



ENVIRONMENTAL MANAGEMENT GROUP

Technical report

INTERNAL



SAFEGUARDING YOUR ENVIRONMENT + KAITIAKI TUKU IHO



Whakaki Lagoon Ecological Monitoring 2005

June 2006
EMI 06/11
HBRC Plan No. 3861

Environmental Management Group Technical Report

Internal

Environmental Monitoring Section

Whakaki Lagoon Ecological Monitoring 2005

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WHAKAKI LAGOON ECOLOGICAL MONITORING 2005

Contract document prepared for Hawke's Bay Regional Council



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INTRODUCTION

Regular monitoring of ecological condition and trend is built into the planned management of Whakaki Lagoon, northern Hawke's Bay, by the Hawke's Bay Regional Council (Hawke's Bay Regional Council Draft Plan No. 2783, April 1999).

In December 1999, a regime for monitoring the ecological condition and trend of the lagoon was set up on contract for the Hawke's Bay Regional Council by Geoff Walls. This was done using the experience gained in establishing a similar monitoring regime in Pekapeka Swamp, Hawke's Bay, a year earlier. It also had the benefit of the local knowledge of Trustees of Whakaki Lagoon, adjacent landowners and Department of Conservation staff. Baseline surveys of vegetation and fauna were carried out at the same time.

That work was reported upon (Whakaki Lagoon Ecological Monitoring, 1999). A companion report provides more background information and forms a monitoring plan (Whakaki Lagoon Ecological Monitoring Plan, February 1999).

In early December 2001, the monitoring programme was repeated as planned. Overall, the lagoon water levels were higher in 2001 than in 1999, due to recent heavy rain. That made some of the monitoring more difficult, particularly around the immediate lagoon margins.

In December 2003, the monitoring was repeated once more. Conditions were similar to those in 2001.

In October 2005, the monitoring was repeated once more. Conditions were similar to those in 2003, indicating that the increased lagoon water levels are now normal rather than ephemeral. This document chronicles the monitoring results and draws comparisons with those obtained in 2003.

1. VEGETATION

1.1 Terrestrial vegetation

There were three aspects to monitoring of the terrestrial vegetation of the lagoon: mapping of the current vegetation cover; establishment of photopoints; establishment of permanent vegetation monitoring plots.

1.1.1 Vegetation map

Method:

The patterns of terrestrial vegetation were mapped in 1999 using recent colour aerial photos. A copy of this map is shown in Appendix 1. Re-mapping is scheduled for 2004 or thereafter.

Observations:

Seven major vegetation types were identified in 1999 and mapped. The observations made then were found to be valid in 2001, 2003 and 2005:

- W** Low herbfield-sedgeland in zone of wave action and periodic inundation; contains turfs of *Mimulus repens* and *Lilaeopsis ruthiana*, much used by waterfowl.
- SR** Lagoon shore fringe of dense sedges and rushes; dominated by *Juncus kraussii* and *Bolboschoenus fluviatilis*; shore ribbonwood (*Plagianthus divaricatus*) present in places.
- MG** Mosaic of rushes, sedges, blackberry and grazed pasture; mainly backing the shore fringe on the west, north and east sides of the lagoon.
- MR** Mosaic of rank grasses, rushes, sedges, pohuehue, lupin, blackberry and other shrubs (including gorse and boxthorn); backing the shore fringe on the south side of the lagoon.
- Ra** Sparse vegetation containing cushions of *Raoulia* aff. *hookeri* and various exotic grasses on open sand-shingle flats at the rear of the dunes. The presence of *Raoulia* aff. *hookeri* is of significance: this species is at the northern end of its geographic range.
- Sp** Spinifex grassland on foredunes; one of the best populations of this native sandbinder left on the East Coast of the North Island (strangely virtually free of marram grass).
- Ma** Marram grassland; two eradicable patches near the south-west corner of the lagoon.

The low wet turfs, *Raoulia* aff. *hookeri* cushion fields and spinifex grasslands are the most natural vegetation types; the others are the product of considerable past modification through burning, mechanical clearance and the impact of farm stock. In the distant past (before people arrived), there is likely to have been a relatively narrow shore fringe of rushes, sedges, harakeke (lowland flax) and cabbage trees. Behind this would have been coastal forest featuring pukatea, tawa, kahikatea and nikau. On the strip between the lagoon and the sea may have been low forest of totara, akiraho, ngaio, kohuhu, kanuka and manuka. Pingao and sand tussock would have accompanied the spinifex.

The low wet turfs are expected to persist, although heightened water levels since 1999 have diminished their extent. The *Raoulia* aff. *hookeri* cushion fields appear to be vulnerable to invasion by exotic grasses. The spinifex grasslands are vulnerable to invasion by marram grass. The existing marram grass patches are expected to spread unless controlled. The shore fringe sedges and rushes are likely to contain increasing amounts of shore ribbonwood as stock are progressively fenced out. Cabbage tree and harakeke may make a reappearance too. In the grazed mosaics, nothing is likely to change much in the foreseeable future. By contrast, in the ungrazed (rank) mosaics various native and exotic shrubs, trees, rushes, sedges and grasses (including weeds) are likely to proliferate according to the management regime (planting, weed control, rabbit control, etc.).

A more recent aerial photo is available, but comparison of the vegetation patterns visible on it and those mapped in 1999 indicates that there has been insufficient change to warrant re-mapping at this stage.

Next monitoring:

General observations in November-December 2007; re-mapping of the vegetation then (if sufficient change has occurred) or subsequently.

1.1.2 Photopoints

Method:

12 photopoints were set up the length and breadth of the wetland in December 1999. Each was marked with an aluminium label attached to a post, mostly an existing fence post. The photopoints were chosen to represent the spectrum of terrestrial vegetation types and situations around the wetland. They were also selected to be readily relocated. Photos were taken from the standing position at each photopoint: mostly panoramas of the vegetation; some more localised and specific. A SLR camera with a 50mm lens was used. Film was Kodak colour print, 200asa. The photopoints were revisited in early December 2001 and again in early December 2003, when an additional photopoint was added. The photopoints were revisited again in October 2005, when digital photography was used. The 2005 prints, in order, are in the album that accompanies this document, and the images have also been supplied on CD.

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

Observations:

Photopoint 1:

Sited at the main inlet channels, overlooking an expanse of dense marsh clubrush (*Bolboschoenus fluviatilis*) sedgeland. In 2001, since the cattle were fenced out (c.1999), the marsh clubrush had grown noticeably taller, and the previously small raupo patch had expanded significantly. Mercer grass (*Paspalum distichum*) and annual beard-grass (*Polypogon monspeliensis*) had proliferated in more open damp pasture sites. In 2003 it was much the same. The raupo had continued to expand. In 2005, it was earlier in season so the *Bolboschoenus* was still brown (hadn't yet grown

back from its winter die-off). The paddocks were more flooded from recent rain (the entire wetland system water level was raised). Raupo had continued to bulk up. There was much waterfowl and bitterns were booming.

Photopoint 2:

Sited at the mouth of the artificial inlet channel, to observe the shore vegetation that includes low turf of *Mimulus repens* and *Lilaeopsis ruthiana*, scattered rushes fringing grazed pasture and dense *Bolboschoenus fluviatilis* sedgeland. Domestic stock still use the site. Higher water levels in 2001 made it difficult to assess the condition of the low turf, but it was evident that the *Bolboschoenus fluviatilis* had grown in both height and density. In 2003, silver poplar, karamu and blackberry had expanded somewhat near the stile. Pressure from cattle had resulted in the *Bolboschoenus fluviatilis* being grazed down. Otherwise, things were similar. There was a wealth of waterfowl present. In 2005, silver polar and blackberry had expanded much near the stile. The water level was high; waders required to reach the lake edge photopoint! At the lake edge there had been a considerable loss/retreat of *Bolboschoenus*, because of cattle impact and high water level.

Photopoint 3:

Sited in an embayment on the northern lagoon shore. Chosen to follow the processes within grazed grassland with rushes and the ungrazed strip of *Bolboschoenus fluviatilis* sedgeland backing it. The grassland is heavily used by waterfowl. In 2001, silver poplars had grown rapidly alongside the railway line, beginning to obscure the view. Otherwise the vegetation appeared similar to how it was in 1999. In 2003, the silver poplars had continued to bulk out and the paddocks were grazed more (the *Bolboschoenus fluviatilis* was lower). In 2005, *Bolboschoenus* had more or less gone because of cattle and inundation. The cattle impact was evident from dense *Bolboschoenus* where cattle were absent, right up to the fence. Sea rush hadn't really changed. Silver poplar had bulked out much.

Photopoint 4:

Two photopoints in the same locality on the north-eastern shore of the lagoon. Chosen to observe the broad fringe of rushes and sedges dominated by *Bolboschoenus fluviatilis* and *Juncus kraussii*. Grazed by stock. In 2001, the *Bolboschoenus fluviatilis* had grown up and thickened. Silver poplars had grown massively by the railway line. In 2003, the silver poplars had grown to virtually obscure the vista and on the lagoon shore *Juncus kraussii* had increased whilst the *Bolboschoenus fluviatilis* had decreased (probably the result of higher water levels in recent years). In 2005, silver poplar had much grown up, otherwise there was little change though the water level was higher.

Photopoint 5:

Sited at the lagoon exit, the beginning of Rahui Channel. Low wet turfs backed by fringes of rough pasture, sedges and rushes, grow here. Used by domestic stock on the true left (west) of the channel; fenced off (in 2000) on the true right. Since fencing, grasses and rushes (including *Bolboschoenus fluviatilis*) had grown and thickened on the true right bank of the channel, despite the presence of a mob of goats. In 2003, these processes had continued. Goats were still present and pampas had appeared (should be controlled). In 2005, things were more or less as in 2003. Goats were present and *Bolboschoenus* had diminished through grazing. Pampas was larger and

should be killed. The 'delta' area was more vegetated, but the turf was inundated. Channel banks were eroding through wave action and cattle impact where not fenced; they would re-grow *Bolboschoenus* if fenced off.

Photopoint 6:

Sited at the south-eastern corner of the lagoon at a fence tie-off. To the north-east is the best area of shore ribbonwood on the lagoon shore, currently used by stock in 1999 but fenced off in 2000. To the south is an ungrazed fringe of rushes and sedges and an area of dunes particularly vulnerable to invasion by lupins and boxthorn. Since fencing, the *Bolboschoenus fluviatilis* had thickened somewhat, as had the shore ribbonwood. In 2003, there had been some recent wave-driven shore erosion. Gorse had been killed but pampas was still thriving (should be controlled). In 2005, it was similar. *Bolboschoenus* and three-square were holding the shore together in the face of wave action. Regeneration of shore ribbonwood was continuing (it was becoming more dominant). Pampas had burgeoned and should be killed.

Photopoint 7:

Sited on the southern lagoon shore at a planted area fenced to exclude rabbits and hares. Chosen to follow the progress of the revegetation programme and the anticipated proliferation of shrubs and vines in the shore fringe of rushes and sedges. Since 1999, the planted native plants had grown substantially, the most successful being ngaio, flax and pohutukawa. Since there were many hares in the vicinity, the fence was clearly doing a good job of protecting the plantings. Pohuehue (*Muehlenbeckia complexa*) and tree lupins had also grown much on the site, both inside and outside the fenced area. In 2003, the plantings had continued to flourish. The netting, no longer necessary, had been removed. Blackberry was present but not yet a problem. In 2005, the plantings had continued to flourish. The wetland vegetation looked similar to 2003. Pohuehue and blackberry were abundant but not impeding the planted trees and shrubs.

Photopoint 8:

Sited on the dune crest at the south-western corner of the lagoon system. Chosen to observe the important communities of spinifex and *Raoulia* aff. *hookeri*, both vulnerable to invasion by exotic grasses (including nearby marram grass). In 2001, the spinifex and *Raoulia* aff. *hookeri* were much as they were in 1999. However, in the dune slack zone there was more ground cover of sheep's sorrel, flatweeds and Indian doab, all exotic invaders of some concern as competitors to the native plants. Lupins and *Bolboschoenus fluviatilis* had grown up nearer the lagoon. In 2003, the same processes had continued, and spinifex and *Lagurus ovatus* were flowering heavily. Spinifex and *Raoulia* appeared to be holding their own. In 2005, it was pretty much as in 2003, but changing in places. The spinifex population was very healthy. Lupins were increasing. Bare sand was being clothed in shore convolvulus, Indian doab and herbaceous exotic plants, indicating that the habitat for *Raoulia* is becoming poorer.

Photopoint 9:

Sited on a rise on the new fenceline at the south-western corner of the lagoon system. Chosen to observe the marram grass areas here (expected to rapidly spread unless controlled) and the mosaics of vegetation either side of the fence erected to keep stock out of this part of the lagoon system. A 360-degree panorama was observed and

photographed at this strategic site. In 2001, marram grass had significantly advanced, blackberry had thickened, lupins had much expanded and *Bolboschoenus fluviatilis* had thickened. On the sand, the ground cover of exotic flatweeds and grasses (especially Indian doab and haretail) had increased notably. In 2003, marram had continued to spread unchecked, and an ecological warning about the consequences of not eradicating it was issued. Lupins had spread further and small exotic herbs were now abundant on the sand. The shore vegetation had continued to thicken. In 2005, marram was still advancing fast. North of the fence it had been sprayed, but it was unimpeded south of there (**desperately necessary now to eradicate, see 1.3 Weeds**). Lupins were spreading fast also. Evening primrose had much increased in the *Raoulia* zone and may pose a considerable threat. Bare sand was becoming vegetated. In the wet zone, there had been much increase in *Isolepis prolifer*.

Photopoint 10:

Sited just north of Photopoint 9, at the fence corner. Chosen to follow the changes expected in the fringe of rushes and sedges following recent (c.1999) exclusion of stock. In 2001, *Bolboschoenus fluviatilis* had grown up and thickened, blackberry had grown up and pasture grasses (especially Yorkshire fog) had grown rank. Nearby cabbage trees had sprouted from their bases and a clump of pampas grass required control before it spread. In 2003, pohuehue had nearly engulfed the tagged post. Blackberry had grown, the cabbage trees were healthy and the pampas had been killed. At the shore, *Juncus kraussii* appeared to be increasing at the expense of *Bolboschoenus fluviatilis*, due to increased water levels. In 2005, things were much as in 2003. *Juncus* could be expanding at the expense of *Bolboschoenus*, but it was not clear at this stage. Fernbird and bittern were heard.

Photopoint 11:

Sited on the lagoon shore at the south-western corner (also aquatic sampling site 4). A complement to Photopoint 10, right at the lagoon shore. The water level was too high in 2001 to reach this spot. It was evident though that *Bolboschoenus fluviatilis* had thickened and grown taller since 1999. In 2003, the water levels were still too high to reach the photopoint. In 2005, water levels were still too high to reach the photopoint and the vegetation appeared much as previously.

Photopoint 12:

Sited along the new fenceline on the western side of the lagoon, among a great expanse of rushes and sedges. *Bolboschoenus fluviatilis* had thickened and grown taller on both sides of the fence, but more so on the lagoon side where stock were totally excluded. The site was in standing water in 2001. In 2003 it was decided not to revisit this photopoint because of the water. The *Juncus kraussii* had increased and the *Bolboschoenus fluviatilis* was tall and dense. In 2005, the photopoint was again not visited because of high water levels. The vegetation looked essentially as in 2003.

Photopoint 13:

A new photopoint established in December 2003. Sited at the seaward corner post of the western fenceline and chosen to follow the well-being of the spinifex on the raised foredune and the *Raoulia* aff. *hookeri* in the dune hollow. Exotic plants like Indian doab, sheeps sorrel and flatweeds appeared to threaten the *Raoulia*, whilst the spinifex looked dense and healthy. In 2005, open sand was more clothed with vegetation: shore

convolvulus, *Carex pumila*, harestail and herbaceous plants. *Raoulia* had definitely retreated. Spinifex was very healthy. 3 photos were taken.

Next monitoring:

November-December 2007; thence every second year. Photos to be repeated; recording sheets to be used.

1.1.3 Permanent vegetation plots

Method:

Six permanent vegetation monitoring plots were established in sites chosen to represent the main parts of the lagoon edge. Their locations are marked on the map (Appendix 1), and described on the recording sheets (one for each plot, Appendix 3). Each plot is actually a line transect, varying in length from 135 to over 550 metres. Each samples a sequence of vegetation from the lagoon shore, along a strip two metres either side of the transect line. The vegetation composition is described in obvious segments or types, using the transect recording sheets. The ecological processes at the site are also outlined. Photos taken to portray each transect are in the album with the photopoint photos.

Observations:

Vegetation transect 1:

Sited at the north-western corner of the lagoon and chosen to sample the vegetation sequence where heavily used by domestic stock and waterfowl. In 2001 the lagoon water level was too high to assess about half of the transect, particularly the turf vegetation at the shore. To landward, *Bolboschoenus fluviatilis* had increased in dominance somewhat, despite continued grazing. In 2003, the silver poplar, blackberry and karamu near the stile had increased. The *Bolboschoenus fluviatilis* had been grazed down by cattle, and *Carex ovalis* (an exotic sedge) had become well established. In 2005, the wetland zonations had moved inland with a higher average lake level; the turf was inundated and gone. Waders were required to measure the transect now. *Bolboschoenus fluviatilis* had been further grazed down by cattle. *Carex ovalis* (oval sedge) had increased further.

Vegetation transect 2:

Sited on the north-eastern shore of the lagoon and chosen to represent the broad dense fringe of rushes and sedges there. In 2001, *Bolboschoenus fluviatilis* had increased substantially in dominance, despite continued grazing. The explanation could be that the grazing intensity has lessened; higher water levels on average could also be a contributor. In 2003, the effect of higher water levels was more obvious: *Bolboschoenus fluviatilis* had decreased in the standing water, whilst *Juncus kraussii* had increased. There was no sign at the shore of the macrophytes *Ruppia polycarpa* and *Potamogeton pectinatus*, formerly conspicuous as drifted masses having been pulled up by swans. In 2005, much of the transect was underwater and waders were required to reach the maimai. *Bolboschoenus fluviatilis* had decreased a little whilst *Juncus kraussii* had increased; probably the effect of raised water levels. Still being grazed a bit. Overall, little change from 2003 except the proliferation of *Carex ovalis* in pasture and loss of shore ribbonwood (drowned).

Vegetation transect 3:

Sited on the south-eastern shore of the lagoon and chosen to sample the best area of shore ribbonwood. The lagoon margin (about half of the transect) was fenced to exclude stock in 2000. As a result, in 2001 shore ribbonwood and *Bolboschoenus fluviatilis* had increased in stature and density, as had smaller rushes and sedges. To landward, where grazing had continued, *Bolboschoenus fluviatilis* had decreased somewhat, through selective grazing, but there had been an increase in other rushes, sedges and blackberry. Purei (*Carex secta*) had appeared in the transect since 1999. Fernbirds were heard calling in the shore ribbonwood. In 2003 things were similar, the processes continuing. However, *Baumea articulata* had burgeoned in one spot and the shore zone was showing the effects of raised water levels (more *Juncus kraussii*, Mercer grass and creeping bent; extinguished ex-pasture component). Saltmarsh ribbonwood had continued to grow in stature and density. In 2005, things were much as in 2003: continued good regeneration of shore ribbonwood, and general increase in rushes and sedges. *Baumea articulata* had locally burgeoned. Pampas was multiplying in the vicinity and should be controlled.

Vegetation transect 4:

Sited on the southern shore of the lagoon and chosen to sample a sequence of spinifex, *Raoulia* aff. *hookeri* and shore fringe of rushes and sedges. In 2001, on the sand, spinifex had spread and the quantity of Indian doab and small exotic herbs had increased significantly. The *Raoulia* aff. *hookeri* did not appear to be at risk yet, but the Indian doab was considered to be a potential threat. Some detailed photopoints were established using small wooden pegs in the immediate vicinity to provide more insight into this situation. On the lagoon shore, *Bolboschoenus fluviatilis* had increased in stature and density. In 2003, the *Raoulia* and spinifex were still looking as though they were holding their own. The Indian doab had invaded *Raoulia* in places, coinciding with *Raoulia* dieback. Sand convolvulus (*Calystegia soldanella*, a native) did not appear to be threatening the *Raoulia*. The wet lagoon edge vegetation had not changed appreciably. In 2005, the *Raoulia* population appeared to be in decline and in retreat as the sand was being stabilised by *Calystegia* and exotic grasses and flatweeds. There were still many healthy adults but not many young ones. Indian doab was not as dominant as predicted. There was not much change on the lake margin except that the turf had been inundated. The marram clump just to the N needed follow-up control.

Vegetation transect 5:

Sited on the southern shore of the lagoon and chosen to sample a typical sequence that includes duneland, ungrazed mosaic vegetation and shore fringe of rushes and sedges. In 2001, in the sand, spinifex was in good condition and Indian doab had increased significantly. A patch of exotic ice plant (*Carpobrotus edulis*) had expanded markedly and may require control. Nearer the shore, the flax plantings looked healthy, convolvulus had increased, there were new plants of shore ribbonwood and *Bolboschoenus fluviatilis* had increased in stature and density. *Bolboschoenus fluviatilis* had increased in stature and density at the expense of three-square (*Schoenoplectus pungens*). In 2003, the processes had continued as before. Iceplant, karo, Tasmanian ngaio and taupata had been planted at the hut: of these, **iceplant was considered a real threat to the dunes (see 1.3 Weeds)**. The planted harakeke and

cabbage trees were thriving. At the water's edge, the turf had been inundated and sedges were holding sway, including *Bolboschoenus fluviatilis* and the newly established *Isolepis prolifer* and *Carex ovalis*. Saltmarsh ribbonwood had died where inundated but was thriving where it was a bit drier. In 2005, the planted iceplant had become a serious threat to the natural integrity of the dunes. The wonderful plantings of harakeke and cabbage trees had grown up much. There was newly planted pohutukawa. Traps and bait stations were being operated for animal pest control. Lupins appeared to be increasing in the vicinity. Some boxthorn was needing control. There had been much increase in *Calystegia* in open sand. Shore ribbonwood was increasing near the shore.

Vegetation transect 6:

Sited at the south-western corner of the lagoon, following the new fenceline, and chosen to sample the long sequence from the lagoon shore to the sea. Spinifex and *Raoulia* aff. *hookeri* are vulnerable to invasion by nearby marram grass, various changes are expected following the exclusion of cattle and the abundance of driftwood near the sea is ecologically interesting. In 2001, the lagoon level was too high to assess about a quarter of the transect, and conditions precluded measurement of the rest. However, obvious changes since 1999 were noted. Near the shore, *Bolboschoenus fluviatilis* had increased in stature and density, as had *Cyperus ustulatus*, lake clubrush (*Schoenoplectus validus*), *Isolepis prolifer*, convolvulus and blackberry. On the sand, exotic flatweeds and grasses had increased (particularly Indian doab), putting the *Raoulia* aff. *hookeri* at risk. Marram grass and spinifex had spread. The marram grass should be eliminated as soon as possible: it is only here but threatens the whole beach system. There is a lone gorse bush that also needs to be destroyed. In 2003, it was decided not to re-measure this transect, because it was well covered by photopoints and was still partially inundated. The processes observed previously had continued. The gorse bush had been killed, **but the marram grass had continued to expand and was regarded as a very serious threat, worth eradicating (see 1.3 Weeds)**. In 2005, it was again decided not to re-measure the transect, but to report on the trends. Bare sand areas were being clothed by exotic herbs and grasses, putting *Raoulia* at risk; marram was continuing to invade but had been sprayed on north side of fence; lake shore turf was inundated; sea rush looked as though it may be prevailing over marsh clubrush; there was some increase in shore ribbonwood.

Next monitoring:

November-December 2007; thence every second year. Photos to be repeated; recording sheets to be used.

1.2 Aquatic vegetation

Method:

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

Sampling at each site was done by hand-pulling aquatic vegetation and "washing" it in white plastic trays for examination. 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:

In 1999, the aquatic macrophytes were dominated by the natives *Ruppia polycarpa* and *Potamogeton pectinatus*. Floating plants were also natives: *Lemna minor* and *Azolla filiculoides*. The only weeds found were *Potamogeton crispus*, common at Site 1, and crack willow at Site 3 (Rahui Channel). In 2001, there was little change. Mercer grass had increased at Sites 1 and 3, *Myriophyllum propinquum* had decreased at Site 1 and the exotic floating pondweed *Spirodela punctata* was detected at Site 1. At Site 3, *Potamogeton pectinatus* and *Ruppia polycarpa* were not seen (in 1999 floating mats had drifted to the site). Site 4 was too submerged to assess changes in turf plants. In 2003, surprisingly, *Potamogeton crispus* and *P. suboblongus*, formerly obvious at Site 1, had vanished. *Spirodela punctata* was not detected. At Sites 2 and 3, *Ruppia polycarpa* and *Potamogeton pectinatus*, previously drifted on the shore in masses because of swan activity, were absent. Those changes may have been due to the heightened water levels. Site 4 was again too submerged to visit and sample. In 2005, *Potamogeton crispus* and *Spirodela punctata* were found again at Site 1, but *P. suboblongus* had not reappeared. At Site 2 sea rush had been largely replaced by marsh clubrush and creeping bent, probably as a result of increased freshwater levels. At Site 3 there was less marsh clubrush but more creeping bent and floating plants. Site 4 was inaccessible as before. Overall, there appears to have been a significant shift in macrophyte composition since the lagoon has been less open to saline influence and has retained more freshwater.

Next monitoring:

November-December 2007; thence every second year. 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 are regarded as requiring surveillance or **control**:

- **Crack willow (*Salix fragilis*)**, established in Rahui Channel and capable of spreading around the lagoon shores; also considered an aquatic weed; **should be controlled**;
- **Weeping willow (*Salix babylonica*)**, in vicinity and could spread on shores, inlets and outlet channel, but not considered particularly invasive;
- **Silver poplar (*Populus alba*)**, well established on the north-eastern shore; **expanding fast and should be kept in check**;

- **Gorse** (*Ulex europaeus*), a minor threat to the rear dune areas; *readily controlled at present*;
- **Sweet brier** (*Rosa rubiginosa*), present in small quantities, *readily controllable at present*; could aggressively invade the dunes;
- **Pampas grass** (*Cortaderia seloana*), becoming increasingly established in places on the rear dunes and elsewhere; *readily controlled now but likely to spread rapidly if left*;
- **Marram grass** (*Ammophila arenaria*), in two controllable patches at the south-western corner of the lagoon system; another smaller patch (11m x 8m) found on the rear dunes to the north (E2904774 N6228923) in December 2003; *a major threat to the native dune communities; some control has been done, but requires extension and follow-up as a matter of urgency*;
- **Boxthorn** (*Lycium ferocissimum*), invading the dunes; *controllable at present; should be kept in check*;
- **Lupin** (*Lupinus arboreus*), invading the dunes; not a serious threat as susceptible to disease and defoliation but could be a problem for *Raoulia* aff. *hookeri* cushion fields;
- **Indian doab** (*Cynodon dactylon*), a creeping grass rapidly invading the dunes; a definite threat to *Raoulia* aff. *hookeri* cushion fields; *may be difficult to control, but trials of grass-specific herbicide use should be carried out in preparation for a bigger control effort if required*;
- **Iceplant** (*Carpobrotus edulis*), a patch near Vegetation transect 5 and more planted by the hut there; *a potentially serious threat to the dune vegetation, especially the Raoulia, and should be controlled as a matter of urgency*;
- **Blackberry** (*Rubus fruticosus* agg.), common in mosaic communities; not considered an ecological problem; provides habitat for fernbirds;
- **Bone-seed** (*Chrysanthemoides monilifera*), a small patch found on the rear dune near the SE corner of the lagoon (E2905427 N6228921) in December 2003; *a potentially serious threat to the dune vegetation, newly established, and should be eradicated as a matter of urgency*;
- **Japanese honeysuckle** (*Lonicera japonica*), not yet present, but in the vicinity and capable of invading shrubby areas;
- **Bindweeds** (*Calystegia silvatica* and *Convolvulus arvensis*), abundant around the margins; not a serious ecological threat at present.

The following aquatic weeds are regarded as requiring surveillance:

- **Purple-backed duckweed** (*Spirodela punctata*), that could displace the native floating species;
- **Curly pondweed** (*Potamogeton crispus*), found at the main inlet in the past but seems to have diminished recently.

Next monitoring:

November-December 2007, along with other vegetation monitoring; thence every second year.

1.4 Notable flora

Method:

Plants of note were searched for during baseline survey and monitoring.

Observations:

To date, no rare native plants have been recorded from Whakaki Lagoon. However, the colony of the cushion plant *Raoulia* aff. *hookeri* between the lagoon and the sea is significant. It is a large thriving population at the northern end of the geographical range of this species, which is classified as nationally threatened (de Lange et al 2004, Hitchmough 2002). However, the population is very isolated from any other and there are several threats (mainly weeds) that require monitoring. Three of the photopoints (Photopoints 8, 9 and 13) and three of the vegetation transects (Transects 4, 5 and 6) cover that requirement. There are three additional photoplots that focus on the issue at Transect 4. Indian doab, an exotic grass, looks poised to become a serious problem for the *Raoulia* aff. *hookeri* in the near future, so now is the time to be considering control methods (see 1.3 above). Photographs of *Raoulia* aff. *hookeri* are in the photo album that accompanies this report, along with the photopoint and vegetation transect photos.

No other notable flora was detected in 1999, 2001, 2003 or 2005. Should any other notable plants be detected or introduced in future, extra monitoring will be needed.

Next monitoring:

November-December 2007, along with other monitoring and via Photopoints 8, 9 and 13 and Vegetation Transects 4, 5 and 6; thence every second year.

2. FAUNA

2.1 Water birds

Method:

Two methods were used:

1. **Directed searches**, whereby a number of sites around the lagoon were visited to listen and look 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 water birds were searched for during other survey and monitoring activities.

Observations:

Forty-six species of water birds have been recorded from the Whakaki Lagoon catchment (Hawke's Bay Regional Council Management Plan No. 2783, 1999; this survey). Not all may still be present. The list includes NZ Dabchick, an uncommon endemic, and Australasian Bittern, a rare native. Both are listed as threatened by the Department of Conservation (Molloy and Davis 1994, Hitchmough 2002). The list also includes three native wetland birds a little more common nationally but now very rare in Hawke's Bay: Spotless Crake, Fernbird and Banded Rail. The latter species may have now gone from the scene.

No definite detections of crakes, rails or bitterns were made in 1999, despite several hours of searching. Nor were crakes or rails detected in 2001. It was probably too late in the birds' breeding season for strong responses to taped calls to be expected and traffic noise was frequently disruptive to good listening. However, Spotless Crake were heard near the inlet in October 2005 and are reported to be still in good numbers at the lagoon (pers. com. Malcolm Smith, Department of Conservation, Wairoa).

Bitterns were heard booming in several places around the lagoon shores in 2001, 2003 and 2005. In 1999, 2001, 2003 and 2005, fernbirds were found in several places around the lagoon, especially on the western side and at the eastern end, and the population appears to be reasonably strong at present.

The other wetland birds include swans, ducks, geese, shelducks, shags, herons, Royal Spoonbill (present in 1999 but not in 2001 or 2003), Pukeko, Australasian Harrier, NZ Kingfisher, Welcome Swallow and a number of migrant and resident waders. The swans, ducks, geese, shelducks and Pukeko are seasonally hunted in the wetland. Although it is the nature of water birds to be somewhat shy, they are extremely wary, suggesting that hunting is making it difficult for them to feed, roost and breed in safety. Species added to the list during the 1999 survey were Black Shag and Black-fronted Dotterel.

Estimated numbers were similar in 2005 to those of earlier visits, but there were no terns, oystercatchers or Australian Coot were seen during the survey. Since those birds

are highly mobile around the wider landscape, these apparent absences are not regarded as significant.

The full list of birds and their estimated numbers for October 2005 is in Appendix 5.

Next monitoring:

November-December 2007; thence every second year.

2.2 Other birds

Method:

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

Observations:

Eighteen other species of birds have been recorded at the lagoon in the past. Four (Pipit, Riroriro, Fantail and Silvereye) are common natives, whilst the remainder are common introduced species typical of the Hawke's Bay rural scene. The only change in 2001 from 1999 was that Pheasant and Riroriro were not detected. In 2003, Pheasant was present but Riroriro was not detected. Both Pheasant and Riroriro were detected in 2005. The full October 2005 list of birds and their estimated numbers is in Appendix 5.

Next monitoring:

November-December 2007; thence every second year.

2.3 Fish

Method:

Fish were surveyed largely using netting and trapping. Fyke nets, hinaki and minnow traps were set overnight in 1999 at the four aquatic sampling sites (for locations, see map, Appendix 1, and aquatic vegetation and macroinvertebrate recording sheets, Appendix 4). Meat was used as bait in the fyke nets and hinaki; vegemite in perforated film canisters was used as bait in the minnow traps. Fish were also observed in open water sites and caught for identification using a scoop net. Because of practical difficulties, nets were set in only three sites in 2001 and at only two sites (the inlet and outlet) in 2003 and 2005.

Observations:

The fish in 1999 were:

- Shortfin eel (*Anguilla australis*): caught at Sites 1, 2 and 3; all small (24-53cm long).
- Inanga (*Galaxias maculatus*): seen only at Site 3 (Rahui Channel).
- Goldfish (*Carassius auratus*): erroneously known as carp (McDowall 2000); introduced to New Zealand; a single fish 15cm long caught at Site 1 (inlet to lagoon).
- Common bully (*Gobiomorphus cotidianus*): very common; caught at all sites; 3-6cm long.

In 2001, the results were similar, except that fewer eels were caught, more bullies (2-6 cm long) were caught and goldfish were seen but not caught. Whether these findings are significant or not is not clear; they could have been artefacts of the higher water levels.

In 2003, shortfin eels (20-50cm long) were caught at Sites 1 and 3, and common bullies (including one large individual 150mm long) were caught at both sites and seen elsewhere. No inanga or goldfish were seen, but that is not taken as an indication of their absence.

In 2005, no eels were caught but the remains of shortfin eels (40-50cm long) were found at Site 2 (the results of someone else's fishing), and numerous common bullies were caught at both Sites 1 and 3 and seen elsewhere. Goldfish were seen in several places but not caught. No inanga were seen or caught.

Not recorded during any of the surveys, but reported from the lagoon were:

- Longfin eel (*Anguilla dieffenbachii*), now rare in the North Island.
- Black flounder (*Rhombosolea retiaria*).
- Yelloweyed mullet (*Aldrichetta forsteri*).

Next monitoring:

November-December 2007; thence every second year.

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). Aquatic vegetation samples were gathered by hand, and "washed" into trays to dislodge invertebrates. Water and substrate (mud, etc.) samples were also gathered and 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 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 and averages of the scores are tabulated below. They show that at none of the sites was the water of very good quality, but neither was it poor. The number of species found ranged from 11-15 in 1999, from 7-18 in 2001, from 7-13 in 2003 and from 10-12 in 2005. The changes in numbers of species are not considered important,

probably due to the fluctuations in water levels and aquatic vegetation. In 2003 and 2005, Site 4 was not sampled because of practical difficulties associated with the high water levels.

	Number of species found				Range of sensitivity scores			
	1999	2001	2003	2005	1999	2001	2003	2005
Site 1	15	18	13	12	1-5	1-5	1-5	1-5
Site 2	11	7	7	11	1-5	1-5	1-5	1-5
Site 3	11	11	9	10	1-5	1-5	1-5	1-5
Site 4	12	9	-	-	1-5	1-5	-	-

Next monitoring:

November-December 2007; thence every second year. 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 could be regarded as pests in the wetland were detected during baseline survey and monitoring set-up in 1999:

- Domestic cattle: present in many places; fenced out from the south and west of the lagoon but still occasionally penetrating.
- Domestic sheep: present in relatively low numbers on the north and east sides.
- Domestic/feral goats: present in small numbers at the east (outlet) end; should be controlled if feral.
- Rabbit and hare: present right around the margins, but especially on the dunes; require ongoing control.
- Possum: present around the lagoon margins, though not in high numbers; best controlled.
- Hedgehog: present around the lagoon margins.
- Feral cat: present in low numbers around the lagoon margins.

In 2001, all were still present in much the same estimated numbers, with the exception of rabbits, which were in much lower numbers (the result of RCD?). Hares seemed to be more conspicuous, possibly as a consequence. Eaten petrel remains on the beach in 2001 suggested cat predation.

In 2003, the situation was much the same as in 2001, except that sheep were not present at the time of survey. In 2005, sheep were also absent and possums (perhaps also rabbits and hares) were being controlled near the plantings.

Other mammalian pests probably present but not detected include:

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

Next monitoring:

November-December 2007; thence every second year.

2.6 Terrestrial invertebrates

Not deliberately surveyed or included in the monitoring plan, but worthy of separate study. The suite of invertebrates living in driftwood is particularly noteworthy, especially considering the relative intactness of the seashore. Rapid examination showed that many native species were present, including earwigs, termites, weevils, other beetles, sand scarabs, ants and spiders. However, the native katipo spider was not found; it may have already been largely replaced by the invasion of related Australian and South African spiders afflicting the North Island coasts.

2.7 Reptiles and amphibians

Also not deliberately surveyed or included in the monitoring plan, but worthy of separate study. Common skinks (*Leiopisma nigriplantare polychroma*) were seen among dune vegetation. In 1999, frogs were heard on the south-western shore of the lagoon. They were probably the southern bell frog (*Litoria raniformis*), native to Australia and reasonably widespread in New Zealand. In 2001, adult frogs were not heard, but tadpoles were found at the aquatic sample site at the NW corner of the lagoon. Frogs were not found in 2003, but were heard at both ends of the wetland in 2005. Frogs have rapidly declined recently world-wide (and in New Zealand) through fungal disease. The presence 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:

General observation, November-December 2007; thence every second year.

CONCLUSIONS AND RECOMMENDATIONS

The key natural features of Whakaki Lagoon and its surrounds are:

- Lagoon: outstanding habitat for wetland birds, including several rare and iconic species; eels, bullies, inanga and other native fish; beds of native aquatic macrophytic plants; fringes of primarily native vegetation, including shore ribbonwood;
- Beach/dune system: *Raoulia* aff. *hookeri* cushion fields; spinifex; native invertebrates and lizards; the potential for restoration of pingao and sand tussock;
- Overall restoration potential: wetland and coastal shrubland and forest, flax, rushlands and sedgeland, wetland turfs, sand plants, eel populations, wetland and coastal bird populations.

In addition, there is a strong tradition of customary custodianship, which persists. Therefore there are bright prospects for restoration and enhancement of the natural features of the lagoon system. The monitoring regime has allowed a series of conclusions to be drawn about various aspects of the ecological condition and trend of the lagoon system, and the efficacy of management. Out of these conclusions flow a consequent series of recommendations. 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

Raoulia aff. *hookeri* is the most note-worthy plant species present, forming remarkable cushion fields in the sand hollows behind the beach. These communities are probably of great antiquity but are threatened by invading exotic grasses, herbs and shrubs. Indian doab, a creeping grass, is the worst of these, although evening primrose also looks to have troublesome potential. Intensive monitoring has been set up to follow the issue, but now is the time to do some small-scale management trials in preparation for a larger effort which looks likely to be needed in future. Localised grass-specific herbicide application may be all that is needed. Trials and monitoring of their efficacy are required, sooner than later.

Recommendation: That *Raoulia* aff. *hookeri* cushion fields continue to be monitored intensively, that small-scale herbicide trials be carried out and the results monitored to assess the efficacy of controlling Indian doab without damaging *Raoulia*.

3. Fauna

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

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

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

4. Rare water birds

The variety and numbers of water birds appear to be holding their own well at present. One nationally rare species - Australasian bittern - may now be resident at the lagoon, and the populations of fernbird and spotless crane (both regionally rare) appear strong. It is not known whether banded rail or marsh crane still persist; they are notoriously hard to detect, especially after the breeding season. A specific search by experts in spring might reveal these birds. What is sure is that the condition of the habitat for these birds is improving with the changes in management in recent years.

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

5. Land birds

Land birds use the wetland in considerable numbers. Most are exotic (introduced) species, but a few are natives. The native species should progressively benefit from the restoration plantings.

Recommendation: That land birds continue to be monitored routinely.

6. Fish

The wetland is clearly depleted in terms of its native fish fauna. Native eels appear to be in moderate numbers now, sufficient to support a regular harvest, although there appear to be few large ones left. The owners may welcome assistance in getting a scientific perspective on the status of the fish populations, especially eels, in the lagoon. If so, specialist survey and monitoring would be required.

Recommendation: That if the owners request it, a specialist survey of the fish of the lagoon be carried out, and a regime to effectively monitor their condition and trend be established.

7. Aquatic invertebrates and water quality

Aquatic macroinvertebrates provide a useful measure of water quality and habitat condition. They indicate that the lagoon can support a considerable diversity of small animal life, but that the water quality is compromised by artificial nutrient input. There are limitations to the technique though, because it was primarily developed for stream systems, and other measures of water quality are necessary for comprehensive monitoring of condition and trend. The

Ecological Monitoring Plan for Whakaki Lagoon (Walls 2000), adopted by Hawke's Bay Regional Council, proposed regular (monthly or quarterly) sampling of standard parameters. These included pH, conductivity, turbidity, colour absorbances, biochemical oxygen demand, dissolved reactive phosphorus, ammoniacal-nitrogen, nitrate-nitrogen, total phosphorus and total nitrogen. To date, this is the only aspect of the Ecological Monitoring Plan not to have been enacted.

Recommendation: That aquatic macroinvertebrate monitoring continue.

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

8. Monitoring techniques and frequency

In the light of eight years' experience in Pekapeka Swamp and other wetlands in Hawke's Bay, the suite of techniques being used to monitor the ecological condition and trend of Whakaki Lagoon appear to be appropriate and valuable. The only issues are the difficulty of detecting rare water birds, inadequate information on fish (especially eels) and the lack of monitoring of water quality parameters (see above). In view of the relative stability of the wetland but some pressing management needs, monitoring at two-yearly intervals seems sensible.

Recommendation: That the current ecological monitoring programme be continued.

State of the Environment (SOE) monitoring and reporting

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

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

The conclusion is that the wetland is in a moderately natural state and is improving in condition in key aspects. There has been a significant improvement in native flora and water regime since 1999, and detectable positive change since 2001. It is expected that restoration management will produce further marked improvement in status/condition 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 Whakaki Lagoon, showing vegetation types and monitoring site locations

Vegetation types

W	Low herbfield-sedgeland in zone of wave action and periodic inundation
SR	Lagoon shore fringe of dense sedges and rushes
MG	Mosaic of rushes, sedges, blackberry and grazed pasture
MR	Mosaic of rank grasses, rushes, sedges, pohuehue, lupin, blackberry, etc.
Ra	Sparse vegetation of <i>Raoulia</i> aff. <i>hookeri</i> and exotic grasses on rear of dunes
Sp	Spinifex grassland on foredunes
Ma	Marram grassland

Monitoring sites

- Photopoints
- Vegetation transects
- Aquatic sampling sites
- Water bird search sites

APPENDIX 2: Photopoint recording sheets, October 2005

- Photopoint no. 1
- Photopoint no. 2
- Photopoint no. 3
- Photopoint no. 4
- Photopoint no. 5
- Photopoint no. 6
- Photopoint no. 7
- Photopoint no. 8
- Photopoint no. 9
- Photopoint no. 10
- Photopoint no. 11
- Photopoint no. 12
- Photopoint no. 13

PHOTOPOINT RECORDING SHEET

Location/Area: Whakaki Lagoon		Photopoint no: 1
Establishment date: 2/12/99		GPS reference: E2902212 N6231138
Photopoint relocation notes:		Observer/Photographer: Geoff Walls
Via access track along W end of orchard & across railway line, thence across paddock to bridge across inlet channel. Photopoint on small knoll c. 10m from gate on S side of bridge (material dredged from channel).		
Direction from marker/post (magnetic bearing): 6-7-photo pan SW-S		
Camera info (lens, film, etc): 50mm, 200asa colour		
Vegetation (composition, structure, patterns, processes):		
Expanse of dense tall <i>Bolboschoenus fluviatilis</i> with occasional <i>Juncus effusus</i> . Single clump of raupo near fence to S: expanding? A few cattle using area, but essentially now fenced to exclude them. Should show recovery of shrubs in time.		
REPHOTOGRAPHY DETAILS:		
Date	Observer/ Photographer	Comments (changes, processes, etc)
6/12/01	G. Walls	Now cattle free. <i>Bolboschoenus</i> expanse looks essentially as in 1999. Raupo patch has expanded in both directions. In absence of grazing Mercer grass and annual beard-grass are growing up in wet open ground (ex pasture). In next-door paddock, <i>Bolboschoenus</i> is poised to take over if grazing is abandoned or eased. 3 extra photos taken to N and W.
8/12/03	G. Walls	Essentially as in 2001. <i>Bolboschoenus</i> dominant where free of grazing. Raupo has bulked up a little. Next-door paddock is grazed down. This area is now managed by DOC.
10/10/05	G. Walls	Earlier in season so <i>Bolboschoenus</i> still brown (hasn't yet grown back from its winter die-off). Paddocks more flooded from recent rain (entire wetland system water level raised). Raupo continuing to bulk up. Much waterfowl. Bittern booming.

PHOTOPOINT RECORDING SHEET

Location/Area: Whakaki Lagoon		Photopoint no: 2
GPS reference: E2902946 N6231036, E2902883 N6230833		
Establishment date: 5/12/99		Observer/Photographer: Geoff Walls
Photopoint relocation notes:		
From corner of road at small bluff, across railway line. Tag on stile post, from which 1 photo taken. 4 photos taken from lake edge where artificial inlet channel meets lagoon.		
Direction from marker/post (magnetic bearing): 1 photo SW; 4 photos SW-E		
Camera info (lens, film, etc): 50mm, 200asa colour		
Vegetation (composition, structure, patterns, processes):		
Shore turf of <i>Mimulus repens</i> and <i>Lilaeopsis ruthiana</i> . <i>Azolla</i> dominant in channel mouth and around shore. Backed by dense <i>Bolboschoenus fluviatilis</i> with scattered <i>Juncus kraussii</i> . Heavy use by cattle, swans, geese & ducks, so heavily grazed. <i>Bolboschoenus fluviatilis</i> tall and dominant on S side of channel.		
REPHOTOGRAPHY DETAILS:		
Date	Observer/ Photographer	Comments (changes, processes, etc)
6/12/01	G. Walls	From stile: looks to be little change except karamu has grown up and blackberry has expanded slightly. From lake edge: little change except water level at least 30cm higher than in 1999 and <i>Bolboschoenus</i> has grown in both height and density. Because of the water, photos taken from about 20m north of 1999 spot; angle difference makes it look like a change in <i>Juncus kraussii</i> , but not so.
8/12/03	G. Walls	From stile: silver poplar and blackberry have expanded somewhat. From lake edge: pressure from cattle has increased, knocking down the <i>Bolboschoenus</i> especially. Otherwise similar to 2001. Amazing abundance of waterfowl.
10/10/05	G. Walls	From stile: silver polar and blackberry have expanded much. Water level high. From lake edge: a considerable loss/retreat of <i>Bolboschoenus</i> , because of cattle and higher water level. Waders required to reach photopoint!

PHOTOPOINT RECORDING SHEET

Location/Area: Whakaki Lagoon		Photopoint no: 3
Establishment date: 2/12/99		GPS reference: E2903756 N6230777
Photopoint relocation notes:		Observer/Photographer: Geoff Walls
<p>Base of bluff on NW shore of lagoon. 2 photos taken from railway line, near yellow-painted upright piece of railway iron (tag on sleeper nearby)</p> <p>Direction from marker/post (magnetic bearing): 2 photos, SE & SW, from 20m apart</p> <p>Camera info (lens, film, etc): 50mm, 200asa colour</p>		
<p>Vegetation (composition, structure, patterns, processes):</p> <p>Shore fringe of very dense <i>Bolboschoenus fluviatilis</i>, grazed and browsed by cattle and waterfowl. Very damp. Behind is pasture in which <i>Bolboschoenus fluviatilis</i> is a major component. <i>Juncus kraussii</i> is scattered in pasture, sometimes in a substantial shore fringe but elsewhere sparse. Chosen to follow changes where there is continued stock use on lagoon shore.</p>		
REPHOTOGRAPHY DETAILS:		
Date	Observer/ Photographer	Comments (changes, processes, etc)
6/12/01	G. Walls	Lagoon water level much higher than in 1999; paddocks inundated. Paddock vegetation looks similar though. Silver poplars have rapidly grown up along railway line and will soon obscure the view!
8/12/03	G. Walls	Little different from 2001 except paddocks grazed harder (<i>Bolboschoenus</i> lower) and silver poplar has bulked out considerably.
10/10/05	G. Walls	<i>Bolboschoenus</i> more or less gone: cattle and inundation. Cattle impact evident from dense <i>Bolboschoenus</i> right up to fence. Sea rush hasn't really changed. Silver poplar has bulked out much.

PHOTOPOINT RECORDING SHEET

Location/Area: Whakaki Lagoon		Photopoint no: 4
GPS reference: E2904965 N6230304, E2905006 N6230158		
Establishment date: 2/12/99		Observer/Photographer: Geoff Walls
Photopoint relocation notes:		
Pull-off at NE of lagoon, with lots of silver poplar. Access track at E end of pull-off, across railway line thence down to lagoon shore at maimai. 1 photo (4a) from railway line, marked with tagged batten; 3 photos from maimai.		
Direction from marker/post (magnetic bearing): 1 photo SSE; 3 photos W,N,E		
Camera info (lens, film, etc): 50mm, 200asa colour		
Vegetation (composition, structure, patterns, processes):		
Shore fringe of <i>Bolboschoenus fluviatilis</i> and <i>Juncus kraussii</i> in varying proportions. Inland of this, pasture of grasses and buttercup, grazed by cattle and sheep. <i>Ruppia polycarpa</i> and <i>Potamogeton pectinatus</i> in drifts on shore (pulled up by swans). Chosen because is a representative lagoon fringe system used by stock.		
REPHOTOGRAPHY DETAILS:		
Date	Observer/ Photographer	Comments (changes, processes, etc)
6/12/01	G. Walls	4a: <i>Bolboschoenus fluviatilis</i> has grown up and thickened much in the <i>Juncus kraussii</i> zone. Flooded of 1999. Silver poplar has grown massively by the railway line and will soon obscure the vista. 4b: As 4a. More flooded than in 1999, so can't see lower plant tiers.
8/12/03	G. Walls	4a: silver poplar has grown to virtually obscure the vista now. 4b: As 2001; little change except <i>Bolboschoenus</i> has decreased amongst <i>Juncus</i> which seems to have increased in standing water. Probably the effect of higher water levels in recent years.
10/10/05	G. Walls	4a: silver poplar much grown up. 4b: Little change from 2003, though water level higher.

PHOTOPOINT RECORDING SHEET

Location/Area: Whakaki Lagoon		Photopoint no: 5
Establishment date: 3/12/99		GPS reference: E2906128 N6229875
Photopoint relocation notes: Outlet, where Rahui Channel leaves lagoon. S side, at fence tie-off.		Observer/Photographer: Geoff Walls
Direction from marker/post (magnetic bearing): 3 photos, NW, NE, SW		
Camera info (lens, film, etc): 50mm, 200asa colour		
Vegetation (composition, structure, patterns, processes): Rank rough pasture with sedges and rushes (<i>Bolboschoenus fluviatilis</i> , <i>Juncus kraussii</i> , <i>J. gregiflorus</i>) and lots of exotic herbs and grasses. On shore, areas of <i>Schoenoplectus pungens</i> and turf of <i>Mimulus repens</i> , <i>Lilaeopsis ruthiana</i> and <i>Cotula coronopifolia</i> . Chosen to follow changes with varying regimes of stock exclusion, water level fluctuation, revegetation, etc.		
REPHTOGRAPHY DETAILS:		
Date	Observer/ Photographer	Comments (changes, processes, etc)
8/12/01	G. Walls	Water level significantly higher than in 1999, so can't see turfs. Since fencing of the right bank of channel mouth and east shore of lagoon, grasses, rushes, <i>Bolboschoenus fluviatilis</i> and <i>Schoenoplectus pungens</i> have all increased in density and height. Expect marsh ribbonwood to appear and flourish on shore in future. Goats on channel bank just downstream.
8/12/03	G. Walls	Water level as 2001. Portion to SE of system fenced now and regenerating well in <i>Bolboschoenus</i> , <i>Juncus kraussii</i> and <i>Schoenoplectus</i> . A lone pampas has appeared and should be killed. To N, where not fenced, grazed harder than in 2001 and channel banks cut down and exposed more. A few goats present.
11/10/05	G. Walls	More or less as in 2003. Goats present. <i>Bolboschoenus</i> has diminished through grazing. Pampas is larger and should be killed. The 'delta' area is more vegetated, but the turf is inundated. Channel banks are eroding through wave action and cattle impact where not fenced; would regrow <i>Bolboschoenus</i> if fenced off.

PHOTOPOINT RECORDING SHEET

Location/Area: Whakaki Lagoon		Photopoint no: 6
Establishment date: 3/12/99		Grid reference: X19/055292
Observer/Photographer: Geoff Walls		
Photopoint relocation notes: SE corner of lagoon, at old fence tie-off where it enters water. Photos taken standing on big log.		
Direction from marker/post (magnetic bearing): 4 photos NE, W, S. Also one to E.		
Camera info (lens, film, etc): 50mm, 200asa colour		
Vegetation (composition, structure, patterns, processes): Mix of <i>Juncus kraussii</i> , <i>Bolboschoenus fluviatilis</i> and shore ribbonwood to NE of fence; little of these to S, instead a mix of <i>Bolboschoenus fluviatilis</i> , rushes, occasional shore ribbonwood, pohuehue and grasses, and <i>Carex pumila</i> by shore. Shore ribbonwood expected to increase, along with other woody natives, when fenced to exclude stock. To S, boxthorn and lupin are spreading along the dune system from the east, and require surveillance.		
REPHTOGRAPHY DETAILS:		
Date	Observer/ Photographer	Comments (changes, processes, etc)
8/12/01	G. Walls	Lagoon levels higher than in 1999. Still, lots of drifted <i>Potamogeton</i> and <i>Ruppia</i> washed up on shore. <i>Bolboschoenus fluviatilis</i> has thickened up a bit since shore fenced off in 2000. Shore ribbonwood likewise. Otherwise looks similar; perhaps a bit more <i>Carex pumila</i> on beach to S. Extra photo taken to E of gorse and pampas grass that need to be eliminated.
8/12/03	G. Walls	Similar to 2001. Has been some shore erosion in recent times (wave-driven). Regeneration process continuing. Gorse has been killed but pampas is thriving and should also be killed.
11/10/05	G. Walls	Similar to 2003. <i>Bolboschoenus</i> and three-square are holding the shore together in the face of wave action. Regeneration of shore ribbonwood continues (it is becoming more dominant). Pampas has burgeoned and should be killed.

PHOTOPOINT RECORDING SHEET

Location/Area: Whakaki Lagoon		Photopoint no: 7
Establishment date: 3/12/99		GPS reference: E2903926 N6229166
Photopoint relocation notes: Northwards of hut with black header tank to fenced revegetation area. Photopoint at NE corner of fenced area. Netting removed (2003).		Observer/Photographer: Geoff Walls
Direction from marker/post (magnetic bearing): 4 photos, E, SE, S, W		
Camera info (lens, film, etc): 50mm, 200asa colour		
Vegetation (composition, structure, patterns, processes): Mosaic of pohuehue, blackberry, convolvulus, lupin, grasses and flatweeds on dry sand; wet hollows dominated by <i>Baumea articulata</i> ; shore fringe of <i>Juncus kraussii</i> and <i>Bolboschoenus fluviatilis</i> . Plantings of taupata, ngaio, karo, cabbage tree, pohutukawa, flax. Single boxthorn nearby: should be controlled. Some cabbage trees and clumps of pampas to the E. The area should show recovery of native shrubs in time. The plantings are likely to change the face of the locality.		
REPHTOGRAPHY DETAILS:		
Date	Observer/ Photographer	Comments (changes, processes, etc)
7/12/01	G. Walls	Planted plants have survived and grown, especially ngaio, flax and pohutukawa. Netting is successfully preventing hare damage to them. Tree lupin has grown much, as has <i>Muehlenbeckia complexa</i> . Boxthorn dead (has been controlled). Cabbage tree has new basal shoot.
9/12/03	G. Walls	Plantings have flourished: ngaio, karo, flax, pohutukawa, taupata and cabbage trees. Those responsible can be justifiably proud. Although some plants are exotic, and others 'exotic natives', the plantings show what can be done by local communities, and also that forest must have grown on the spit in the past. Pohuehue and blackberry a bit weedy but not yet threatening. <i>Raoulia</i> looks much as before.
10/10/05	G. Walls	Plantings have continued to flourish. The wetland vegetation looks similar to 2003. Pohuehue and blackberry are abundant but not impeding the planted trees and shrubs.

PHOTOPOINT RECORDING SHEET

Location/Area: Whakaki Lagoon		Photopoint no: 8
GPS reference: E2902824 N6226874 (post), E2902777 N6228904 (photopoint)		
Establishment date: 3/12/99		Observer/Photographer: Geoff Walls
Photopoint relocation notes: SW of lagoon on top of foredune, c. 40m SW of a huge old strainer post just behind the foredunes.		
Direction from marker/post (magnetic bearing): 4 photos, E, NE, NW, W		
Camera info (lens, film, etc): 50mm, 200asa colour		
Vegetation (composition, structure, patterns, processes): Spinifex dominant on foredunes, with accumulations of driftwood to seaward. On sand flats, scattered <i>Raoulia hookeri</i> patches with sparse flatweeds and exotic grasses. Both communities at threat from nearby marram grass.		
REPHOTOGRAPHY DETAILS:		
Date	Observer/ Photographer	Comments (changes, processes, etc)
7/12/01	G. Walls	Spinifex still healthy. In dune slack zone, more ground cover of sorrel, flatweeds and exotic grasses (including Indian doab) than in 1999. Less bare sand. Lupins and <i>Bolboschoenus fluviatilis</i> have grown up nearer lagoon.
9/12/03	G. Walls	As before: processes have continued. Spinifex and <i>Lagurus</i> flowering heavily this year. Much pumice in with the driftwood on the strand zone.
10/10/05	G. Walls	Pretty much as in 2003, but changing in places. Spinifex population is very healthy. Lupins are increasing. Bare sand is being clothed in shore convolvulus, Indian doab and herbaceous exotic plants, indicating that the habitat for <i>Raoulia</i> is becoming poorer.

PHOTOPOINT RECORDING SHEET

Location/Area: Whakaki Lagoon		Photopoint no: 9
Establishment date: 3/12/99		GPS reference: E2902583 N6229239
Photopoint relocation notes: SW corner of lagoon, on new fenceline. Tag on 6 th post S of gate at top of small but strategic rise.		Observer/Photographer: Geoff Walls
Direction from marker/post (magnetic bearing): 360-degree panorama (13 photos)		
Camera info (lens, film, etc): 50mm, 200asa colour		
Vegetation (composition, structure, patterns, processes): Sparse vegetation of <i>Carex pumila</i> , <i>Raoulia hookeri</i> patches and various exotic grasses and herbs on dry sand. Areas of marram grass, threatening to expand, on either side of the fence. Rushes and sedges in damp hollows. Patches of blackberry and some gorse, lupins and pampas grass. Control of marram, gorse and pampas proposed. Fate of <i>Raoulia</i> is significant. Regeneration of native shrubs is likely in rushland-sedgeland where stock now excluded.		
REPHOTOGRAPHY DETAILS:		
Date	Observer/ Photographer	Comments (changes, processes, etc)
7/12/01	G. Walls	Marram grass has significantly advanced in places. <i>Bolboschoenus fluviatilis</i> has thickened on the lagoon shore. Blackberry has expanded. Ground cover on sand of exotic flatweeds and grasses (especially haretail and Indian doab) has increased notably.
9/12/03	G. Walls	Marram continuing to advance: <u>desperately necessary to eradicate it asap</u> . Lupins spreading, flowereing heavily. <i>Lagurus</i> abundant, flowering heavily. Herbs on sand now abundant. <i>Bolboschoenus</i> still abundant by shore; looks like <i>Juncus kraussii</i> is increasing with it. Fernbirds present.
10/10/05	G. Walls	Marram is still advancing fast. North of the fence it has been sprayed, but it is unimpeded south of there. Lupins spreading fast also. Evening primrose has much increased in the <i>Raoulia</i> zone and may pose a considerable threat. Bare sand is becoming vegetated. In the wet zone, much increase in <i>Isolepis prolifer</i> .

PHOTOPOINT RECORDING SHEET

Location/Area: Whakaki Lagoon		Photopoint no: 10
Establishment date: 3/12/99		GPS reference: E2902601 N6229378
Photopoint relocation notes: SW corner of lagoon; corner of new fence, 130m S of shore.		Observer/Photographer: Geoff Walls
Direction from marker/post (magnetic bearing): 4 photos, NW, NE, S		
Camera info (lens, film, etc): 50mm, 200asa colour		
Vegetation (composition, structure, patterns, processes): Dense rushland-sedgeland of <i>Juncus kraussii</i> and <i>Bolboschoenus fluviatilis</i> . Blackberry well established; some pohuehue. With grazing relief, shore ribbonwood and cabbage tree expected to expand in time.		
REPHTOGRAPHY DETAILS:		
Date	Observer/ Photographer	Comments (changes, processes, etc)
7/12/01	G. Walls	Blackberry has grown much. <i>Bolboschoenus fluviatilis</i> has grown up and thickened. Pasture grasses (especially Yorkshire fog) have grown up rank. Cabbage trees nearby have resprouted from their bases. The pampas grass clump should be killed.
9/12/03	G. Walls	Muehlenbeckia complexa has completely smothered tagged post. Blackberry has grown. Cabbage trees looking healthy now, and pampas has been killed. <i>Juncus kraussii</i> appears to be expanding at the expense of <i>Bolboschoenus</i> .
10/10/05	G. Walls	Much as in 2003. <i>Juncus</i> could be expanding at the expense of <i>Bolboschoenus</i> , but not clear at this stage. Fernbird and bittern heard.

PHOTOPOINT RECORDING SHEET

Location/Area: Whakaki Lagoon		Photopoint no: 11
Establishment date: 3/12/99		Grid reference: X19/026295
Observer/Photographer: Geoff Walls		
Photopoint relocation notes: SW corner of lagoon, at shore. Access from new fence corner. Site marked by dual posts with iron tacked between them on water's edge.		
Direction from marker/post (magnetic bearing): 3 photos, N, W, SSW		
Camera info (lens, film, etc): 50mm, 200asa colour		
Vegetation (composition, structure, patterns, processes): Expanse of dense <i>Juncus kraussii</i> and <i>Bolboschoenus fluviatilis</i> around shore. Also short turf, mostly submerged, of <i>Mimulus repens</i> and <i>Lilaeopsis ruthiana</i> , possibly maintained by waterfowl. Regeneration of shore ribbonwood is likely now that stock are excluded.		
REPHTOGRAPHY DETAILS:		
Date	Observer/ Photographer	Comments (changes, processes, etc)
7/12/01	G. Walls	Water levels too high to reach, so did not photograph. <i>Bolboschoenus fluviatilis</i> has thickened much and is taller since relieved of grazing.
9/12/03	G. Walls	Water levels too high to reach. <i>Juncus kraussii</i> appears to be expanding at the expense of <i>Bolboschoenus</i> . Standing water appears to have pushed back the <i>Bolboschoenus</i> , favouring the <i>Juncus</i> . Mercer grass is very dense in places.
10/10/05	G. Walls	Water levels too high and vegetation too dense to reach. Appears essentially as in 2003.

PHOTOPOINT RECORDING SHEET

Location/Area: Whakaki Lagoon		Photopoint no: 12
Establishment date: 3/12/99		GPS reference: E2902402 N6229783
Photopoint relocation notes: W side of lagoon, on new fenceline. Photopoint is at gate (photos taken standing on gatepost).		Observer/Photographer: Geoff Walls
Direction from marker/post (magnetic bearing): 4 photos, NNW, ENE, SSE, WSW		
Camera info (lens, film, etc): 50mm, 200asa colour		
Vegetation (composition, structure, patterns, processes): Admixture of <i>Juncus kraussii</i> (evergreen) and <i>Bolboschoenus fluviatilis</i> (summer green). <i>Bolboschoenus fluviatilis</i> coming away where cattle are excluded; may overcome the <i>Juncus kraussii</i> . Much small fathen and <i>Cotula coronopifolia</i> on ground. With exclusion of cattle to E of fence, there may be regeneration of shore ribbonwood, cabbage tree, flax, etc.		
REPHTOGRAPHY DETAILS:		
Date	Observer/ Photographer	Comments (changes, processes, etc)
7/12/01	G. Walls	Reached after a long exhausting wade through deep water! Main change is that <i>Bolboschoenus fluviatilis</i> has grown up in height and density on both sides of fence (stocking levels are down on the SW side), but especially on the lagoon side where stock are excluded.
9/12/03	G. Walls	Not visited because of high water levels. Viewed from the fence at Transect 6. <i>Bolboschoenus</i> now dense and tall (released from grazing); <i>Juncus kraussii</i> has increased also.
10/10/05	G. Walls	Not visited because of high water levels. Essentially as in 2003.

PHOTOPOINT RECORDING SHEET

Location/Area: Whakaki Lagoon		Photopoint no: 13
Establishment date: 9/12/03		GPS reference: E2902554 N6228972
Photopoint relocation notes:		Observer/Photographer: Geoff Walls
Seaward end of the fence that constitutes Transect 6 at the western end of the dune system.		
Direction from marker/post (magnetic bearing): 2 photos, N & S		
Camera info (lens, film, etc): 50mm, 200asa colour		
Vegetation (composition, structure, patterns, processes):		
Sparse vegetation on sand: <i>Raoulia</i> mats with <i>Lagurus ovatus</i> , <i>Carex pumila</i> , Indian doab and a few flatweeds; dense spinifex on the raised foredune.		
REPHTOGRAPHY DETAILS:		
Date	Observer/ Photographer	Comments (changes, processes, etc)
9/12/03	G. Walls	New photopoint. Chosen to monitor the <i>Raoulia</i> and spinifex. Invasion of Indian doab (just arriving) affecting the <i>Raoulia</i> is the current concern. The spinifex looks very healthy at present.
10/10/05	G. Walls	Open sand is more clothed with vegetation: shore convolvulus, <i>Carex pumila</i> , haretail and herbaceous plants. <i>Raoulia</i> has definitely retreated. Spinifex very healthy. 3 photos taken.

APPENDIX 3: Vegetation transect recording sheets, October 2005

- Transect no. 1
- Transect no. 2
- Transect no. 3
- Transect no. 4
- Transect no. 5
- Transect no. 6

VEGETATION TRANSECT RECORDING SHEET

Location/Area: Whakaki Lagoon		Transect no: 1	
		GPS reference (start point): E2902946 N6231040	
Establishment date: 7/12/99		Observer: Geoff Walls	
Transect description (location, terrain, etc): NW of lagoon, between bend in road and the mouth of the inlet channel (artificial drain). Broad flat at lagoon margin.			
Relocation details (start point, compass bearing, etc.): Start point is stile on lagoon side of railway line (post tagged). Bearing 170 degrees mag. [distances paced].			
Photos taken (if any): Photo taken looking from start point			
MEASUREMENT DETAILS			
Date: 10/10/05		Observer: Geoff Walls	
Distance (m)	Height class	Main species present % cover*	Notes
0-12	0-3m	<u>Blackberry</u> <u>Silver poplar</u> <u>Karamu</u> <u>Fennel</u> <u>Pasture grasses</u> <u>Pasture herbs</u> <u>Carex ovalis</u> <u>Isolepis prolifer</u>	Silver poplar & karamu have bulked up.
12-54	0-1.5m	<u>Blackberry</u> <u>Buttercup</u> <u>Penny royal</u> <u>Pasture grasses</u> <u>Juncus kraussii</u> <u>J. effusus</u> <u>Carex ovalis</u>	Damp flat, blackberry spreading?
54-90	0-1m	<u>Juncus kraussii</u> <u>Bolboschoenus fluviatilis</u> <u>Mercer grass</u> <u>Other grasses</u> <u>Buttercup</u> <u>Fathen</u> <u>Carex ovalis</u> <u>Cotula coronopifolia</u>	Some standing water, Bolbo. grazed. C.ovalis expanded.
90-195	0-80cm	<u>Juncus kraussii</u> <u>Bolboschoenus fluviatilis</u> <u>Cotula coronop.</u> <u>Azolla (floating)</u>	Standing water. Bolbo. grazed down.
195-225	0-1m	<u>Juncus kraussii</u>	Standing water; Turf inundated and gone.
225-234	0-1m	<u>Juncus kraussii</u> <u>Bolboschoenus fluviatilis</u> <u>Fathen</u> <u>Cotula coronop.</u> <u>Bare ground</u> <u>Introduced grasses</u>	Raised berm of drainage channel material.
234-238	0-50cm	<u>Bolboschoenus fluviatilis</u> <u>Mimulus repens</u> <u>Lilaeopsis ruthiana</u> <u>Fathen</u> <u>Azolla (floating)</u>	Very wet.
238-	floating	<u>Azolla filiculoides</u> <u>Lemna minor</u>	Channel and lagoon edge.
Comments (patterns, processes, changes): <i>The wetland zonation has moved inland with a higher average lake level; turf inundated and gone. Waders required to measure transect now. Bolboschoenus fluviatilis has been further grazed down by cattle. Carex ovalis (oval sedge) has increased further.</i>			
Species list/Notable flora (in addition to above):			

* () = <1% = 1-5% = 5-25% — = 25-50% == = 50-75% == = >75%

VEGETATION TRANSECT RECORDING SHEET

Location/Area: Whakaki Lagoon		Transect no: 2	
GPS reference: E2902946 N6231040 (start point); E2902946 N6231040 (maimai)			
Establishment date: 7/12/99		Observer: Geoff Walls	
Transect description (location, terrain, etc.): NE of lagoon, between road pull-off and lagoon shore at maimai. Broad damp grazed flat at lagoon margin.			
Relocation details (start point, compass bearing, etc.): Start point is railway line at access path. Bearing 140 degrees mag. to maimai. [distances paced].			
Photos taken (if any): Photos taken looking from each end of transect.			
MEASUREMENT DETAILS			
Date: 10/10/05		Observer: Geoff Walls	
Distance (m)	Height class	Main species present % cover*	Notes
0-13	0-3m >3m	<u>Blackberry</u> <u>Silver poplar</u>	Steep drop from railway.
13-50	0-30cm	<u>Buttercup</u> <u>Penny royal</u> & <u>herbs</u> <u>Creeping bent</u> & <u>Mercer grass</u> <u>Other grasses</u> <u>Bolboschoenus fluviatilis</u> <u>Carex ovalis</u>	Bolb. decreased; Carex ovalis has further proliferated
50-77	0-100cm	<u>Bolboschoenus fluviatilis</u> <u>Creeping bent</u> & <u>Mercer grass</u> <u>Carex ovalis</u>	Bolb. has increased
77-155	0-1.5m	<u>Juncus kraussii</u> <u>Bolboschoenus fluviatilis</u> <u>Mercer grass</u> <u>Fathen</u> <u>Cotula coronop.</u> <u>Mimulus repens</u>	Standing water; Juncus has increased, Bolb. has decreased, Mercer grass has colonised.
155-	water	[<u>Ruppia polycarpa</u> <u>Potamogeton pectinatus</u>]	Ruppia and Potamogeton not evident this time.
Comments (patterns, processes, changes): Much of transect underwater. <i>Bolboschoenus fluviatilis</i> has decreased a little whilst <i>Juncus kraussii</i> has increased; probably the effect of raised water levels. Still being grazed a bit. Overall, little change from 2003 except proliferation of <i>Carex ovalis</i> in pasture and loss of shore ribbonwood (drowned). Waders required to reach maimai.			
Species list/Notable flora (in addition to above):			

* () = <1% = 1-5% = 5-25% — = 25-50% == = 50-75% == = >75%

VEGETATION TRANSECT RECORDING SHEET

Location/Area: Whakaki Lagoon		Transect no: 3	
GPS reference: E2905766 N6229144 (hut); E2905557 N6229236 (tagged post near shore)			
Establishment date: 7/12/99		Observer: Geoff Walls	
Transect description (location, terrain, etc.): SE of lagoon, between shore and green hut. Broad flat at lagoon margin. Intermittently used by stock.			
Relocation details (start point, compass bearing, etc.): Start point is lagoon shore, with wee stick just in water and tagged post 14m from shore. Bearing 90 degrees mag. [distances paced].			
Photos taken (if any): Photos taken looking from start and finish points.			
MEASUREMENT DETAILS			
Date: 11/10/05		Observer: Geoff Walls	
Distance (m)	Height class	Main species present % cover*	Notes
0-2	0-80cm	<u>Juncus kraussii</u> <u>Bolboschoenus fluviatilis</u>	Juncus incr., 3-square gone
2-10	0-1m	<u>Juncus kraussii</u> <u>Bolboschoenus fluviatilis</u> <u>Tall fescue</u>	More fescue
10-19	0-1m	<u>Bolboschoenus fluviatilis</u> <u>Juncus kraussii</u> <u>Creeping bent & Mercer grass</u>	Wet. Juncus regen.
19-82	0-2m	<u>Juncus kraussii</u> <u>Bolboschoenus fluviatilis</u> <u>Creeping bent</u> <u>Shore ribbonwood</u> <u>Blackberry</u> <u>Isolepis prolifer</u> <u>Convolvulus</u> <u>Schoenoplectus validus</u> <u>Cyperus ustulatus</u> (raupo)	Shore ribbonwood healthy, Juncus & Bolbo incr. Raupo new
82-103 [New fence 103m]	0-1.5m	<u>Baumea articulata</u> <u>Bolboschoenus fluviatilis</u> <u>Convolvulus</u> <u>Exotic grasses</u> <u>Blackberry</u> <u>Plagianthus divaricatus</u> <u>Isolepis prolifer</u> <u>pohuehue</u>	Local dominance of Baumea!
103-145	0-1.5m	<u>Bolboschoenus fluviatilis</u> <u>Cyperus ustulatus</u> <u>Isolepis prolifer</u> <u>Juncus effusus</u> <u>Blackberry</u> <u>Pasture grasses & herbs</u> <u>Convolvulus</u> (<u>Carex secta</u>) <u>Gorse</u>	Gorse increasing; less Bol flu, more pasture plants
145-170	0-1.5m	<u>Isolepis prolifer</u> <u>Cyperus ustulatus</u> <u>Creeping bent & Merxcer grass</u> <u>Schoenoplectus validus</u> <u>Callitriche stagnalis</u> <u>Myriophyllum</u>	Very wet hollow, Isolepis dominant
170-185	0-1.5m	<u>Baumea articulata</u> <u>Blackberry</u> <u>Gorse</u> <u>Pasture grasses & herbs</u> <u>Schoenoplectus validus</u> <u>Convolvulus</u> <u>Cyperus ustulatus</u>	Baumea locally dominant at expense of other plants
185-240	0-2m	<u>Blackberry</u> <u>Pasture grasses & herbs</u> <u>Pohuehue</u> <u>Lupin</u> <u>Sorrel</u> <u>Boxthorn</u> <u>Bare sand</u> <u>Gorse</u>	Grazed lightly; gorse and pohuehue increased
Comments (patterns, processes, changes): <i>Lagoon shore fenced in 2000. As 2003: continued good regeneration of shore ribbonwood since, and general increase in rushes and sedges. Baumea articulata has locally burgeoned. Pampas is multiplying in the vicinity and should be controlled.</i>			
Species list/Notable flora (in addition to above): Fernbirds here in shore ribbonwood.			

* () = <1% = 1-5% = 5-25% — = 25-50% == = 50=75% == = >75%

VEGETATION TRANSECT RECORDING SHEET

Location/Area: Whakaki Lagoon		Transect no: 4	
GPS references: E2904674 N6228863 (start point); E2904695 N6228940, E2904699 N6228933, E2904681 N6228924 (<i>Raoulia</i> plots)			
Establishment date: 7/12/99		Observer: Geoff Walls	
Transect description (location, terrain, etc): S side of lagoon, at narrow point between lagoon and sea. Mostly dry dune, but also a wet lagoon fringe. 3 small <i>Raoulia</i> plots marked with pegs near transect middle.			
Relocation details (start point, compass bearing, etc.): Start point is old railway sleeper used as fence post; tagged. Bearing 335 degrees mag.			
Photos taken (if any): Photos taken looking from each end of transect, also middle.			
MEASUREMENT DETAILS			
Date: 10/10/05		Observer: Geoff Walls	
Distance (m)	Height class	Main species present % cover*	Notes
0-45	0-20cm	<u>Bare sand</u> <u>Driftwood</u> <u>Carex pumila</u> <u>Calystegia soldanella</u> (Spinifex) Ephemeral exotic herbs	Spinifex still there, new herbs
45-65	0-20cm 20-50cm	<u>Bare sand</u> <u>Driftwood</u> <u>Carex pumila</u> <u>Spinifex</u> <u>Calystegia soldanella</u> <u>Herbs</u> <u>Spinifex</u>	Spinifex still spreading, <i>Raoulia</i> gone
65-81	0-20cm	<u>Bare sand</u> <u>Carex pumila</u> <u>Calystegia soldanella</u> <u>Raoulia hookeri</u> <u>Indian doab</u> <u>Herbs</u> <u>Spinifex</u>	<i>Raoulia</i> declined Spinifex incr.
81-104	0-30cm	<u>Bare sand</u> <u>Carex pumila</u> <u>Calystegia soldanella</u> <u>Indian doab</u> <u>Small herbs</u>	More <i>Calystegia</i>
104-109	0-30cm	<u>Bare sand</u> <u>Carex pumila</u> <u>Calystegia soldanella</u> <u>Indian doab</u> <u>Other grasses</u> <u>Small herbs</u>	More <i>Calystegia</i> Less doab
109-115	0-1m	<u>Cyperus ustulatus</u> <u>Bolboschoenus fluviatilis</u> <u>Juncus kraussii</u> Shore ribbonwood <u>Convolvulus</u> <u>Creeping bent</u> <u>Blackberry</u> <u>Muehlenbeckia complexa</u>	Not much change
115-120	0-70cm	<u>Isolepis prolifer</u> <u>Bolboschoenus fluviatilis</u> <u>Creeping bent & Mercer grass</u>	
120-126	0-1m	<u>Bolboschoenus fluviatilis</u>	
126-132	0-1m	<u>Bolboschoenus fluviatilis</u> <u>Juncus kraussii</u>	
132-	0-50cm	<u>Schoenoplectus pungens</u> <u>Mimulus repens</u> <u>Mud and water</u>	
Comments (patterns, processes, changes): <i>Raoulia</i> population appears to be in decline now and in retreat as the sand is being stabilised by <i>Calystegia</i> and exotic grasses and flatweeds. There are still many healthy adults but not many young ones. <i>Indian doab</i> not as dominant as predicted. Not much change on the lake margin except the turf has been inundated. Marram clump just to N needs follow-up control.			
Species list/Notable flora (in addition to above): Fernbirds here.			

* () = <1% = 1-5% = 5-25% — = 25-50% == = 50-75% ■ = >75%

VEGETATION TRANSECT RECORDING SHEET

Location/Area: Whakaki Lagoon		Transect no: 5	
GPS references: E2904326 N6228883 (hut); E2904344 N6228962 (tagged post N 122m)			
Establishment date: 7/12/99		Observer: Geoff Walls	
Transect description (location, terrain, etc.): S side of lagoon, representative transect from sea to lagoon shore across dry dunes and flats. Transect is straight for half its length, then follows quad track to lagoon shore.			
Relocation details (start point, compass bearing, etc.): Start point is 35m seawards of lone Norfolk pine alongside hut. Bearing 340 degrees mag. [distances paced].			
Photos taken (if any): Photo taken looking from each end of transect and from post			
MEASUREMENT DETAILS			
Date: 10/10/05		Observer: Geoff Walls	
Distance (m)	Height class	Main species present % cover*	Notes
0-5	0-50cm	<u>Bare sand</u> <u>Driftwood</u>	Spinifex healthy Iceplant much increased
5-30	0-50cm	<u>Bare sand</u> <u>Spinifex</u> <u>Iceplant</u> Tas. ngaio Karo	
30-35	Hut	Norfolk pine, iron, etc. Taupata	
35-83	0-20cm	<u>Bare sand</u> <u>Carex pumila</u> <u>Calystegia soldanella</u> <u>Spinifex</u> (Raoulia hookeri) <u>Indian doab</u> Flatweeds <u>Lagurus ovatus</u>	
83-93	0-15cm	<u>Bare sand</u> <u>Calystegia soldanella</u> <u>Indian doab</u> Flatweeds	Spinifex incr a little; Calystegia incr. markedly
93-119	15-50cm 0-25cm	<u>Spinifex</u> <u>Lagurus ovatus</u> <u>Bare sand</u> <u>Calystegia soldanella</u> <u>Indian doab</u> Flatweeds <u>Carex pumila</u> <u>Cranesbill</u> <u>Other grasses</u>	
119-127	0-50cm	<u>Pohuehue</u> <u>Blackberry</u> <u>Calystegia soldanella</u> Grasses <u>Bare sand</u> <u>Iceplant</u> <u>Indian doab</u>	Dense pohuehue; Iceplant patch, new doab
127-141	0-150cm	<u>Blackberry</u> <u>Pohuehue</u> <u>Cyperus ustulatus</u>	
141-145	0-2m	<u>Blackberry</u> <u>Yorkshire fog</u> & other grasses <u>Planted harakeke</u> Pasture herbs	Harakeke grown Many planted harakeke, cabbage trees
145-198	0-1m	<u>Rank exotic grasses</u> <u>Blackberry</u> <u>Pasture herbs</u>	
198-290	0-150cm	<u>Rank exotic grasses</u> <u>Blackberry</u> <u>Pohuehue</u> <u>Cyperus ustulatus</u> <u>Convolvulus</u> Sch val Jun eff	
290-342	0-180cm	<u>Juncus kraussii</u> <u>Bolboschoenus fluviatilis</u> <u>Dock</u> <u>Creeping bent/Mercer</u> Fathen <u>Cyperus ustulatus</u> <u>Convolvulus</u> <u>Carex sp.</u> Jun eff Sch pun (Pla div) Isolepis prolifer <u>Carex ovalis</u>	Bol flu dominant,
342-352	0-180cm	<u>Juncus kraussii</u> <u>Bolboschoenus fluviatilis</u> Fathen <u>Cotula coronopifolia</u>	
352-	Lagoon	Open water	flu
Comments (patterns, processes, changes): Planted iceplant a serious threat to dunes. Wonderful plantings of harakeke and cabbage trees, grown up much. Newly planted pohutukawa. Traps and bait stations for animal pest control. Lupins appear to be increasing in the vicinity. Some boxthorn needing control. Much increase in Calystegia in open sand. Shore ribbonwood increasing near the shore.			
Species list/Notable flora (in addition to above):			

* () = <1% = 1-5% = 5-25% — = 25-50% == = 50=75% == = >75%

VEGETATION TRANSECT RECORDING SHEET

Location/Area: Whakaki Lagoon		Transect no: 6	
Establishment date: 6/12/99		Grid reference (start point): X19/026295	
Observer: Geoff Walls			
Transect description (location, terrain, etc):			
SW corner of lagoon, a long sequence from the lagoon shore to the sea, along fenceline.			
Relocation details (start point, compass bearing, etc.):			
Start point is lagoon edge (dual post tagged). Bearing 162 degrees mag.			
[distances measured using tape].			
Photos taken (if any): Photos taken looking from start point and middle (photopoints 9-11)			
MEASUREMENT DETAILS			
Date: 6/12/99 (7/12/01) (9/12/03) (10/10/05)		Observer: Geoff Walls	
Distance (m)	Height class	Main species present % cover*	Notes
0-3.5	0-30cm 30cm-1m >1m	<u>Mimulus repens</u> <u>Juncus kraussii</u> <u>Bolboschoenus fluviatilis</u> <u>Juncus kraussii</u>	Very wet
3.5-49	0-30cm 30cm-1m	<u>Mimulus repens</u> <u>Fathen</u> <u>Sorrel</u> <u>Cotula coronop.</u> <u>Lilaeopsis ruthiana</u> <u>Juncus kraussii</u> <u>Bolboschoenus fluviatilis</u> <u>Epilobium</u> sp. <u>Cyperus ustulatus</u>	Damp, periodically inundated
49-86	0-30cm 30cm-1m	<u>Sorrel</u> <u>Fathen</u> <u>Cotula coronop.</u> <u>Juncus kraussii</u> <u>Bolboschoenus fluviatilis</u> <u>Epilobium</u> sp.	Damp, periodically inundated
86-120	0-30cm 30cm-1m	<u>Creeping bent</u> <u>Sorrel</u> <u>Carex</u> sp. <u>Bolboschoenus fluviatilis</u> <u>Juncus kraussii</u> <u>Epilobium</u> sp.	Gentle rise
120-170	0-150cm	<u>Dock</u> <u>Bolboschoenus fluviatilis</u> <u>Carex</u> sp. <u>Blackberry</u> <u>Rank grasses</u> <u>Pasture herbs</u> <u>Isolepis prolifer</u> <u>Juncus effusus</u> <u>J. kraussii</u> <u>Willow weed</u> <u>Convolvulus</u>	Step up
170-181	0-1m	<u>Blackberry</u> <u>Pohuehue</u> <u>Grasses</u> <u>Pasture herbs</u> <u>Lupin</u>	Step up
181-230	0-30cm	<u>Sorrel</u> <u>Flatweeds</u> <u>Grasses</u> <u>Carex pumila</u> (<u>Raoulia hookeri</u>) <u>Bare sand</u>	Rise
230-251	0-1m	<u>Juncus effusus</u> <u>Grasses</u> <u>Pasture herbs</u>	Hollow
251-398	0-25cm	<u>Carex pumila</u> <u>Raoulia hookeri</u> <u>Sorrel</u> <u>Other herbs</u> <u>Lagurus</u> <u>Bare sand</u> <u>Calystegia soldanella</u> (<u>Gorse</u>)	Broad flat
398-460	0-30cm	<u>Carex pumila</u> (<u>Raoulia hookeri</u>) <u>Other herbs</u> <u>Lagurus</u> <u>Bare sand</u> <u>Calystegia soldanella</u> <u>Indian doab</u>	Broad flat
460-499	0-20cm	<u>Carex pumila</u> <u>Raoulia hookeri</u> <u>Other herbs</u> <u>Lagurus</u> <u>Bare sand</u> <u>Calystegia soldanella</u>	Gentle rise
499-539	0-20cm 20-50cm	<u>Carex pumila</u> <u>Lagurus</u> <u>Bare sand</u> <u>Calystegia soldanella</u> <u>Spinifex</u> <u>Driftwood</u>	Gentle rise
539-554	0-20cm 20cm-1m	<u>Bare sand</u> <u>Driftwood</u>	Top of foredune
554-		<u>Bare sand</u>	Descent to sea
Comments (patterns, processes, changes):			
<i>Not measured this time or in 2001 or 2003 because of various constraints. Trends as in 2003: bare sand areas being clothed by exotic herbs and grasses, putting Raoulia at risk; marram continuing to invade but sprayed on north side of fence; lake shore turf is inundated; sea rush may be prevailing over marsh clubrush; some increase in shore ribbonwood.</i>			
Species list/Notable flora (in addition to above):			

* () = <1% = 1-5% = 5-25% — = 25-50% == = 50-75% == = >75%

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

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

**AQUATIC VEGETATION AND MACROINVERTEBRATE
RECORDING SHEET**

Location/Area: Whakaki Lagoon		Site no: 1
Establishment date: 5/12/99		GPS reference (post): E2902207 N6231140
Observer: Geoff Walls		
Site notes (location details, vegetation, etc): NW of lagoon at inlet channels, where crossed by bridges. Also Photopoint 1 site. Tag on gatepost just across first bridge from railway access.		
SAMPLING DETAILS		
Date: 10/10/05		Observer: Geoff Walls
Sampling methods/notes: Tray and handlens; samples from southern channel; fish traps set at same site.		
AQUATIC VEGETATION PRESENT		COMMENTS
Species	Relative abundance*	
Azolla filiculoides	s	
Lemna minor	s	
Spirodela punctata	s	
Mercer grass	m	
Creeping bent	s	
<i>Bolboschoenus fluviatilis</i>	m	
Raupo	s	Potamogeton suboblongus not found.
Green alga	s	
Potamogeton crispus	s	Pulled up by swans
Myriophyllum propinquum	s	Pulled up by swans
MACROINVERTEBRATES PRESENT		SENSITIVITY SCORE (1-10)
Isopod (estuarine)	5	Many Abundant Abundant
Dytiscid beetle	5	
Microvelia bug	5	
Anisops backswimmer	5	
Water boatman	5	
Copepod	5	
Paratya shrimp	5	
Ephydrid fly larva	4	
Potamopyrgus snail	4	
Physa snail	3	
Oligochaete worm	1	
Chironomus midge larva	1	

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

AQUATIC VEGETATION AND MACROINVERTEBRATE
RECORDING SHEET

Location/Area: Whakaki Lagoon		Site no: 2
Establishment date: 5/12/99		GPS reference: E2905006 N6230158 (maimai)
Observer: Geoff Walls		
Site notes (location details, vegetation, etc): NE of lagoon at lagoon edge. Also Photopoint 4 site. Near maimai, within edge of <i>Juncus kraussii</i> and <i>Bolboschoenus fluviatilis</i> fringe.		
SAMPLING DETAILS		
Date: 10/10/05		Observer: Geoff Walls
Sampling methods/notes: Tray and handlens; samples from shore at maimai; fish traps set at same site.		
AQUATIC VEGETATION PRESENT		COMMENTS
Species	Relative abundance*	
Juncus kraussii	s	In standing water, has decreased
Bolboschoenus fluviatilis	m	In standing water, has increased
Creeping bent	m	In standing water, has increased
MACROINVERTEBRATES PRESENT		COMMENTS
	SENSITIVITY SCORE (1-10)	
Dytiscid beetle	5	
Water boatman	5	
Anisops backswimmer	5	
Copepod	5	
Freshwater shrimp	5	
Microvelia bug	5	
Potamopyrgus snail	4	
Physa snail	3	
Mosquito larva	3	
Chironomus midge larva	1	
Unidentified fly larva		

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

AQUATIC VEGETATION AND MACROINVERTEBRATE
RECORDING SHEET

Location/Area: Whakaki Lagoon		Site no: 3
Establishment date: 6/12/99		GPS reference: E2907128 N6229973
Observer: Geoff Walls		
Site notes (location details, vegetation, etc): Road bridge across Rahui Channel, E of lagoon.		
SAMPLING DETAILS		
Date: 11/10/05		Observer: Geoff Walls
Sampling methods/notes: Tray and handlens; samples from near bridge; fish traps set at same site.		
AQUATIC VEGETATION PRESENT		COMMENTS
Species	Relative abundance*	
Azolla filiculoides	m	Floating, increased
Lemna minor	s	Floating, increased
<i>Bolboschoenus fluviatilis</i>	s	Decreased
Crack willow	u	Margins
Raupo	m	
Mercer grass	m	Shallow water
Creeping bent	m	Shallow water, increased
MACROINVERTEBRATES PRESENT		COMMENTS
	SENSITIVITY SCORE (1-10)	
Isopod (estuarine)	5	Many
Amphipod	5	Many
Copepods	5	
Microvelia bug	5	
Water boatman	5	
Freshwater shrimp	5	
Stratiomyid fly larva	5	
Potamopyrgus snail	4	
Oligochaete worm	1	
Mayfly larva (unidentified)	?	
		Damselfly larva and Hyrudinea leech not detected this time

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

AQUATIC VEGETATION AND MACROINVERTEBRATE
RECORDING SHEET

Location/Area: Whakaki Lagoon		Site no: 4
		Grid reference: X19/026295
Establishment date: 6/12/99		Observer: Geoff Walls
Site notes (location details, vegetation, etc): SW corner of lagoon. Also Photopoint 11 site. Tag on dual post at water's edge. Not measured in 2003 or 2005 because water level too high to reach site.		
SAMPLING DETAILS		
Date: 6/12/99, 7/12/01		Observer: Geoff Walls, Erna Zimmermann
Sampling methods/notes: Tray and handlens; samples from shore; fish traps set at same site.		
AQUATIC VEGETATION PRESENT		COMMENTS
Species	Relative abundance*	
Azolla filiculoides	s	Floating
Potamogeton pectinatus	s	Floating; pulled up by swans
Mimulus repens	m?	Submerged, so couldn't see
Lilaeopsis ruthiana	s?	Submerged, so couldn't see
Bolboschoenus fluviatilis	s	
Juncus kraussii	s	
		Not measured in 2003
MACROINVERTEBRATES PRESENT		SENSITIVITY SCORE (1-10)
		COMMENTS
Isopod (estuarine)		5
Amphipod		5
Potamopyrgus snail		4
Physa snail		3
Microvelia bug		3
Anisops backswimmer		3
Hydrudinea leech		3
Sandfly larva		3
Chironomus midge larva		1
Unident. fly larva		-
		Not measured in 2003 or 2005

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

APPENDIX 5: Bird lists, Whakaki Lagoon, October 2005

Water birds			Other birds		
Species	Est. Nos.	Breeding (yes/no)	Species	Est. Nos.	Breeding (yes/no)
<u>Native species</u>			<u>Native species</u>		
Australasian bittern	5+	?	Fantail	10	?
Black shag	30	n	Riroriro	10	?
Little shag	20	y	Shining cuckoo	-	
Grey duck	?	y	Silvereye	50	y
NZ shoveler	20	y	NZ pipit	20	y
Paradise shelduck	50	y			
Grey teal	30	?	<u>Introduced species</u>		
Pied stilt	30	y	Skylark	20	y
White-faced heron	20	?	Starling	100+	?
Pukeko	50+	y	Blackbird	20	y
Welcome swallow	30+	y	Thrush	20	y
NZ kingfisher	10	?	Redpoll	100+	y
Australasian harrier	10	?	Greenfinch	100+	y
Spur-winged plover	30+	y	Goldfinch	50+	y
Banded dotterel	10+	?	Chaffinch	20	y
NZ dabchick	-		Yellowhammer	30	y
Australian coot	-		House sparrow	30	y
Variable oystercatcher	-		Dunnock	30	y
White-fronted tern	-		Magpie	20	y
Caspian tern	-		Myna	30	?
Black-backed gull	20	?	Pheasant	5	?
Red-billed gull	20	n			
Fernbird	20	y			
Spotless crane	10+	?			
<u>Introduced species</u>					
Mallard	150+	y			
Black swan	200+	y			
Canada goose	100+	y			

APPENDIX 6: Other animal lists, Whakaki Lagoon, October 2005

Species	Est. Nos.	Breeding (yes/no)	Species	Est. Nos.	Breeding (yes/no)
<u>Introduced mammals (detected)</u>			<u>Native reptiles</u>		
Cattle	adjacent		Common skink	50	y
Goat	adjacent	y	<u>Introduced frogs</u>		
Rabbit	20	y	Southern bell frog	50+	y
Hare	30	y	<u>Native fish</u>		
Hedgehog	20	y	Shortfin eel	Many	n
Feral cat	10	y	Longfin eel	-	
Possum	20	y	Common bully	Many	y
			Inanga	-	
<u>Introduced mammals (probably present)</u>			<u>Introduced fish</u>		
Stoat			Goldfish	Present	?
Ferret					
Weasel					
Ship rat					
Norway rat					
Mouse					