



ENVIRONMENTAL MANAGEMENT GROUP

Technical report

INTERNAL



SAFEGUARDING YOUR ENVIRONMENT + KAITIAKI TUKU IHO



Pekapeka Swamp Ecological Monitoring 2005

June 2006
EMI 06/09
HBRC Plan No. 3859

Environmental Management Group Technical Report

Internal

Environmental Monitoring Section

Pekapeka Swamp Ecological Monitoring 2005

Prepared by:
Geoff Walls – Consultant Ecologist

Reviewed by:
Anna Madarasz – Scientist Coastal Quality

Approved:
Murray Buchanan, Group Manager – Asset Management

June 2006
EMI 06/09
HBRC Plan Number 3859

PEKAPEKA SWAMP ECOLOGICAL MONITORING 2005

Contract document prepared for Hawke's Bay Regional Council



**Geoff Walls
Consultant Ecologist
5 Paulus Tce, Cashmere, Christchurch**

May 2006

CONTENTS

Introduction	3
1. Vegetation	4
1.1 Terrestrial vegetation	4
1.1.1 Vegetation map	4
1.1.2 Photopoints	4
1.1.3 Permanent vegetation plots	10
1.2 Aquatic vegetation	13
1.3 Weeds	14
1.4 Notable flora	15
2. Fauna	17
2.1 Waterbirds	17
2.2 Other birds	18
2.3 Fish	18
2.4 Aquatic invertebrates	19
2.5 Mammalian pests	20
2.6 Other fauna	21
Conclusions and recommendations	22
Acknowledgements	24
References and identification guides used	25
Appendices:	
1. Map of Pekapeka Swamp, showing vegetation types and monitoring site locations	26
2. Photopoint recording sheets, October 2005	28
3. Vegetation permanent plot recording sheets, October 2005	48
4. Aquatic vegetation and macroinvertebrate recording sheets, October 2005	53
5. Bird lists, October 2005	58
6. Other animal lists, October 2005	59

INTRODUCTION

Regular monitoring of ecological condition and trend is built into the planned management of Pekapeka Swamp, Hawke's Bay, by the Hawke's Bay Regional Council (Pekapeka Swamp Management Plan 1998-2003).

In November 1998, a plan for monitoring the ecological condition and trend of the swamp was produced on contract for the Hawke's Bay Regional Council by Geoff Walls. The intended next steps were to carry out baseline surveys and set up the monitoring system, guided by the plan.

Geoff Walls carried out those tasks – baseline surveys of vegetation and fauna, and establishment of the ecological monitoring system – in December 1998. In late November 1999, and again in late November-early December 2000, the monitoring done in 1998 was repeated, using the same sites and the same methods, and reported upon.

In late November-early December 2001, the monitoring programme was repeated for a third time. In addition, the opportunity was taken to familiarise new Hawke's Bay Regional Council staff with the monitoring regime and techniques. It was subsequently decided that annual monitoring was not required, and that the monitoring regime would be every two years. Accordingly, ecological monitoring of the wetland was carried out in early December 2003 and again in October 2005.

This document chronicles the monitoring results from October 2005 and draws comparisons with those obtained in 1998, 1999, 2000, 2001 and 2003.

1. VEGETATION

1.1 Terrestrial vegetation

There were three aspects to monitoring of the terrestrial vegetation of the swamp: assessment of the current vegetation cover via mapped patterns; re-examination of photopoints; remeasurement of permanent vegetation monitoring plots.

1.1.1 Vegetation map

Method:

The patterns of terrestrial vegetation were mapped in 1998 using recent colour aerial photos (August 1996, scale 1:6700). A monochrome copy of this map is shown in Appendix 1. A copy of the map was taken into the field so that any obvious changes could be detected. Re-mapping was scheduled for 2003, but was not carried out because a new aerial photograph was not available. The same applied in 2005.

Observations:

Until late 1999, the general overall trend throughout the wetland was of progressive loss of the indigenous wetland vegetation communities, and the increasing dominance of exotic willows. Direct evidence for that was obtained from the photopoints and vegetation plots. However, two management actions have reversed that trend. Fencing to exclude domestic stock has allowed the recovery of some communities, notably raupo and harakeke (lowland flax). The most dramatic change has been the death of most of the willow forest that occupied and dominated the wetland. Beginning in the south-east of the wetland in December 1999 using aerially-applied herbicide, this is part of the Hawke's Bay Regional Council's programme to remove the willows and restore native wetland vegetation. Subsequent control has used a combination of aerial herbicide application and ground control (cutting and poisoning). In most places the willow forest canopy has been killed or felled, although there are survivors in places (especially where a weaker herbicide mix was used) and some recovery has shown up (and been controlled by subsequent aerial and ground operations). Areas of raupo and purei (tussock sedge, *Carex secta*) have also been killed by the herbicide; they have shown little signs of recovery where the herbicide was strongly applied but have begun to recover elsewhere. Plantings (native trees, shrubs and harakeke) have been carried out in places on the wetland fringes and are starting to form discernable vegetation communities.

Next monitoring:

General observations in November-December 2007; re-mapping of the vegetation then too if appropriate aerial photograph available.

1.1.2 Photopoints

Method:

18 photopoints were set up the length and breadth of the wetland in 1998. Each was marked with a fence post: either an existing one or a new one driven in on site. Each post was tagged with an aluminium label. The photopoints were chosen to represent

the spectrum of terrestrial vegetation types and situations in the swamp. They were also selected to be readily relocated. Photos were taken from the standing position at each photopoint: mostly panoramas of the vegetation; some more localised and specific. A SLR camera with a 50mm lens was used. Film was Kodak colour print, either 400asa or 200asa. The photopoints were photographed again in late November 1999, in late November-early December 2000, in late November-early December 2001, in early December 2003 and again in October 2005. The latter photos, in order, are in the album that accompanies this document, and are also supplied digitally on CD.

The location of each photopoint is marked on the map (Appendix 1). It is also described on the photopoint recording sheet (one for each photopoint, Appendix 2). Also on each sheet is a description of the vegetation and the ecological patterns and processes occurring there.

Observations:

Photopoint 1:

The NE portion of the swamp was used by stock in 1998 and 1999, but was fenced off in 2000. As a consequence, the grass initially became ranker and blackberry increased. There was marked growth of willows, especially young plants. Harakeke (lowland flax) remained in good condition. In 2001, the trends evident in 1999 and 2000 had clearly continued. Willow had continued to expand, and the harakeke was flowering intensely. Goats (apparently semi-domestic, but not confined by the fences) were present, as in previous years, but were not adversely affecting the native vegetation significantly. In 2003, the goats had gone and the willows had been aerially herbicided and/or cut. The herbicide had killed the crack willow trees but not the grey willows, and in the cutting zone there were still some smaller willows. The harakeke was again flowering profusely, blackberry was mostly killed and convolvulus was locally common. In 2005, the adult willow trees were collapsing, although saplings were still present. Harakeke and raupo looked healthy. Blackberry and convolvulus were locally abundant. At the N end a strip had been fenced and one drain had been filled.

Photopoint 2:

As Photopoint 1. Real progress was now evident towards restoration of a more natural wetland ecosystem. Standing water was visible in several places. Raupo, purei (tussock sedge) and marsh clubrush appeared to be expanding.

Photopoint 3:

Similar to Photopoints 1 and 2. Excellent control had been achieved of adult willows and the previous crop of young, but regeneration of saplings and seedlings had occurred so would need to be followed up. Standing water had substantially increased, and was becoming vegetated with watercress. Raupo had continued to expand into areas "freed up" by willow control. The lone cabbage tree was healthy. Marginal plantings were beginning to show up.

Photopoint 4:

Grey willow adults had been herbicided and bulk killed, but there was substantial regeneration (saplings and seedlings).

Photopoint 5:

In 1999, a dramatic change since 1998 was evident. The rare native swamp nettle (*Urtica linearifolia*), abundant in 1998, had been virtually extinguished from the site. Most of the large clumps had gone without trace, and a little live growth was found only at the base of the marker post. Compared with 1998, there was less bare ground and more willow weed, watercress and grasses. In 2000, further dramatic change to the site was apparent. Raupo had grown and thickened markedly, and no swamp nettle (either seedlings or older plants) could be found anywhere in the vicinity. These changes were probably the result of exclusion of stock (particularly cattle) and standing water having been on the site for prolonged periods. In 2001, the raupo had grown so tall the marker post was almost invisible. Much willow weed (*Polygonum salicifolium*), beggars' ticks (*Bidens frondosa*) and creeping bent (*Agrostis stolonifera*) had also grown up on site, and nearby willow trees were reaching branches out to the site. A few sedges were becoming established. No sign of swamp nettle was found whatsoever. An extra photo of the site from the fence was taken, in order that the future progress of the raupo and willows could be followed more readily. In 2003, still another dramatic change had occurred in this dynamic site. The willows (except grey willow) had been killed. The raupo had been knocked hard but was regenerating. The site was wetter than before. Swamp nettle had bounced back, but sedges (*Carex secta* and *C. geminata*) had disappeared. In 2005, the adult willows had collapsed, but there was substantial regeneration (resprouts, saplings and seedlings), requiring follow-up control (considerable but ecologically worthwhile). Raupo had regenerated and expanded dramatically. Swamp nettle had diminished but was still present. There had been terrific growth of creeping bent, and some regeneration of *Carex secta*.

Photopoint 6:

In 2000, recent fencing had changed the face of this site. As a result, the exotic grassland was becoming rank, raupo was advancing and thickening and the purei (*Carex secta*) were bigger and healthier than in 1999. The cabbage tree, although healthy, was beginning to be smothered by adjacent willows. In 2001, these processes had continued, the raupo having advanced significantly and the cabbage tree becoming enveloped by willows. A nearby willow tree and some of the raupo looked unhealthy, as though affected by local herbicide application. In 2003, most willows had been killed but the marginal ones not sprayed were still alive. They would be best controlled using ground methods because of the healthy raupo, cabbage trees and purei there. In 2005, the cabbage trees were still healthy. Much willow growth had occurred along the edge, the willows expanding fast and needing to be dealt with sooner than later. Standing water was now visible as dead willows collapsed.

Photopoint 7:

In 2001, the situation at this site was similar to that in 2000, with tall rank grasses dominant and some additional growth in willows and blackberry. A couple of willow trees on this margin showed signs of defoliation as though from local herbicide application. In 2003 the big willows had been mostly killed, but young willows were invading a former area where stock had been corralled. Because of the good raupo regeneration there, follow-up ground control of willows was recommended. In 2005,

willow regeneration and growth was spectacular and prolific, especially to the south. Urgent control would be required to prevent further major re-invasion.

Photopoint 8:

In 2001, little change from the situation in 2000 was evident, other than a continuation in the growth of young willows, less dead raupo and slightly more floating vegetation on the open water. Dead willow forest, herbicided in December 2000, was now visible in the background. In 2003 there was a massive change, with the big crack and grey willows cut either side of the railway and raupo, purei, weeping willows and cabbage trees healthy. In 2005, regeneration was evident amongst willows cut in the past. Raupo and *Carex secta* thickets were still healthy. There was a dense cover of *Lemna* and *Azolla* on the water in places, open elsewhere. Ducks and black swans were present.

Photopoint 9:

This site had been aerial herbicided up to and in part in December 2000. As a result, in 2001 the willows and raupo had been killed (but not completely) at the southern end of the open water. There was virtually no floating vegetation (duckweed, azolla, etc.), unlike in previous years. In 2003 there was a huge change brought about by the cutting out of the willow forest. The open water was again covered in duckweed and azolla. This is the largest body of open water in the wetland and at the time of visit was being used by many aquatic birds. In 2005 willow regeneration had continued (needed some mopping up). Raupo had expanded. There was more open water, used by ducks and swans. Dense marginal growth of an annual herb had occurred, but had died off.

Photopoint 10:

In 2001 this site looked like a plant graveyard, having been blanket sprayed with herbicide in December 2000. Most of the willows and all of the raupo and purei (*Carex secta*) were dead, the only living aquatic vegetation being a dense floating cover of duckweed. The cabbage tree had survived, but looked distinctly unwell. In 2003 there had been good purei regeneration and the cabbage tree was healthy again. The pa site had been accidentally burnt. In 2005 purei regeneration had continued. There was a little willow regeneration. Dense marginal growth of an annual herb had occurred but had died off. The pa site had reclothed in exotic grasses and herbs following burning. Only native duckweed (*Lemna minor*) was on the water.

Photopoint 11:

In 2001 the willows and raupo at the site had been killed by the aerial herbicide application of December 2000, and the only living vegetation there was water speedwell (*Veronica anagallis-aquatica*), grown up since. The pa site itself was clad in rank grasses and pasture herbs, although in use by cattle. In 2003 there was little change except some willow regeneration (none of raupo). In 2005, willow regeneration had been mopped up with control. Raupo and purei had yet to reappear. There was much new growth of celery buttercup (*Ranunculus sceleratus*), watercress and veronica.

Photopoint 12:

In 2001 the willows, purei and raupo at the site had been killed by the aerial herbicide application of December 2000. Watercress and celery buttercup (*Ranunculus*

sceleratus) were growing lustily in the wet places, and oxtongue, thistles and rank grasses were dominant on the margin that was grazed pasture prior to stock being fenced out (in 1998). In 2003 there was dramatic growth of seedling grey willow, not previously evident, already forming small trees. Some regeneration of raupo and purei had occurred. In 2005, most willow regrowth has been killed. Raupo had been knocked back but was recovering. Purei was recovering where not killed outright by past spraying. Rank ex-pasture would be a good place for revegetation.

Photopoint 13:

In 2001 there was a dramatic difference at this site. There was standing water in 1999 (it was dry in 1998). There was a big recovery in raupo and marsh clubrush then too, following relief from stock impact. There had been much peripheral growth in willows. In 2000, yet another dramatic difference was apparent. The raupo had largely been cut down only the previous day, to provide open water for duck shooting. Otherwise, the willows had continued to grow considerably. This site was just outside the area treated with herbicide in late 1999, but was within the area treated a year later, though the pond itself (or at least parts of it) was deliberately avoided. As a result, the surrounding willows, raupo and purei had been largely killed, whilst some purei and raupo in the pond were unaffected. Significant numbers of the sprayed willows had survived and require follow-up control. The water appeared higher than in 2000, and was covered in floating duckweed and azolla. Flourishing swamp nettle was found on nearby big purei tussocks killed by the herbicide. The situation in 2003 was similar, with some purei survivors but no raupo regeneration. In 2005, there was quite a lot of willow regeneration, though some had been controlled. Raupo was recovering and there was some purei recovery. Planted harakeke had grown somewhat.

Photopoint 14:

This area had been herbicided in late 1999, just after the monitoring visit. As a result, the willows and raupo had been mostly killed, except for a missed strip, and in 2000 the purei looked dead and not likely to recover. The area appeared wetter than in 1999, with open water covered in duckweed and azolla. In 2001, there had been significant recovery in the willows and the appearance of seedlings and saplings, requiring follow-up control. However, no recovery in raupo was evident, but some young plants of purei had appeared. There was more standing water than in the previous year. In 2003 there had been continued regeneration of both willows and purei, but none of raupo. The water level was higher than in 2001. A bittern was seen at the site, the first sighting in the wetland since survey and monitoring began in 1998. In 2005, most willow regrowth had been killed, but a lot had been missed along the edge. Most purei was looking healthy still, but some had died.

Photopoint 15:

This area too had been herbicided in late 1999, with consequent death of willows except on the edges where the herbicide had been less effective. In 2001, the edge willows were mostly alive and well. Some raupo was alive too, but considerably less than prior to the herbicide application. There was little change in 2003. In 2005, the edge willows had been killed and the long dead willows were collapsing. No raupo could be seen on the edge. Some cabbage trees and purei had survived the application of herbicide and looked okay, but other cabbage trees were stone dead.

Photopoint 16:

What was a virtually dried-up area covered in pink azolla in 1998 was an open water pond with little floating vegetation in 1999. There had been considerable advance of raupo and willows (both seedlings and basal sprouts). Purei looked very healthy, although it was being invaded by willows (a problem) and raupo (not a problem). By 2000, a spectacular change had been brought about by the application of herbicide in late 1999. The willows had been largely killed, and the formerly lush raupo and purei were devastated. Some purei recovery was evident, but most tussocks appeared to have been killed. In 2001, only a little recovery of the formerly luxuriant purei had occurred, but there had been significant regrowth of willow. The pond surface was covered in floating plants (duckweed, azolla, etc.) and there was a proliferation of fleshy introduced herbs (watercress, sow thistle and water speedwell). In 2003, there had been good recovery of purei but none of raupo. There was much willow regeneration around the pond. The site was hard to reach because of higher water levels, fallen willows and the derelict boardwalk. In 2005, the boardwalk had been reconstructed (using some of the vegetation plot corner posts!). Purei recovery had continued, but no raupo had yet reappeared. Willow regrowth had been mainly taken care of, but there was still a little. Water was covered by *Azolla* and *Lemna*. A bittern was heard booming to the north.

Photopoint 17:

Massive change had taken place on this site. Water channels, open and herbicided in 1998 but regrown with herbaceous plants in 1999, were choked with watercress, water speedwell and green algae in 2000. These indicated that water flow had been minimal and that there had been a high nutrient loading. The willows at the site had been cut and poisoned since 1999. In 2001, the situation was similar, with the waterways choked and stagnant. An electric fence had been erected to keep stock out, but in the process the adjacent pa site had been damaged by bulldozing. The only bright spot was the discovery of swamp nettle on willow stumps in the vicinity. Otherwise, without a significant increase in water flow, it will be hard to view this site with much sense of ecological improvement in future. The photopoint site was changed by necessity in 2001 because the works had made it extremely difficult to reach the original site. In 2003 a small bridge allowed access to the original photopoint site again. The waterways were less stagnant but had more macrophytes, crack willow had regenerated much, requiring ground control, and the planted harakeke and cabbage trees were looking well. In 2005, the original photopoint was accessible. The vegetation appeared much as in 2003, though *Potamogeton crispus* was less visible. The high nutrient loading of the waterways was evident in the prolific macrophytes. Willow regrowth had been controlled effectively. Planted cabbage trees and harakeke were struggling, with some losses.

Photopoint 18:

This area was herbicided from the air in December 2000. This killed most of the willows, although there was some survival and recovery. In 2001 the cabbage trees, formerly luxuriant, were looking distinctly unwell, and the raupo had been killed in places. Purei had also died where exposed to herbicide, but was flourishing otherwise. In 2003 some willows were still alive and saplings were growing up, but the dead original canopy trees were collapsing. The recovery of purei and raupo was marked, and the cabbage trees looked better. In 2005, the willow trees were all dead and

collapsing. Saplings had grown appreciably in 2 years and more had shown up (both species). Cabbage trees seemed okay. Raupo and purei had continued to recover and were very healthy. Planted harakeke had grown.

In summary, in 2001 the photopoints showed that the processes producing changes apparent in 1999 and 2000 had mostly continued. Overall water levels in the swamp were similar to those in 2000, except that in the upper portion of the wetland they appeared to be a little higher. This may be a reflection of another fairly damp spring-early summer. It could also be a desirable by-product of recent extensive willow control in that part of the wetland. However, lack of water flow was still a problem. The relief from stock in most places had allowed recovery in native plants, and growth in exotics as well, including willows. The continued advance of uncontrolled willows, obvious in 1999 and 2000, was again dramatically evident. The sudden death of willows, raupo and purei at the SE end of the wetland following aerial herbicide application in December 1999 and December 2000 was even more visually spectacular.

In 2003, the previous observations were reinforced. There was more spectacular change, especially in the northern half of the wetland where aerial spraying and ground cutting of the big willows had recently been carried out. The persistence of some willows and subsequent recovery is partly due to the herbicide being of insufficient strength to kill grey willows, and also due to the resilience of both grey and crack willows. It indicates the need for follow-up control: aerial herbicide application where there is little native vegetation; ground control elsewhere. The recovery of raupo, purei and cabbage trees following initial herbicide damage is heartening. It is clear though that if the herbicide is strong enough to kill willow trees outright, then the raupo and purei suffer badly and may take many years to recover. Overall, the photopoints have continued to prove valuable in demonstrating ecological change and in giving insights into the processes involved.

In 2005, the previous trends had continued. Willow control has been effective in most places, but mopping up of regeneration is still necessary, especially in the lower middle section of the swamp. The concentration of applied herbicide is clearly important in both willow control and “collateral damage” to native vegetation. Cabbage trees, purei, raupo and other native plants have been killed in many places, but overall the photopoints indicate that the restoration process towards a more natural wetland ecosystem is on track. There is more standing water, just because of the control of willows (that act as “water pumps” when alive), making the conditions better for waterfowl and frogs. Natural regeneration of native vegetation will gather momentum once the mass willow destruction phase is over and plantings begin to grow up and contribute sources of seeds to the wetland.

Next monitoring:

November-December 2007; thence biennially. Photos to be repeated; recording sheets to be used.

1.1.3 Permanent vegetation plots

Method:

Four permanent vegetation monitoring plots were established in 1998 at sites chosen to represent the main parts of the swamp. Their locations are marked on the map (Appendix 1), and described on the vegetation plot recording sheets (one for each plot, Appendix 3). Each plot is a 20m x 20m square, defined by a fence post at each corner. Each post has an aluminium label, and some have orange collars for ease of relocation. At each plot, the vegetation composition was described in structural tiers, using the recording sheets. The ecological processes on site were also outlined. Photos were taken to portray each plot: these are in the album with the photopoint photos.

Observations:

Vegetation Plot 1:

NE corner of the wetland. In 2000, comparison of photos showed little discernible difference from the 1999 condition. Field examination of the plot vegetation showed that there had been continued growth in grey (pussy) willow and expansion of blackberry, Japanese honeysuckle and convolvulus. Few stock had visited the site recently, just the occasional wandering goat. In 2001, the situation was very similar. Grey willow had continued to grow markedly, and there had been continued expansion of the vines, especially Japanese honeysuckle. Recovery in purei (*Carex secta*) was notable, and some ferns had appeared. Raupo, sedges and harakeke (lowland flax) had increased at the expense of rank grasses. The harakeke was flowering profusely. In 2003, the willows had been cut but regeneration was happening quite rapidly, requiring follow-up ground control. Purei was healthy and the harakeke, the chief beneficiary of willow control, was expanding at the expense of raupo. Convolvulus, Japanese honeysuckle and blackberry were still increasing. In 2005, things were similar, but the willows had been well controlled with only a little regeneration requiring follow-up control. The harakeke had continued to flourish and raupo was still plentiful. Japanese honeysuckle was expanding fast, indicating that specific control of this smothering weed will be required.

Vegetation Plot 2:

NE side of wetland. In 2001, both the photos and plot examination showed substantial change since 1998, a continuation of the trend observed in 1999. There had been continued growth in size and extent of the grey (pussy) willow. However, there were fewer willow seedlings, possibly because of competition from rapidly-growing raupo. As predicted, raupo had grown markedly, both in height and in density, since relief from cattle use of the site. The large old purei, although not visible in the 1999, 2000 or 2001 photos because of raupo growth, were still healthy. This part of the wetland was now fully fenced to exclude stock. Aerial control of the willows was carried out in 2002 and in 2003 most of the willows, raupo and purei (including the big old clump) had been severely knocked back but the raupo and a lot of the willow had regenerated rapidly. A repeat aerial herbicide application was recommended. In 2005, there was still some willow regeneration requiring control. Raupo had yet to reassert itself but purei was regenerating. There had been a proliferation of exotic pasture grasses (especially Yorkshire fog).

Vegetation Plot 3:

SW end of wetland, across a pond from a well-used maimai. In 2001 there was a dramatic change since the 2000 visit, brought about by the death of the willow forest

from aerial herbicide application in December 2000. Smaller willows adjacent to the pond (which wasn't sprayed) had been cut by hand. Cabbage trees caught by the spray were looking ill. Raupo was healthy had continued to advance. Purei and swamp nettle (*Urtica linearifolia*) had continued to recover well from previous clearance and burning. The swamp nettle appeared to be mostly now growing on purei tussocks, out of water reach. The water level was higher than that in 2000, probably the result of the willow death (stopping them acting as evapotranspiration water pumps). An Australasian bittern was heard booming just to the south. The planted silver willow (*Salix alba* var. *alba*) at the northern end of the pond was in seed and has the potential to spread. This site showed that the use of fire as a tool to control raupo had considerable advantages over the use of herbicides; it merely removed the bulk of dead matter without killing the plants. Purei also appeared to survive burning, and the burnt trunks provided new sites for swamp nettle seedlings. In 2003 the water level was higher still; too high to allow the plot to be reached. The cabbage trees had recovered, there was only a little willow left alive and a turf, maintained by waterfowl, had formed on the edge of the pond. As before, the silver willow was deemed a threat and though attractive was recommended for removal before it seeded and spread about the wetland. In 2005, things were much as in 2003, with the elevated water level preventing more than a visual inspection of the plot from across the pond. Water celery (*Apium nodiflorum*) had proliferated in the vicinity. The cabbage trees had died as a result of the herbicide onslaught on the remaining live willows (also now dead), but purei and raupo were healthy. Swamp nettle was still present. A spotless crane was heard. **The recommendation to remove the silver willow had still not been heeded, and this plant remains an ecological threat to the wetland.**

Vegetation Plot 4:

SE end of wetland in willow forest. This site showed the most dramatic change in 2000, because of the aerial herbicide application in December 1999. With almost complete death of the willow canopy, the forest floor had been exposed to far greater light levels. This had led to a proliferation of dock, thistles, fireweed, cleavers, water speedwell and other opportunistic exotic herbs. It also seemed to have favoured swamp nettle, of which there were many seedlings and flourishing older plants. There was significant recovery in the willows, but cabbage trees in the vicinity had been killed. Purei and *Carex virgata* seemed to have been initially killed by the herbicide, but *Carex virgata* had regenerated considerably since. Vine weeds, especially blackberry and Japanese honeysuckle, had been severely knocked back by the herbicide but not killed, and had since proliferated at the site. Two previously undetected plants were found in the plot in 2000, both revealed by the herbicide-induced dieback: a pampas plant, now dead; several shrubs of a garden escape (strawberry dogwood, *Cornus capitata*), recovering from herbicide damage. The dogwood was still alive in 2001. The water level was higher in 2001 than previously. In 2003, the water levels were still higher, making access to the plot difficult. A welcome range of native plants had established: purei, *Carex virgata*, *C. lambertiana*, karamu, cabbage tree, swamp nettle and toetoe. The vine weeds had increased somewhat but the strawberry dogwood had disappeared (probably because it was too wet for it). In 2005 the plot had been demolished by whoever used and maintained the boardwalk: three of the corner posts had been pulled out and used in the boardwalk, despite being clearly marked! Elevated water levels meant that the plot could not be re-measured anyway, probably now better serving as a photopoint. It presented as a

death zone, with the dead adult willows largely collapsed and the regrowth sprayed and killed, at the same time killing the previously good regeneration of purei, cabbage trees, toetoe and karamu. Swamp nettle was still present, but Japanese honeysuckle was still plentiful and will probably need to be killed using herbicide. The prolific growth of watercress, buttercups and other exotic herbs was probably a reflection of the nutrients released into the water by the decaying willows.

Next monitoring:

November-December 2007; thence biennially. Photos to be repeated; recording sheets to be used.

1.2 Aquatic vegetation

Method:

The composition of the aquatic vegetation was assessed at four sites, chosen in 1998 to represent the main parts of the swamp. Macroinvertebrate sampling and fish surveys were done at these sites too. The site locations are marked on the map (Appendix 1) and described on the combined aquatic vegetation and macroinvertebrate recording sheets (one for each site, Appendix 4).

Samples from each site were examined in the field using plastic buckets and trays. The aquatic macrophytes present were identified, and their relative abundances were recorded. Macroinvertebrates were searched for in each sample (see 2.4), and their standard sensitivity scores recorded to give a measure of water quality.

Observations:

All the macrophytes recorded in 1998-2003 – native duckweed (*Lemna minor*), the floating fern *Azolla filiculoides*, the tiny floating plant *Wolffia australiana*, exotic duckweed (*Spirodela punctata*), willow weed (*Polygonum salicifolium*), watercress (*Rorippa nasturtium-aquaticum*), hornwort (*Ceratophyllum demersum*), water speedwell (*Veronica anagallis-aquatica*) and curly pondweed (*Potamogeton crispus*) – were still present in 2005.

Comparisons between 2003 and 2005 were noted at each site in terms of the relative abundance of the species:

Site 1: less watercress, curly pondweed, *Azolla filiculoides* and native duckweed, but more green alga. *Callitriche stagnalis* now established. These apparent changes may reflect the 2005 survey being earlier in the season, but are probably more a reflection of the removal of shade (old willows) and mechanical cleaning of the channels.

Site 2: Mercer grass, creeping bent, *Veronica anagallis-aquatica*, water pepper and watercress had established since 2003; water levels were higher and pond quality had improved with willow control.

Site 3: not much change, just a proliferation of water celery in the vicinity.

Site 4: less hornwort, curly pondweed and watercress; more *Veronica anagallis-aquatica*. Less stagnant than in the past: still a high nutrient input (resulting in prolific macrophytes) but a better water flow regime.

Overall, the changes seem to have favoured exotic aquatic plants, perhaps because of their quicker and positive response to elevated nutrient and water levels. It will be interesting to see if this trend continues or is reversed in future, as the wetland settles into a more natural ecology.

Next monitoring:

November-December 2007; thence biennially. Sampling to be repeated; recording sheets to be used.

1.3 Weeds

Method:

Weeds were searched for during the survey and monitoring of both the terrestrial and aquatic vegetation (1.1, 1.2). Their presence and impact were noted.

Observations:

The following terrestrial weeds, regarded in 1998, 1999, 2000 and 2001 as requiring surveillance, were confirmed as ongoing pests in 2003:

Willows (all three species), invading indigenous communities;
 Japanese honeysuckle (*Lonicera japonica*), invading all communities except open water;
 Buddleia (*Buddleja davidii*), present on the NE margin;
 Bindweeds (*Calystegia silvatica* and *Convolvulus arvensis*), abundant around the margins;
 Blackberry (*Rubus fruticosus* agg.), common in all communities except open water;
 Stinking iris (*Iris foetidissima*), present in the south and middle under willow.
 Ivy (*Hedera helix*), climbing on trees at former "dump site" adjacent to highway on western side near hives and aquatic sampling site 2;
 Elderberry (*Sambucus nigra*), a single plant found at pond/maimai in SW (aquatic sampling site 3);
 Beggars' ticks (*Bidens frondosa*), initially found in SE end (vegetation plot 4), now common throughout;
 Celery buttercup (*Ranunculus sceleratus*), common throughout;
 Silver willow (*Salix alba* var. *alba*), planted trees at northern end of pond with maimai in SW (aquatic sampling site 3);
 Pampas grass (*Cortaderia selloana*), a spray-killed plant found at vegetation plot 4 in the south of the wetland, others likely to be present or to arrive from wind-blown seeds.

Two new weeds were found in 2003:

Smilax (*Asparagus asparagoides*), a scrambling plant very hard to control once established, found dumped with garden waste at the maimai access in the SW of the swamp;

Spindle tree (*Euomyzus europaeus*), a small tree garden escape, found near the burnt pa site in the central part of the wetland.

Strawberry dogwood (*Cornus capitata*), a garden escape found in SE end (vegetation plot 4) in 2001, appeared to be no longer present.

In 2005, the list of terrestrial weeds was essentially the same, although smilax and spindle tree were not seen this time. Japanese honeysuckle and willows remained the two greatest weed management problems. Silver willow still needed to be eliminated before it becomes invasive. Pampas appeared to be increasing, although it was still in low numbers. An additional weed was found:

Periwinkle (*Vinca major*), present in the mid section of the wetland, on the highway side. This creeper has the capacity to spread quite quickly, but is readily controlled with herbicide.

The following aquatic weeds were confirmed as requiring surveillance:

Purple-backed duckweed (*Spirodela punctata*), that could displace the native floating species;

Curly pondweed (*Potamogeton crispus*), dominant in places;

Hornwort (*Ceratophyllum demersum*), apparently only present in the south end so far.

Water net (*Hydrodictyon reticulatum*), not yet detected, but present upstream in Lake Poukawa and downstream in Karamu Stream.

Next monitoring:

November-December 2007, along with other vegetation monitoring; thence biennially.

1.4 Notable flora

Method:

During survey and monitoring in 1998, swamp nettle (*Urtica linearifolia*) was discovered. This endemic species is listed as nationally threatened (Molloy and Davis 1994; de Lange et al 2004; Hitchmough 2002). It is known from a handful of other wetland sites in the Hawke's Bay lowlands, including Lakes Poukawa, Hatuma and Runanga. Since it is plentiful throughout Pekapeka Swamp, in a range of different situations, the only monitoring required is general annual observation of its distribution, relative abundance and condition. This was done in 1999, 2000, 2001, 2003 and 2005. Photographs of swamp nettle are in the 1998, 1999, 2000, 2001, 2003 and 2005 albums with the photopoint and vegetation plot photos.

An eye was kept open during survey and monitoring for any other notable plants.

Observations:

Swamp nettle was found to be still generally plentiful and widespread in Pekapeka Swamp in 2005. It had recovered from the decline noted in 2001 at the NW end and from near Photopoint 5 on the eastern side. The species was still flourishing elsewhere, including within the areas herbicided in December 1999 and subsequently. It is not clear what impact repeated follow-up herbicide application might have on the

swamp nettle, or even whether or not it is affected by the herbicide used. It is possible that it has survived the aerial applications because it was sheltered by taller vegetation or can regenerate rapidly from seeds. It is evident that it can persist in localised places that are burnt and cut on occasion, perhaps because its seeds are water-borne and resilient.

No other notable flora was detected in 2005.

Next monitoring:

November-December 2007, along with other monitoring and via photopoint 5 and vegetation plots 2, 3 & 4; thence biennially.

2. FAUNA

2.1 Waterbirds

Method:

Two methods were used:

1. **Crepuscular searches**, whereby a number of sites around the swamp were visited at dawn and dusk to listen for crakes, rails and bitterns. Taped calls were played to elicit responses. The search sites are marked on the map (Appendix 1).
2. **General fauna survey**, whereby waterbirds were searched for during other survey and monitoring activities.

Observations:

No definite detections of crakes or rails were made in 1998-2003. The survey time (November-December) was probably too late in the birds' breeding season for strong responses to taped calls to be expected and traffic noise was invariably disruptive to good listening. Discussions with wetland bird experts also suggest that the technique is a bit hit-and-miss: it can be highly successful where birds are numerous or tapes are played in their immediate territories, but it can draw a blank where birds are uncommon or taped calls are played on their territorial margins. This suggests that there are very few such birds remaining in Pekapeka Swamp. Less effort was expended on the crepuscular search method in 2003 and 2005 accordingly. However, a call that was almost certainly that of a spotless crane was heard at the pond used for aquatic sampling and vegetation monitoring in the SW of the wetland on 4 October 2005. Spotless crane have been suspected to be present there during previous monitoring but not confirmed.

The booming call of a bittern was heard at the southern end of the swamp on 29 November 2001, a year almost to the day after hearing one booming in the same place. Probably the same bird was again heard on a brief visit on 14 December 2001, suggesting there may be a pair rather than individuals just passing through. On 5 December 2003 a bittern was seen in the SE of the wetland at Photopoint 14. This was the first actual sighting of the species in the wetland since survey and monitoring began in 1998, and suggested that at least one pair was resident in the wetland and could be breeding there. On 6 October 2005 a bittern was heard calling from the same vicinity, possibly the same resident bird seen and heard in previous years.

15 species of waterbirds were recorded during general fauna survey, out of a total of 34 bird species. The corresponding figures for 1998 were 16 and 34 respectively, for 1999 were 12 and 30, for 2000 were 16 and 35, for 2001 were 16 and 34 and for 2003 were 16 and 35. Not detected in 2005, but previously detected, were pied stilt, black-fronted dotterel and NZ dabchick. This is no cause for concern, because these species are transient rather than resident, so their detection requires a certain amount of luck. NZ kingfisher appeared to be back up in numbers after an apparent dip in 2001.

The full list of birds and their estimated numbers is in Appendix 5.

Next monitoring:

November-December 2007; thence biennially.

2.2 Other birds

Method:

General fauna survey, whereby birds other than waterbirds were searched for during other survey and monitoring activities.

Observations:

19 species of other birds were recorded during general fauna survey, out of a total of 35 bird species. These were the same species as recorded in 2003. Most were exotic species. The native species were shining cuckoo, riroriro, fantail and silvereye. There were no significant differences in estimated numbers between 2003 and 2005. Although the numbers of finches appeared to be lower, that probably reflected the earlier time of monitoring in 2005. The full list of birds and their estimated numbers is in Appendix 5.

Next monitoring:

November-December 2007; thence biennially.

2.3 Fish

Method:

Fish were surveyed largely using netting and trapping. Fyke nets, hinaki and minnow traps were set overnight at either end of the wetland (two of the four aquatic sampling sites; for locations, see map, Appendix 1, and aquatic vegetation and macroinvertebrate recording sheets, Appendix 4). Meat was used as bait in the fyke nets and hinaki; vegemite was used as bait in the minnow traps. Fish were also observed in open water sites. Because of past difficulty of setting nets at Sites 2 and 3, only the other two sites were concentrated on for net fishing.

Observations:

The fish caught were:

- Shortfin eel (*Anguilla australis*): a single fish 40cm long was caught at the north end of the swamp (Site 1), and two fish (40cm and 60cm long respectively) were caught at the southern end only; numbers appear to have been substantially lowered by commercial harvesting in recent years. Commercial eeling was carried out in the southern end of the swamp without HBRC knowledge or permission in late 2001, and may have continued since.
- Longfin eel (*Anguilla dieffenbachii*): none caught. This species is in serious decline nationally because of unrestrained commercial eeling.
- Mosquito fish (*Gambusia affinis*): native to the Gulf of Mexico; recorded from Pekapeka Swamp for the first time in 1998; very common at the N end of the swamp, as in 1998, 1999, 2000, 2001 and 2003. In 2005, found in the centre of the wetland on the eastern side, but below the proposed weir site. It seems inevitable

that they will colonise the extent of the swamp and have a negative effect on native fish and invertebrate populations, but hopefully with raised water levels and quality their main impact will be confined to shallow nutrient-rich places.

Not recorded in 2005, but recorded in the past, were:

- Inanga (*Galaxias maculatus*): seen at Site 1 (N end of swamp) in 1998 and 1999, but not seen in 2000 or 2001. Possibly stopped by a downstream barrier, or ousted by mosquito fish.
- Common bully (*Gobiomorphus cotidianus*): previously abundant at the southern end of the wetland, but not detected in 2005. Numerous were seen and caught in minnow traps at Site 4 in 2003 and recorded from there in 1999, 2000 and 2001. The significance of this apparent loss or radical decline is not clear, and needs further investigation.

Not recorded during this survey, but recorded in 1984 by electric fishing (Hooper et al 1986), was:

- Goldfish (*Carassius auratus*): erroneously known as carp (McDowall 2000); found in the past at the south end of the swamp but not in recent times.

In summary, there appears to have been a serious decline in the numbers of all native fish (eels, bullies and inanga) in the wetland in the last 7 years. It seems clear that commercial harvesting is responsible for the eel decline, but just what has affected the bullies and inanga is not so obvious. Mosquito fish could be at least partly responsible. This is an important issue for the restoration of the natural ecology of the wetland.

Next monitoring:

November-December 2007; thence biennially.

2.4 Aquatic invertebrates

Method:

Macroinvertebrates (invertebrates big enough to see with the naked eye) were sampled along with aquatic vegetation at four representative sites (see 1.2 and 2.3; locations marked on the map, Appendix 1, and described in the aquatic vegetation and macroinvertebrate recording sheets, Appendix 4). A garden rake or stick was used to gather the aquatic vegetation samples, and a small bucket was used to gather water and substrate (mud, etc.) samples. The samples were examined with the use of trays and a hand lens. Invertebrates were identified using the Taranaki Regional Council guidebook (1997) and Parkinson and Cox (1990). Sensitivity scores, indicative of water quality, were initially assigned from the Taranaki Regional Council guidebook (1997), but updated from Boothroyd & Stark (*in* Collier and Winterbourn 2000). Species found and their scores are listed in the aquatic vegetation and macroinvertebrate recording sheets (Appendix 4).

Observations:

In all four sites, the invertebrates found had sensitivity scores ranging from 1 (very low water quality) to 5 (moderate water quality; 10 is very high water quality). The ranges of the scores are tabulated below. They show that at none of the sites was the water of very good quality, probably a reflection of the lack of water flow into and through the wetland. However, judging by the scores the quality of water overall had not diminished substantially over time, nor had it improved.

	Range of sensitivity scores					
	1998	1999	2000	2001	2003	2005
Site 1	1-5	1-5	1-5	1-5	1-5	1-5
Site 2	1-5	1-6	1-5	1-5	1-5	1-5
Site 3	1-5	1-5	1-5	1-5	1-5	1-5
Site 4	1-5	1-5	1-5	1-5	1-5	1-5

At Sites 1 and 3 the suite of aquatic invertebrates was similar to that in 2001. However at Site 2, previously stagnant but of improved water quality since willow control, there were more invertebrate species of higher sensitivity score than before, reflecting a recovery in the habitat. By contrast, there were fewer species than in 2003 at Site 4 at the southern end of the wetland, where bullies appear to have disappeared. In particular there were surprisingly few snails compared with previous sampling.

Next monitoring:

November-December 2007; thence biennially. Sampling to be repeated; recording sheets to be used.

2.5 Mammalian pests

Method:

General fauna survey, whereby signs of mammalian pests were searched for during other survey and monitoring activities.

Observations:

Eight mammals that can be regarded as pests in the wetland were detected in 1998. In 1999 there were seven, and in 2000 and 2001 there were six. In 2003 and 2005 there were only four. Changes observed between the years are:

- Domestic cattle: present in many places in 1998; absent in 1999; totally excluded in 2000.
- Domestic sheep: present in varying densities in many places in 1998; only on the eastern side in relatively low numbers in 1999; totally excluded in 2000.
- Domestic goats: present in small numbers in the north end; still there in 1999, perhaps in greater numbers; there in 2000 in higher numbers still; still present in 2001. Absent but nearby in 2003 and 2005.
- Rabbit and hare: present around the margins in 1998, 1999, 2000, 2001, 2003 and 2005.
- Possum: common throughout (except open water) in 1998; far less common in 1999, 2000 and 2001 because of control. Remarkably, No sign detected at all in 2003 or 2005.

- Hedgehog: present throughout (except open water) in 1998, 1999, 2000, 2001, 2003 and 2005.
- Feral cat: present in low numbers in 1998, 1999, 2000, 2001, 2003 and 2005. Scat found in December 2000, full of rodent fur (probably mouse).
- Ferret: one killed by farm manager's dog at SE end of wetland, November 2000.

Other mammalian pests probably present but not detected in 1998, 1999, 2000, 2001, 2003 or 2005 include:

- Ship rat and Norway rat: known predators of birds, lizards and invertebrates.
- Mouse: known predator of invertebrates.
- Stoat and weasel: known predators of birds, lizards and invertebrates; good swimmers.

In summary, fencing to exclude domestic stock from the wetland has been entirely successful. Possum control has been so successful that there must now be very few possums left in the wetland.

Next monitoring:

November-December 2007; thence biennially.

2.6 Other fauna

Method:

General fauna survey, whereby signs of other animals were searched for during other survey and monitoring activities.

Observations:

Frogs were heard croaking throughout the wetland, as in 2001 and 2003. In 2000, they were heard only at aquatic site 3. They had not been recorded from the wetland previously (1998-9). They were the southern bell frog (*Litoria raniformis*), native to Australia and reasonably widespread in New Zealand. Frogs have rapidly declined recently world-wide (and in New Zealand) through fungal disease. The increase of frogs in this wetland can therefore be viewed as positive, particularly considering that they are not regarded as having a significant adverse impact on the natural ecology.

Next monitoring:

November-December 2007; thence biennially.

CONCLUSIONS AND RECOMMENDATIONS

The monitoring regime has allowed a series of conclusions to be drawn about various aspects of the ecological condition and trend of Pekapeka Swamp, and the efficacy of management. Out of these conclusions flow a consequent series of recommendations. Most of the 2003 conclusions and recommendations are still relevant, but are updated in the light of 2005 observations. They are split into two sections:

- Monitoring methods
- State of the Environment (SOE) monitoring and reporting

Monitoring methods

1. Vegetation

The monitoring regime for terrestrial and aquatic vegetation is practical and meaningful, therefore appropriate in addressing the current management issues.

Recommendation: That the current monitoring regime for vegetation (including weeds) continue.

2. Notable flora

Swamp nettle (*Urtica linearifolia*) is the only known rare plant in the wetland. It is currently flourishing in places and is widespread throughout the wetland. However, it recently disappeared suddenly from at least one site in which it was abundant, and its ability to withstand the herbicides being used to control willows is unknown.

Recommendation: That swamp nettle continue to be monitored, and its response to herbicide be tested in a limited ground trial.

3. Fauna

The monitoring regime for most terrestrial fauna and aquatic macroinvertebrates is practical and meaningful, therefore appropriate in addressing the current management issues. However, it is insufficient to properly determine the condition and trend of rare water bird and fish populations, each of which would require more effort and different timing. Separate contracts would probably be needed for these aspects.

Recommendation: That the current monitoring regime for terrestrial fauna and aquatic macroinvertebrates continue.

Recommendation: That additional emphasis be given to monitoring rare water birds and fish (see below).

4. Rare water birds

The variety and numbers of water birds appear to be holding their own at present. Two rare species - NZ dabchick and Australasian bittern - are regular users of the wetland, if not resident, and spotless crane has recently been detected. It is not known whether banded rail or marsh crane still persist; they are notoriously hard to detect, especially alongside a busy noisy highway. A specific search by experts in spring might reveal these birds.

Recommendation: That a specific search be mounted biennially in spring for rare water birds, using local expertise.

5. Fish

Indications from this monitoring are that there has been a serious decline in the populations of native fish, and an expansion of exotic mosquito fish. This aspect needs more in-depth study (survey and monitoring) than possible during the current monitoring regime.

Recommendation: That a comprehensive fish survey be carried out in the wetland and that an in-depth fish monitoring regime be established.

6. Aquatic invertebrates and water quality

Aquatic macroinvertebrates provide a useful measure of water quality and habitat condition. Significant changes in species composition at the southern end of the wetland in 2001, and subsequent recovery in 2003, indicate that water quality deteriorated through diminished flow but improved again. A slight decline again in 2005 indicates that the inlet may be a very sensitive part of the wetland system. Changes in the central zone indicate that habitat (water levels and vegetation cover) has changed for the better, through aerial herbicide use and subsequent regeneration. There are limitations to the technique though, because it was primarily developed for stream systems, and other measures of water quality are necessary for comprehensive monitoring of condition and trend. The Ecological Monitoring Plan for Pekapeka Swamp (Walls 1998), adopted by Hawke's Bay Regional Council, proposed regular (monthly or quarterly) sampling of standard parameters. These included pH, conductivity, turbidity, colour absorbances, biochemical oxygen demand, dissolved reactive phosphorus, ammoniacal-nitrogen, nitrate-nitrogen, total phosphorus and total nitrogen. To date, this is the only aspect of the Ecological Monitoring Plan not to have been enacted.

Recommendation: That aquatic macroinvertebrate monitoring continue.

Recommendation: That monitoring of other standard water quality parameters be seriously considered.

7. Monitoring techniques and frequency

In the light of eight years' experience, the suite of techniques being used to monitor the ecological condition and trend of Pekapeka Swamp appears to be appropriate and valuable. The only issues are the difficulty of detecting rare water birds, the need for a comprehensive fish survey and the lack of monitoring of water quality parameters (see above). In view of the massive ecological change being wrought in the wetland due to management, much of which is experimental, at least biennial monitoring seems sensible.

Recommendation: That the current ecological monitoring programme be continued on a biennial basis.

State of the Environment (SOE) monitoring and reporting

Parameters used in this monitoring regime are directly applicable to State of the Environment (SOE) monitoring and reporting. Using a basic assessment of status (or condition) and trend for each parameter, they can be used as environmental indicators, and an overall condition and trend rating for the wetland as at October 2005 can be arrived at:

Indicator	Status/Condition (High, Medium, Low)	Trend (Improving, Stable, Deteriorating)
Native vegetation	L-M	I
Native flora	L-M	I
Native birds	M	I
Native fish	L	D
Native macroinvertebrates	M	S
Water levels	L-M	I
Water flows	L	S
Water quality parameters	?	?
Overall ecology	L-M	S-I

The conclusion is that the wetland is not yet in a very natural state but is beginning to improve in ecological quality. It is expected that restoration management will produce a marked continuation in improvement in future.

Recommendation: That a similar tabulation of ecological condition and trend be used as part of the regular monitoring reporting for the wetland.

ACKNOWLEDGEMENTS

For their help, interest and support in this survey and monitoring work, my particular thanks go to:

Landowners Andrew Scoular, Andrew Field, Craig Magner, Harold Magon and Ivan Grieve; Anna Madarasz, Sara Gerard, Graham Sevicke-Jones and Garth Eyles of Hawke's Bay Regional Council, Napier; Hans Rook and John Adams of the Department of Conservation, Napier; Taranaki Regional Council (freshwater invertebrates guide); Marie Taylor, Bay View; Sue Scheele and Finn Scheele, Christchurch.

REFERENCES AND IDENTIFICATION GUIDES USED

- Boothroyd, I.; Stark, J. *In* Collier, K.J.; Winterbourn, M.J. 2000. New Zealand stream invertebrates: ecology and implications for management. NZ Limnological Society, Hamilton.
- De Lange, P.J.; Norton, D.A.; Heenan, P.B.; Courtney, S.P.; Molloy, B.P.J.; Ogle, C.C.; Rance, B.D.; Johnson, P.N.; Hitchmough, R. 2004. Threatened and uncommon plants of New Zealand. *New Zealand Journal of Botany* 42: 45-76.
- Hawke's Bay Regional Council. 1999. Pekapeka Swamp management plan 1998-2003. HBRC Plan Number 2729.
- Heather, B.; Robertson, H. 1996. Field guide to the birds of New Zealand. Viking, Auckland.
- Hitchmough, R. (compiler). 2002. New Zealand Threat Classification System lists. *Threatened Species Occasional Publication 23*. Department of Conservation, Wellington.
- Hooper, G.W.; McGuinness, J.M.; Porter, S.E.; Williams, G.J. 1986. Pekapeka Swamp Resources Report. Hawke's Bay Catchment Board and Regional Water Board.
- Johnson, P.N.; Brooke, P.A. 1998. Wetland plants in New Zealand. Manaaki Whenua Press, Lincoln.
- McDowall, R.M. 2000. The Reed field guide to New Zealand freshwater fishes. Reed Books, Auckland.
- Molloy, J.; Davis, A. 1994. Setting priorities for the conservation of New Zealand's threatened plants and animals. Department of Conservation, Wellington.
- Moore, S.C. 1997. A photographic guide to the freshwater invertebrates of New Zealand. Otago Regional Council.
- Parkinson, B.; Cox, G. 1990. A field guide to New Zealand's lakes and rivers. Random Century.
- Stark, J.D. 1985. A macroinvertebrate community index of water quality for stony streams. *Water and Soil Miscellaneous Publication No. 87*.
- Sutherland, W.J. ed. 1996. Ecological census techniques, a handbook. Cambridge University Press.
- Taranaki Regional Council. 1997. A photographic guide to the freshwater invertebrates of Taranaki. Taranaki Regional Council.
- Walls, G. 1998. Pekapeka Swamp Ecological Monitoring Plan. Contract document prepared for Hawke's Bay Regional Council, November 1998.
- Williams, G. & E. Consultants Ltd. 2001. Pekapeka Swamp assessment of water levels management and maintenance of higher water levels. Consultant report to Hawke's Bay Regional Council; HBRC Plan Number 3072.

APPENDIX 1: Map of Pekapeka Swamp, showing vegetation types and monitoring site locations

Vegetation types

- Willows dominant;
- Raupo dominant;
- Sedges and rushes dominant;
- Harakeke (lowland flax), forming a mosaic with raupo, willows, grasses, sedges, rushes, etc.;
- Marginal grasslands, weeds and rough pasture;
- Open water;
- Periodically inundated areas, seasonally dominated by willow weed and other ephemeral herbs.

Monitoring sites

- Photopoints
- Vegetation plots
- Aquatic sampling sites
- Waterbird search sites

APPENDIX 2: Photopoint recording sheets, October 2005

- Photopoint no. 1
- Photopoint no. 2
- Photopoint no. 3
- Photopoint no. 4
- Photopoint no. 5
- Photopoint no. 6
- Photopoint no. 7
- Photopoint no. 8
- Photopoint no. 9
- Photopoint no. 10
- Photopoint no. 11
- Photopoint no. 12
- Photopoint no. 13
- Photopoint no. 14
- Photopoint no. 15
- Photopoint no. 16
- Photopoint no. 17
- Photopoint no. 18

PHOTOPOINT RECORDING SHEET

Location/Area: Pekapeka Swamp		Photopoint no: 1
Establishment date: 7/12/98		GPS reference: E2835262 N6159530
		Observer/Photographer: Geoff Walls
Photopoint relocation notes: Gatepost at NE corner of swamp. Aluminium tag on post (as with other photopoints). Photo taken from standing position (as with other photopoints).		
Direction from marker/post (magnetic bearing):		
Camera info (lens, film, etc): 50mm lens; Kodak 200asa print film		
Vegetation (composition, structure, patterns, processes): Mix of raupo, grasses, sedges, rushes, willows, harakeke, blackberry and hemlock. Willows probably threaten harakeke. Sedges, rushes and raupo possibly held back by grazing. Blackberry may be increasing.		
2-photo panorama taken		
REPHOTOGRAPHY DETAILS:		
Date	Observer/ Photographer	Comments (changes, processes, etc)
24/11/99	G. Walls	The NE portion of the swamp is less used by stock than in 1998. As a consequence, the grass is ranker. Blackberry has increased. There is obvious growth of willows, especially young plants. Harakeke (lowland flax) remains in good condition but its flowering is less intense this year. There is more dead raupo visible, perhaps because it hasn't been so knocked down during winter and spring or has yet to be overtaken by the new summer growth.
30/11/00	G. Walls	Sheep and cattle now totally excluded, but goats occasionally visit. Willow has continued to expand. Harakeke is in good condition and flowering. Otherwise, similar to 1999.
27/11/01	G. Walls	Goats present. Willows have grown markedly. Harakeke in good condition and flowering profusely. Blackberry looks to have expanded somewhat.
4/12/03	G. Walls	Goats have gone: dense rank exotic grasses and herbs as a result. Willows have been aerial herbicided by HBRC: crack killed but grey still alive. Grey willows on E side have been felled by HBRC: excellent work, tho a few smaller ones still present. Harakeke flowering profusely and in very good condition. Blackberry mostly killed; convolvulus locally common.
4/10/05	G. Walls	Thorough willow control has been done, with collapse of adult trees now. Saplings still present though. Harakeke and raupo look good. Blackberry and convolvulus locally abundant. Fenced strip and one drain filled at N end.

PHOTOPOINT RECORDING SHEET

Location/Area: Pekapeka Swamp		Photopoint no: 2
		GPS reference: E2835267 N6159466
Establishment date: 7/12/98		Observer/Photographer: Geoff Walls
Photopoint relocation notes: From Photopoint 2, uphill c.60m along fenceline to 14th post (13th after bottom strainer).		
Direction from marker/post (magnetic bearing):		
Camera info (lens, film, etc): 50mm lens; Kodak 200asa print film		
Vegetation (composition, structure, patterns, processes): Mosaic of willows, raupo, grassland (tall fescue), periodically inundated areas (willow weed, etc), sedges and rushes. Harakeke scattered through NE area. Blackberry, convolvulus and Japanese honeysuckle common on eastern margin. The photopoint is to study the interplay of these vegetation elements. This is the best harakeke area of the swamp.		
4-photo panorama taken		
REPHOTOGRAPHY DETAILS:		
Date	Observer/ Photographer	Comments (changes, processes, etc)
24/11/99	G. Walls	Similar to Photopoint 1. Grass more rank, expansion of blackberry and willows, less flax flowering, more dead raupo. There is also a lot more dead marsh clubrush (<i>Bolboschoenus fluviatilis</i>) than in 1998, the same phenomenon as with raupo.
30/11/00	G. Walls	Much as Photopoint 1. Raupo has possibly expanded near fenced margin; convolvulus has expanded. Some willow has been cut for the new fenceline; blackberry controlled there too (will be interesting to see if it recovers).
27/11/01	G. Walls	As Photopoint 1. Continuation of previous years' processes following fencing. Fenceline blackberry control has been successful. Willows show significant growth. Harakeke in profuse flower.
4/12/03	G. Walls	As Photopoint 1. Massive change with willow control. Standing water now visible. Grey willows not killed by aerial herbicide, and still some young ones. Harakeke freed from willow influence and should now flourish. Toetoe detected here for the first time. Japanese honeysuckle and convolvulus locally rampant near fence: could herbicide. Forest & Bird plantings not yet visible.
4/10/05	G. Walls	As Photopoint 1. Real progress evident towards restoration of a more natural wetland ecosystem. Standing water visible in several places. Raupo, purei (tussock sedge) and marsh clubrush appear to be expanding.

PHOTOPOINT RECORDING SHEET

Location/Area: Pekapeka Swamp		Photopoint no: 3
Establishment date: 9/12/98		GPS reference: E2835050 N6159334
		Observer/Photographer: Geoff Walls
Photopoint relocation notes:		
Tanalised post put in below access track on edge of raupo. Photopoint is 30m uphill, marked by a small aluminium peg.		
Direction from marker/post (magnetic bearing):		
Camera info (lens, film, etc): 50mm lens; Kodak 200asa print film		
Vegetation (composition, structure, patterns, processes):		
Willows flanking a raupo "channel" across the swamp. An area of sedge-rushland (hard grazed) on the eastern margin. Willows are likely to invade the raupo unless controlled; the raupo, sedges and rushes are possibly in retreat under grazing pressure.		
2-photo panorama taken		
REPHOTOGRAPHY DETAILS:		
Date	Observer/ Photographer	Comments (changes, processes, etc)
24/11/99	G. Walls	Similar to Photopoints 1 and 2 (more dead raupo, expansion of willows into raupo area, more rank grass). Raupo has advanced somewhat along its eastern edge, enveloping the marker post that was out in the open in 1998. This is probably due to regrowth from rootstocks that were previously chewed and trampled by cattle.
30/11/00	G. Walls	Stock now fully excluded. Willows have expanded considerably; blackberry clump by fenceline destroyed; convolvulus has apparently increased. Small cabbage tree now visible. Raupo will expand now in absence of stock.
27/11/01	G. Walls	Continuation of previous years' processes. Willow has continued to expand and grow dramatically. Raupo has expanded. Small cabbage tree has continued to grow and has flowered. Willow seriously invading raupo zone.
4/12/03	G. Walls	Massive change with willow control. Standing water now visible. Much raupo regeneration. Lots of small grey willow still. Cabbage tree has been liberated.
4/10/05	G. Walls	Excellent control of adult willows and previous crop of young, but regeneration of saplings and seedlings so will need to be followed up. Standing water substantially increased, and becoming vegetated with watercress. Raupo has continued to expand into areas "freed up" by willow control. Cabbage tree healthy. Marginal plantings beginning to show up now.

PHOTOPOINT RECORDING SHEET

Location/Area: Pekapeka Swamp		Photopoint no: 4
Establishment date: 9/12/98		GPS reference: E2834830 N6159207
		Observer/Photographer: Geoff Walls
Photopoint relocation notes: Approx. 300m S of Photopoint 3, in a similar situation. Just past mouth of small gully with a lone cabbage tree. Post sunk into wet ground 4m below access track.		
Direction from marker/post (magnetic bearing):		
Camera info (lens, film, etc): 50mm lens; Kodak 200asa print film		
Vegetation (composition, structure, patterns, processes): Sedge-rushland in foreground, backed by raupo, in turn backed by pussy willows. Many young pussy willows invading the sedge-rushland and raupo. Photopoint set up to track this process.		
2 photos taken: one looking across swamp, the other looking along it to the NE.		
REPHOTOGRAPHY DETAILS:		
Date	Observer/ Photographer	Comments (changes, processes, etc)
24/11/99	G. Walls	Young willows have grown appreciably on the edge between raupo and damp pasture. Adolescent willows behind this have also grown considerably. The damp pasture is grazed less hard (sheep only now), so the marginal raupo and rushes are in better condition. Grass is ranker and there is more dead raupo visible.
30/11/00	G. Walls	Willow has continued to expand via seedlings and bulking up: advancing eastwards and thickening. Following fencing of this margin from stock, pasture has gone rank. Blackberry patch by fence has been controlled but not killed.
27/11/01	G. Walls	Willow advance has continued apace. Pasture even more rank. Raupo has advanced southwards somewhat, but is seriously invaded by willow. Blackberry is still alive and regenerating.
4/12/03	G. Walls	Willows partly cut and aerial sprayed, but grey willow continuing to advance. Nothing precious at risk in terms of re-spraying. Blackberry has been killed. Tag relocated to fence.
4/10/05	G. Walls	Grey willows have been herbicided and bulk killed, but there is substantial regeneration (saplings and seedlings).

PHOTOPOINT RECORDING SHEET

Location/Area: Pekapeka Swamp		Photopoint no: 5
		GPS reference: E2834120 N6158670
Establishment date: 9/12/98		Observer/Photographer: Geoff Walls
Photopoint relocation notes: Along access track on eastern side of swamp, through third gate and c.30m past pumphouse. Down from track to edge of willows (c.80m). Between 2 derelict fences is a new photopoint marker post driven into the ground through a clump of swamp nettle.		
Direction from marker/post (magnetic bearing):		
Camera info (lens, film, etc): 50mm lens; Kodak 200asa print film		
Vegetation (composition, structure, patterns, processes): Grazed boggy area with sparse raupo, willow weed, grasses, sedges and rushes. 12 clumps of swamp nettle (<i>Urtica linearifolia</i>) within a radius of 7m from post; all looking healthy despite stock presence (sheep and cattle). This photopoint set up to keep tabs on the nettle.		
2 photos taken (different views). An additional photo taken looking at the site from the fence.		
REPHOTOGRAPHY DETAILS:		
Date	Observer/ Photographer	Comments (changes, processes, etc)
24/11/99	G. Walls	A dramatic change since 1998 is evident. The rare native swamp nettle (<i>Urtica linearifolia</i>), abundant in 1998, has been virtually extinguished from the site. Most of the large clumps have gone without trace, and a little live growth was found only at the base of the marker post. Compared with 1998, there is less bare ground and more willow weed, watercress and grasses, suggesting less intensive grazing/trampling in recent months by stock. However, there is evidence that the area may have been intensively used by cattle within the last year, perhaps sufficient to destroy the nettle clumps. It also looks as though there may have been more standing water, which could have added to the impact on the nettle. All is not lost though: the resilience of the nettle is demonstrated by the presence of some new growth on the one remaining adult plant and numerous seedlings under the willow canopy nearby.
30/11/00	G. Walls	Swamp nettle now gone from site and vicinity. Raupo has thickened dramatically following stock exclusion. Dense ground cover of willow weed, watercress, water speedwell and creeping bent. Site has had standing water at least 30cm deep over it, perhaps sufficient to kill swamp nettle.
27/11/01	G. Walls	Yet more dramatic change. Raupo has grown up tall, rendering the marker post almost invisible. Much willow weed, beggars' ticks and creeping bent. No sign of swamp nettle. Willows trees nearby reaching out to site. <i>Carex secta</i> and <i>C. geminata</i> becoming established.

4/12/03	G. Walls	Yet another dramatic change. Willows have been killed (except grey willow). Raupo also, but regenerating. Much wetter than before. Swamp nettle has bounced back, but <i>Carex secta</i> and <i>C. geminata</i> have been killed - at least for now.
4/10/05	G. Walls	Adult willows have collapsed, but there is substantial regeneration (resprouts, saplings and seedlings), requiring follow-up control (considerable but ecologically worthwhile). Raupo has regenerated and expanded dramatically. Swamp nettle has diminished but is still present. Terrific growth of creeping bent; some regeneration of <i>Carex secta</i> .

PHOTOPOINT RECORDING SHEET

Location/Area: Pekapeka Swamp		Photopoint no: 6
Establishment date: 9/12/98		GPS Reference: E2833947 N6158395
Photopoint relocation notes:		Observer/Photographer: Geoff Walls
At boundary of landowners Tony Parker and Peter Collins, on eastern flank of swamp. Fencelines meet here. Post driven into swamp in front of the lone cabbage tree on the willow/raupo edge, 4m from a big totara/concrete strainer post. Photo taken from edge of small "flat", 30m NE of tagged post.		
Direction from marker/post (magnetic bearing):		
Camera info (lens, film, etc): 50mm lens; Kodak 200asa print film		
Vegetation (composition, structure, patterns, processes):		
Wetland edge, with big willows, raupo and periodically inundated areas dominated by willow weed. Heavily used by sheep. Photopoint set up to follow the fate of the cabbage tree and to examine the marginal processes here.		
1 photo taken.		
REPHOTOGRAPHY DETAILS:		
Date	Observer/ Photographer	Comments (changes, processes, etc)
24/11/99	G. Walls	The water table is clearly higher than in 1998. A dead willow tree has fallen, making more room for the cabbage tree, which remains healthy. The tussock sedges or purei (<i>Carex secta</i>) are healthier. There is less willow weed, probably simply due to the two-week difference in monitoring time.
30/11/00	G. Walls	Margin now well fenced to exclude stock. Grass has become rank; raupo advancing and thicker on edge; purei bigger and healthier; cabbage tree healthy but being smothered by willows (will probably be overcome unless relieved).
27/11/01	G. Walls	As previous year; same processes have continued. Cabbage tree now being enveloped by willows, but okay for the meantime. A nearby willow tree looks unhealthy (herbicide?).
4/12/03	G. Walls	Most willows have been killed by aerial herbicide, but marginal ones have survived, including crack willow, where not sprayed. Cabbage trees seemingly unaffected and in full flower. Unsprayed strip along edge has healthy raupo and <i>Carex secta</i> . Could 'mop up' along here by ground control of remaining willows.
4/10/05	G. Walls	Cabbage trees still healthy. Much willow growth along edge, expanding fast and needing to be dealt with sooner than later. Standing water now visible as dead willows collapse.

PHOTOPOINT RECORDING SHEET

Location/Area: Pekapeka Swamp		Photopoint no: 7
Establishment date: 9/12/98		GPS Reference: E2833746 N6158274
		Observer/Photographer: Geoff Walls
Photopoint relocation notes: Along new fenceline S from Photopoint 6 to end of second strain. Big strainer post here is tagged (aluminium). Photos taken along each wing of fence (i.e. swamp edge) from post.		
Direction from marker/post (magnetic bearing):		
Camera info (lens, film, etc): 50mm lens; Kodak 200asa print film		
Vegetation (composition, structure, patterns, processes): Marginal areas of rank grasses and herbaceous weeds (thistles etc), backed by old willows (weeping and crack). One cabbage tree near post. Raupo in S vista. The willow edge and rank areas look to be quite dynamic, especially if stock (sheep) are removed and planting is done. Raupo growing hard up to old former fence suggests it is being held back by stock.		
2 photos taken: each wing of fence.		
REPHOTOGRAPHY DETAILS:		
Date	Observer/ Photographer	Comments (changes, processes, etc)
24/11/99	G. Walls	In 1998 sheep were inside the swamp fence. This year they have not been there recently, and as a result the grass is very tall and rank. Some method of grass control will be required if trees are to be planted on this flank of the swamp.
30/11/00	G. Walls	Rank grass inside fence is taller and thicker if possible. Cabbage trees nearby appear to be recovering well. An area to the south has been fenced off with electric tape to corral stock temporarily: the pasture there is less rank, nevertheless willows and blackberry on this edge are expanding.
27/11/01	G. Walls	Continuation of processes, except the corral has gone and pasture is growing up rank where it was. Raupo has appeared in a few places in tall rank pasture: it will be interesting to see how the interaction progresses.
4/12/03	G. Walls	Young willows invading former corralled area. Much raupo regeneration there. Big willows mostly killed by aerial herbicide. Grass very rank and dense. Suggest ground control of remaining willows.
4/10/05	G. Walls	Willow regeneration and growth is spectacular and prolific, especially to the south. Requires urgent control.

PHOTOPOINT RECORDING SHEET

Location/Area: Pekapeka Swamp		Photopoint no: 8
Establishment date: 7/12/98		GPS Reference: E2833541 N6158139
		Observer/Photographer: Geoff Walls
Photopoint relocation notes: Near Peter Collins' house, at top of drive; c.20m S of house on final bend of drive. Obvious lookout point at edge of drive alongside fence.		
Direction from marker/post (magnetic bearing):		
Camera info (lens, film, etc): 50mm lens; Kodak 200asa print film		
Vegetation (composition, structure, patterns, processes): Southern arm of loop in wetland. Willows, open water, raupo, willow herb, grassland, etc., all in this section. Photos taken to follow changes over time.		
5-photo panorama taken.		
REPHOTOGRAPHY DETAILS:		
Date	Observer/ Photographer	Comments (changes, processes, etc)
25/11/99	G. Walls	There is substantially more standing water than in 1998. There is more floating azolla fern (<i>Azolla filiculoides</i>) in places, and more duckweed (<i>Lemna minor</i> and <i>Spirodela punctata</i>) in others, reflecting the depth of water. There is much more dead raupo in the centre of the wetland, perhaps because of the higher water levels preventing new growth there.
1/12/00	G. Walls	The biggest change is that the water is open (not covered in floating vegetation): perhaps due to wind, cool temperatures and/or numerous birdlife.
30/11/01	G. Walls	Water is mostly open (but there are also areas of <i>Lemna</i> and <i>Azolla</i>). Willows have grown. Perhaps a little drier overall than in 1999. Raupo dense and healthy. Much waterfowl use.
4/12/03	G. Walls	Major change. Big willows each side of railway cut out. Raupo and <i>Carex secta</i> thickets very healthy. <i>Azolla</i> forming a dense cover on standing water. Weeping willows and cabbage trees healthy. No waterfowl seen.
4/10/05	G. Walls	Regeneration amongst willows where cut in the past. Raupo and <i>Carex secta</i> thickets still healthy. Dense cover of <i>Lemna</i> and <i>Azolla</i> on water in places, open elsewhere. Ducks and black swans present.

PHOTOPOINT RECORDING SHEET

Location/Area: Pekapeka Swamp		Photopoint no: 9
Establishment date: 7/12/98		GPS Reference: E2833274 N6158113
		Observer/Photographer: Geoff Walls
Photopoint relocation notes: From Peter Collins' sheds/yards S along railway c.200m. Pipe gate on right (road side). Aluminium tag on wooden post next to gate strainer. Photopoint is on small rise W of this c.8m.		
Direction from marker/post (magnetic bearing):		
Camera info (lens, film, etc): 50mm lens; Kodak 200asa print film		
Vegetation (composition, structure, patterns, processes): Permanent ponds covered in <i>Azolla</i> , <i>Lemna</i> and <i>Spirodela</i> . Fringed with raupo. Big willows throughout, some cleared in past. Blackberry on near terrestrial margin. Photopoint is to track developments.		
2-photo panorama taken.		
REPHOTOGRAPHY DETAILS:		
Date	Observer/ Photographer	Comments (changes, processes, etc)
25/11/99	G. Walls	The water level is higher and there is more duckweed and less azolla as a result. Young willows have grown substantially.
1/12/00	G. Walls	Much water is clear of floating plants (as Photopoint 8). Blackberry is advancing; willow too. Little change in raupo.
29/11/01	G. Walls	Has been sprayed right up to this point in December 2000, but only at the south end of the open water area. Willows and raupo have been killed (but not totally) on that side. Seen on water: NZ dabchick, mallard, black swan, NZ shoveler, grey teal. Best open water site in Pekapeka Swamp. Water clear of floating plants.
4/12/03	G. Walls	5-photo panorama (180 degrees) taken this time. Huge changes. Willows all cut out. Some willow regeneration. Raupo and <i>Carex secta</i> healthy. Huge expanse now of standing water, but rather stagnant and covered in dense <i>Azolla</i> and <i>Lemna</i> . Lots of waterfowl (ducks and swans).
4/10/05	G. Walls	5-photo panorama taken again. Willow regeneration has continued (needs some mopping up). Raupo has expanded. More open water, used by ducks and swans. Dense marginal growth of an annual herb, now died off.

PHOTOPOINT RECORDING SHEET

Location/Area: Pekapeka Swamp		Photopoint no: 10
Establishment date: 7/12/98		GPS Reference: E2833200 N6157900
		Observer/Photographer: Geoff Walls
Photopoint relocation notes: From Peter Collins' sheds/yards, along railway past Photopoint 9, following new fence around loop of wetland SE from railway. Fencepost tagged with aluminium marker. Photo taken from c.15m uphill.		
Direction from marker/post (magnetic bearing):		
Camera info (lens, film, etc): 50mm lens; Kodak 200asa print film		
Vegetation (composition, structure, patterns, processes): Willows (weeping, crack, pussy); raupo; <i>Carex secta</i> (big); <i>Bolboschoenus fluviatilis</i> fringe; open water with <i>Azolla</i> , <i>Lemna</i> , etc. Photopoint intended to track <i>Carex secta</i> in particular.		
1 photo taken.		
REPHOTOGRAPHY DETAILS:		
Date	Observer/ Photographer	Comments (changes, processes, etc)
25/11/99	G. Walls	Several smaller purei (tussock sedges, <i>Carex secta</i>) have died or died back, possibly through prolonged inundation. Competition from encroaching willows is another possible contributing factor. Young willows have grown substantially. The lesser amount of green raupo looks to be a product of slightly different monitoring times rather than an ecological change.
1/12/00	G. Walls	Willows are continuing to expand and thicken, especially grey (pussy) willow. Purei being crowded and smothered as a result. Raupo and terrestrial plants appear to have largely replaced the former <i>Bolboschoenus</i> fringe.
29/11/01	G. Walls	Aerial herbicided in December 2000; as a result most willow dead (occasional survivor), <i>Carex secta</i> dead, raupo and marsh clubrush dead. Very little <i>Carex secta</i> recovery; none in raupo or clubrush. Cabbage tree has survived - just.
4/12/03	G. Walls	Good regeneration of <i>Carex secta</i> . A little regeneration of willows, but not much. Cabbage tree healthy. Strangely, only <i>Lemna</i> on standing water, not <i>Azolla</i> . Pa site has been recently burnt.
4/10/05	G. Walls	<i>Carex secta</i> regeneration has continued. A little willow regeneration. Dense marginal growth of an annual herb, now died off. Pa site has reclothed in exotic grasses and herbs following burning. Only <i>Lemna</i> on water. NZ shovelers here.

PHOTOPOINT RECORDING SHEET

Location/Area: Pekapeka Swamp		Photopoint no: 11
Establishment date: 7/12/98		GPS Reference: E2832820 N6157875
		Observer/Photographer: Geoff Walls
Photopoint relocation notes: Just SW of pa site. Large strainer post on fenceline has aluminium marker (nailed horizontally) and a white insulator. Photo taken c.15m uphill from knoll.		
Direction from marker/post (magnetic bearing):		
Camera info (lens, film, etc): 50mm lens; Kodak 200asa print film		
Vegetation (composition, structure, patterns, processes): Small corner of wetland with raupo and willows, wrapping around pa site. Pa site is grazed pasture. Photopoint chosen for heritage reasons.		
1 photo taken.		
REPHOTOGRAPHY DETAILS:		
Date	Observer/ Photographer	Comments (changes, processes, etc)
25/11/99	G. Walls	There has been major growth in the young willows near the fence corner. The pa site looks to be in a similar state to that of 1998.
30/11/00	G. Walls	Continued growth of willows; pa site much as previously.
29/11/01	G. Walls	Willows and raupo killed stone dead by December 2000 spraying. Water speedwell has proliferated in the suddenly vacant sites. The pa site is clad in rank grasses and herbs; it is used by cattle and will therefore continue to have its earthworks degraded. Should be stocked with sheep only.
4/12/03	G. Walls	Little change except some regeneration of willows but none at all of raupo.
4/10/05	G. Walls	Willow regeneration has been mopped up. Raupo and <i>Carex secta</i> yet to reappear. Much new growth of celery buttercup (<i>Ranunculus sceleratus</i>), watercress and veronica.

PHOTOPOINT RECORDING SHEET

Location/Area: Pekapeka Swamp		Photopoint no: 12
Establishment date: 7/12/98		GPS Reference: E2832610 N6157666
Photopoint relocation notes: Along new fenceline N from Glenogle c.500m. Can be approached via subway beneath railway and straight down small watercourse to prominent fence strainer (angle) - marked with aluminium tag.		Observer/Photographer: Geoff Walls
Direction from marker/post (magnetic bearing):		
Camera info (lens, film, etc): 50mm lens; Kodak 200asa print film		
Vegetation (composition, structure, patterns, processes): Edge of periodically inundated ground covered in rank grasses, exotic herb weeds, willow weed, beggars' ticks, etc. Backed by raupo in places and willows all along. A potential planting area.		
3 photos taken: along each fence wing and into swamp.		
REPHOTOGRAPHY DETAILS:		
Date	Observer/ Photographer	Comments (changes, processes, etc)
25/11/99	G. Walls	Raupo has recovered somewhat since the exclusion of domestic stock. So too has purei (<i>Carex secta</i>). Willow growth has been pronounced.
30/11/00	G. Walls	Willow has grown noticeably. Raupo has advanced somewhat. Pasture herbs and grasses have got taller and denser. Purei is looking healthy.
29/11/01	G. Walls	Willows, purei and raupo killed by December 2000 spraying. Very little willow survival. Watercress and <i>Ranunculus sceleratus</i> growing lustily. Thistles, oxtongue and other rank pasture herbs taller and denser in ungrazed ex-pasture.
5/12/03	G. Walls	Dramatic growth of seedling grey willow, not evident in 2001, forming small trees already. Some raupo and purei regeneration. Rank ex-pasture much as before.
6/10/05	G. Walls	Most willow regrowth has been killed. Raupo has been knocked back but is recovering. <i>Carex secta</i> recovering where not killed outright by past spraying. Rank ex-pasture would be a good place for revegetation.

PHOTOPOINT RECORDING SHEET

Location/Area: Pekapeka Swamp		Photopoint no: 13
		GPS Reference: E2832541 N6157591
Establishment date: 7/12/98		Observer/Photographer: Geoff Walls
Photopoint relocation notes:		
Approx. 100m S of Photopoint 12. On small dry grassy rise c.30m from fence within swamp. Point marked by half-round post with aluminium tag and electric wire in place. Maimai in swamp clearing nearby.		
Direction from marker/post (magnetic bearing):		
Camera info (lens, film, etc): 50mm lens; Kodak 200asa print film		
Vegetation (composition, structure, patterns, processes):		
Usually wet, an opening within the surrounding willows. Filled with raupo; some <i>Carex secta</i> remnants; fringed with willow weed, umbrella sedge, broadleaved dock, etc. <i>Lemna</i> etc. on drying-up mud in centre. <i>Urtica linearifolia</i> within willows here.		
1 photo taken, looking into clearing.		
REPHOTOGRAPHY DETAILS:		
Date	Observer/ Photographer	Comments (changes, processes, etc)
25/11/99	G. Walls	There is a dramatic difference at this site. There is standing water (it was dry in 1998). There is a big recovery in raupo and marsh clubrush, following relief from stock impact. There has been much peripheral growth in willows. Purei (<i>Carex secta</i>) is beginning to recover, although this is not evident in the photos.
30/11/00	G. Walls	Willows have grown. Raupo was cut by the farmer the previous day for duck shooting. Just out of zone of 1999 herbicide.
29/11/01	G. Walls	Willows were sprayed in December 2000, but the pond was left (parts of it anyway). So, some purei and raupo was killed, whilst other areas of it were unaffected. Significant numbers of willows have survived, so require follow-up control. Water levels seem higher than before; water covered in <i>Lemna</i> and <i>Azolla</i> . Swamp nettle alive and well despite herbicide - growing cheerfully on herbicide-killed willows and purei.
5/12/03	G. Walls	Willows are still alive in places. Some purei has recovered, but others and the sprayed raupo have not. Swamp nettle still alive and well. Planted harakeke struggling where ground is very wet.
6/10/05	G. Walls	Quite a lot of willow regeneration, though some has been dealt to. Raupo recovering; some <i>Carex secta</i> recovery. Planted harakeke have grown somewhat.

PHOTOPOINT RECORDING SHEET

Location/Area: Pekapeka Swamp		Photopoint no: 14
Establishment date: 10/12/98		GPS Reference: E2832484 N6157464
		Observer/Photographer: Geoff Walls
Photopoint relocation notes:		
Approx. 150m S of Photopoint 13, on same grassy low rise. Also marked by electric fence post (quarter-round, tagged with aluminium label).		
Direction from marker/post (magnetic bearing):		
Camera info (lens, film, etc): 50mm lens; Kodak 200asa print film		
Vegetation (composition, structure, patterns, processes):		
Very interesting site, periodically inundated. Backed by dense willows. Interplay between dense umbrella sedge; lower-stature <i>Juncus articulatus</i> , creeping bent and various herbs; dense raupo. Is raupo advancing? Is willow likely to invade? Not being grazed now.		
6-photo panorama taken.		
REPHTOGRAPHY DETAILS:		
Date	Observer/ Photographer	Comments (changes, processes, etc)
25/11/99	G. Walls	Following destocking there has been an advance in raupo, major growth in willows and flourishing of various annual herbs, particularly willow herbs (<i>Epilobium</i> species), and grasses. The amount of dead raupo visible is due to lack of stock use of the area and less advanced new growth.
30/11/00	G. Walls	Herbiced in Dec 99. Willows and raupo mostly killed: a little recovery and some missed. Purei killed and not apparently recovering. Seems to have flooded, and now much wetter than in 1998 or 1999: possibly the result of the willow control. Numerous pukeko on site.
29/11/01	G. Walls	Significant regrowth in willows. No recovery at all in raupo as yet. Some young plants of purei have appeared. Seedlings and saplings of willows in places. Much open water, as in previous year.
5/12/03	G. Walls	Continued regrowth of willows, both from original trees and from seedlings. Good recovery of purei but none at all of raupo. Water level higher than before. Bittern seen here, the first seen in the swamp since the survey/monitoring began in 1998.
6/10/05	G. Walls	5-photo panorama taken this time. Most willow regrowth has been killed, but a lot missed along the edge. Most <i>Carex secta</i> looking healthy still, but some has died.

PHOTOPOINT RECORDING SHEET

Location/Area: Pekapeka Swamp		Photopoint no: 15
Establishment date: 10/12/98		GPS Reference: E2832508 N6157063
		Observer/Photographer: Geoff Walls
Photopoint relocation notes: At beginning of Glenogle driveway, alongside big poplars.		
Direction from marker/post (magnetic bearing):		
Camera info (lens, film, etc): 50mm lens; Kodak 200asa print film		
Vegetation (composition, structure, patterns, processes): Overview of wetland edge here: solid willows and margin of grasses/herbs. Fenced from stock.		
3-photo panorama taken.		
REPHOTOGRAPHY DETAILS:		
Date	Observer/ Photographer	Comments (changes, processes, etc)
25/11/99	G. Walls	Raupo has recovered somewhat since the exclusion of domestic stock. So too has purei (although that is not evident in the photos). Willow growth has been pronounced along its fringe.
30/11/00	G. Walls	Willow forest herbicided in Dec 99: most of canopy killed, only some on edge still alive. Raupo essentially as in 1999.
29/11/01	G. Walls	Willows on edge alive and well still - will require specific control. Some raupo alive on edge, but apparently less than previously.
5/12/03	G. Walls	Some live willows along edge still. Some raupo regeneration, but not much.
6/10/05	G. Walls	Edge willows have been killed; the long dead willows are collapsing. No raupo on the edge at present. Some cabbage trees and <i>Carex secta</i> look okay, but other cabbage trees are stone dead.

PHOTOPOINT RECORDING SHEET

Location/Area: Pekapeka Swamp		Photopoint no: 16
Establishment date: 10/12/98		GPS Reference: E2832338 N6157106
		Observer/Photographer: Geoff Walls
Photopoint relocation notes:		
At maimai on edge of pond reached by boardwalk through willow forest from Glenogle. Approx. 50m past Vegetation Plot 4. Aluminium tag nailed to willow by maimai.		
Direction from marker/post (magnetic bearing):		
Camera info (lens, film, etc): 50mm lens; Kodak 200asa print film		
Vegetation (composition, structure, patterns, processes):		
Pond. Open water: covered in <i>Azolla</i> , <i>Lemna</i> , <i>Spirodela</i> . Fringe of <i>Carex secta</i> (healthy) and raupo. Backed by dense willows, which look to be invading <i>Carex secta</i> .		
3-photo panorama taken.		
REPHOTOGRAPHY DETAILS:		
Date	Observer/ Photographer	Comments (changes, processes, etc)
25/11/99	G. Walls	What was a virtually dried-up area covered in pink azolla in 1998 is now an open water pond with little floating vegetation. There has been considerable advance of raupo and willows (both seedlings and basal sprouts). Purei (<i>Carex secta</i>) looks very healthy, although it is being invaded by willows (a problem) and raupo (not a problem).
30/11/00	G. Walls	Herbiced from air Dec 99: willows mostly killed; raupo mostly killed; purei mostly killed (a little of each still alive though and regrowing).
29/11/01	G. Walls	Little recovery in purei, though some. No recovery in raupo as yet. Significant regrowth in willows. Pond surface covered in <i>Lemna</i> , <i>Azolla</i> , <i>Spirodela</i> and <i>Wolffia</i> . Proliferation of fleshy exotic herbs (watercress, sow thistle and water speedwell).
5/12/03	G. Walls	Very hard to reach this site because of high water levels, fallen willows and derelict boardwalk. Good recovery of purei but none of raupo. Much regeneration of small willow around pond. <i>Azolla</i> entirely dominant on pond.
6/10/05	G. Walls	<i>Carex secta</i> recovery has continued, but no raupo yet. Willow regrowth mainly taken care of, but still a little. Water covered by <i>Azolla</i> and <i>Lemna</i> . A bittern heard booming to the north.

PHOTOPOINT RECORDING SHEET

Location/Area: Pekapeka Swamp		Photopoint no: 17
Establishment date: 10/12/98		GPS Reference: E2832233 N6156664
		Observer/Photographer: Geoff Walls
Photopoint relocation notes: At Aquatic Site 4. Very SE tip of swamp, at confluence of streams enclosing pa site. Post erected with aluminium tags.		
Direction from marker/post (magnetic bearing):		
Camera info (lens, film, etc): 50mm lens; Kodak 200asa print film		
Vegetation (composition, structure, patterns, processes): Small stream here, naked through grazing to waters' edge, recent cutting of willows and herbicide use. Crack willows flank stream at confluence. Water surface covered in <i>Azolla</i> , <i>Lemna</i> , <i>Spirodela</i> . Process of stream bank recovery/decline will be interesting.		
1 photo taken, looking along stream.		
REPHOTOGRAPHY DETAILS:		
Date	Observer/ Photographer	Comments (changes, processes, etc)
26/11/99	G. Walls	Channel banks bare of vegetation through herbicide use in 1998 have become clothed in rank growth of tall herbs (thistles, buttercups, watercress and water speedwell) and grasses. Willows have grown, including from cut stumps. The channel has been mechanically excavated in places.
30/11/00	G. Walls	Massive change: willows have been cut and cleared; channel has been dug/widened and is now choked with watercress, water speedwell, azolla and duckweed. Water flow seems to be minimal; lots of green algae.
30/11/01	G. Walls	As in previous year, waterways sluggish and choked with vegetation. Electric fence has been installed; pa site has been damaged by bulldozing for fencing. Overall, it is hard to view the work done as achieving restoration progress at this site as yet. The only positive is that swamp nettle is doing well.
5/12/03	G. Walls	3 photos taken. Waterways now with more flow; less stagnant, more macrophytes. Much crack willow regeneration; will need ground control. Planted harakeke and cabbage trees looking well. Swamp nettle scarcely visible now, because of rank growth of exotic herbs and grasses.
6/10/05	G. Walls	Much as in 2003, though <i>Potamogeton crispus</i> less visible. High nutrient loading, hence prolific macrophytes. Willow regrowth has been controlled effectively. Planted cabbage trees and harakeke struggling, with some losses.

PHOTOPOINT RECORDING SHEET

Location/Area: Pekapeka Swamp		Photopoint no: 18
Establishment date: 10/12/98		GPS Reference: E2831950 N6157182
		Observer/Photographer: Geoff Walls
Photopoint relocation notes:		
SW end of swamp. From roadside stock ramp c.200m eastwards to wetland across paddock. Fence post with white collar and aluminium tag erected on wet edge. Photos taken from small rise 10m away and from 5m to N.		
Direction from marker/post (magnetic bearing):		
Camera info (lens, film, etc): 50mm lens; Kodak 200asa print film		
Vegetation (composition, structure, patterns, processes):		
Marginal pond with raupo, <i>Carex secta</i> , willows and various exotic herbs. Water covered in <i>Spirodela</i> , <i>Lemna</i> , (<i>Azolla</i>). Willows have been cut and poisoned; raupo and <i>Carex secta</i> have been recently burnt. Not a pretty sight, but may recover. 2 photos taken: one of wet area, one of cabbage tree.		
REPHTOGRAPHY DETAILS:		
Date	Observer/ Photographer	Comments (changes, processes, etc)
26/11/99	G. Walls	The water level is higher. There is recovery in raupo and purei (<i>Carex secta</i>) and herbaceous plants since burning. Willows have grown substantially around the margins. The cabbage tree present is still healthy, although willows are starting to crowd it.
30/11/00	G. Walls	Purei and raupo have bounced back and look healthy. Cabbage trees also healthy. Some regrowth in willows. Overall, looking much better than in 1998. Due to be herbicided in Dec 2000.
30/11/01	G. Walls	Fenced from stock since previous visit. Herbicided in December 2000. Some recovery in willows since. Cabbage trees looking distinctly unwell, especially nearest one to photopoint. Raupo and purei killed where exposed to herbicide, but flourishing where not sprayed. Continued growth in willows where not cut or sprayed.
5/12/03	G. Walls	Some willow trees still alive, and saplings showing up. Good recovery of raupo and purei. Cabbage trees have recovered fairly well too. Standing dead willows collapsing now.
6/10/05	G. Walls	Willow trees all dead and collapsing. Saplings grown appreciably in 2 years and more shown up (both spp.). Cabbage trees seem okay. Raupo and <i>Carex secta</i> have continued to recover and are very healthy. Planted harakeke has grown.

**APPENDIX 3: Vegetation permanent plot recording sheets,
October 2005**

- Plot no. 1
- Plot no. 2
- Plot no. 3
- Plot no. 4

VEGETATION PLOT RECORDING SHEET

Location/Area: Pekapeka Swamp		Plot no: 1		
GPS reference: S corner E2835150 N6159492, N corner E2835154 N6159500				
Establishment date: 9/12/98		Observer: Geoff Walls		
Plot description (size, shape, etc): 20m x 20m square, marked by orange-capped tanalised fence posts; one at each corner.				
Relocation details: Near NE corner of swamp. Along access track on E side to redundant gateway (no gate, just a concrete strainer); wooden post with blue tag here. Follow raupo margin around clockwise for 30m, then plunge into raupo for 20m, going NE (parallel to track). Orange-capped corner post within raupo, just past first willows.				
Photos taken (if any): Yes: 3 taken from SW corner (E2835135 N6159505)				
MEASUREMENT DETAILS				
Date: 4/10/05		Observer: Geoff Walls		
Tier	Height	Main species present	% cover*	Notes
Terrestrial:				
Emergents	>2m	Harakeke	2	Big bushes, Expanding Willow gone
Canopy	0-2m	Raupo	3	Dominant
		Harakeke	3	Thickening
		<u>Bolboshoenus fluviatilis</u>	2	
		Tall fescue	2	
		Pussy willow	0	Resprouts and saplings
Subcanopy-		Pussy willow	0	
Upper		Blackberry	2	Spreading
understorey		<u>Carex secta</u>	1	Recovering well
		<i>Juncus microcephalus</i>	1	
Lower		<i>Schoenoplectus validus</i>	1	
understorey		Convolvulus	2	Checked
		Japanese honeysuckle	2	Spreading fast
		<i>Apium nodiflorum</i>	0	
Ground		<i>Carex geminata</i>	1	
cover		<i>Hypolepis millefolium</i>	0	
		<i>Hypolepis ambigua</i>	0	
Aquatic:		Watercress	0	
Comments (patterns, processes, changes): <i>As 2003. Willows have been well controlled, just a little regeneration to be mopped up. Vines (especially Japanese honeysuckle) still increasing. Carex secta healthy. Harakeke healthy and expanding; is the chief beneficiary of willow control. Management required now: just regular ground control of willows.</i>				
Species list/Notable flora (in addition to above): Harakeke (best area of whole swamp).				

* 0 = <1% 1 = 1-5% 2 = 5-25% 3 = 25-50% 4 = 50-75% 5 = >75%

VEGETATION PLOT RECORDING SHEET

Location/Area: Pekapeka Swamp		Plot no: 2		
GPS reference: S corner E2834492 N6158946, NE corner E2834512 N6158958				
Establishment date: 9/12/98		Observer: Geoff Walls		
Plot description (size, shape, etc): 20m x 20m square, marked by aluminium-tagged tanalised fence posts; one at each corner.				
Relocation details: 40m past second gate on access track. Fence near NE corner post tagged with orange tape. Posts and big <i>Carex secta</i> plants now invisible due to raupo growth.				
Photos taken (if any): Yes: 3-photo panorama of plot taken from track edge above NE post				
MEASUREMENT DETAILS				
Date: 4/10/05		Observer: Geoff Walls		
Tier	Height	Main species present	% cover*	Notes
Terrestrial:				
Emergents	2-5m	Pussy willow (dead and alive)	1	Less than before
Canopy	60cm- 2m	Raupo (dead)	2	Less than before Less than before
		Raupo (alive)	2	
		Pussy willow	1	
		<i>Carex secta</i> (dead)	0	
Subcanopy- Upper understorey- Lower understorey- Ground cover	<60cm	<i>Juncus articulatus</i>	2	Regeneration Some More than before
		<i>Carex secta</i>	1	
		<i>Schoenoplectus validus</i>	1	
		Pussy willow seedlings	1	
		<i>Glyceria fluitans</i>	1	
		<i>Eleocharis acuta</i>	0	
Aquatic:		Exotic pasture grasses/herbs	4	
		<u><i>Carex ?diandra</i></u>	1	
Watercress				
<u>Lemna minor</u>				
Comments (patterns, processes, changes): Much of area herbicided from the air in 2002, killing willows and raupo and <i>Carex secta</i> . Some regeneration of <i>Carex secta</i> , but raupo yet to reassert itself. Willows still regenerating: needs follow-up control.				
Species list/Notable flora (in addition to above):				

* 0 = <1% 1 = 1-5% 2 = 5-25% 3 = 25-50% 4 = 50-75% 5 = >75%

VEGETATION PLOT RECORDING SHEET

Location/Area: Pekapeka Swamp		Plot no: 3		
GPS reference: N-most post E2832194 N6157302				
Establishment date: 9/12/98		Observer: Geoff Walls		
Plot description (size, shape, etc): 20m x 20m square, defined by aluminium-tagged tanalised fence posts; one at each corner. The two posts within the willow margin with orange collars as well.				
Relocation details: Plot is directly across the pond from the maimai, c.35m from it to the E. Not measured because water levels too high.				
Photos taken (if any): Yes: 1 taken from maimai; also from silver willows and from fence.				
MEASUREMENT DETAILS				
Date: 4/10/05		Observer: Geoff Walls		
Tier	Height	Main species present	% cover*	Notes
Terrestrial:				
Emergents	>2.5m	Pussy willow (dead and alive)	1	Less than before
Canopy	50cm- 2.5m	Raupo	2	Healthy
		<u>Carex secta</u>	2	Healthy
		Pussy willow	1	Mostly dead
		<i>Cyperus ustulatus</i>	1	
Subcanopy- Upper understorey	<50cm	<i>Rumex obtusifolius</i>	1	
		Creeping bent	4	
		<i>Juncus articulatus</i>	3	
Lower understorey	<50cm	<i>Carex geminata</i>	1	
		<i>Rumex obtusifolius</i>	1	
		<i>Apium nodiflorum</i>	2	More than before
		<i>Bidens frondosus</i>	2	
Ground cover	<50cm	<i>Urtica linearifolia</i>	0	
		Water forget-me-not	1	
		<u>Polygonum salicifolium</u>	0	
		Water speedwell	1	
		<u>Carex secta</u>	0	
		<i>Carex secta</i>	0	
Aquatic:				
		Water speedwell	1	
		Watercress	1	
		<i>Lemna</i>	1	
		<i>Wolffia</i>	1	
		<i>Azolla</i>	1	
Comments (patterns, processes, changes): Water level significantly higher than in 2001. Turf, maintained by waterfowl, has formed. A little willow still alive. Cabbage trees have not recovered from aerial herbicide. Silver willows still pose a threat. <i>Carex secta</i> and raupo healthy.				
Species list/Notable flora (in addition to above): <i>Urtica linearifolia</i> – appears to have refugia on <i>Carex secta</i> tussocks, out of inundation zone; healthy population at present.				

* 0 = <1% 1 = 1-5% 2 = 5-25% 3 = 25-50% 4 = 50-75% 5 = >75%

VEGETATION PLOT RECORDING SHEET

Location/Area: Pekapeka Swamp		Plot no: 4		
GPS reference: Track near NE corner post E2832390 N6157068				
Establishment date: 10/12/98		Observer: Geoff Walls		
Plot description (size, shape, etc): 20m x 20m square, the four corner posts (tanalised, orange-collared) at 330/60 degrees (mag.) from each other.				
Relocation details: From the Glenogle driveway entrance, down paddock over railway and stiles. Along boardwalk in willow forest for 40m. NB 2005: the plot has been demolished, the posts used for the boardwalk! Too wet to use as a plot now anyway; better as a photopoint.				
Photos taken (if any): Yes: along boardwalk, swamp nettle				
MEASUREMENT DETAILS				
Date: 6/10/05		Observer: Geoff Walls		
Tier	Height	Main species present	% cover*	Notes
Terrestrial:				
Emergents				
Canopy	4-15m	Pussy willow	2	Mostly dead; a little live foliage
Subcanopy-	1-4m	Karamu	1	Saplings
Upper		Cabbage tree	0	Regenerating
understorey		Pussy willow	1	Regenerating
		Blackberry	1	Increasing
Lower	<1m	Japanese honeysuckle	1	Increasing
understorey		Toetoe	0	New arrival
		Dock, thistles, fireweed, puwha	2	Regenerating
		<i>Carex virgata</i>	1-2	
Ground		<i>Polygonum salicifolium</i>	0	Killed off
cover		<i>Carex secta</i>	1-2	Much increased
		<i>Urtica linearifolia</i>	1-2	Abundant
		<i>Hypolepis millefolium</i>	0	Regenerating
		<i>Carex lambertiana</i>	0	Has increased
		<i>Carex geminata</i>	0	
		<u>Ranunculus sceleratus</u>	2	
		<i>Myosotis laxa subsp. caespitosa</i>	1	
		<i>Bidens frondosa</i>	0	
Aquatic:		<i>Veronica anagallis-aquatica</i>	1	In wettest sites
		Cleavers	1	Standing water
		Watercress	2	
		<u>Lemna, Azolla</u>	2	
Comments (patterns, processes, changes): A real death zone. Dead willows have collapsed. Regrowth has been sprayed and killed, at the same time killing the previous good recovery of Carex, karamu, cabbage trees and toetoe (hopefully they will recover again). Prolific growth of watercress, buttercups and other exotic herbs. Japanese honeysuckle is still prevalent.				
Species list/Notable flora (in addition to above): <i>Urtica linearifolia</i> – common, regenerating, holding its own well.				

* 0 = <1% 1 = 1-5% 2 = 5-25% 3 = 25-50% 4 = 50-75% 5 = >75%

APPENDIX 4: Aquatic vegetation and macroinvertebrate recording sheets, October 2005

- Site no. 1
- Site no. 2
- Site no. 3
- Site no. 4

AQUATIC VEGETATION AND MACROINVERTEBRATE RECORDING SHEET

Location/Area: Pekapeka Swamp		Site no: 1
		GPS reference: E2835077 N6159663
Establishment date: 6/12/98		Observer: Geoff Walls
Site notes (location details, vegetation, etc): Very northern tip of wetland, where the fenceline meets the drainage channel. Railway line just up bank. Aluminium tag on strainer post. Willow edge, but trees overhanging site. Sluggish water flow, very muddy bottom. Watercress, and willow weed dominant. Also fish sampling site.		
SAMPLING DETAILS		
Date: 6/10/05		Observer: Geoff Walls
Sampling methods/notes: Samples of macrophytes, water and substrate gathered and examined in a white plastic tray.		
AQUATIC VEGETATION PRESENT		COMMENTS
Species	Relative abundance*	
<i>Rorippa nasturtium-aquaticum</i>	s	Less than previously
<i>Potamogeton crispus</i>	s	Less than previously
<i>Polygonum salicifolium</i>	m	
<i>Azolla filiculoides</i>	s	Less than previously
<i>Lemna minor</i>	s	Less than previously, no <i>Spirodela</i> detected
<i>Veronica anagallis-aquatica</i>	s	this time
<i>Wolffia australiana</i>	u	
Green alga	m	More than previously
Creeping bent	s	
<i>Callitriche stagnalis</i>	s	
MACROINVERTEBRATES PRESENT		COMMENTS
	SENSITIVITY SCORE (1-10)	
<i>Paraleptamphopus</i> amphipod	5	Adults seen too
Copepod	5	
<i>Xanthocnemis</i> damselfly nymph	5	
<i>Sigara</i> water boatman	5	
<i>Microvelia</i> bug	5	
<i>Potamopyrgus</i> snail	4	
<i>Physa</i> snail	3	
<i>Gyraulus</i> snail	3	
Flatworm	3	
<i>Hirudinea</i> leech	3	
<i>Chironomus</i> midge larva	1	
Oligochaete worm	1	

* estimated % or: u = uncommon/rare s = some m = much

AQUATIC VEGETATION AND MACROINVERTEBRATE RECORDING SHEET

Location/Area: Pekapeka Swamp		Site no: 2	
		GPS reference: E2832984 N6158013	
Establishment date: 7/12/98		Observer: Geoff Walls	
Site notes (location details, vegetation, etc):			
Rather squalid pond with slow water flow near beehives in middle section of swamp. On margin of swamp. Pretty shallow when sampled; stagnating in sun. Overhung and surrounded by big willows. No bottom-rooted macrophytes to speak of, just a bit of marginal willow weed. Floating plants not very dense. Also fish sampling site.			
SAMPLING DETAILS			
Date: 6/10/05		Observer: Geoff Walls	
Sampling methods/notes:			
Samples of macrophytes, water and substrate gathered and examined in a white plastic tray.			
AQUATIC VEGETATION PRESENT		COMMENTS	
Species	Relative abundance*		
<i>Azolla filiculoides</i>	m	More than previously	
<i>Lemna minor</i>	m	No <i>Spirodela punctata</i> this time (much in '01)	
<i>Wolffia australiana</i>	s		
Mercer grass/creeping bent	m)Have established since 2003; water levels	
Water speedwell	s)higher & pond quality improved with willow	
Water pepper	s)control	
Water cress	s)	
MACROINVERTEBRATES PRESENT		SENSITIVITY SCORE (1-10)	COMMENTS
<i>Paraleptamphopus</i> amphipod		5	Many
Damselfly larva		5	Many
<i>Microvelia</i> bug		5	
Ostracod		3	
Flatworm		3	
<i>Physa</i> snail		3	
<i>Gyraulus</i> snail		3	
<i>Potamopyrgus</i> snail		3	
Nematode		3	
Oligochaete worm		1	

* estimated % or: u = uncommon/rare s = some m = much

AQUATIC VEGETATION AND MACROINVERTEBRATE RECORDING SHEET

Location/Area: Pekapeka Swamp		Site no: 3
Establishment date: 7/12/98		GPS reference: E2832194 E6157302
		Observer: Geoff Walls
Site notes (location details, vegetation, etc): Large pond at SW of wetland. Accessible from SH2 down small access track, thence on foot from gate with stile to big maimai. Samples taken from around the pond margin. Water very shallow. Open still pond covered in floating plants. More terrestrial plants straying into shallows. Also fish sampling site.		
SAMPLING DETAILS		
Date: 6/10/05		Observer: Geoff Walls
Sampling methods/notes: Samples of macrophytes, water and substrate gathered and examined in a white plastic tray.		
AQUATIC VEGETATION PRESENT		COMMENTS
Species	Relative abundance*	
<i>Azolla filiculoides</i>	m	<i>Much more than in 2001</i>
<i>Lemna minor</i>	m	
<i>Spirodela punctata</i>	s	<i>Not detected previously</i>
<i>Wolffia australiana</i>	s	
Creeping bent	s	Regenerated since herbicide treatment
Water speedwell	s	Regenerated since herbicide treatment
Green alga	s	
Water celery	s	Proliferating in the vicinity
MACROINVERTEBRATES PRESENT		SENSITIVITY SCORE (1-10)
		COMMENTS
Dytiscid beetle	5	Numerous
Copepods	5	
Amphipod	5	Many
Mite	5	
<i>Xanthocnemis</i> damselfly larva	5	
Water boatman	5	
<i>Microvelia</i> waterskater bug	5	
<i>Potamopyrgus</i> snail	4	
<i>Physa</i> snail	3	
<i>Gyraulus</i> snail	3	
Nematode	3	
<i>Chironomus</i> midge larva	1	
Oligochaete worm	1	

* estimated % or: u = uncommon/rare s = some m = much

AQUATIC VEGETATION AND MACROINVERTEBRATE RECORDING SHEET

Location/Area: Pekapeka Swamp		Site no: 4
Establishment date: 10/12/98		GPS reference: E2832233 N6156664
		Observer: Geoff Walls
Site notes (location details, vegetation, etc): SE corner of wetland, where 2 streams converge at a tongue of land that contains a pa site. Access via Te Mahanga Road. Post with aluminium tag set in at site. Also fish sampling site.		
SAMPLING DETAILS		
Date: 6/10/05		Observer: Geoff Walls
Sampling methods/notes: Samples of macrophytes, water and substrate gathered and examined in a white plastic tray.		
AQUATIC VEGETATION PRESENT		COMMENTS
Species	Relative abundance*	
<i>Potamogeton crispus</i>	s	Less than previously
<i>Ceratophyllum demersum</i>	s	Has diminished somewhat
<i>Azolla filiculoides</i>	s	
<i>Lemna minor</i>	m	<i>Spirodela</i> not detected
<i>Wolffia australiana</i>	u	
<i>Veronica anagallis-aquatica</i>	m	Water speedwell, now abundant
Watercress	s	Less than previously
Green algae	s	Less stagnant than before
Creeping bent/Mercer grass	m	Has continued to proliferate; better flow and less stagnant than in the past
MACROINVERTEBRATES PRESENT		SENSITIVITY SCORE (1-10)
		COMMENTS
Dytiscid beetle		5
<i>Paraleptamphopus</i> amphipod		5
<i>Xanthocnemis</i> damselfly nymph		5
<i>Sigara</i> water boatman		5
<i>Anisops</i> backswimmer		5
<i>Microvelia</i> bug		5
<i>Potamopyrgus</i> snail		4
<i>Gyraulus</i> snail		3
Flatworm		3
Ostracod		3
Oligochaete worm		1

- estimated % or: u = uncommon/rare s = some m = much

APPENDIX 5: Bird lists, Pekapeka Swamp, October 2005

Water birds			Other birds		
Species	Est. Nos.	Breeding (yes/no)	Species	Est. Nos.	Breeding (yes/no)
<u>Native species</u>			<u>Native species</u>		
Australasian bittern	2	?	Fantail	20	?
Black shag	5	n	Riroriro	15	?
Grey duck	?	?	Shining cuckoo	2	?
NZ shoveler	25	y	Silvereye	20	y
Paradise shelduck	20	y			
Grey teal	20	?	<u>Introduced species</u>		
White-faced heron	5	?	Skylark	5	y
Pukeko	100	y	Starling	20	y
Welcome swallow	30	y	Blackbird	20	y
NZ kingfisher	15	?	Thrush	20	y
Australasian harrier	15	y	Redpoll	20	y
Spur-winged plover	10	?	Greenfinch	30	y
Spotless crane	2+	?	Goldfinch	30	y
			Chaffinch	20	y
<u>Introduced species</u>	40	y	Yellowhammer	15	y
Mallard	20	y	House sparrow	30	y
Black swan			Dunnock	15	y
			Magpie	10	y
			Myna	20	y
			Californian quail	10	?
			Pheasant	5	?

APPENDIX 6: Other animal lists, Pekapeka Swamp, October 2005

Species	Est. Nos.	Breeding (yes/no)	Species	Est. Nos.	Breeding (yes/no)
<u>Introduced mammals (detected)</u>			<u>Native reptiles</u>		
Cattle	adjacent		<u>Introduced reptiles</u>		
Sheep	adjacent		<u>Introduced frogs</u>		
Goat	adjacent		Southern bell frog	50	y
Rabbit	5	y	<u>Native fish</u>		
Hare	5	y	Shortfin eel	Some	n
Hedgehog	20	y	Longfin eel	Few	n
Feral cat	5		Common bully	Few	?
Possum	0		Inanga	-	-
<u>Introduced mammals (probably present)</u>			<u>Introduced fish</u>		
Stoat			Mosquito fish	Many	y
Ferret			Goldfish	-	-
Weasel					
Ship rat					
Norway rat					
Mouse					