Waiwhakareke Restoration Plantings:
Establishment of Monitoring Plots 2005-06

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CBER Report No. 44

2006

THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato

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1. Introduction

Waiwhakareke Natural Heritage Park is being developed to reconstruct native lowland and wetland ecosystems as were once widespread in the Waikato Region. The 60ha Natural Heritage Park is located on the north-west outskirts of Hamilton City and includes a peat lake (Horseshoe Lake) which is surrounded by introduced willow trees. There is some native marginal vegetation around the lake, including rushes and sedges, and an extensive area of gently sloping pasture completes the catchment. The restoration and recreation of the native plant and animal communities is being lead by the Hamilton City Council in partnership with The University of Waikato, Wintec, Nga Mana Toopu o Kirikiriroa Limited Resource Management and Cultural Consultants and Tui 2000 (McQueen 2005; McQueen & Clarkson 2003).

Restoration plantings on the formerly grazed pasture are to be staged in planting zones which focus on the lake margin initially and will progressively expand onto the adjacent hillslopes. Replanting of native vegetation began in September 2004 with further areas of lakeside pasture being successively fenced off from grazing stock and planted in May and June 2005.

This document describes the establishment of monitoring 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

To establish baseline monitoring plots within early stages of restoration plantings for the present and future assessment of:

- Canopy cover/closure in plantings
- Plant health and survivorship rates
- Animal browsing impacts on plants
- Reproductive output of plants
- Groundcover composition

3. Method

Five monitoring plots were established between November 2005 and January 2006 in four plantings of varied ages (Table 1). Plots were variably sized according to planting size and extend perpendicular to the lake shore or inlet from one edge of the planting to the other (see map, 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.

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

Planting zone	Area (m^2)	Date of planting	Plot number	Plot dimensions	Plot size ($m^{2)}$
A	359	Sep 2004	1	10m x 11.5m	115
B	2,592	May 2005	2	5m x 18m	90
C	1,944	June 2005	4	10 x 29m	290
K	14,159	June 2005	3 & 5	5m x 40m & 5m x 32m	200 & 160

All plantings within plots had height, width (longest and shortest axis perpendicular to ground surface), health (dead, poor, good), browse (presence/absence), weeds at base (live/dead) and flowers and fruits (presence/absence) assessed. Canopy percent cover was calculated for each plot using measures of width to calculate the surface area covered by each plant.

In addition ground cover was assessed throughout each of the plots using a point-height intercept method. At 25cm intervals along transects the ground cover species was identified and height recorded, an assessment was also made of whether the ground had been recently sprayed (dead/dying plants) at each intercept. Data was gathered for at least 125 points (32m) for each plot.

Photopoints were taken at plots and are described in Appendix 2.

4. Results

Canopy cover
Total canopy cover was greatest in plot 1 (Figure 1) and least in plots 3 and 4. This variation in canopy cover accurately reflects comparative ages of plantings. A linear trend line indicates that at present growth rates plantings will reach 100 percent canopy cover by 21 months, less than two years, after planting.

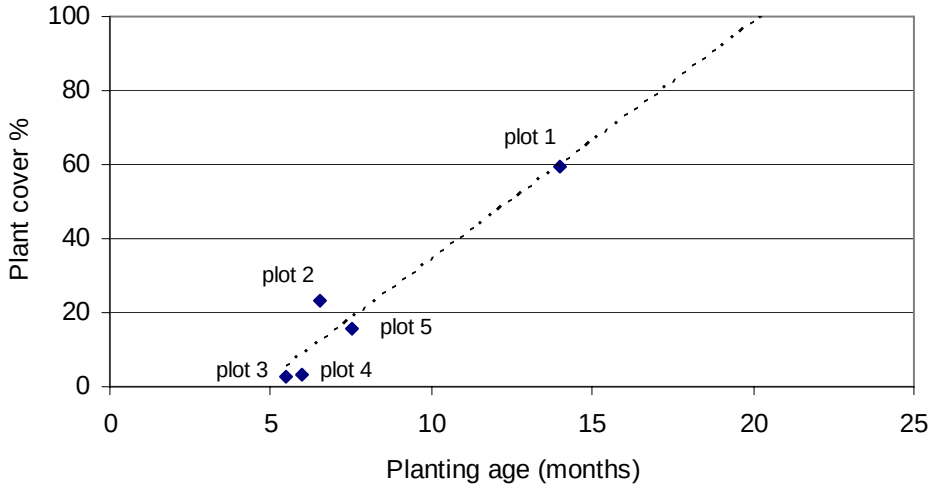


Figure 1: *Percent cover by plant canopy Vs planting age for all plots.*

Analysis of initial planting densities reveals that a higher density of planting occurred in plot 1, planting zone A (Fig. 2). This may mean that plantings in the other plots will take slightly longer than two years to reach 100% cover due to lower initial planting densities. Plot 2 shows a high plant density and high percentage cover in relation to the low initial planting density in this zone, likely a reflection of the good health and no browse scores recorded here.

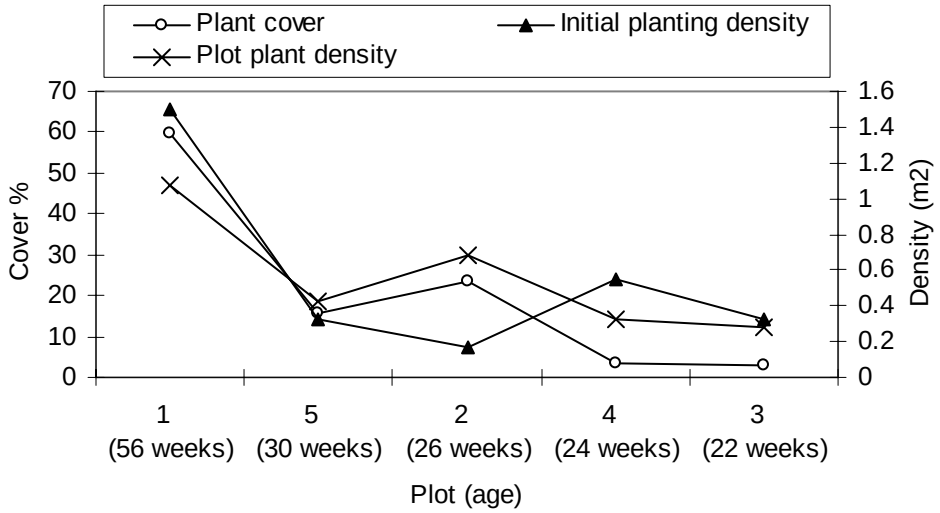


Figure 2: *Plant cover and density recorded for each plot in comparison to initial planting densities.*

Health and mortality

Only one quarter of all planted *Carex* sedges monitored were in good condition, with over one third of plants in each of the dead and poor health categories (Fig. 3). Cabbage trees and *Coprosma tenuicaulis* were less abundant in the plantings but only 38% and 50% of plants respectively were found in good health. Of the more abundant species only one dead flax was found in plots and 14% of flax were in poor health, manuka had a greater number of dead plants (9%) with only a few plants in poor health (3%).

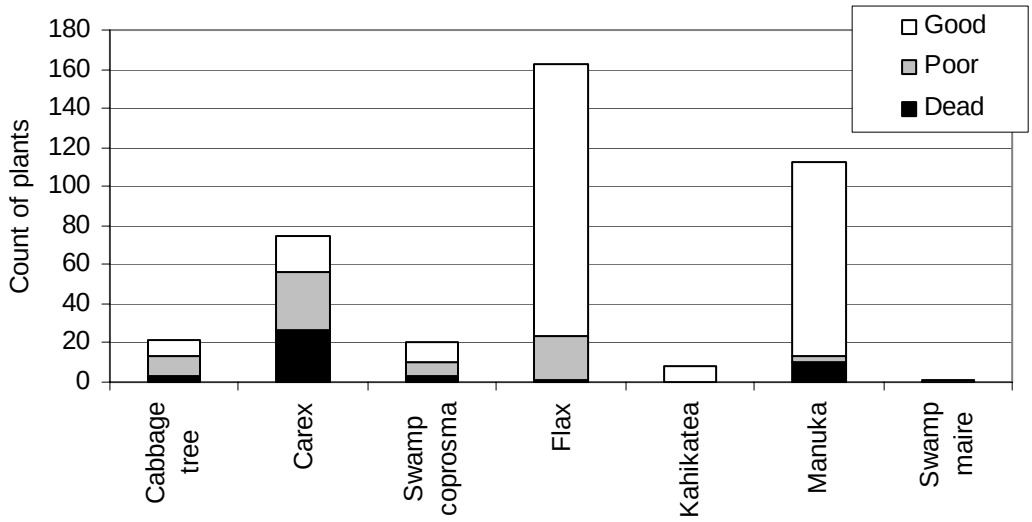


Figure 3: C*ondition of health for individuals of each species.*

In terms of the different aged plantings (plots) most deaths were found in plots one and four (Fig. 4). All of the deaths in plot one were Carex sedges whereas plot four was more mixed with predominantly manuka and cabbage tree deaths with a few other species also. Plot three had a couple of manuka and cabbage tree deaths.

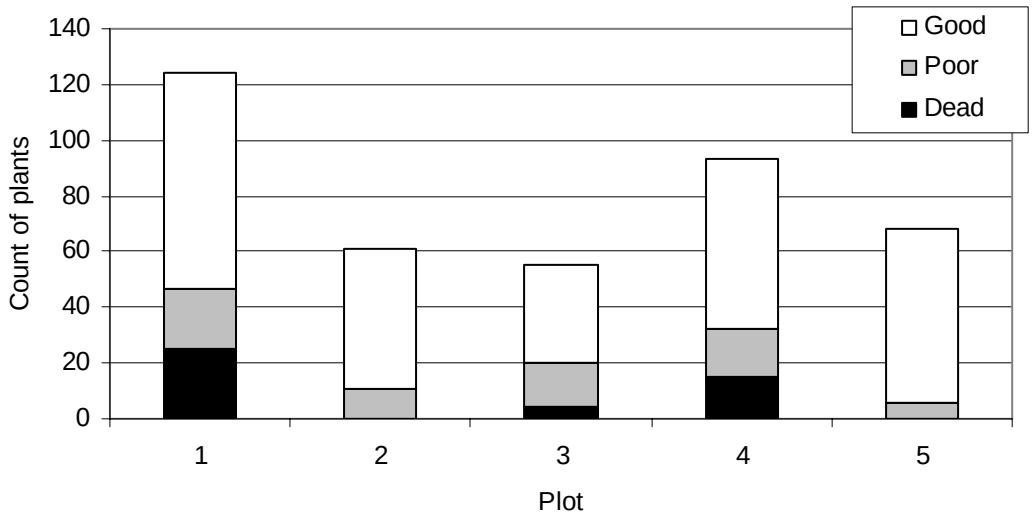
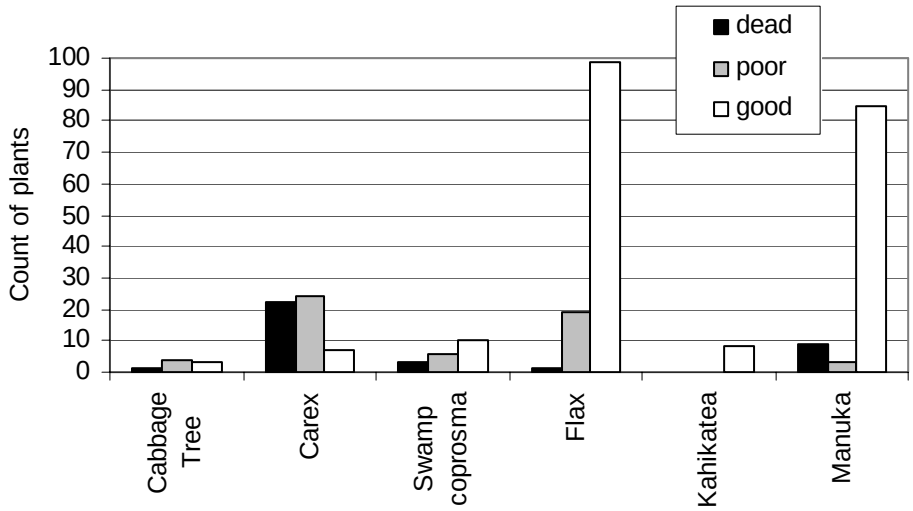


Figure 4: *Condition of health of plants totalled for each plot.*

Less than half of the dead Carex were associated with animal foraging sign and it is more likely that environmental factors such as water or soil conditions and/or spray-drift play a role in the high loss of plants. The majority of Carex which were dead or in poor health were found to have dead weeds at their base (Fig. 5a) as opposed to those in good health which more often had live weeds around them (Fig. 5b) suggesting that spray close to plants may have been detrimental to their health. Manuka, flax and *Coprosma tenuicaulis* health may also have been affected by spraying with more plants with dead weeds at their base in poor health. Cabbage trees show similar health in the presence of weeds or with dead weeds and poor health was commonly associated with browse impacts for this species.

a) *dead weeds present*



b) *live weeds present*

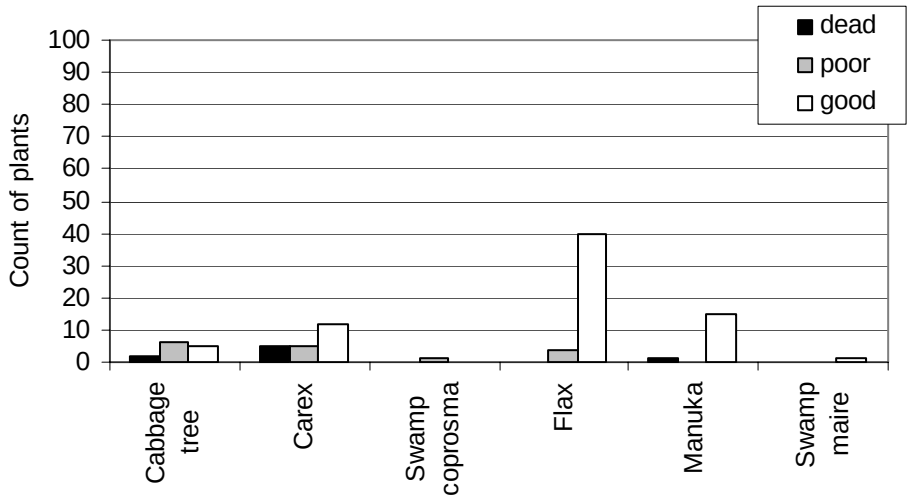


Figure 5: *Plant health for each species with a) dead weeds present at base and b) live weeds present at base*

Three manuka were found knocked over at the base in plot 4 and strong westerly winds were noted on this side of the lake.

Browse impacts

Animal browsing was recorded on planted *Carex*, *Coprosma*, flax, and cabbage trees, no browsing was noted on kahikatea, manuka or swamp maire (Fig. 6). Browse was most prevalent on cabbage trees (67%) with a smaller proportion of *Coprosma tenuicaulis* (20%), *Carex* (13%) and flax (4%) showing browse impacts.

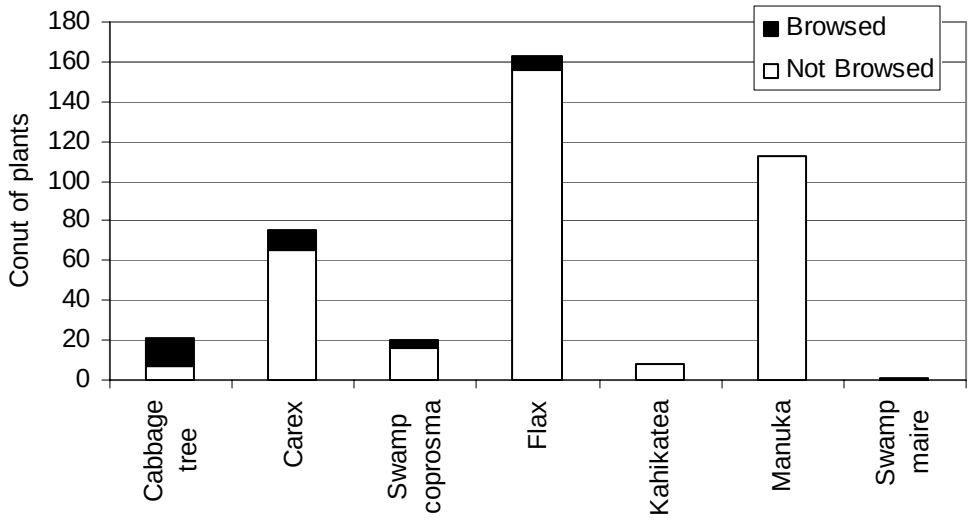


Figure 6: *Proportion of plants with browse impacts recorded.*

No browse was observed in Plot 2 (Table 2) and browse was most common on plants in Plot 4 (16% of all plants) and Plot 5 (13% of all plants). Cabbage trees were only recorded in Plots 4 and 5, they were heavily browsed in both plots. *Coprosma tenuicaulis* were all browsed in Plot 4 as were many flax. *Carex* occurred in every plot yet was only browsed in Plots 1 and 3.

Table 2: *Proportion of each species browsed in each plot.*

	Plot				
Species	**1**	**2**	**3**	**4**	**5**
Cabbage tree	-	-	-	56%	75%
Carex sedges	14%	0	44%	0	0
Coprosma tenuicaulis	0	0	10%	100%	-
Flax	0	0	0	20%	0
Kahikatea	0	0	-	0	-
Manuka	0	0	0	0	0
Swamp maire	-	-	-	-	0

Browse on *Coprosma tenuicaulis* was identified as by hare or rabbit, being a clean cut to the stem (Plate 1), whereas browse on cabbage trees and flax was characteristic of stock damage (Plate 2). Carex damage could either be attributable to birds foraging (e.g. pukeko or ducks) or rabbits and hares (Plate 3).

Reproductive output
Carex, manuka and flax were the only planted species observed with flowers or seeds present. In each plot between 33% (plots 4 and 5) and100% (plot one) of manuka had produced flowers or seeds. Seeding Carex were most common in plots 2 and 3, 56% and 67% of plants respectively, but only around 20% in the other plots. Only three flax plants had produced seed, all in plot one (6% of flax in plot one).

Ground cover
The predominant ground cover for all plots was dead leaf litter except plot 5 where introduced plants had the greatest cover just ahead of litter (Fig. 7). Bare soil was the next most common cover in plot 4 whereas introduced plants were the second most common in plots 1, 2 and 3. A high percentage of groundcover appeared to have been sprayed recently (89-97%) in plots 1-4, explaining the predominance of leaf litter, whereas in plot 5 only 55% of the groundcover showed affects of spraying.

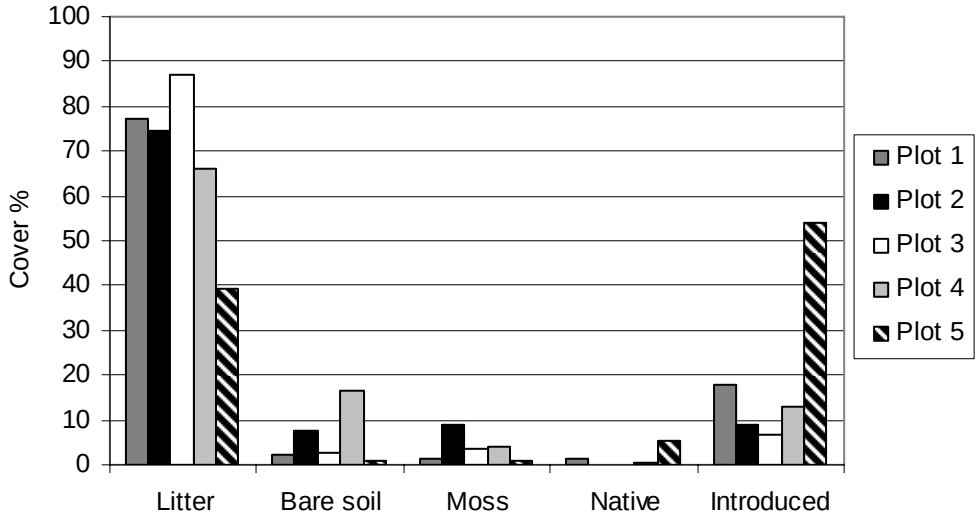


Figure 7: *Groundcover for each plot using transect point-intercept data.*

5. Conclusion and recommendations

These initial findings indicate that overall survival of plantings to date has been variable between species and planting zones, e.g. *Carex* sedges have a high mortality rate in the oldest planting. Some mortality and poor health may have been caused by spray drift from weed control, particularly for *Carex*, manuka, flax and *Coprosma*. Some manuka appeared to have snapped off due to exposure to strong westerly winds. Kahikatea have been staked and some staking may be required for other woody plants on the western edge until plantings thicken up.

Browsing impacts by several different animals were recorded, some of which may be reduced by management. Heavy browsing by hares or rabbits was recorded on several of the small-leaved shrubs (*Coprosma tenuicaulis*), in one case leading to plant death. Stock damage to cabbage trees was extensive and was occasionally noted on flax. Browsing damage noted at the base of some Carex sedges could have been caused by birds or hares and rabbits.

Some mortality is to be expected as the plantings establish however some measures can be taken to reduce deaths by careful management of plant and animal pests and planting in appropriate situations.

Plantings at Waiwhakareke are projected to achieve complete canopy cover around two years after planting. This should help to shade out some weed species and may allow further native plants to self-establish. Some recommendations are provided below:

- Monitoring of these plots (including photopoints) should be undertaken annually in the same season for the first five years, then at 5 yearly intervals.
- 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.
- Stock must be excluded from the planted areas completely.
- Rabbit and hare damage to small leaved shrubs (e.g. *Coprosma* sp.) can be reduced by planting older plants, using plant protection sleeves or by pest animal control.
- Weed maintenance by mulching around plantings may be less damaging than close spraying for sensitive species such as *Carex* sedges.
- Staking may be necessary for other young woody trees besides kahikatea in exposed situations.

6. Acknowledgements

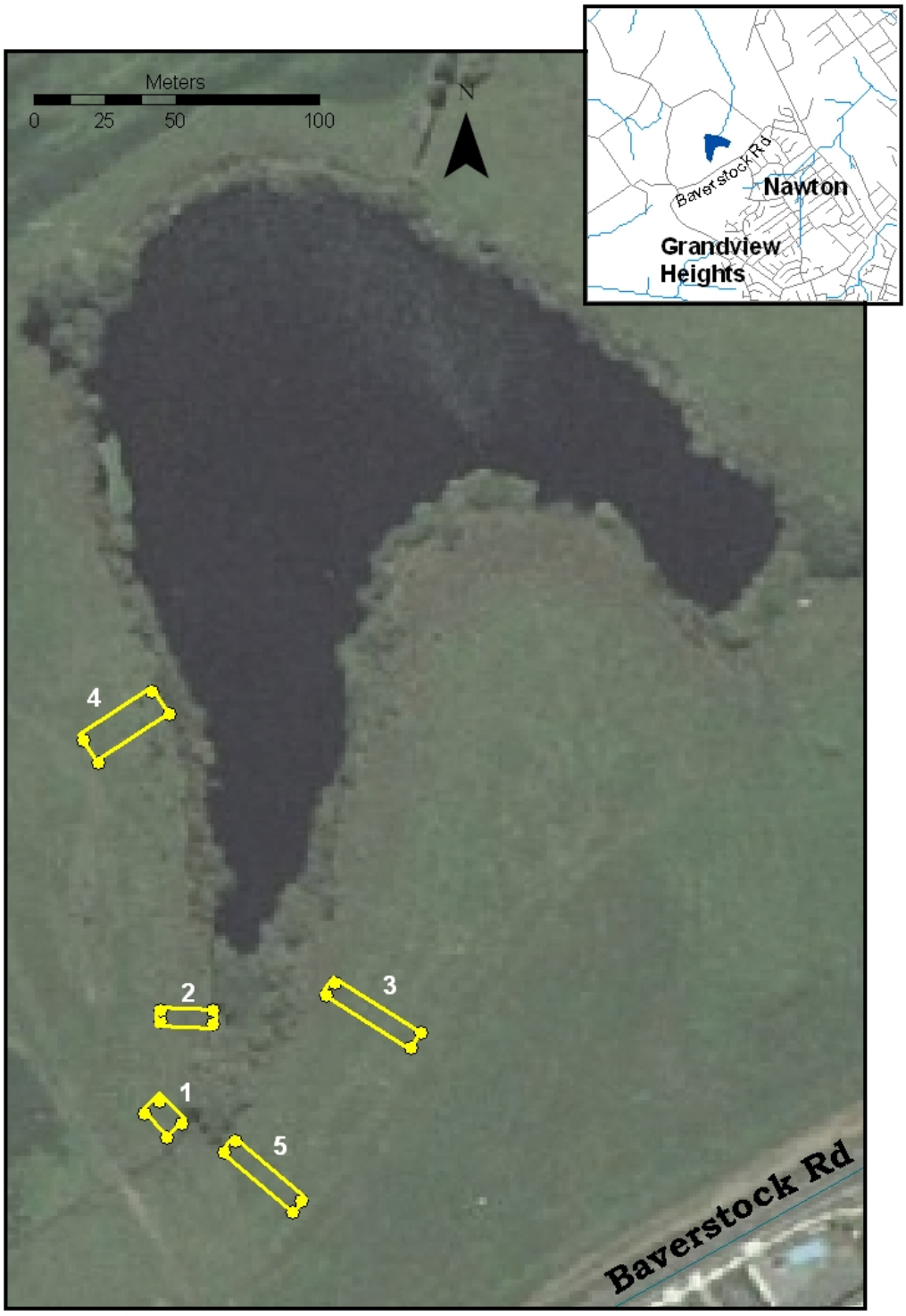
Some funding for this project came from FRST grant: Urban Restoration UOW X0501. Field data was collected by E. Grove and B. Paris. Thank you to G. Wiseman for access to the site and to D. Cartwright, G. Kelly and K. Pudney of Hamilton City Council for assistance with planting information. The map was produced by N. Caie at The University of Waikato. Photographs were taken by E. Grove.

7. References

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.

Plot 1: Three photos from corner A facing other corners.
Plot 2: One photo from corner A facing corner B.
Plot 4: Three photos from corner A facing other corners.
Plot 5: Three photos from corner A facing other corners.

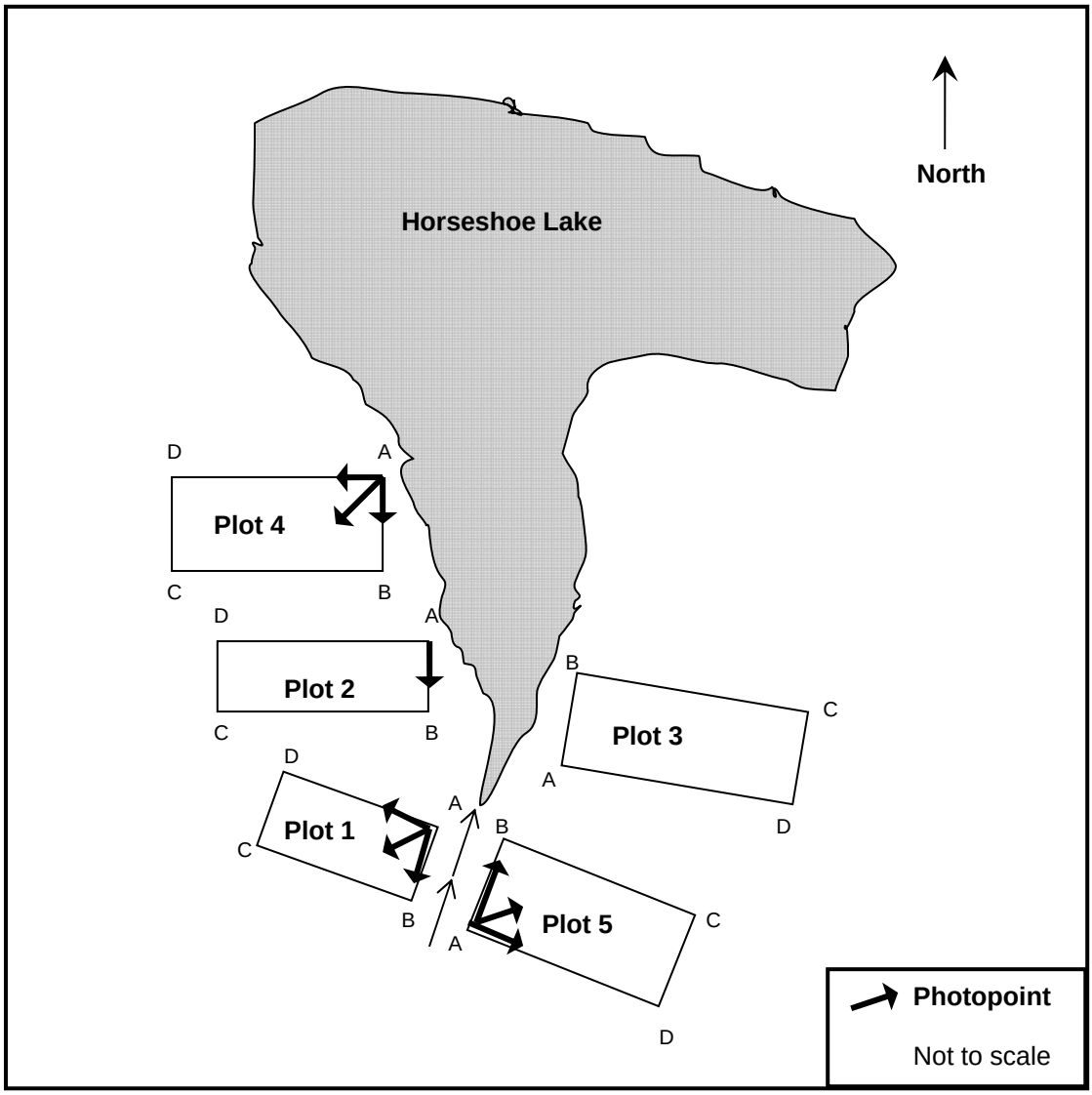


Plate 1: Hare browse on planted *Coprosma tenuicaulis*

Plate 2: Stock browse on planted cabbage trees.

Plate 3: Browse damage on Carex sedge (note healthy Carex in background with live weeds at base)