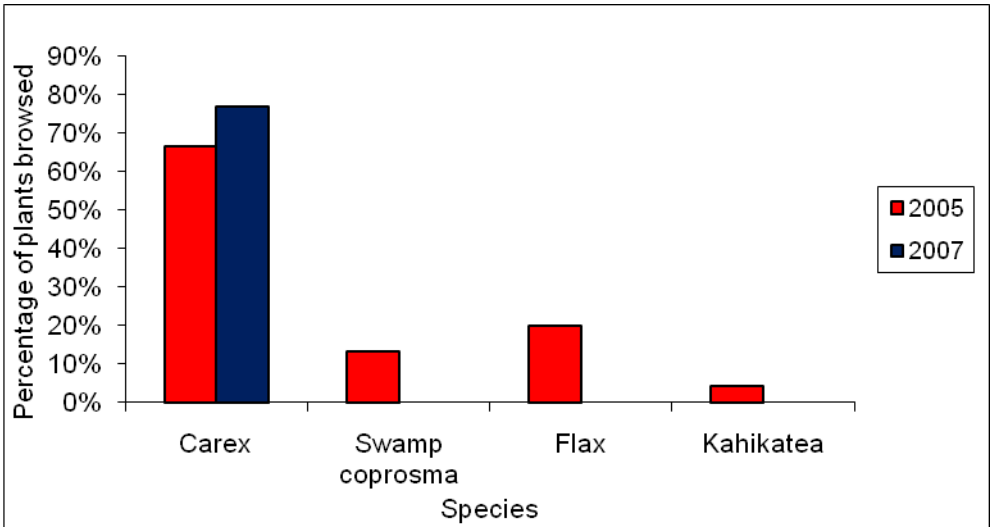

Figure 5: *Proportion of plants with browse impacts recorded in 2005 and 2007 measurements.*

Reproductive output

Three of the eight planted species were observed with flowers or seeds present: *Carex* spp., manuka and flax (Figure 6). Manuka flowers and seeds were particularly profuse with 78% of plants flowering or seeding in plot two and 100% in plots one and three. Seeding *Carex* spp. plants were most common in plots one and five, with 33% and 100% seeding respectively. Flax plants had produced flowers and/or seed in all but the youngest plot (plot six) ranging from 29% (plot three) to 61% (plot two).

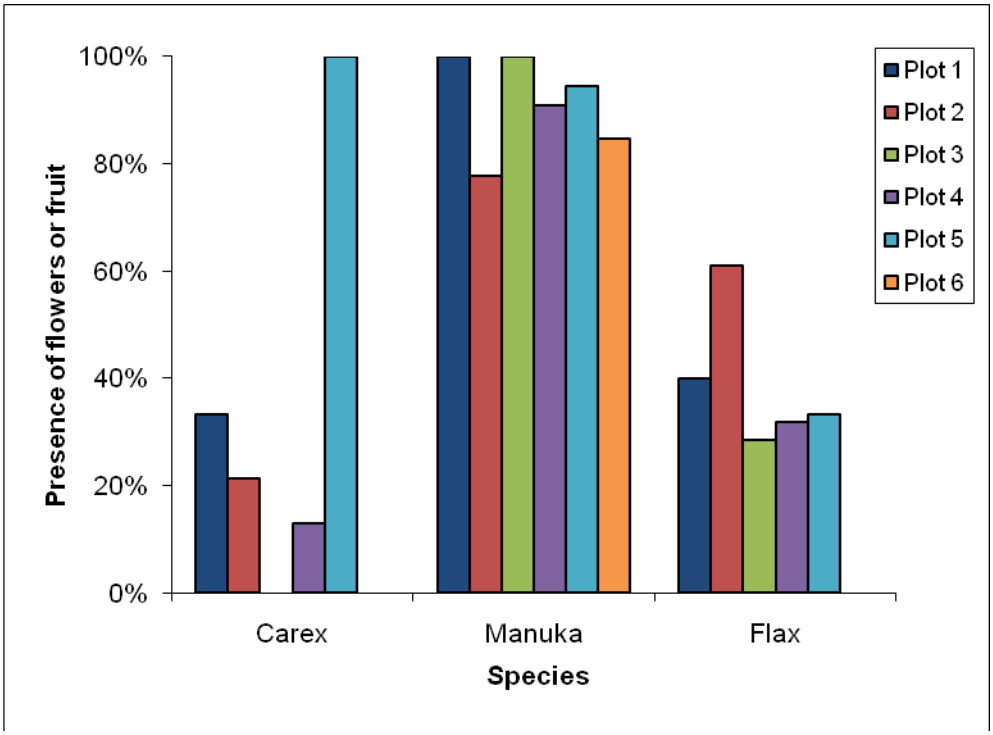

Figure 6: *Percentage of plants flowering and/or fruiting in each plot*

Ground cover

Introduced pasture species remain the predominant ground cover in 2007 ≈83.7% per plot (Fig. 7). Native plants covered on average 13.1% per plot. The average groundcover was higher in summer ($\bar{x}$ = 45cm), but when establishing plot six in winter 2008 the groundcover was shorter ($\bar{x}$ = 20cm).

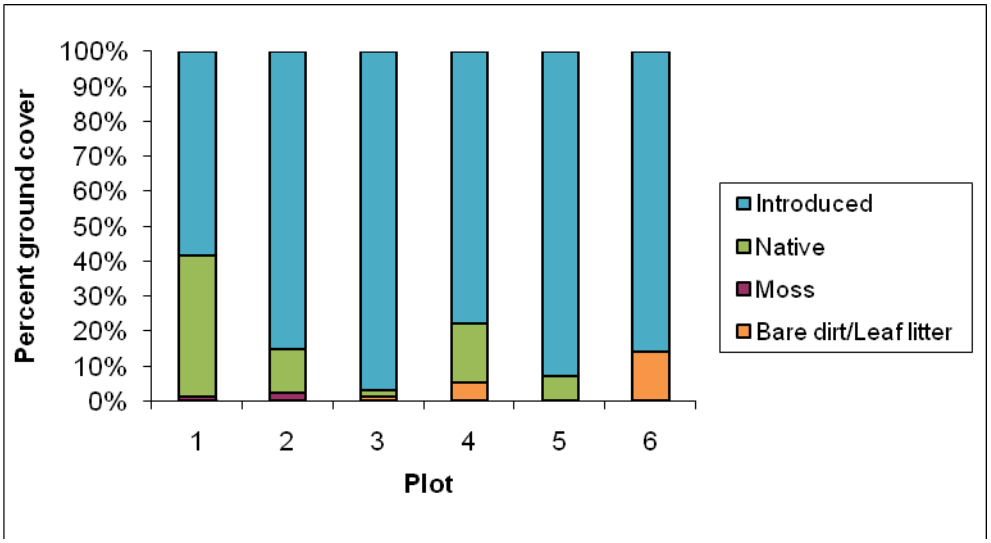

Figure 7: *Groundcover composition for each plot in 2007/8*

In the oldest plantings (plot one) under the closed manuka canopy the groundcover was predominantly leaf litter with little introduced cover. A small number of native seedlings were also found under this canopy; *Coprosma robusta*, *Cyathea* sp., *Asplenium oblongifolium, Histiopteris incisa, Paesia scaberula* and swamp coprosma. A *Crataegus monogyna* (hawthorn) seedling and *Rubus fruticosus* (blackberry) seedlings were also found under this canopy. However these seedlings did not all show in the groundcover intercept as they were not at the intercept points.

5. Discussion

Canopy closure

All plots have had an increase in native canopy even though there are fewer plants than in the 2006 measurement. This is to be expected with plant growth. However, it is likely that percent cover is over estimated for two reasons. First, using plant width to predict canopy closure percent cover results in increasing percent cover measurement due to some species such as flax having one or two outstretched leaves. Secondly, in the oldest plot the large manuka and flax are now intertwined, thus also over estimating species cover. Another measure is needed such as total canopy % to record more accurately total plot canopy cover which will then show if the plot has gaps in the canopy.

Some plots such as plot five had higher recorded densities than planned, suggesting that modification to the original planting plans occurred. For example, we noted *Coprosma propinqua x robusta* was not part of the planting plan but was present in plot six. This could be due to a hybrid accidentally being planted instead of a parent plant.

The increase in numbers of *Carex* spp. was due to supplementary plantings after the 2005 measurements to replace dead *Carex* spp. The increase in the

total number of manuka and swamp coprosma was due to the addition of plot six.

Plant health
Health of all species increased in all plots in the 2007/8 measurement. This was in part due to a reduction in browse and reduced spray drift from herbicides.
In 2005 the presence/absence of dead weeds at the base of plants was recorded as an indicator of effects of herbicide on plants. In 2007/8 there were no dead weeds at the base of plants, showing the affect of spray drift was not a contributor to plant deaths. In contrast to 2005, weeds are now controlled by mowing or targeted spot spraying.

Browse impacts
With the exclusion of cows from the site most species browsed in 2005 showed no sign of browse in 2007. *Carex* spp. were still browsed most probably by hares, rabbits, ducks and/or pukeko. Browsing of *Carex* spp. is unlikely to stop as there are no control programs in place for either species

Reproductive outputs
The high proportion of manuka and *Carex* spp. flowering and fruiting shows seeds can enter the seed bank from these plants at a very young age. However, as most *Carex* spp. individuals were from the supplementary plantings and hence relatively young, this would account for a slightly lower proportion of flowering in these species. It is likely that flax requires a couple more years to reach its reproductive potential than manuka and *Carex* spp.
Self seeding of native ferns and woody species is now occurring in the oldest plantings. Swamp coprosma is the only species of these seedlings which is found in 2005 or earlier plantings.

6. Conclusion and Recommendations

There is an increase in canopy cover in all the plantings. As in 2005/6 the overall survival of plantings is still variable between species and planting zones.

In the oldest plantings a closed canopy has reduced weed numbers and facilitated the arrival of a few new seedlings.

Ground cover around the lake margin is poor quality pasture as indicated by the high cover of Yorkshire fog. Weed control seems to be effective as the ground cover does not seem to be detrimental the plantings. Problem weeds are kept at bay due to spot spraying.

Carex spp. was the only plant group noted as being detrimentally browsed. These impacts may be reduced by management, such as controlling rabbit and hare populations.

Manuka, *Carex* spp. and flax all have individuals capable of reproduction in 2007.

Recommended changes in method

- When establishing monitoring plots, corner pegs larger than 30cm above the ground should be used. This will make plots easier to find during re-measurement as groundcover can easily overtop small pegs.

- For a more accurate measure of canopy closure, total canopy cover for the plots should be taken. This will reduce the over estimation caused by the area calculations preformed on plant widths.

- In areas with high mortality rates, replacement planting should be done in open canopy areas. As before, grazed *Carex* spp. should be replaced. This will help accelerate canopy closure and maintain species diversity in plantings.

- In the oldest plantings manuka has now moved from the shrub stage into the small tree stage. Since plants are changing habit the sampling method needs to be adapted to accommodate this. In the next measurement (2009) of the oldest plantings manuka should have a diameter measurement taken for stems larger than 2cm DBH in addition to the usual measurements.

- Using point intercept does not give a full representation of how the groundcover of the plot is changing. In the next measurement, all plots should have percentage ground cover taken instead. In the oldest plots some seedling plots should be established to give a clearer picture of when new seedlings are entering the plots and how they are developing over time.

- Weed control has changed at the park with less spraying taking place. Therefore it is not necessary to record live weeds at base for the plantings unless there is noticeable spray damage.

- Monitoring of these plots (including photopoints) should be undertaken in 2009.

- Further monitoring plots should continue to be established in new plantings to gain adequate coverage of site variability and variation in planting or maintenance techniques.

7. Acknowledgements

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8. References

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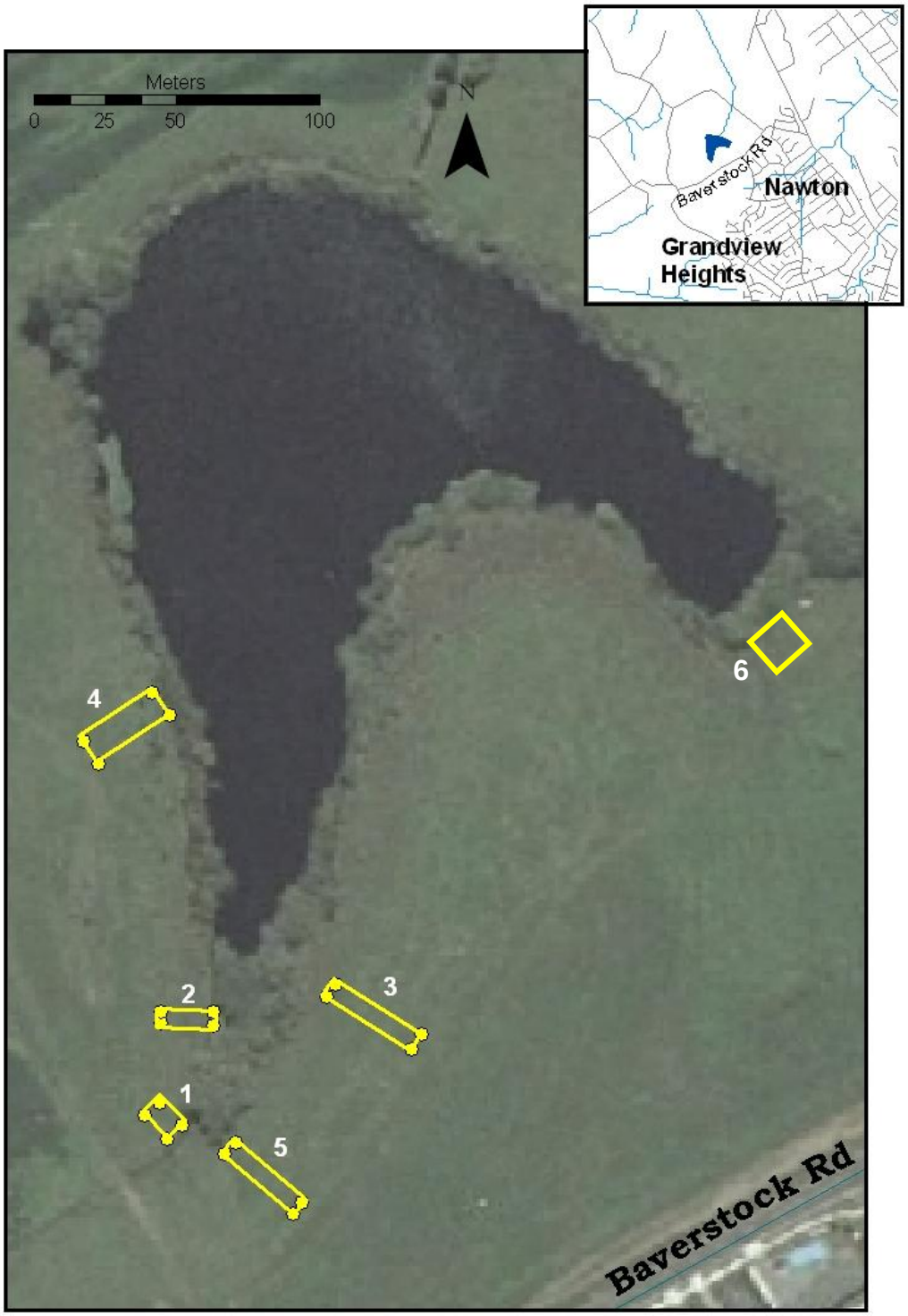
McQueen J. C. (2005) Waiwhakareke (Horseshoe Lake) Natural Heritage Park: Draft Management Plan. Prepared for Hamilton City Council. CBER Contract Report No. 37, The University of Waikato, Hamilton.

McQueen J. C. & Clarkson B. D. (2003) An Ecological Restoration Plan for Waiwhakareke (Horseshoe Lake). Scoping Report prepared for Hamilton City Council. CBER Contract Report No.29, The University of Waikato, Hamilton.

Appendix 1 Map showing Horseshoe Lake and location of monitoring plots in initial planting zones.



Appendix 2 Location of monitoring photopoints (not to scale).

All plots have three photos from corner A facing other corners.