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Estuarine Vegetation Survey

Aotea Harbour

July 2012

Prepared for Waikato Regional Council

Estuarine Vegetation Survey – Aotea Harbour, July 2012

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1. Introduction

A 1997 pilot study of Whangamata, Wharekawa, and Otahu estuaries determined that it is feasible to map vascular estuarine vegetation from aerial photography together with field surveys. The success of this work encouraged Waikato Regional Council to continue with this method. The estuarine vegetation of Tairua, Coromandel, Te Kouma, Manaia, Whitianga, Port Waikato, Raglan, Aotea, Kawhia, Otama, Whangapoua harbours and the inner Firth of Thames have since been surveyed and mapped. Of these harbours, Whangamata, Wharekawa, Otahu, Tairua, Coromandel, Te Kouma, Manaia, Whitianga, Port Waikato and Raglan have been re-surveyed to enable any changes in vegetation communities over time to be determined.

The vegetation that has been mapped is within the Coastal Marine Area (CMA) and includes the spatial cover of mangrove, seagrass, sea meadow, saltmarsh and estuarine weed communities. The results of the estuarine vegetation surveys are included in Waikato Regional Council's Global Information System (GIS) database, and are used for State of the Environment investigations and assessing activities that may affect estuarine vegetation.

This report details the results from the second survey of estuarine vegetation in Aotea Harbour which was first surveyed in 2005. Comments are included about the estuarine vegetation present, the threats to native estuarine vegetation communities, and other field notes of interest. This report complements the estuarine vegetation community spatial dataset of the survey site in relation to the relevant aerial photography.

2. Methodology

The field survey was undertaken over 7 days between the 4th June and the 20th July 2012. The survey was undertaken using a combination of boating and walking. The same methodology for mapping estuarine vegetation communities was followed as that previously used to map Coromandel Peninsula estuaries (e.g. see Graeme, 2010b) using a personal digital assistant (Yuma PDA) loaded with aerial photographs (WRAPS 2007) of the survey area. Coded polygons were drawn directly onto the PDA aerial photographs to define the spatial extent of wetland vegetation types as they were being ground-truthed in the field. The use of colour pen notations on hard copy aerial photographs were reserved (but not used) as a backup for when there were instrument problems.

The upper saltwater influence in estuaries is usually indicated by the upstream limit of oioi, saltwater paspalum or saltmarsh ribbonwood, which determined the inland/upstream extent of the survey.

Field notes were made of estuarine wetland characteristics and their vulnerability to any particular threats.

2.1. Wetland vegetation classification

Estuarine wetland vegetation of the Waikato Region is split into four groups:

1. **Saltmarsh -** a multi-species community in which three sub-communities are distinguishable in the Waikato Region. They are:

    a) 'Rush/sedge community' – This is generally sea rush (*Juncus krausii* subsp. *australiensis*), oioi *(Apodasmia similis),* and generally only common on the West Coast, three-square sedge *(Schoenoplectus pungens).* Marsh clubrush *(Bolboschoenus fluviatilis)* is commonly found up streams and rivers at the upper estuarine limit in some estuaries, although it is not generally mapped[1] within this survey as it is a species of brackish-freshwater.

    b) 'Saltmarsh ribbonwood community' - Saltmarsh ribbonwood *(Plagianthus divaricatus)* dominates this zone, although rushes are often common giving a patchy appearance compared with the uniformity of the 'rush/sedge community'. Small areas of sea primrose *(Samolus repens)*, remuremu *(Selliera radicans)*, the coast spear grass *(Stipa stipoides)* and glasswort *(Sarcocornia quinqueflora)* can also be present.

    c) 'Sea meadow community' - This is devoid of tall plants such as rushes and saltmarsh ribbonwood, with the exception of coast spear grass. The sea meadow community can

[1] Except where marsh clubrush is intermingled with oioi and is too difficult to separate out for mapping

include sea primrose, remuremu, glasswort, slender clubrush *(Isolepis cernua)*, and arrow grass (*Triglochin striata*), and in more brackish areas bachelor's button (*Cotula coronopifolia*), leptinella (*Leptinella doica)* and sharp spike-sedge (*Eleocharis acuta*).

2. **Mangrove** *(Avicennia marina* subsp. *australasica)* – This is usually a monospecific community although seagrass, spartina *(Spartina* spp.*)*, saltwater paspalum *(Paspalum vaginatum)* and sea meadow beds can sometimes be found underneath mature mangrove stands.

3. **Seagrass** *(Zostera capricorni*) – This is usually a monospecific community, and is the vegetation which occurs at the lowest level in the tide and very occasionally including areas in the subtidal zone.

4. **'Weed community'** - In the Waikato Region the most significant estuarine weeds are saltwater paspalum and spartina. Both of these grasses generally grow in the open estuary and trap sediment, greatly increasing the estuary's infilling rate. These weeds also compete with the native wetland communities.

   There are other weed species (such as tall fescue (*Schedonorus phoenix)* and alligator weed (*Alternanthera philoxeroides*)) which can tolerate a degree of salt influence but for clarity of mapping they have not been included in the surveys due to their presence above the spring high tide mark.

Table 1 lists common estuarine plant species (and their associated estuarine vegetation community) mapped during the survey.

While these are the dominant vegetation communities other categories are also used to indicate the occurrence of 'mixed' vegetation communities. Saltwater paspalum in particular is often recorded as mixing with all of the other vegetation communities. Saltwater paspalum is known to co-exist with spinifex also, however mapping of saltwater paspalum stops once spinifex is present as this is regarded as a terrestrial open coast rather than estuarine environment.

Table 1: Estuarine plant species recorded in Aotea Harbour.

Common/Maori name	**Scientific name**	**Estuarine Vegetation Community**
arrow grass	*Triglochin striata*	sea meadow
coast spear grass	*Austrostipa stipoides*	sea meadow
glasswort	*Sarcocornia quinqueflora*	sea meadow
leptinella	*Leptinella dioica*	sea meadow
lilaeopsis	*Lilaeopsis novae-zelandiae*	sea meadow
mangrove	*Avicennia marina* subsp. *australasica*	mangrove
native celery	*Apium prostratum* var. *filiforme*	sea meadow
oioi	*Apodasmia similis*	rush/sedge
remuremu	*Selliera radicans*	sea meadow
saltmarsh ribbonwood	*Plagianthus divaricatus*	saltmarsh ribbonwood
saltwater paspalum *	*Paspalum vaginatum*	weed
seagrass	*Zostera capricorni*	seagrass
sea primrose	*Samolus repens*	sea meadow
sea rush	*Juncus krausii* subsp. *australiensis*	rush/sedge
shore lobelia	*Lobelia anceps*	sea meadow
slender clubrush	*Isolepis cernua*	sea meadow
spartina *	*Spartina anglica/ S. alterniflora*	weed
three square	*Schoenoplectus pungens*	rush/sedge

* denotes an exotic species

3. Results

The geographical features of Aotea Harbour and photopoint positions shown in Figure 1 are referred to in the site descriptions below.

3.1. Overview

- Extensive seagrass beds cover the middle tidal regions of the harbour.
- The most predominant harbour edge vegetation community is the rush/sedgeland. The sedge three square is found around the harbour (particularly in the southern harbour) along with the ubiquitous sea rush and oioi.
- Bands of saltmarsh ribbonwood can be found all around the harbour, particularly where stream flats have not been drained or filled. Areas where saltmarsh ribbonwood was a large feature were south of Motutere Island, south of Puketutu Stream, the head of the Pakoka River, Makaomako Stream bay, the mouth of the Waiteika Stream and at Matakowhai Bay.
- Sea meadow communities are widespread but are always small and either discrete patches on rocky promontories or wave platforms or behind or in front of rushland; or are mixed with rushland.
- There are very few mangroves in the harbour. A handful of mature trees are found scattered around the harbour usually near the head of sheltered arms. A number of seedlings were noted in association with these trees.
- Spartina has been sprayed within the harbour by the Department of Conservation however a number of small patches still remain to be controlled.
- Saltwater paspalum does not develop the thick exclusive mats as it does further north in the Coromandel. It is however invading many areas of the harbour where there is low vegetation such as sea meadow and particularly where there has been disturbance e.g. from stock.
- Much of the harbour edge is now fenced off from stock so stock were only noted to be a problem in a few areas. Some excellent riparian and wetland fencing has been occurring.
- Aotea Harbour is still a relatively sandy harbour with high levels of sediment accretion only noted in a few stream arms.
- Much of the harbour still has forest around the coastal margin giving these areas high natural character.

3.2. Site descriptions

The estuarine vegetation in Aotea Harbour is described below clockwise from the harbour mouth.

The first estuarine vegetation was encountered at a dune lake (Figure 3 and Figure 4) in **Korua Bay**. Sea rush, three square and saltwater paspalum occur around the edge of the lake as well as raupo and marsh clubrush. Saltwater paspalum is dominant around the southern edges of the lake. Oioi, sea primrose, shore lobelia, slender clubrush and scattered pampas occur on

slightly higher but wet ground east of the lake. A number of clumps of tall spartina were also found here out from the rush edge in the water. *Cassinia leptophylla*, *Carex pumila*, marram grass, and pampas characterise the higher dune land to the east. There is a lot of rabbit sign. Further eastward there is a healthy spinifex zone with *Cassinia leptophylla* in the background and then pampas, kanuka, cabbage tree, *Leucopogon fasciculatus* and some akeake. As the dune narrows marram becomes more predominant. Knobby clubrush was present in the back-dune swale area.

A lot of South Island pied oystercatchers, some black swan, godwits and banded dotterel were observed feeding out on the tidal flats.

There is a network of fingers of higher ground that extend out to **Rauiwi Head** and which support knobby clubrush, flax, akeake, pampas, gorse, kanuka, pohuehue and *Coprosma rhamnoides*. The hollows in between the higher ground support rushland (sea rush and oioi) with areas of saltmarsh ribbonwood along the edges (Figure 5). Towards the upper reaches of the hollows the vegetation community is dominated by *Baumea juncea*. The seaward edge either side of Rauiwi Head is dominated by marram, pampas and knobby rush. There are little bits of saltwater paspalum along the open edge mainly in the shelter of sea rush patches.

Around past the rushland mosaic at Rauiwi Head there is a frontal band of spinifex and some marram which grades into bracken, kanuka, akeake and cabbage tree forest. Further along the shoreline there isn't much estuarine vegetation on the steep dune forest edges except for small populations of saltwater paspalum scattered along this exposed edge.

Around the point into the bay with **Motutere Island**, the dune forest and pasture around Te Hihi Stream are edged by a cabbage tree swamp forest and raupo wetland and then estuarine vegetation along the coastal edge (Figure 6 and Figure 7). Further along the coastline the dune forest is replaced by farmland which is mostly fenced except for the eroded coastal edge which has steep edges so stock access to the harbour isn't likely. However this lack of fencing means there is essentially no riparian vegetation. There are a few large leaved tree privet, wattle and pampas plants that would be good to remove before they spread further. Estuarine vegetation is restricted here to little bits of oioi and sea rush.

Further around into the embayment of the **Tauranga Stream** there is a wide sea rush and oioi edge that is backed by raupo, cabbage tree swamp and kanuka forest (Figure 8). This wide band of rushland extends around the coastal edge up to the Puketutu Stream embayment. Near the southern end of the farmed edge there is a small watercourse with saltwater paspalum mixed with sea rush, oioi, remuremu, sea primrose and coast spear grass. Stock tracks were seen on the mudflats here. Fernbird, geese, pied stilt (~30) and a couple of Caspian terns were noted here. There is saltmarsh ribbonwood scattered in behind the rushland. Figure 9 shows a view of the wide rushland with raupo behind that is south of Puketutu Stream. Further north fernbird and banded rail were heard in the wide rushland and saltmarsh ribbonwood.

Banded rail were heard calling in the **Puketutu Stream** embayment. The sea was quite stormy the day before and fine sediment was noted to have recently settled out in divets in the mudflats here (Figure 10). Pig rooting in the rushland (sea rush, oioi and some three square) was also noted in this embayment (Figure 11 and Figure 12).

Around towards **Piritoka Point** there is a thin band of oioi backed by *Baumea juncea*, coastal shrub daisy (*Olearia solandri*), flax, gorse, pampas, cabbage trees and then coastal forest (rewarewa, punga, cabbage tee, rimu, kowhai, pohutukawa, lancewood and some broadleaf). The coastal forest looked healthy with the pohutukawa not showing any sign of possum

browse. Further around into the **Parawai Stream** embayment, coastal shrub daisy was a predominant feature of the back-swamp vegetation (Figure 13 and Figure 14). Fernbird were heard in this wetland.

Figure 15 shows a spit at **Te Pahi Point** which is a repeat view of Figure 7 in the 2005 report. There is raupo in behind with sea rush, coastal shrub daisy, cabbage tree and coastal forest. There was the occasional ribbonwood but coastal shrub daisy generally dominated the back-swamp shrubland. Fernbird and banded rail were heard here. Rushland extends along the coastline around **Te Heru Point** and up into the **Pakoka River** arm. Limestone edges became a prominent feature up the river arm with totara and karaka common in the coastal forest as well as kowhai and some akeake. Fernbird were heard at the top of the river. Oioi lines a wide mosaic of raupo and oioi and scattered areas of saltmarsh ribbonwood (Figure 16 and Figure 17) in the upper reaches. The river forks at the top into a number of watercourses with healthy native forest particularly along the TRB. *Coprosma propinqua* was common along the upper river banks together with raupo, flax and a tall *Carex* sp. Some of the farmland at the head of the river arm was not fenced back from the river edge along the TLB. Downstream of the upper wide rush/sedgeland there was generally only thin bands of sea rush and oioi along the lower TLB although a patch of short spartina was found (Figure 18). This short spartina was missed during an earlier visit when the tide was full.

A lone mangrove occurs just upstream of **Karetoto Island** before the coastline bends into a little bay (Figure 19). This bay has a sand spit extending across the majority of the open flats and provides shelter for titiko on the muddy flats behind. There was sea rush further into the bay, backed by *Cyprus ustulatus*, raupo, flax, cabbage trees, and scrubby kanuka regeneration along the farm edge. The chenier sand spit joins onto the TLB of the little bay and supports saltmarsh ribbonwood and coastal shrub daisy. There is more rushland in behind the chenier ridge. Some saltwater paspalum was mixed with three square along the outer edge of the rush band. A fernbird was heard here.

Further along the coastline opposite the two islands, the sea rush edge is noticeably eroded however neighbouring oioi is unaffected (Figure 20). Past the islands, the rush zone (oioi only) is actively eroding and there are old stumps seaward of the rush zone. Sea primrose was found in places with oioi and a few coast spear grasses on rocky outcrops.

Near **Mowhiti Point** there is an area of healthy, though patchy, seagrass (Figure 21) between a patch of *Hormosira* and the pacific oysters lining the main river banks at the point. Figure 22 shows a view looking west to the river mouth over eroded oioi edges and to limestone cliffs with regenerating coastal forest. The coastal edge was generally severely eroded with oioi, three square and some sea rush present.

Figure 23 shows the view from the sand spit towards the steep coastal edge with rushland grading into freshwater wetland below. This area used to have a lot of short spartina present but control work has reduced this population back to a few small patches (**Figure 25**). Spoonbills, South Island pied oystercatchers and couple of Caspian terns were seen on the spit and fernbird were heard in the saltmarsh ribbonwood behind and to the west of the spit. The old catamaran (from Figure 10 of the 2005 survey report) had moved further west behind the spit. To the east of the spit was a mosaic of chenier ridges with coast spear grass, glasswort, sea primrose, remuremu and native celery amongst the sea rush. There is also three square dying back with sea rush, oioi, marsh clubrush and raupo all mixed up due to freshwater influences and the effects of the chenier ridges.

Further along the coastline towards the **Kainamunamu Stream**, mats of arrow grass occur in front of the rushland and over extensive sprayed spartina sites that still have decaying root masses and a firm base.

Figure 25 shows the large mangrove beside a macrocarpa pictured in Figure 11 of the 2005 survey report and some juvenile plants amongst the rotting mat of spartina roots. There are more sprayed spartina mats and a couple of mangrove seedlings further up the **Papatapu Stream** in the background. A couple of the outer juvenile mangroves are struggling to stay upright. This may be due to their exposure to wave action now the spartina had been controlled. Another small clump of short spartina occurs further along the coastline mixed with oioi between hard sandstone outcrops. Bands of rush/sedgeland occur along the coastline to the mouth of the Makomako Stream embayment.

Figure 27 shows a view up the tidal reaches of the **Makomako Stream.** The rushland at the mouth of the stream is a mosaic of sea rush, oioi and marsh clubrush. The full extent of the oioi mixed with marsh clubrush was not mapped in 2005. Saltmarsh ribbonwood is replaced along the TRB bank edges by *Corposma propinqua* backed by raupo/marsh clubrush wetland and a kahikatea/cabbage tree wetland in behind. Fernbird were heard here. The higher ground supported totara, tikoki, kowhai and kanuka forest. Upstream of the large totara on the bend of the TLB is a grazed freshwater rushland with Mercer grass. Downstream of the totara but upstream of the main estuarine wetland edge was some sea rush with either Mercer grass or saltwater paspalum.

Further south along the coast at the mouth to the **Kaingata Stream** embayment there is a rock stack, and behind this is an eroded coastal edge of sea meadow, sea rush and oioi (Figure 28). The farmed edge is not fenced and the sea meadow and rushland is pugged. There is extensive stock pugging and damage to rushland further into the embayment as well as dung along the foreshore and tracks over the mud flats. Saltwater paspalum is associated with the stock pugging. The embayment is quite silty. A small patch of spartina occurs up the top of the embayment that has been recently sprayed but a few plants have survived. There is also quite an extensive sea rush band with some scattered oioi patches, and a background fringe of giant umbrella sedge and raupo swamp. There are very few saltmarsh ribbonwood here and only a few *Coprosmas propinqua* had survived the grazing pressure along the coastal edge. A tall kanuka canopy is common around the embayment adjoining the rush/sedgeland however it is heavily grazed underneath (Figure 29). Some more short spartina occurs amongst and in front of sea rush along the outer TLB of the bay. These patches were also recently sprayed but some plants have survived. More sprayed spartina occurs either side of a tall fence extending into the CMA also with some live spartina plants. A rushland continues to line the coastline out of the embayment and around to the more exposed harbour edge.

The only notable estuarine vegetation along the next stretch of coastline occurs in the shelter of the **Te Kopua Stream** embayment which has a healthy rush/sedgeland. The outer coastline has impressive limestone bluffs and rock stacks backed by young regenerating coastal forest. Two groups of goats (2-3 in each group) were seen here. There were scattered small patches of saltwater paspalum.

Around into the **Waitaika/Omaia Stream arm** there is a little shack in the Paikakariki Stream embayment surrounded by flax, saltmarsh ribbonwood, sea rush and oioi (Figure 30). At the back of this embayment are two mangroves and a band of rushland surrounded by healthy regenerating forest (akeake, kowhai, kanuka, rewarewa, pohutukawa, tree daisy and karaka). Further up the main arm at the mouth of the Waitaika Stream there are four mature mangroves along the sea rush and oioi edge. Figure 35 shows a view of these mangroves with

sea primrose submerged in the foreground seaward of the sea rush (a repeat of Figure 12 of 2005 survey report). Figure 36 shows the same mangroves from a different angle with native forest along the TRB and farmland with poor riparian management along the TLB. The lower TRB of the stream mouth is dominated by sea rush however there are a couple of patches of saltwater paspalum too. Not visible when first seen during high tide was the extensive pig rooting within the marsh clubrush along the stream bank (Figure 31). The pigs had also been rooting amongst the saltwater paspalum, increasing the chance of this weed spreading. The upper TRB of the stream is lined with undisturbed *Coprosma propinqua*, coastal shrub daisy and saltmarsh ribbonwood with rushland behind. Fernbird are present. This contrasts with the upper TLB where similar vegetation was severely pugged and grazed by cattle (Figure 32 and Figure 33). Figure 34 shows a view looking upstream. The pampas visible in the photograph is almost completely within the disturbed wetland. Moving around the TLB of the bay, Figure 37 shows an unfenced sea rush edge of the harbour.

Around the coastal edge of the main harbour the limestone edge is exposed and supports little estuarine vegetation. There is however a healthy pohutukawa riparian fringe with some broadleaf and tree daisy, kanuka and karaka where stock cannot graze them. Little populations of saltwater paspalum are scattered around the coastline often with some rush where shelter was provided. Figure 38 shows a repeat view of Figure 15 from the 2005 survey of unfenced coastal edge with a new road and culvert in the low saddle. The wide tidal range of saltwater paspalum is evident in Figure 39 where there is a little beach with no saltwater paspalum adjacent to another little beach dominated by saltwater paspalum. Further along the coast the head of the **Wairoa Stream** embayment is fenced within grazed land (Figure 40). There is a lot of saltwater paspalum infested sea rush and large band of saltmarsh ribbonwood half of which is grazed within a paddock.

Out along the main harbour edge again, the exposed sedimentary edge doesn't support estuarine vegetation until south of Puketoa pa at the entrance to **Matakowhai Bay** where there is a large wave-washed sea rush edge with remuremu, native celery, slender clubrush along the outer edge and tall fescue, sea rush, saltwater paspalum and some remuremu in a landward swale with pasture grasses dominating on slightly higher ground. Recent high tides had extended a long way inland. These flats appeared to be grazed as there was cow dung amongst the rushes. This wave-washed wetland edge was separated from the expansive rushland and saltmarsh ribbonwood community at the head of Matakowhai Bay by a steep eroding siltstone bluff (**Orotangi Cliff**). 4x4 vehicle tracks were noted out on the harbour here. The expansive wetland along the inner TRB of Matakowhai Bay has an eroded edge of sea rush and oioi lined with sea meadow (Figure 42). Saltmarsh ribbonwood is common within and behind the rushland. Stock are fenced from the majority of these estuarine communities. However where the fence cuts through estuarine vegetation communities, the saltmarsh ribbonwood has generally been grazed out of the rushland and much of the freshwater wetland in behind is unprotected. A few patches of saltwater paspalum occur along the coastal edge often with sea meadow communities. There is more saltmarsh ribbonwood at the head of the embayment as well as sea rush, oioi and some small areas of saltwater paspalum. Banded rail and fernbird were heard here. Excellent new fencing extends from the head of the bay around the TRB. Figure 43 shows an old fence line that cuts through sea rush and saltmarsh ribbonwood and a new fence line set well back from the estuarine edge with a decent riparian margin. The flats were not very muddy and where quite firm in places. A lot of juvenile and adult titiko were seen.

The seagrass bed extends in very close to the pohutukawa lined **Matakowhai Point** and then moves further out from the shoreline. Around point there is rushland in indented sheltered areas plus saltwater paspalum but otherwise the edges are often exposed eroded siltstone

platforms with a few large pohutukawa and macrocarpa along the riparian edge. The farmland is sporadically fenced along this coastline, with some estuarine edges fenced off but landward freshwater wetlands not, leaving them open to pugging and grazing. Cotoneaster was noted along the eroded headland towards the **Okapu** marae. Rushland fringes much of the bay with a spit in front of the marae covered with sea rush and coast spear grass. A large area of saltmarsh ribbonwood with flax and gorse lies in behind. Fernbird were heard here. At the end of the spit is a raised sandy area covered by scattered glasswort that is in pretty poor shape due to 4x4 tracking. Around the bay the road comes in close to harbour edge and there is another 4x4 access point with tracks over the mudflats. Beside the road where the rush isn't thick there is mixed sea meadow with slender clubrush, remuremu, glasswort, sea primrose and scattered sea rush. Figure 44 repeats the Figure 17 photo in the 2005 report and still shows vehicle tracks out in the harbour but no stock tracks. Around the small headland at the Aotea-Morrison Roads intersection is the impounded stream mouth of the **Waitetuna Stream** that does not flush naturally due to the road culvert being too small (see Figure 45 for a repeat of 2005 photo). A thin band of rush extends around the coast line westward from the impounded embayment, becoming thicker around the point towards the head of the next bay. Saltmarsh ribbonwood also backs the rushland within the bay. Upstream of the road the wetland edge is unfenced and the wetland grazed and pugged (Figure 46). Oioi and sea rush grade into raupo and willow. Partially fencing of the estuarine edge on the western seaward side of the road leaves some wetland protected and some grazed and pugged (Figure 47). Here sea rush also grades back into raupo and willow. Further out along the TLB of the bay the rushland becomes very wide in places (Figure 48). Figure 49 shows the three species that compromise the rush/sedgeland community in the harbour. There is poor fencing of the harbour edge around **Kakawa Point** headland. Often where freshwater seepages join the harbour edge the whole wetland is not fenced off leaving the back estuarine vegetation and freshwater wetland vegetation open to pugging and grazing by stock. Two mangroves were found along the outer edge of a sea rush band amongst the more seaward open band of three square. Some mangrove seedlings were present. Horses were noted grazing and tracking the steep banks with some remnant mahoe coastal forest and the large freshwater/estuarine wetland complex at the point (Figure 50).

Around into **Te Kowiwi Creek** bay the fences are regularly within the CMA (Figure 51). Shelly ridges are covered in saltwater paspalum, sea rush, three square and sea primrose. Around near a house there is mainly saltwater paspalum with scattered grazed three square and taller ungrazed three square outside the fence. Saltwater paspalum dominates a low drainage swales within a paddock. Tyres have been placed along the coastal edge in an attempt to control erosion of the edge. Further within the bay three square is a major feature with sea rush common along the landward edge. Figure 52 shows a mature mangrove stump that has been cut and dead seedlings amongst three square sedge. Two live juvenile plants are nearby. Fernbird were heard upstream and downstream of the road. Upstream of the road there is sea rush and saltwater paspalum as well as pure rushland and saltmarsh ribbonwood. Seaward of the road, marsh clubrush lines the stream edge, with a mixture of sea rush and three square either side of the creek edge. There are also little bits of sea meadow (mainly sea primrose, some glasswort and small native celery), some saltwater paspalum and a couple of saltmarsh ribbonwood. Figure 53 shows a view along the inner TLB with a raupo and flax wetland backing the estuarine rushland. The embayment has titiko on the relatively firm flats. Tyre tracks extend from the road along the upper tidal zone of the TLB around towards the boat launching point. Climbing asparagus was noted in the remnant coastal forest edge. Saltwater paspalum was scattered along the edge towards the boat ramp together with patches of sea rush and the odd seagrass patch. Figure 54 shows a sand spit with *Carex pumila* and knobby rush up on top and saltwater paspalum dominating the swale in behind. Saltwater paspalum mixes with oioi in behind the spit and also extends down into the slender

clubrush sea meadow in the background (with pampas behind). A bit further on is a pool surrounded with dense saltwater paspalum before the armoured housing edge is reached. Patches of seagrass line either side of the channel edge until near the mussel barge mooring at Tahuri Point (Figure 55). An extensive seagrass bed covers the flats that extend between Tahuri Point and Matakowhai Point. Two spoonbills were seen feeding here. Around past the two houses near the mussel farm there is oioi in swales in behind the spinifex dunes at the boat launching site.

Generally the seagrass is found on tidal flats from north of Korua Bay across to Tahuri Point up into the upper harbour covering the middle tidal flats to a point in line with Tauranga Stream and Tikitiki Point. The seagrass is generally short and thin-leaved and sparsely covering the flats except where the harbour floor topography provides greater shelter and the seagrass beds are often denser.

Figure 1a: Northern Aotea Harbour with geographical features and photopoints.

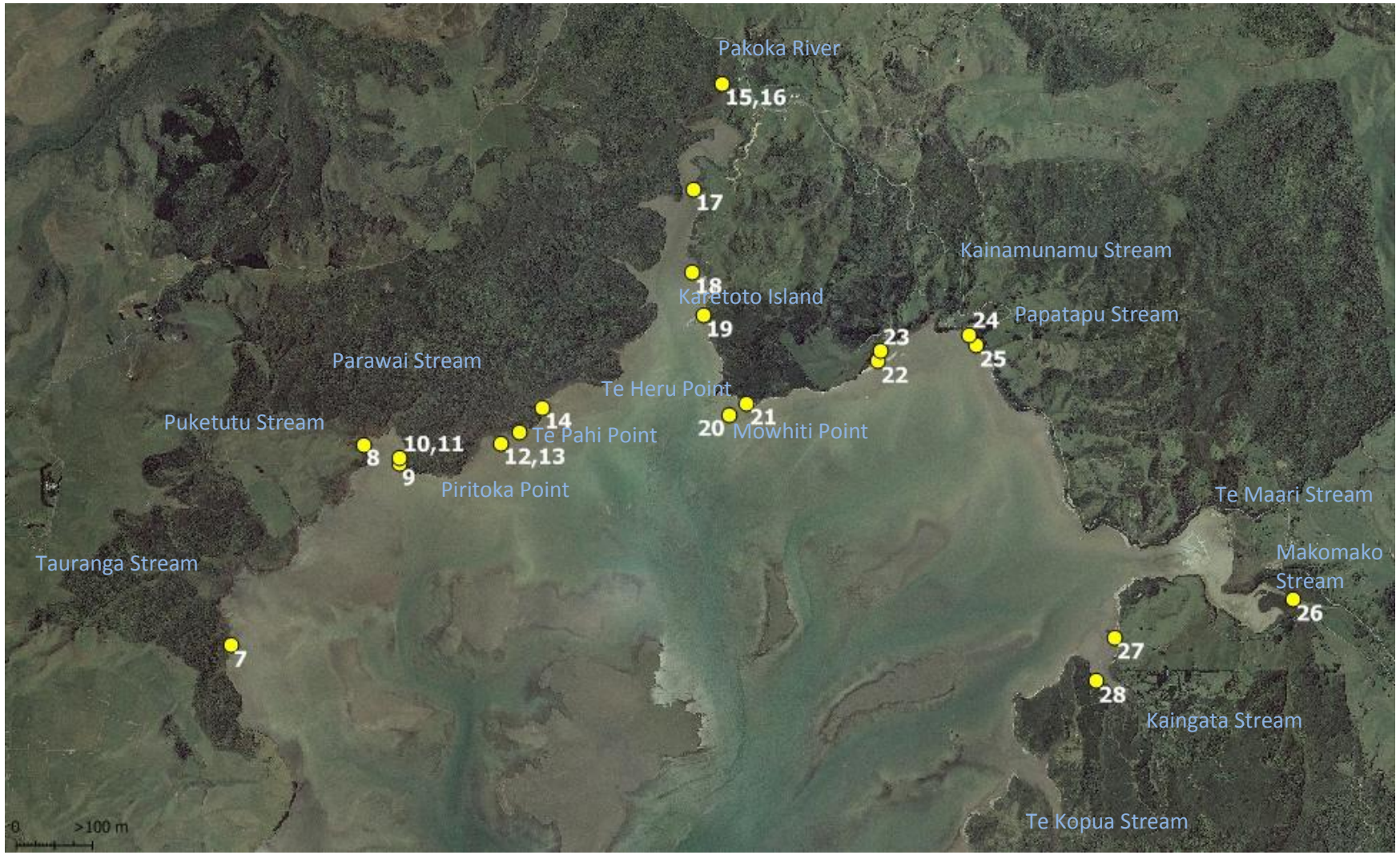

Figure 2b: Southern Aotea Harbour with geographical features and photopoints.

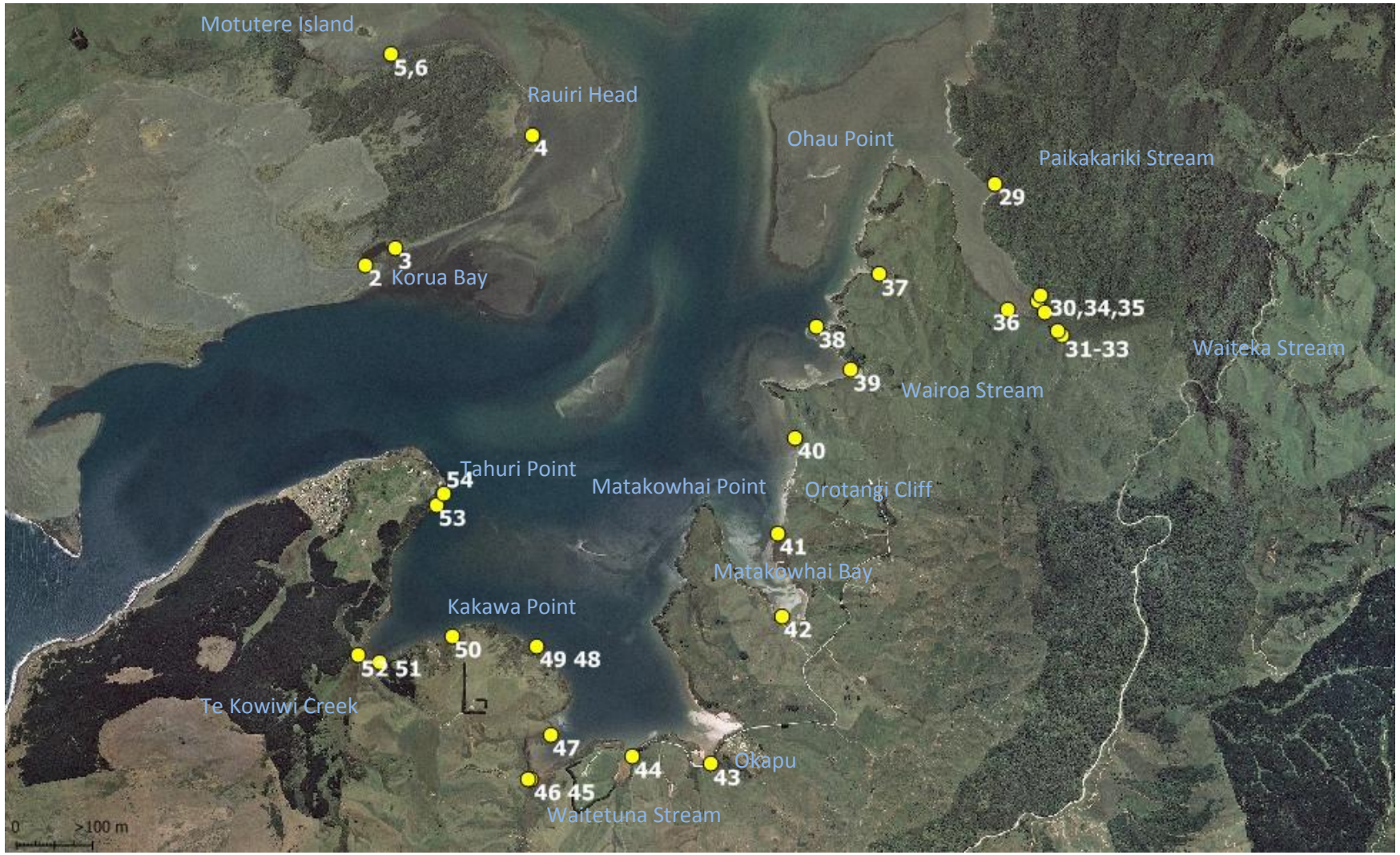

Figure 3: A view from the sand dunes over the Korua Bay dune lake. Most of the light brown vegetation is frosted saltwater paspalum except for the raupo in the middle background.

Figure 4: A view looking westward over the dune lake at Korua Bay with a swath of saltwater paspalum mixed with oioi and sea rush in the foreground.

Figure 5: Looking from Rauiri Head over the lower end of the mosaic of saltmarsh ribbonwood, flax, manuka and tauhinu around the higher edges, grading down into oioi and sea rush.

Figure 6: A similar view to Figure 4 in the 2005 report looking east over dune forest, cabbage tree wetland and a thin rush/ribbonwood edge with some gorse and pampas on higher ground.

Figure 7: Looking west to the dunes of the open coast with a cabbage tree wetland behind saltmarsh ribbonwood and sea rush along the harbour edge.

Figure 8: A sea rush and oioi edge backed by raupo, cabbage tree wetland and kanuka forest.

Figure 9: A sea rush fringe grading into raupo swamp with cabbage tree, manuka and flax and then into kanuka coastal forest and farmland.

Figure 10: Silt settled out in dimples on firm sand.

Figure 11: Pig rooting in oioi and three square.

Figure 12: Photo of uprooted sea rush and holes in sediment from pig rooting.

Figure 13: A sea rush and oioi fringe with a wide back-swamp zone of coastal shrub daisy, flax, *Coprosma propinqua*, raupo, manuka and cabbage tree wetland backed by coastal kanuka forest.

Figure 14: A closer up view of *Baumea juncea*, flax and coastal shrub daisy community behind the oioi and sea rush. Fernbird were heard here.

Figure 15: This photo is a repeat of Figure 7 from the 2005 survey. The oioi patch in the foreground appears to have expanded and the knobby clubrush and coast spear grass out on the spit has grown. A coastal shrub daisy with a small pampas is visible on the spit to the left. In the background there is raupo and sea rush backed by coastal shrub daisy, cabbage trees and coastal forest.

Figure 16: A view looking downstream at the upper limit of estuarine vegetation of the Pakoka River: oioi intermixed with raupo.

Figure 17: A view looking upstream at the upper limit of estuarine vegetation along the Pakoka River.

Figure 18: A low patch of spartina is visible above and to the right of the rocky outcrops. The taller golden rush in the background is oioi with kanuka behind. There are a couple of containers up on the skyline that are hard to see in this light.

Figure 19: A lone mangrove up the Pakoka River. This is the same mangrove as pictured in Figure 8 of the 2005 survey (taken from a slightly different angle). The kanuka previously sprayed in the left background is regenerating with gorse.

Figure 20: This photo shows an eroded sea rush edge between two healthy oioi edges.

Figure 21: Looking over a patch of healthy, but patchy, seagrass toward the mouth of the Pakoka River arm and oyster banks lining the main channel edge.

Figure 22: An eroded oioi edge at Mowhiti Point.

Figure 23: A repeat view of photo 10 from the 2005 survey. There are a few small patches of short spartina remaining amongst mostly sea rush and some oioi with marsh clubrush, saltmarsh ribbonwood and manuka in behind.

Figure 24: Short spartina mixed with three-square sedge.

Figure 25: A view of the large mangrove shown in Figure 11 of the 2005 survey report at the mouth of the Papatapu Stream (beside the macrocarpa). The nearby juvenile mangroves are within the zone of dead spartina root bases.

Figure 26: Some short spartina beside a clump of oioi. Also note the mangrove seedling in the oioi.

Figure 27: A view up the Makomako Stream with saltmarsh ribbonwood lining the true right streambank. A mosaic of oioi and raupo wetland lies behind and further back is a kahikatea wetland. The coprosma propinqua on the stream bank to the left has a mistletoe in it and a small mangrove beneath.

Figure 28: An eroded rush and sea meadow edge. Sea meadow species present include slender clubrush, remuremu, *Leptinella squalida* subsp. *squalida* and *Lilaeopsis novae-zelandiae*.

Figure 29: A sea rush fringe grades into a grazed kanuka land edge. Note the debris line at the base of the seaward kanuka from high tides. A few live spartina plants occur with the sea rush at the back of the photo.

Figure 30: The view from a limestone headland in Paikakariki Stream embayment across to a little shack surrounded by flax, saltmarsh ribbonwood, sea rush and oioi. Two mangroves are present at the head of the embayment and the regenerating coastal forest includes akeake, kowhai, kanuka, rewarewa, pohutukawa, tree daisy and karaka.

Figure 31: Fresh severe pig rooting of the marsh clubrush band at the mouth of the Waitaika Stream.

Figure 32: The upper TRB of the Waitaika Stream is lined with *Coprosma propinqua* and coastal shrub daisy with saltmarsh ribbonwood and freshwater wetland behind. This stream bank is severely pugged and grazed by cattle.

Figure 33: A cow in the wetland along the upper TRB of the Waitaika Stream.

Figure 34: Pampas in the disturbed areas of the wetland along the upper TRB of the Waitaika Stream.

Figure 35: A repeat photo of Figure 12 from the 2005 report of four mangroves along the seaward edge of the rushland at the mouth of the Waitaika Stream. Patches of sea primrose is submerged seaward of the sea rush in the foreground.

Figure 36: The same four mangroves at the mouth of the Waitaika Stream taken from a different angle showing the native forest along the TRB and saltmarsh ribbonwood lining the lower TLB of the stream, and pasture and poor riparian management featuring further upstream along the TLB.

Figure 37: Looking over the TLB of the Waitaika Stream bay out towards Ohau Point which is dominated by sea rush edges. There is no fencing of the estuary here. There are posts of an old fence line out along the seaward edge of sea rush in the distance.

Figure 38: A repeat photo of Figure 15 of the 2005 report with some oioi and kowhai, tree daisy and kanuka remnant along the coastal edge.

Figure 39: The beach on the left of the rocky outcrop has no saltwater paspalum while the beach on the right does have saltwater paspalum.

Figure 40: This repeat photo of Figure 14 from 2005 shows a steep eroding hill side and fence across the head of the estuary. There is a lot of saltwater paspalum, often mixed in with sea rush and a large band of saltmarsh ribbonwood half of which is grazed within the paddock.

Figure 41: An grazed and exposed edge with sea rush, remuremu, native celery, slender clubrush, *Einadia triandra* and tall fescue. Sea rush, scattered remuremu and saltwater paspalum are in swales landward. Recent high tides had extended inland towards the base of the hill.

Figure 42: An eroding edge of sea rush and sea meadow backed by saltmarsh ribbonwood in Matakowhai Bay.

Figure 43: A greatly improved new fence line that protects the harbour from stock intrusion and provides a riparian buffer (unlike the old fence visible in the middle of harbour). Note the saltwater paspalum and kikuyu along the harbour edge have been recently frosted.

Figure 44: A repeat view of Figure 17 in the 2005 report of Opaku Bay. Vehicle tracks are still present but there are no stock tracks.

Figure 45: A repeat photo of Figure 18 of the 2005 report showing the impounded tidal embayment at the Aotea/Morrison Road intersection.

Figure 46: Looking upstream from Morrison Road over an estuarine-freshwater wetland edge that is grazed and pugged. Oioi and sea rush grade up into raupo and willow.

Figure 47: A view looking north from Morrison Road over a partially-fenced harbour margin. The healthy sea rush is less likely to be invaded by exotic plant pests such as saltwater paspalum than the unprotected and disturbed rushland.

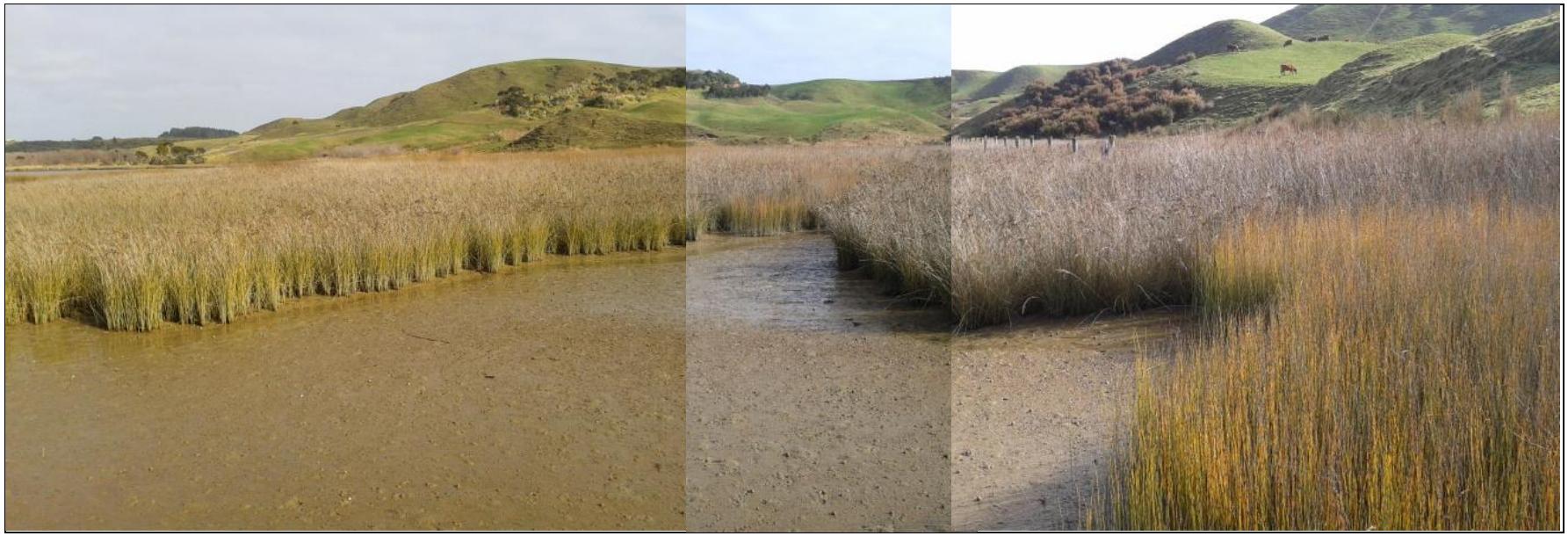

Figure 48: A repeat of Figure 19 in the 2005 report of the wide rushland in the western arm of Okapu Bay with the Aotea Road climbing the hill in the left background.

Figure 49: A tall dense oioi patch, a sparser patch of short three-square and then dense taller sea rush behind.

Figure 50: Poor fencing allowing horses out on the harbour flats. Tracks were noted through the rushland and into the remnant mahoe riparian vegetation on the steep coastal faces.

Figure 51: A fence line within the CMA with saltwater paspalum prevalent with three-square and sea rush.

Figure 52: A cut mature mangrove and dead seedlings within a patch of three-square sedge. The sedge dies back annually over winter.

Figure 53: Looking over a wide sea rush band in the Te Kowiwi Creek embayment with three-square along the seaward edges. The estuarine vegetation grades into a raupo and flax wetland behind.

Figure 54: *Carex pumila* and knobby rush along the top of a sand spit with saltwater paspalum behind intermingling with oioi and slender clubrush to the back left.

Figure 55: Seagrass extends up the harbour over much of the flats at the mouth of Okapu Bay (Okapu marae visible in middle background). The seagrass patches on the near side of the channel peter out just past the tyre at the low tide mark at the right of the photo.

3.3. Birds

Birds seen or heard during the estuarine vegetation survey:

Banded dotterel (~70)
Banded rail
Barnyard goose
Bar-tailed godwit (~60)
Black-backed gulls
Canadian goose
Fernbird
Gannet
Kingfisher
Mallard duck
Paradise duck
Pied shag
Pied stilt
South Island pied oystercatcher
Spoonbill (~40)
Spur-winged plover
Red-billed gull
Welcome swallow

3.4. Threats

Spartina

Spartina has been sprayed by the Department of Conservation however small patches still remain around the harbour. Follow-up control visits will be necessary to achieve eradication of spartina from Aotea Harbour

Saltwater paspalum

Saltwater paspalum is a threat to all native estuarine vegetation communities except seagrass. It has the ability to completely smother native estuarine vegetation reducing the floral diversity of the harbour.

The saltwater paspalum was frosted following a particularly cold spell of weather. This will reduce its growth rate but will not kill the grass.

Agricultural land use

Farmland with unfenced margins along streams, freshwater wetlands and the harbour margin do not provide a vegetation buffer that can absorb and filter land run-off, and hence results in elevated levels of sediment, nutrients and pathogens in the harbour. Also large remnant coastal forest trees such as pohutukawa that are not protected by fencing have no replacements with stock restricting forest regeneration.

The level of direct stock access to the harbour seems to have decreased slightly since the last field survey in 2005. Stock physically damage the harbour vegetation and water quality by pugging sediments and vegetation, grazing vegetation, spreading weed species such as spartina and saltwater paspalum, and defecating directly into the harbour.

There is a widespread need for fencing of all agricultural land next to the harbour, although stock access to the harbour was a particular problem at the following sites:

- Kaingata Stream embayment
- TLB of the Waiteika Stream mouth
- North of Orotangi Cliff
- Kakawa Point
- Various heads of estuarine/freshwater wetlands e.g. Te Kowiwi Creek and the embayment on the other side of Kakawa Point.

Feral animals

Feral goats and pigs are an issue around the harbour margins as they hinder natural regeneration of the riparian vegetation. Pig rooting can also cause elevated sedimentation and spread weeds. Very few goats or pig sign was noted during the survey however it would be wise to control them around the harbour.

4. Discussion and Recommendations

The results from this survey will allow for an analysis of changes in the spatial extent of the estuarine vegetation communities in Aotea Harbour since the 2005 survey. However, comparisons will need to keep in mind the difference in survey techniques over time.

Mapping of the extent of seagrass was compromised due to the 2007 aerial photograph having been taken at mid-tide. This meant that much of the seagrass was submerged and the seagrass boundaries were unclear. Mapping was undertaken as best as could be achieved. This problem was particularly an issue for the tidal flats between Tahuri and Matakowhai Point. This was overcome in this particular area by overlaying a Google 2009 aerial with the tide out and mapping the seagrass from this later aerial. While this is not ideal, it was assumed that the difference in seagrass between 2007 and 2009 would not be that great.

Another plant species that was sometimes difficult to map was three square. This was due to the patchy and sparse growth habit of this sedge making it difficult to see on the aerial photographs.

A limitation to the all estuarine vegetation surveys is the chance of missing low-lying vegetation when surveying at high tide. This is unavoidable due to the accessibility of some sites and time constraints.

Just prior to this survey, the invasive weed *Euphorbia paralias* was found on the dunes north of Aotea Harbour. While an eye was kept out for this none was seen during this survey.

It was encouraging to see signs of proactive fencing of the harbour margins. This effort needs to be supported for the rest of the harbour. It was also good to see that the fencing was undertaken in a manner that protected a useful riparian width rather than fencing hard to the estuarine edge. While the protected riparian margin was often dominated by thick kikuyu there is potential for this riparian strip to be revegetated in native coastal forest species to enhance the natural character of the coast.

There is opportunity for Waikato Regional Council to work more closely with the Aotea community to enhance protection of harbour values.

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Appendix A: Figure waypoints

Figure No.	Latitude	Longitude
2	-37.995772	174.822193
3	-37.994738	174.824410
4	-37.987980	174.834286
5, 6	-37.983438	174.823795
7	-37.967067	174.815568
8	-37.955165	174.825061
9	-37.956272	174.827724
10, 11	-37.955932	174.827784
12	-37.954924	174.835214
13	-37.954228	174.836587
14	-37.952804	174.838180
15, 16	-37.933681	174.851011
17	-37.939860	174.849006
18	-37.944755	174.849054
19	-37.947240	174.849948
20	-37.952997	174.852000
21	-37.952340	174.853285
22	-37.949716	174.862921
23	-37.949134	174.863040
24	-37.948063	174.869610
25	-37.948671	174.870164
26	-37.963137	174.893902
27	-37.965580	174.880746
28	-37.968144	174.879468
29	-37.990325	174.868604
30	-37.997765	174.872440
31, 33	-37.999113	174.873779
32	-37.998833	174.873361
34	-37.996737	174.872080
35	-37.997128	174.871870
36	-37.997622	174.869644
37	-37.995744	174.860097
38	-37.998871	174.855538
39	-38.001347	174.858192
40	-38.005381	174.854215
41	-38.011003	174.853001
42	-38.015849	174.853442
43	-38.024552	174.848438
44	-38.024221	174.842609
45	-38.025646	174.835196
46	-38.025631	174.834946
47	-38.023031	174.836523
48, 49	-38.017854	174.835427
50	-38.017396	174.829104
51	-38.018994	174.823804
52	-38.018598	174.822236
53	-38.009710	174.827766
54	-38.009095	174.828303