



ENVIRONMENTAL MANAGEMENT GROUP

Technical report

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Pekapeka Swamp Ecological Monitoring 2007/08

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EMI 0812
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Environmental Management Group Technical Report

Internal

Environmental Science

Pekapeka Swamp Ecological Monitoring

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TABLE OF CONTENTS

INTRODUCTION.....	Error! Bookmark not defined.
1.0 VEGETATION	Error! Bookmark not defined.
1.1 Terrestrial vegetation	Error! Bookmark not defined.
1.1.1 <i>Vegetation map</i>	Error! Bookmark not defined.
1.1.2 <i>Photopoints</i>	Error! Bookmark not defined.
1.2 Aquatic vegetation.....	Error! Bookmark not defined.
1.3 Weeds.....	Error! Bookmark not defined.
1.4 Notable flora.....	Error! Bookmark not defined.
2.0 FAUNA	Error! Bookmark not defined.
2.1 Waterbirds.....	Error! Bookmark not defined.
2.2 Other birds	Error! Bookmark not defined.
2.3 Fish.....	Error! Bookmark not defined.
2.4 Aquatic invertebrates	Error! Bookmark not defined.
2.5 Mammalian pests	Error! Bookmark not defined.
2.6 Other fauna.....	Error! Bookmark not defined.
CONCLUSIONS AND RECOMMENDATIONS.....	Error! Bookmark not defined.
APPENDIX 1: Map of Pekapeka Swamp, showing vegetation types and monitoring site locations.....	Error! Bookmark not defined.
APPENDIX 2: Photopoint recording sheets, february 2008	Error! Bookmark not defined.
APPENDIX 3: Aquatic vegetation and macroinvertebrate recording sheets, february 2008	Error! Bookmark not defined.
APPENDIX 4: Bird lists, Pekapeka Swamp, february 2008....	Error! Bookmark not defined.
APPENDIX 5: Other animal lists, Pekapeka Swamp, february 2008	Error! Bookmark not defined.

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 2005-2010).

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.

The Monitoring programme was repeated a third time in late November – early December 2001 and the opportunity was taken to familiarise new Hawkes Bay Regional Council staff with the monitoring techniques. At this time, annual monitoring was abandoned for a bi-annual repetition and ecological monitoring was carried out in early December 2003, October 2005 and again in February 2008.

This report documents the findings from 2008 and draws comparisons with those obtained in previous surveys.

1.0 VEGETATION

1.1 Terrestrial vegetation

In previous years 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 photo points; remeasurement of permanent vegetation monitoring plots.

In 2008 it was decided that the vegetation plots be abandoned due to them being too time consuming. As a result, photo points covered monitoring of these plots, which was considered to be as valuable to the monitoring programme.

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 and 2008

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 photo points 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 2009; re-mapping of the vegetation then too if appropriate aerial photograph available.

1.1.2 Photopoints

The method as described by Walls (2005) was that 18 photo points were set up to cover the entire length and breadth of the wetland in 1998. A fence post marked each of the sites: either existing or a new one driven in on site and each was marked with an aluminium label. The photo points were chosen by Geoff Walls in 1998 to represent the spectrum of terrestrial vegetation types and situations in the swamp. In 2008 digital photographs were taken from a standing position at each photo point: mostly panoramas although some were more localised and specific. These photo points have been photographed in 1998, 1999, 2000, 2001, 2003 and 2005 using SLR camera and Kodak colour prints and the photographs are collated in albums that accompany the documents for these years. ‘

The 2008 photographs are supplied digitally on a CD that accompanies this document. The location of each photo point is marked on the map (Appendix 1) and described in the photo point recording sheets (Appendix 2). Previous years observations of each of the photo points have been documented below by Geoff Walls (2005) and have been added to with current years observations.

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.

In 2008 there was a dramatic change in the reduction of willows. The raupo and Flax were in a very healthy condition and the Flax in particular had expanded and was flowering heavily. A new road and shallow drain has been established to the North of the swamp and there was no evidence of blackberry although the convolvulus was spreading from the edge of the wetland.

Photopoint 2:

As Photopoint 1. In previous years it was noted that a 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.

In 2008 the open water areas were not evident and seem to be ephemeral. *Convolvulus* was dominant in the North Western corner. The willow control seems to have been successful here and only larger stems remain. Harakake is flowering well and there is no evidence of *Carex secta*, *bolboschoenus fluviatalis* or blackberry.

Photopoint 3:

Similar to Photopoints 1 and 2. In previous years it was noted that 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.

In 2008 all the willows appeared to be dead with only large stems persisting. The new plantings were in good health with flowering on some Harakeke and the cabbage trees were growing strongly. As with photopoint 2 the ephemeral water areas were dry due to the long droughty summer. *Carex germinata* was spreading from the fence line and appeared very healthy. There was no evidence of blackberry but *convolvulus* was dominant beneath the dead willows.

Photopoint 4:

In 2005 it was noted that Grey willow adults had been herbicided and bulk killed, but there was substantial regeneration (saplings and seedlings).

In 2008 there was evidence of grey willow saplings remaining amongst the Raupo. The site was relatively dry and the Raupo was less vigorous and more scattered. The sedge-rushland in the foreground comprised of lake clubrush *scheonoplectus tabernaemontani* and individual plants of *Carex secta*. Rank pasture grasses dominate beneath the old willow canopy.

Photopoint 5:

Previous years have observed that 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*.

In 2008 the Raupo has continued to expand. The adult willows all appear now to be dead, however there are occasional live saplings evident. There is a lot of willow weed, beggars tick and creeping bent evident at this site. Next to the channel there are healthy plants of *Carex secta* and *C. maorica*. On the true right bank of the channel there is evidence of swamp nettle existing amongst *C. maorica* and blackberry. *Carex germinata* is spreading Eastwards from the fence line.

Photopoint 6:

Previous observations in 2000 noted, 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.

In 2008 it appears that the willow control has been very successful with no new saplings found. The cabbage trees are generally in good condition but some die back has occurred from previous years. Again as in photopoint 5, beggars tick is plentiful along the Raupo edge.

Photopoint 7:

Previous observations in 2001 noted, 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.

In 2008 the Willow control since 2005 seems to have been successful. There are however, several crack willow saplings persisting around the large weeping willows. Oxtongue and tall fescue are dominant at this site with *convolulus* spreading. There is no obvious expansion of Raupo and the large Cabbage tree nearest the photopoint is now dead with others being threatened by the spreading *convolvulus*.

Photopoint 8:

Previous observations in 2001 noted that 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.

In 2008 the shallow ponded areas were completely dry and as a result there is no evidence of *Lemna minor* or *Azolla*. The Raupo has expanded into the pre-spray area and many annual weeds are present within the ephemeral zone. There is some *convolvulus* near the fenceline.

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.

In 2008 the Raupo seems to be expanding and establishing new stands within the open water areas. There are many swans, mallard and paradise shell duck at this site. There are no obvious signs of willows although some dead heads remain. The Harakeke plantings are growing well and the areas of Raupo that were cut and sprayed remain dead.

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.

In 2008 the open water areas are fully covered with *Lemna* and *Wolfia*. *Carex secta* is showing signs of recovery and had some new plants establishing themselves along the fenceline. Also along the fenceline there was a small patch of Raupo that was expanding. There was some evidence of willow regeneration and blackberry was expanding up onto the peninsula. There was evidence of many annual weeds ie. *Bidens frondosa*, *Veronica anagallis-aquatica*.

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.

In 2008 there was evidence that *Carex secta* has began to re-establish and there was a new small stand of Raupo. There was some re-growth of crack willow at the apex of the fence.

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.

In 2008 *Ranunculus sceleratus* had reduced a little in the rank pasture but there was an increase in oxtongue. The willow eradication has been successful at this site and there did not seem to be any evidence of regrowth. There has been much re-growth of Raupo here but less so of *Carex secta* which has been obscured by a thick sward of *Bidens frondosa*.

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.

In 2008 there was evidence of willow re-growth between the water and the fenceline. The clumps of Raupo seem to have expanded as has the willow herb and water speedwell. There is a lot of *Lemna* cover on the open water amongst these stands.

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.

In 2008 the *Carex secta* was essentially as in 2005. The plants were looking unhealthy with some die back evident. Still there is persistent re-growth of willow. The small patches of Raupo are expanding as too are the *juncus* islands. The water level is lower than 2005 and there is *Eleocharis acuta* present along the margins.

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.

In 2008 there is some regeneration of willow along the edge, otherwise only larger stems of long dead willows remain. Raupo exists to the South and West but the near area is dominated by *Carex spp.* The cabbage trees are not looking healthy and are either dead or nearly so. Occasional clumps of elephant ear are present which is of some concern and needs to be controlled and the source identified if possible.

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.

In 2008 there was marked improvement and recovery of *Carex secta*. Of concern are the many young and regenerating Grey and Crack willows adjacent to the maimai which need to be controlled. There seems to be some regeneration of young cabbage trees which are now present and appear healthy.

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.

In 2008 the vegetation was much as in 2005. There was still many macrophytes in the stream although the flow was reasonable and the water clear. Crack willow saplings remained and blackberry appeared to be spreading. There was a lot of oxtounge evident at this site and a good fringe of *bulbosceonus* developing alongside the stream. The plantings of cabbage trees and harakeke were progressing well but there was no evidence of swamp nettle perhaps due to the rank growth of pasture grasses.

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 2008 the vegetation was essentially as 2005. Raupo had extended landward and there were several grey willow saplings that were now up to 5m tall and have become established. The planted flax has flowered but the lone cabbage tree looks unhealthy

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 and 2005 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 2008, 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 2009; thence biennially. Photos to be repeated; recording sheets to be used.

1.1.1 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.

In 2008 these vegetation plots were not revisited due to them being difficult and time consuming to undertake. Previous observations from Walls can be found in the ecological reports for the corresponding years.

1.2 Aquatic vegetation

Method:

Four sites were chosen by Geoff Walls (1998) to monitor the composition of aquatic vegetation. At each of the sites macroinvertebrate sampling and fish surveys were also undertaken. 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).

The method designed by Walls (1998) required samples taken from each site to be 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 - 2005 – 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 2008. Common water starwort (*Callitriche stagnalis*) appeared in 2005 and was still present in 2008.

Comparisons between 2005 and 2008 were noted at each site in terms of the relative abundance of the species:

Site 1: There was less *Potamogeton crispus*, *Azolla filiculoides*, *Callitriche stagnalis* and water speedwell, but more *lemna minor*. 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. *Callitriche stagnalis*, in particular, is commonly found in disturbed waterways.

Site 2: Mercer grass, creeping bent and *Azolla filiculoides* have all decreased since 2005. *Veronica anagallis-aquatica*, and watercress which had established since 2003 were no longer present but water pepper still remained.

Site 3: There was a reduction in abundance of all species present at this site apart from *Lemna minor* and Green alga which had maintained the same abundances as previous years.

Site 4: There was less *Veronica anagallis-aquatica*, but all the other species had increased in abundance. *Elodea sp.*, water pepper and water celery had newly established since 2005

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 2009; 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 2008, 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 controlled, although it was still present in low numbers. An additional weed Periwinkle (*Vinca major*) was found to be 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 2009, 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.

Observations:

Swamp nettle was found to be still generally plentiful and widespread in Pekapeka Swamp in 2008.

No other notable flora was detected in 2008.

Next monitoring:

November-December 2008, along with other monitoring and via photopoint 4.

2.0 FAUNA

2.1 Waterbirds

Method:

Two methods have been used previously to search for waterbirds.

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.

In 2008 only the general fauna survey was undertaken and liason with local experts to determine species within the wetland

Observations:

As discussed by Walls (2005) 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 crake was heard at the pond used for aquatic sampling and vegetation monitoring in the SW of the wetland on 4 October 2005. Spotless crake have been suspected to be present there during previous monitoring but were not confirmed as present in 2008.

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. In 2008 bittern were not detected but are known to be resident in the Southern regions of the swamp.

Local wetland experts have indicated that there is a breeding pair of marsh crake within the wetland. This is heartening as there has not been any definite detections of these rare birds in previous searches but this may be due to their secretive nature. The raupo and sedges provide an abundance of excellent habitat for these birds.

19 species of waterbirds were recorded during general fauna survey, out of a total of 41 bird species. The figures for previous years indicate that the number of species within the swamp have increased. Birds now present include the rare Marsh Crake, Little black shag and NZ dabchick which all have a threatened classification, given by the Department of Conservation, of sparse. There has also been the introduction of two non native species to the wetland, Mute swan and Feral goose. These are transient birds and may not have been detected in previous searches which were carried out in late spring – early summer. This survey was carried out later in February 2008

The full list of birds and their estimated numbers is in Appendix 4.

Next monitoring:

November-December 2009; 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:

22 species of other birds were recorded during general fauna survey, out of a total of 41 bird species. The majority of birds found were exotic species. In addition to the species found in previous years, Rock pigeon and Rook were now present at the swamp. The native species found previously were shining cuckoo, grey warbler, fantail and silvereye. In 2008 there was an addition of the native owl, Morepork. There were no significant differences in estimated numbers between 2005 and 2008 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 4.

Next monitoring:

November-December 2009; thence biennially.

2.3 Fish

Method:

Fish were surveyed largely using netting and trapping. Fyke nets 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 3). Dog biscuits were used as bait in the fyke nets and minnow traps. Fish were also observed in open water sites. Because of past difficulty of setting nets at Sites 2 and 3, only minnow traps were used.

Observations:

The fish caught were:

- Shortfin eel (*Anguilla australis*): twenty three fish were caught at the north end of the swamp (Site 1), one fish was caught in the middle section (site 2) no fish were caught at the southern end of the swamp. The fish caught ranged in sizes from

500 – 700mm. This was a vast improvement to the numbers caught in 2005 when only one single fish was trapped and may indicate that there has been a reduction in commercial fishing operations.

- Mosquito fish (*Gambusia affinis*): native to the Gulf of Mexico; recorded from Pekapeka Swamp for the first time in 1998 and they have been recorded in the Northern regions of the swamp in 1999, 2000, 2001 and 2003 and 2005. Most notably they were not present in the Northern site in 2008 but were found to have colonised the middle and Southern reaches of the swamp which may be due to the implementation of a fish pass designed to allow passage for native species above the weir. Their absence in the Northern site may be due to the increase of short-finned eels which could be using them as a food source.
- Goldfish (*Carassius auratus*): erroneously known as carp (McDowall 2000); One fish found in the middle section of the swamp (site3) previously recorded in 1984 by electric fishing (Hooper et al 1986)

Not recorded in 2008, 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 consequent years. The addition of the fish pass erected in 2007 may provide them with a migratory pathway to the upper reaches of the wetland.
- Common bully (*Gobiomorphus cotidianus*): previously abundant at the southern end of the wetland, but not detected in 2008. 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.

In summary there has been a significant increase in the number of short-finned eels caught in the swamp. These are the only native species in the swamp which also has the exotic pest fish *Gambusia affinis* and goldfish. There has been a sharp decline in the abundance of Inanga and common bully in the wetland since monitoring began in 1998 and this is of some concern. It may be due to the historical absence of migratory pathways or could be due to the increase of *Gambusia* throughout the swamp. The addition of a fish pass in 2007 may open up these migratory pathways and promote relocation of these species and this should be monitored closely.

Next monitoring:

November-December 2009; 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	2008
Site 1	1-5	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	1-5
Site 3	1-5	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	1-5

At site 1 the suite of macroinvertebrates was much less than previous years with only five of the previous species detected. This may be due to excavation of the old channel to accommodate new drainage. Many of the more sensitive species were now no longer present which indicates there has been a reduction in water quality at this site. In contrast, site 2 saw an addition of species with sensitivity scores of 5, indicating that the willow eradication and consequent raised water table has improved the presence of available habitat. Site 3 saw a reduction of species with lower sensitivity scores and an increase of *Xanthocnemis* damselfly larva with many adults seen also. Site 4 was relatively unchanged but there was a reduction of species with lower sensitivity scores.

Next monitoring:

November-December 2009; 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. In 2008 there were no sightings of any pest mammals but they are still most probably present. Changes over the years have been documented by Walls 2005 and are included below.

- 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 2009; 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, 2003 and 2005. 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 2009; 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 2005 conclusions and recommendations are still relevant, but are updated in the light of 2008 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 rare water birds has increased in the wetland since 2005. There are breeding pairs of marsh crake which has small and fragmented populations nationally. Other species of note within the wetland include the NZ Dabchick, spotless crake, little black shag and grey duck. These species are all threatened and should be monitored to ensure that they sustain their populations within the swamp.

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 an increase in the number of short-finned eels within the swamp. This however is the only native species still present and the decline of inanga and common bully is still of concern. The construction of a fish pass in 2007 may reopen migratory pathways for these species and may see them recolonise the Southern reaches of the swamp but this needs to be monitored closely.

Recommendation: That a comprehensive fish survey be carried out annually in the wetland to determine the effectiveness of the fish pass.

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 habitat quality deteriorated through diminished flow but improved again. 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. 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. These recommendations have not been enacted and it is not deemed necessary to do so. Due to the eutrophic nature of the wetland, water quality will never be high and a focus towards habitat condition should be the main priority.

Recommendation: That aquatic macroinvertebrate monitoring continue.

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 and the need for a fish survey above and below the fish pass. 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 February 2008 can be arrived at:

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

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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: PHOTOPPOINT RECORDING SHEETS, FEBRUARY 2008

- 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.
27/02/08	F Cameron A Lamason	New road and shallow drain established to the N of the swamp. No obvious blackberry, convolvulus is spreading from edge of the wetland. Willows are significantly reduced.

		Raupo and Flax are in good condition and heavy flowering of Flax is evident
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PHOTOPOINT RECORDING SHEET

Location/Area: Pekapeka Swamp		Photopoint no: 2
Establishment date: 7/12/98		GPS reference: E2835267 N6159466
		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.
27/02/08	F Cameron A Lamason	As above but no open water. Convolvulus is dominating in the NW corner. Only larger stems remain on Willows. Approx 50% flowering on flax. Carex secta is not obvious nor is Bolboschoenus or blackberry.

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.
27/02/08	F Cameron A Lamason	All willow appears to be dead with only larger stems persisting. New plantings are in good health with flowering on some flax. Cabbage trees growing strongly. No open water. Carex germinata is spreading from the fenceline. No blackberry but convolvulus dominant beneath the dead willow.

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).
27/02/08	F Cameron A Lamason	Grey willow saplings remain amongst the raupo. Site is relatively dry with raupo less vigorous and scattered. Lake club rush present. Some carex secta but few plants. Rank pasture dominates beneath old willow canopy

PHOTOPOINT RECORDING SHEET

Location/Area: Pekapeka Swamp		Photopoint no: 5
Establishment date: 9/12/98		GPS reference: E2834120 N6158670
Photopoint relocation notes:		Observer/Photographer: Geoff Walls
<p>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.</p>		
Direction from marker/post (magnetic bearing):		
Camera info (lens, film, etc): 50mm lens; Kodak 200asa print film		
Vegetation (composition, structure, patterns, processes):		
<p>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.</p>		
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

4/10/05	G. Walls	<p>now.</p> <p>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>.</p>
27/02/08	F Cameron A Lamason	<p>As above. Very occasional live crack willow sapling. Adults are all dead and decaying. <i>Carex secta</i> and <i>C. maorica</i> next to the channel. Some swamp nettle among <i>C. maorica</i> and blackberry on TRB of channel. <i>C. germinata</i> spreading E from fenceline.</p>

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
<p>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.</p> <p>Direction from marker/post (magnetic bearing):</p> <p>Camera info (lens, film, etc): 50mm lens; Kodak 200asa print film</p>		
<p>Vegetation (composition, structure, patterns, processes):</p> <p>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.</p> <p>1 photo taken.</p>		
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.
27/02/08	F Cameron A Lamason	Cabbage trees are generally ok but some die back has occurred. Willow control seems to be 100% successful. Beggars tick plentiful along Raupo edge. No open water can be seen.

PHOTOPOINT RECORDING SHEET

Location/Area: Pekapeka Swamp		Photopoint no: 7
Establishment date: 9/12/98		GPS Reference: E2833746 N6158274
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.		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): 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.
27/02/08	F Cameron A Lamason	Willow control appears to be successful except around larger weeping willows where several crack willow saplings persist. Oxtounge and tall fescue dominant. RPG with convolvulus spreading. No obvious expansion of Raupo. Large cabbage tree dead. Others threatened by bindweeds.

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.
27/02/08	F Cameron A Lamason	As above without <i>Azolla</i> . Shallow ponds are dry. No open water. Raupo has expanded to pre-spray area. Many annual weeds in ephemeral zone. Some convolvulus near fence.

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.
27/02/08	F Cameron A Lamason	Raupo continues to expand and forms new clumps in open water. Many swans, mallard and P Shell duck. No obvious willow although dead heads remain. Cut and sprayed Raupo remains dead. Flax plantings going well.

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.
27/02/08	F Cameron A Lamason	100% cover of the water with <i>Lemna</i> and <i>Wolfia</i> . Some recovery of <i>Carex secta</i> evidence of new plants also and a small 1m ² patch of Raupo on the near fenceline. Some grey willow regeneration. Blackberry is expanding up onto

		the peninsula. Many annual weed – <i>Bidens frondosa</i> , water speedwell etc. are present.
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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.
27/02/08	F Cameron A Lamason	<i>Carex secta</i> has begun to establish and very small Raupo clump. Small regrowth of crack willow at open fence.

PHOTOPOINT RECORDING SHEET

Location/Area: Pekapeka Swamp		Photopoint no: 12
Establishment date: 7/12/98		GPS Reference: E2832610 N6157666
		Observer/Photographer: Geoff Walls
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.		
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.
27/02/08	F Cameron A Lamason	<i>Ranunculus</i> has reduced a little but oxtongue has expanded in the rank pasture. No willow regrowth was noted. Much regrowth of Raupo but less so for <i>Carex secta</i> which is obscured by a thick band of beggars tick.

PHOTOPOINT RECORDING SHEET

Location/Area: Pekapeka Swamp		Photopoint no: 13
Establishment date: 7/12/98		GPS Reference: E2832541 N6157591
		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.
27/02/08	F Cameron A Lamason	Some willow regrowth between water and fenceline. Much <i>lemna</i> cover among the expanding clumps of Raupo and willow herb and water speedwell. Karamu in restoration plantings is OK but needs releasing

PHOTOPOINT RECORDING SHEET

Location/Area: Pekapeka Swamp		Photopoint no: 14
Establishment date: 10/12/98		GPS Reference: E2832484 N6157464
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).		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): 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.		
REPHOTOGRAPHY 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	Herbicide 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.
27/02/08	F Cameron A Lamason	<i>Carex secta</i> as above generally alive but unhealthy with some deaths. Persistent willow growth. Small Raupo patches are expanding as are <i>Juncus</i> islands. <i>Eleocharis acuta</i> is present on margins. Water level is lower.

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.
27/02/08	F Cameron A Lamason	Some regeneration of willows along the edges otherwise only larger stems of long dead willows remain. Raupo to the S and W but near area dominated by <i>Carex spp.</i> Cabbage trees in view either dead or nearly so. Occassional clumps of elephants ear have established and needs controlled and the source identified.

PHOTOPOINT RECORDING SHEET

Location/Area: Pekapeka Swamp		Photopoint no: 16
Establishment date: 10/12/98		GPS Reference: E2832338 N6157106
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.		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): 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	Herbicided 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
27/02/08	F Cameron A Lamason	<i>Carex</i> recovery is v. good. Much <i>Lemna</i> and occasional <i>Azolla</i> on water. Many young and regenerating grey and crack willow adjacent to maimai needs attention. Some young and healthy cabbage trees are now present

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.
27/02/08	F Cameron A Lamason	Flow is reasonable and water clear. Crack willow saplings remain and there is much oxtongue but a good fringe of

		Bulboschoenus fluviatilis is developing. Plantings of flax and cabbage trees progressing well. No swamp nettle seen. Many macrophytes in the stream.
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PHOTOPOINT RECORDING SHEET

Location/Area: Pekapeka Swamp		Photopoint no: 18
Establishment date: 10/12/98		GPS Reference: E2831950 N6157182
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.		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): 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.		
REPHOTOGRAPHY 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.
27/02/08	F Cameron A Lamason	As above. The Raupo has extended landward. Several grey willow saplings up to 5m tall are now established. Open water beyond the Raupo. A lone cabbage tree looks very unhealthy. The planted flax has flowered.

**APPENDIX 3: AQUATIC VEGETATION AND MACROINVERTEBRATE RECORDING SHEETS,
FEBRUARY 2008**

- 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	
Establishment date: 6/12/98		GPS reference: E2835077 N6159663	
		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: 27/02/08		Observer: Fiona Cameron, A Lamason	
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>	u	Less than previously	
<i>Polygonum salicifolium</i>	m		
<i>Azolla filiculoides</i>	u	Less than previously	
<i>Lemna minor</i>	m	More than previously	
<i>Veronica anagallis-aquatica</i>	u		
<i>Wolffia australiana</i>	u		
Green alga	m		
Creeping bent	s		
<i>Callitriche stagnalis</i>	u		
MACROINVERTEBRATES PRESENT		SENSITIVITYS CORE (1-10)	COMMENTS
<i>Microvelia</i> bug		5	
<i>Potamopyrgus</i> snail		4	
Flatworm		3	
<i>Hirudinea</i> leech		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: 2
Establishment date: 7/12/98		GPS reference: E2832984 N6158013
		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: 27/02/08		Observer: Fiona Cameron, A Lamason
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>	s	More than previously
<i>Lemna minor</i>	m	No <i>Spirodela punctata</i> this time (much in '01)
<i>Wolffia australiana</i>	s	No Water speedwell and watercress seen
Mercer grass/creeping bent	s	
Water pepper	s	
MACROINVERTEBRATES PRESENT		SENSITIVITYS CORE (1-10)
<i>Paraleptamphopus</i> amphipod		5
<i>Anisops</i> backswimmer		5
Damselfly larva		5
<i>Microvelia</i> bug		5
Sigara water boatman		5
<i>Triplectides</i>		5
Dysticid beetle larva		5
Ostracod		3
Nematode		3
<i>Hirudinea</i> leech		3
Oligochaete worm		1
<i>Chironomous</i> midge larvae		1
		Many
		Many

* 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: 27/02/08		Observer: Fiona Cameron, A Lamason	
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>	u	Less than previous years	
<i>Lemna minor</i>	m		
<i>Spirodela punctata</i>	u		
<i>Wolffia australiana</i>	u	(Less than previous years	
Creeping bent	u		
Water speedwell	u		
Green alga	s	Proliferating in the vicinity	
Water celery	u		
MACROINVERTEBRATES PRESENT		SENSITIVITYS CORE (1-10)	COMMENTS
Dytiscid beetle		5	Numerous
Mite		5	
<i>Xanthocnemis</i> damselfly larva		5	Many
Water boatman		5	
<i>Microvelia</i> waterskater bug		5	

* 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: 27/02/08		Observer: Fiona Cameron, A Lamason	
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>	m	More 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>	s		
<i>Veronica anagallis-aquatica</i>	s	Water speedwell less than previously	
Watercress	s		
Green algae	m		
Creeping bent/Mercer grass	m		
Water pepper	u		
Water celery	s	(Newly established 2008)	
Elodea	m		
MACROINVERTEBRATES PRESENT		SENSITIVITYS CORE (1-10)	COMMENTS
Dytiscid beetle		5	
<i>Paraleptamphopus</i> amphipod		5	Abundant
<i>Xanthocnemis</i> damselfly nymph		5	Abundant; adults seen too
<i>Sigara</i> water boatman		5	
<i>Anisops</i> backswimmer		5	
<i>Microvelia</i> bug		5	Surprisingly few snails
<i>Potamopyrgus</i> snail		4	
<i>Physa</i> snail		3	Numerous
<i>Hirudinea</i> leech		3	
Flatworm		3	
Oligochaete worm		1	

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

APPENDIX 4: BIRD LISTS, PEKAPEKA SWAMP, FEBRUARY 2008

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	y	Fantail	20	?
Black shag	2	n	Riroriro	15	?
NZ shoveler	5	?	Shining cuckoo	2	?
Paradise shelduck	5	y	Silvereye	20	y
Grey teal	20	y	morepork	?	?
White-faced heron	5	?			
Pukeko	10	?	<u>Introduced species</u>	5	y
Welcome swallow	50	y	Skylark	20	y
NZ kingfisher	5	y	Starling	20	y
Australasian harrier	5	?	Blackbird	20	y
Marsh crane	2+	y	Thrush	20	y
Little black shag	1	y	Redpoll	30	y
Little Shag			Greenfinch	30	y
NZ Dabchick			Goldfinch	20	y
Black-backed gull			Chaffinch	15	y
			Yellowhammer	30	y
			House sparrow	15	y
			Dunnock	10	y
<u>Introduced species</u>			Magpie	20	y
Mallard	40	y	Myna	10	?
Black swan	20	y	Californian quail	5	?
Mute swan			Pheasant		
Feral goose			Rock pigeon		
			Rook		

APPENDIX 5: OTHER ANIMAL LISTS, PEKAPEKA SWAMP, FEBRUARY 2008

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	35	n
Hedgehog	20	y	Longfin eel	-	n
Feral cat	5		Common bully	?	?
Possum	0		Inanga	?	-
<u>Introduced mammals (probably present)</u>			<u>Introduced fish</u>		
Stoat			Mosquito fish	Many	y
Ferret			Goldfish	Some	-
Weasel					
Ship rat					
Norway rat					
Mouse					