

Estuarine vegetation survey – Raglan (Whaingaroa) Harbour

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Estuarine Vegetation Survey – Raglan (Whaingaroa) Harbour

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Prepared for Waikato Regional Council



Estuarine Vegetation Survey – Raglan (Whaingaroa) Harbour, March 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 Environment Waikato 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 and Port Waikato have been re-surveyed to determine changes in vegetation communities over time.

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 Environment Waikato's Global Information System (GIS) database, and are used for State of the Environment investigations and assessing resource consent applications that may affect estuarine vegetation.

This report details the results from the second survey of estuarine vegetation in Raglan Harbour which was first surveyed in 2004. Comments are included about the estuarine vegetation present, the threats to native estuarine vegetation communities, and other field notes of interest. This report accompanies the aerial map and estuarine vegetation community overlays of the survey site.

2. Methodology

The field survey was undertaken over 15 days between the 7th December 2011 and the 12th March 2012. The survey was undertaken using a combination of boating and walking. The same methodology for mapping saltmarsh, mangrove, seagrass and weed communities was followed as that previously used to map Coromandel Peninsula estuaries (e.g. see Graeme, 2010b) with a personal digital assistant (PDA) loaded with 2007 aerial photographs (WRAPS) 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 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 or the weather made using the PDA difficult (e.g. sun exposure made it too difficult to see the PDA screen clearly in the field).

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

Field notes were made of estuarine wetland characteristics and their vulnerability to 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 kraussii* 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 harbours, although it is not generally mapped¹ 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 (*Austrostipa stipoides*) and glasswort (*Sarcocornia quinqueflora*) can also be present.

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

- 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 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.
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 harbour'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.

Mixed mapping categories are used to indicate the occurrence of 'mixed' vegetation communities. Saltwater paspalum in particular is spreading and mixing with rush/sedge, sea meadow and saltmarsh ribbonwood communities. Where vegetation was found under the canopy of mangroves (e.g. seagrass or saltwater paspalum under mangroves) this was mapped as a 'mixed' community.

Saltwater paspalum is known to co-exist with spinifex however mapping of saltwater paspalum stops once spinifex is present as it is then determined to be an 'open coastal' rather than 'estuarine' environment.

Table 1: Estuarine plant species found in Raglan Harbour

Common/Maori name	Scientific name	Estuarine Vegetation Community
arrow grass	<i>Triglochin striata</i>	sea meadow
coast spear grass	<i>Austrostipa stipoides</i>	sea meadow
glasswort	<i>Sarcocornia quinqueflora</i>	sea meadow
	<i>Leptinella dioica</i>	sea meadow
	<i>Lilaeopsis novae-zelandiae</i>	sea meadow
mangrove	<i>Avicennia marina</i> subsp. <i>australasica</i>	mangrove
oioi	<i>Apodasmia similis</i>	rush/sedge
remuremu	<i>Selliera radicans</i>	sea meadow
saltmarsh ribbonwood	<i>Plagianthus divaricatus</i>	saltmarsh ribbonwood
saltwater paspalum *	<i>Paspalum vaginatum</i>	weed
sand buttercup	<i>Ranunculus acaulis</i>	sea meadow
seagrass	<i>Zostera capricorni</i>	seagrass
sea primrose	<i>Samolus repens</i>	sea meadow
sea rush	<i>Juncus kraussii</i> subsp. <i>australiensis</i>	rush/sedge
slender clubrush	<i>Isolepis cernua</i>	sea meadow
spartina *	<i>Spartina anglica</i> / <i>S. alterniflora</i>	weed
three square	<i>Schoenoplectus pungens</i>	rush/sedge

* denotes an exotic species

3. Results

Site locations within the harbour are shown in Figure 1 as well as the position of the photos that are referred to in the site descriptions below.

3.1. Overview

- Estuarine vegetation was predominantly found at the head of sheltered arms.
- Generally the exposed and sedimentary nature of the coastal edge wasn't conducive to estuarine vegetation communities establishing.
- Seagrass beds are a major feature along the town foreshore up past Lorenzen Bay and around up past the one-lane road bridge into the Opotoru River arm.
- The Waingaro River arm supports extensive mangrove communities and a mixed estuarine/freshwater rushland at its head. Seagrass was also a feature up the Freshwater Landing side arm. Banded rail footprints were present amongst the mangroves.
- Ohautira River arm supports extensive rushland and saltmarsh ribbonwood communities.
- Waitetuna River arm supports extensive rushland, saltmarsh ribbonwood and remnant freshwater wetland communities. A feature of this arm was the presence of bittern and fernbird associated with the saltmarsh ribbonwood and freshwater wetland vegetation.
- Estuarine vegetation along the more exposed areas of the harbour was often in the form of thin bands of rushland and sea meadow communities.
- The exotic grass saltwater paspalum was commonly found intermingling with or dominating thin or disturbed areas of rushland and sea meadow communities.
- Thick undisturbed rushland seems to be able to withstand saltwater paspalum invasion.
- Spartina control within the harbour has been very successful with only a few scattered spartina plants found during this survey.
- Sign of saltmarsh receding was seen in various places around the harbour but also there was sign of active growth in other areas.
- Most of the harbour had been fenced off to restrict stock access with only a few areas seen where stock still had access to the harbour and there was associated pugging, dung and grazing.

4. Site descriptions

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

Bird Bay had saltwater paspalum along some of its upper tidal edge and a small patch of seagrass. A feature of the bay was the attractive limestone outcrops with remnant coastal forest patches. Of note was the common occurrence of puka, a highly palatable forest species that survives on the inaccessible limestone stacks.

Maratoka Point Bay was characterised by an unfenced coastal margin (Figure 3) with saltwater paspalum present along much of the open coastal edge and scattered sea rush, sea primrose and slender clubrush at the head of sheltered indents. The rushland showed evidence of stock pugging and dung. The eastern side of the bay was very muddy compared to the firmer western side of bay. The small hornshell and titiko shellfish were present on the tidal flats. Figure 4 shows more remnant coastal forest along the limestone edge.

Not a lot saltwater paspalum occurred along the outer TRB of **Ponganui Creek** arm. The vegetation was mainly narrow bands of rush and sea meadow communities with a few mangroves. Remnant coastal forest along the outer TRB was also a feature. There was vegetation and sediment that had been washed out and scattered over the inner harbour flats downstream of a road culvert along the upper TRB (Figure 5). Mangroves were an average of 2m tall in the upper creek. Saltmarsh ribbonwood and patches of sea meadow occurred at the head of the arm (Figure 6). Cottonwood (*Cassinia leptophylla*) and coastal daisy (*Olearia solandri*) also occurred amongst and above the saltmarsh ribbonwood (Figure 7).

Around into **Paihere Creek** there were discarded sections of old fencing lying in the harbour. Large healthy mangeao, kowhai, kawakawa, kanuka, cabbage tree, karamu and hangehange characterised the riparian vegetation. What appeared to be banded rail footprints were seen at the northern end of Paihere Creek. Old cow bones from a number of animals were found in the harbour. The 1-wire fencing was not well attached in places. Old batteries were found dumped in the harbour edge. The sediment at the head of the bay was quite firm. Saltmarsh ribbonwood was common in sheltered areas along the inner TLB (Figure 8). A small group of mangroves were growing in the lee of the limestone point at the entrance to the bay (Figure 9). Mexican daisy was mixed with native coastal shrubs on the limestone at **Tokatoka Point**.

Patikirua Bay was characterised by a band of rushland and patches of sea meadow intermingled with saltwater paspalum at the head of the bay (Figure 10). Also of note was the large fenced raupo wetland further inland. Figure 11 shows good fencing along the coastal edge out towards the mouth of the bay. Large exposed rocky platforms extend out into the shallow flats of the bay from the eastern headland and pacific oyster beds were found in the mouth of Patikirau Bay.

There was very little remnant coastal vegetation along the harbour edge from Tokatoka Point towards Motukokako Point and the exposed eroding cliffs didn't support any estuarine vegetation of note. The coastal edge was fenced but not planted so was generally dominated by rank exotic grasses and pampas.

About 11 wild goats were seen on the smaller point west of **Motukokako Point**. The end of Motukokako Point has remnant coastal forest cover but an eroding coastal edge with little estuarine vegetation.

Waiwhara Bay is relatively small and shallow and characterised mainly by a band of saltwater paspalum and rush/sedgeland (Figure 12).

North of Waiwhara Bay towards **Matanawe Point** there was some Mexican daisy along the coastal edge as well as remnant coastal forest. The coastline however supports little estuarine vegetation except for narrow populations of sea meadow along the upper tidal limit of the rocky platform.

Around into **Te Tarata Creek** bay there was a lot of saltwater paspalum intermingled with the rushland. Figure 13 shows an old fence line across a small bay and the currently fenced coastal margin that included scattered remnant kanuka. There was some wide rushland and mangroves (ranging from 0.5m – 3m tall, but generally about 1.5m tall) as well as saltwater paspalum in the homestead bay. Further up in the head of the creek there were more mature mangroves that were looking very healthy (Figure 14). The marginal vegetation included kanuka, cabbage tree, *Olearia paniculata*, kowhai and karaka. Sea primrose and some glasswort were commonly found along the high tide mark. Some saltmarsh ribbonwood was also present. The coastal edge was fenced except that a section of forest on the TLB had sheep grazing in it.

Around into **Mokoroa Creek**, the coastal edge was fenced but there were holes in the fence and gates missing. Stock obviously had access to the CMA here as indicated by the pugging and dung. Saltwater paspalum was common in the back of the sea rush and oiioi band. Further around into the bay, rush/sedgeland and saltmarsh ribbonwood became the dominant communities. Further out along the TLB was an area of mixed sea rush and young mangroves (Figure 15).

There were relatively wide rush bands around the western shoreline north of Mokoroa Creek into **Te Kotoku Creek** embayment. The upper TRB of Te Kotoku Creek had only a single wire fence and there was sign of some stock access to the CMA. Saltmarsh ribbonwood and oiioi dominate the upper tidal reaches of the stream. Riparian fencing was missing along the upper TLB (Figure 16 and Figure 17). The estuarine vegetation along the TLB was restricted to thin bands of rush/sedgeland, sea meadow and saltwater paspalum.

The **Tawatahi River** arm was fenced to restrict stock access to the harbour except for the upper TLB. There was plenty of sign of goats along the outer TLB (Figure 18) and around the headland into Waingaro River arm. Figure 19 shows a wide band of rushland grading into native forest. Goat tracks were noted crossing the open flats. There were a lot of mud crabs and titiko (both adult and juvenile) present. Another side embayment with a thick band of rushland (south of Figure 18) was backed by coastal daisy and saltmarsh ribbonwood before grading into native forest. A number of patches of young oiioi were noted.

At the mouth of the bay was a large band of saltmarsh ribbonwood in behind a narrow strip of rush and tall fescue and marsh clubrush (Figure 20). Sea meadow (remuremu, a little sea primrose and the sand buttercup *Ranunculus acaulis*) was also present along the shelly spit protecting more rushland.

The forest around the headland into the Waingaro River contained kowhai, kanuka, miro, tanekaha, hangehange etc.

At the mouth of the **Waingaro/Kerikeri Rivers** on the TRB is a bay protected by a large sand spit (Figure 21). The sea meadow and rushland on the spit (Figure 22) had been heavily pugged by cattle in places. There was also sign of goats. Only a single mature mangrove was

found in this bay (Figure 23). Saltwater *Paspalum* was only found mixed with thin rushland/sea meadow at the entrance (TLB) and scattered along the spit (TRB).

The next embayment upstream along the TRB was completely filled with mangroves. The next embayment upstream was deeper and had some rush and sea meadow lining the upper reaches with mangroves concentrated around the mouth of the embayment and scattered further towards the head. The coastal forest included karaka, titoki and kowhai.

A wide dense mangal extended upstream along the TRB (from opposite the junction with the Waingaro Landing arm) and across the mouth of the next small embayment before petering out. Mangrove heights generally ranged between 3-5m tall with an average height of 4m.

The upstream mature coastal forest was fenced from stock and included rimu, kahikatea, kanuka, tanekaha, kowhai, totara. There was however no fencing along the rush and sea meadow-lined TLB of the small embayment and pugging was noted at the head of the embayment.

The occasional scattered mangrove was found further upstream but oioi, and to lesser extent sea rush, was found all the way up past the forestry block. Marsh clubrush became more common, producing a mosaic of mixed areas of oioi/raupo/marsh clubrush that was mapped as 'rushland', pure oioi/sea rush patches, and marsh clubrush with only a fringe of oioi or sea rush. Where oioi was still a dominant part of the rushland it was mapped as 'rushland' but pure marsh clubrush wasn't mapped where it formed large enough patches that could be identified on the aerial. This differed from the mapping methodology in 2004 when all the marsh clubrush was included in the mapping due to the mapping detail and scale used. Figure 24 shows an embayment at the upper reaches of the Kerikeri River arm with a mosaic of oioi, some sea rush, marsh clubrush and raupo back by an example of good riparian management.

There seemed to be no fencing along the TLB of the Kerikeri River arm upstream of the Waingaro River arm. There were quite a few freshwater seepage areas that would greatly benefit from fencing as they were severely pugged in many places. Bracken and kanuka seedlings were also noted on the steepest riparian slopes and would quickly help the regeneration of the riparian margin if fencing was put in place (Figure 25). A lot of dung and tracking along the grazed riparian edge was noted. Generally the middle reach of the TLB was characterised by a band of mangroves with a thin band of rushland in behind.

There were extensive mangals either side of the Waingaro River arm and of particular note were the wide bands of seagrass below the mangrove line on the sloping mudflats. A few patches of seagrass were also found under mangroves along the inland mangrove boundary. In behind was sea rush and oioi and some marsh clubrush and also the odd sea primrose community. Banded rail footprints were found amongst the mangroves. Oioi extended out under the mangroves in places past the boat ramp. Three spoonbills were seen in the area.

The limestone outcrops at the mouth (TLB) of the Waingaro River arm had well established mangroves either side. Banded rail footprints were again seen amongst the mangroves. Mangroves extended down the TLB and around into the lower two embayments.

Goat and cattle access was common along the coastal margin downstream of the Waingaro River junction to the mouth of both rivers. Pugging, tracking and dung were common within the intertidal zone in this three-armed embayment. A number of rubbish dump sites were passed along the banks of the northern arm (Figure 26). Sea meadow was common under the edge of the extensive mangal and between the mangal and land edge at top of this northern

arm. Occasional patches of healthy seagrass occurred either scattered just under mangroves or just inland of the mangrove band. The sediment was much firmer to walk on under the mangrove canopy than on the flats between the mangal and the banks. Numerous access points for stock and goats from grassed or forested land were found (Figure 27). Saltwater paspalum was quite often present where stock access along the CMA was noted (Figure 27 and Figure 28).

There was limited estuarine vegetation around the exposed coastline from the mouth of the Waingaro and Kerikeri rivers to **Pairere Point**. Stock had access to the harbour all along this coastline and areas of pugging were noted at **Oruawhau Creek** and towards Ohautira Stream.

Ohautira Stream had some good coastal forest regeneration occurring along the TRB with mahoe the predominant regeneration species coming through the gorse. Rushland and saltmarsh ribbonwood communities were a feature of this stream arm. The TLB was not fenced.

Estuarine vegetation around the **Paritata Peninsula** was generally limited to sheltered sites. For example only small amounts of rushland (often mixed with saltwater paspalum) were found in the indents at Te Puna Point. The exposed edges with rock platforms extending into the harbour were characterised in places by narrow populations of sea rush and oioi intermingled with sea primrose. Further south-west there is a narrow bay that was dominated by rushland. Of note was the large area of die-back along the front of this rush band (Figure 29). Further to the south-west again was a mixed zone of saltwater paspalum and sea rush, and oioi and sea primrose. Saltmarsh ribbonwood was found in behind this mixed zone.

Bare eroding banks and rocky platform extending out into the intertidal zone characterised the western end of the peninsula. Small areas of seagrass were found in muddy guts within the platform and in along the lower beach.

The wide bay at the **mouth of the Narrows** had a patch of sea rush and oioi with lots of Indian doab grass behind as well as patches of saltwater paspalum. The saltwater paspalum had a lower tidal range than the Indian doab (which wasn't mapped). Some coast spear grass and *Lilaeopsis* were also found. The coastal edge around the Narrows supported rushland and sea meadow. Sea meadow species included sea primrose, saltwater paspalum, slender clubrush and coast spear grass. Titiko were common in muddy embayments. Regeneration of riparian vegetation was hindered by grazing by goats and by the odd incidence of kanuka spraying (Figure 30). Figure 31 shows two large mangroves in another little bay further to the east.

Pacific oysters were common along the tidal banks in the mid tide range from the Narrows to the Paratata Peninsula 'neck'. Further upstream of the 'neck', the oyster clumps were so thick across the lower flats and the channel that it made boat access impossible between low to mid tide.

West of the 'neck' there was a lot of Mexican daisy along the eroded cliffs. There was a small freshwater wetland in behind the coastal edge east of the 'neck' with flax, cabbage trees, kahikatea and *Carex* sedges. It was fronted by a thin eroded band of rushland with sea meadow and saltwater paspalum.

There was generally no estuarine vegetation east of the 'neck' except for in slight indents where thin bands of rushland, sea meadow or saltwater paspalum had managed to establish. Most of the coastal edge was eroding.

Goats were a common sight along the foreshore all around the peninsula. About 30 goats were seen along the intertidal area at the 'neck' of the peninsula.

Estuarine vegetation became a significant feature of the coastline around the mouth of the **Waitetuna River**. Extensive rushland was a predominant feature with relatively large areas of sea primrose associated with the outer edge of the rushland along the lower TRB. These sea primrose communities were submerged and not visible at high tide but were clearly visible on the aerial. Only a few areas of saltwater paspalum were found at the outer mouth (e.g. Figure 32).

The rushland was mainly sea rush but oioi became more predominant upstream. Patches of marsh clubrush which were not easy to differentiate on aerials were mapped in with the oioi. Marsh clubrush was not only present at the back of the rushland but also along the seaward edge. A bittern was disturbed up a small tributary on the TRB. Saltmarsh ribbonwood became dominant at the upper reaches of the saltwater influence. Otherwise the estuarine vegetation was limited to a thin band of oioi mixed with marsh clubrush along the banks, often backed by flax and swamp coprosma (Figure 33). Raupo and toetoe were also present. A patch of saltwater paspalum was found establishing amongst oioi and raupo (Figure 34).

At the top of the estuarine influence there was extensive saltmarsh ribbonwood mixed with oioi, raupo, marsh clubrush plus some lake clubrush. This community was mapped as saltmarsh ribbonwood as it was the dominant feature. This was the only place fernbird were heard. Banded rail were also heard. The estuarine vegetation graded into a significant freshwater wetland. The extent of the freshwater wetland is truncated by drainage and infilling for farmland and the development of whitebait ponds.

Further upstream the banks became dominated by willows, tall fescue and swamp coprosma. Another significant freshwater wetland remnant was present on the TLB. Here, raupo and little bit of lake clubrush with swamp coprosma dominated the river edge with toetoe and flax behind. This vegetation then merged into kahikatea swamp forest. Downstream the coastal forest edge was dominated by tree privet and hawthorn with some totara, kanuka and kowhai.

Rushland on the TLB at the mouth of the river was a mosaic with patches of saltmarsh ribbonwood and marsh clubrush (not mapped where large areas identifiable). Scattered small areas of three square occurred either side of the river mouth.

The rushland reduced to a thinner band away from the river mouth and into a small embayment with sea meadow and saltwater paspalum present. Scattered mangroves were also present.

Saltwater paspalum became dominant around the farmed **Kupapa Point** and towards the embayment east of Haroto Bay. Cow tracks were noted along the exposed coastal edge where presumably a cow or two have got through a fence and were looking for a way back up the low but cliffy edge into the farmland.

Saltwater paspalum was competing for dominance with rushland in the **embayment west of Kupapa Point** where there used to be a large spartina patch at the head of the bay. NIWA sediment monitoring poles were scattered around the flats. Along the upper TRB the seaward edge of the sea rush seemed to be eroding slightly. A band of very low turfing arrow grass was commonly found directly in front of rushland. Saltwater paspalum and marsh clubrush were common at the head of the embayment. There was generally good fencing and planting of the margins within the embayment with sometimes quite wide riparian protection established in

places. The only area which was not well fenced was at the head of the bay where the fencing crossed through the CMA leaving large areas of saltwater paspalum, some sea rush and freshwater wetland (mainly marsh clubrush) within the paddock.

In between the two indents along the TLB of the embayment about 12 plants of spartina were found in amongst sea rush. In behind and seaward of this sea rush was a relatively large area of three square.

The eroded outer foreshore of the bay supports saltwater paspalum and the occasional patches of sea rush.

Saltwater paspalum dominated around into **Haroto Bay**. Scattered patches of rush occurred in areas sheltered by outcrops. The edge had been planted along the TRB. Unfortunately the fencing was placed too close to the edge along the exposed high eroding banks and erosion had caused many plants had fallen in. Further upstream the plantings were wider and the banks lower and less prone to erosion. The plantings were well established here (cabbage trees and kanuka up to 3m tall) and looking healthy.

The TLB of Haroto Bay was predominantly rushland and didn't have much saltwater paspalum present. Short statured arrow grass was found with remuremu. Riparian protection along the TLB varied with some areas having little setback between the harbour and farmland and others with wider margins fenced off, however all the coastal margin was fenced.

The next **embayment east of 'The Finger'** had really good riparian fencing along the TRB protecting a fringe of mature coastal forest, rushland (mainly oioi and some sea rush) and patches of sea meadow. Not a lot of saltwater paspalum was present. A cow skeleton was found in the mud. The flats were very muddy out from the rush zone with lots of adult and juvenile titiko and crabs. A very large patch of sea primrose was found on the tidal flats at the head of the bay. Out towards the forested end of 'The Finger' stock had access to the harbour and pugging of the upper intertidal zone was common. Saltwater paspalum was also found associated with pugging. An area of sea rush, oioi, saltwater paspalum and slender clubrush was pugged to such an extent that the oioi had died. The forested totara riparian edge didn't have much native regeneration due to stock browse. Towards the end of 'The Finger' was a band of saltmarsh ribbonwood on a sandy ridge. Rushland and sea meadow (coast spear grass, sea primrose, glasswort and remuremu) were found along the seaward edge with a patch of saltwater paspalum half way along (Figure 35).

The **western side of 'The Finger'** supported thin bands of rushland, sea meadow and saltwater paspalum. Stock had access to the intertidal zone as well as the coastal totara forest. The embayment at the base of 'The Finger' was characterised by large scattered mangroves, some of which were about 3m tall.

Figure 36 shows a repeat view of photo 13 from Graeme (2004). This embayment was now fenced to keep stock out of the harbour. The next two embayments to the west had quite a lot of saltwater paspalum. The last embayment at the 'narrows' was very silty around the limestone block edge making for difficult walking. A number of mangroves had established here in the shelter of the limestone blocks. There was no fencing along the limestone section presumably as stock would find it difficult to access the harbour. However this meant there was no protected riparian vegetation zone and grazing occurred right to the coastal edge. Fencing started further up the harbour edge with gorse and scattered mahoe within the protected vegetated zone. Mangroves were found out on the flats at head of embayment. Figure 37 shows an area of outwash associated with a stock access point to the harbour.

Around to the **south-west from Hawea Point** are exposed siltstone platforms with shell built up within indents (Figure 38). There were also large areas of pacific oyster beds. The harbour edge was fenced with good setbacks. Rank grass, gorse, *Olearia paniculata* and some regenerating akeake were found along the steep eroding cliffs. Further along little pockets of regenerating bush were present with rengarenga lily along the cliff. While the coastal edges were fenced, the fencing was often not stock proof. Figure 39 shows a riparian edge that had been extensively grazed and tracked by cattle, while Figure 40 shows tracking through rushland. Karamu and hangehange were regenerating well amongst the gorse. Himalayan fairy grass (*Miscanthus nepalensis*) was noted in one area.

Further around into **Okete Bay** was an area of limestone outcrops surrounded by silt. The estuarine and riparian vegetation in behind the limestone outcrops was heavily tracked and grazed where cattle had access (Figure 41). Saltwater paspalum mixed with rush towards the head of the bay. There was some saltmarsh ribbonwood present and raupo extending up a seepage area. Further around there was a forested edge with some kowhai but mainly tree privet. Here there was the occasional mangrove present along the outer edge of the rush band with marsh clubrush behind (Figure 42).

Further to the west in an indent was the decaying root masses of a spartina patch (Figure 43). Mud crab holes and titiko were noted on the firm but decomposing spartina root mat. Figure 44 shows a close up view of an eleagnus bush that was extending out into the intertidal zone and out-competing sea rush. Figure 45 shows a mangrove with an exposed root base that may be the result of bed level change following the spartina removal.

Mangroves were relatively common towards the south western arm of Okete Bay together with banded rail footprints were footprints. The south western arm was very silty with a waterfall at the head of the arm. There wasn't a lot of estuarine vegetation except for narrow bands of sea rush and sea meadow including sea primrose, remuremu, slender clubrush, sand buttercup and glasswort. The forest weed asparagus fern (*Asparagus scandens*) was common along the forested edge of the arm.

At the **mouth of Okete Bay** is a large shell spit with houses behind it. The inner shelter side of the spit supported a large diverse sea meadow community composed mainly of glasswort on the seaward side, some coast spear grass, remuremu further landward and large expanses of sea primrose backed by a band of sea rush along the land edge (Figure 46 and Figure 47). Unfortunately, although the spartina had been eliminated, saltwater paspalum was rapidly invading this low-lying vegetation community.

Along the exposed harbour edge of the spit there was ineffective erosion protection – rocks, tyres etc which the sea was eroding in behind. Where there was no saltwater paspalum, sea rush was present with a seaward edge of sea meadow.

A portion of the exposed coastal edge between Okete Bay and **Three Streams** had fencing out in the intertidal zone leaving large tracks of intertidal areas within the paddock. This grazed area was dominated by saltwater paspalum with the occasional patch of sea rush. Along the immediate coastal edge there was saltwater paspalum (Figure 48) and closer to the 'hooked' sand chenier a line of sea rush with sea meadow (mainly glasswort). Wading birds were roosting on the chenier.

Further west the open coastal edge became steep and there were scattered remnant kanuka amongst gorse and pampas. Young fleshy boneseed (*Chrysanthemoides monilifera*) seedlings were noted in places along the eroding faces. The eroding slip faces were providing ongoing

silt to the harbour as indicated by the milky water line. There was a lack of large trees to help stabilise the slopes.

A spit extends around into **Three Streams bay**, sheltering a rushland embayment. Cow dung and saltwater paspalum were common amongst the coast spear grass, glasswort and sea rush on the spit. There were also patches of saltmarsh ribbonwood. Behind the spit the sea rush was eroding in a number of places along its seaward edge particularly in the upper eastern corner (Figure 49). Saltmarsh ribbonwood was common around the landward edge of the rushland with kanuka forest remnants behind. There was also a raupo/cabbage tree wetland in the north-eastern corner behind the rushland. There were about 30 mangroves of which some showed signs of browse and some others were dead. The sea rush appeared to be actively growing where it was sheltered by mangroves. The sediment in the embayment was relatively firm and titiko and their egg cases were common. There were also lots of large turret shells in the sediment at the mouth of the embayment.

Saltwater paspalum was common along the edges further into Three Streams Bay together with thin bands of rushland and sea meadow. Sea celery was noted in a number of places along clay banks. The bay terminated with a dense patch of saltwater paspalum but thicker patches of saltmarsh ribbonwood, sea rush and bands of sea meadow were also present. Saltwater paspalum was also common lining the outer half of the TLB. The riparian forest was dominated by tree privet. A thick band of pacific oysters extended across the bay upstream of the spit and embayment opposite (Figure 50). Around from the mouth of Three Streams Bay there are large patches of rubble out on the flats which appear to have been incorrectly recorded as seagrass last time. On inspection this time only a couple of smaller patches of seagrass within the rubble area were found (Figure 51). This was the eastern most extent of the seagrass band that extends intermittently from the town along past the residential area. The rubble supported turfing coralline algae and green lipped mussels.

The coastal edge around to **Tokatara Rocks** did not support significant amounts of estuarine vegetation and armouring of the coastal edge became dominant just east of Tokatara Rocks and into **Lorenzen Bay**. Extensive siltstone platforms are present within Lorenzen Bay (Figure 52). Scattered seagrass beds extended around the outer bay and came closer in to shore opposite Bay View Rd, but don't extend up towards the wharf (Figure 53). Seagrass beds then followed the coastline west of the wharf and across the entrance to Cox Bay.

Armouring was common in **Cox Bay** too (Figure 54). The wetland upstream of the causeway was mainly sea rush with some oioi and little saltmarsh ribbonwood (Figure 55). There was a mixture of raupo, tall fescue and marsh clubrush where freshwater inputs dominated. Riparian plantings had been established around the western edge.

Extensive sea grass beds continued around the coastline and up the lower TRB of the Oporuru River arm around the centre of town (Figure 56, Figure 57, Figure 58) and up towards the one-way bridge. There is an artificial edge to the harbour beside the road with thin bits of oioi, three square, some sea rush and scattered mangroves present. Seagrass was found scattered along the lower tidal zone amongst boulders and either side of the main channel and a short secondary channel immediately downstream of the bridge.

Thick seagrass beds were found on the flats upstream of the one-land bridge against the TRB (Figure 59) and over the wider intertidal flats on the TLB of the main channel.

Coast spear grass, glasswort and some native celery and lobelia were found around the **school headland**. A lot of kingfisher nests were noted in the eroding coastal banks.

Thin bands of rushland characterised the coastal edge along the TRB of **Kaitoke Creek** bay. There was a forested edge with a public walkway along much of this northern side. Weeds noted were a little bit of ginger and Japanese honeysuckle, pampas, asparagus fern, cotoneaster, tree privet and a large boneseed bush (Figure 60). At the head of the bay was a significant area of rushland and extensive saltmarsh ribbonwood which grades into some remnant freshwater wetland. A few mangroves were found along the outer edge of the rushland. Saltmarsh ribbonwood extended out along the TLB of the bay and included some patches of sea meadow. The sediment was relatively firm on this side of bay (more exposed) and there were lots of crabs and titiko. The estuarine vegetation was reduced to thin bands of rushland and sea meadow along the outer half of the bay. Another large patch of eleagnus (3-4m high) was found extending 7-8 m out into the harbour completely eliminating the potential for any native coastal edge vegetation. Opposite the school point there were scattered dead trunks sticking up out of the mud with eroding bank in behind them (suggesting that the coastal edge had eroded more than 10m inland?).

Along the TRB of the main **Oporu River** arm there was a large patch of rushland backed by dense saltmarsh ribbonwood which narrows down to thinner bands of rushland (Figure 61) and sea meadow before reaching a narrow point of the river arm. Sea meadow was common in a thin strip further up along the coast (Figure 62) until a small embayment was reached which supported a mixture of rushland and saltwater paspalum. Out near the head of the bay was a wide rush band with saltwater paspalum common along the landward edge. The next embayment was also characterised by rushland mixed with saltwater paspalum and areas of sea meadow. The last embayment along the TRB had larger intact areas of rushland with mangroves common along the seaward edge. Only two small areas of saltwater paspalum were noted here.

Up at the head of the river arm, a bittern was disturbed in saltmarsh and flew off into raupo. There were a couple of large mangroves present. Sea rush and oioi lined the river banks with bits of saltmarsh ribbonwood and tall fescue also on the islands at river mouth. *Coprosma propinqua* became common along the TRB with coastal daisy, manuka and cabbage trees behind (Figure 63). The saltwater influence stopped before a small rapid in the Oporu River. Oioi and some remuremu and celery were the last estuarine species noted. Moving away from the river mouth, a wide oioi band extended out around the TLB with some sea rush and the occasional mangrove present (Figure 64). A large *Coprosma propinqua*/manuka wetland and coastal forest remnant adjoins the rushland. Figure 65 shows a closer view of the coastal forest remnant with a fringe of sea rush and oioi.

Further along the TLB the coastal edge was characterised by a group of mangroves (Figure 66) and then thin bands of rushland, saltwater paspalum and sea meadow (Figure 67). The upper harbour was very muddy and there were quite a few large beds of pacific oyster in and beside the channel. Titiko and crabs were common.

The upstream limit of seagrass in the main arm was restricted to thin bands along the coast line downstream of where the arm narrows.

The coastal edge was very weedy along the small peninsula at the end of the tidal causeway. Boneseed, asparagus fern, tree privet, cotoneaster, wattle and banana passionfruit were noted. The estuarine vegetation however was dominated by native sea meadow species – including coast spear grass, glasswort, sea celery and sea primrose (Figure 68).

Upstream of the tidal causeway in the **Omahina Creek** arm the tidal edge was characterised by thin bands of rushland and sea meadow and then wide dense bands of rushland around the

head of the arm (Figure 69). A kotuku was seen here. The coastal edges were all fenced off as are the seepage areas. There were remnant kanuka, totara and other native shrubs along the riparian margin. Near the golf course the gorse had been sprayed within the fenced riparian area (Figure 70). A small amount of Japanese honeysuckle was noted in the coastal forest edge in a small embayment below the golf club rooms. Tree privet was also present in the forest edge.

Downstream of the tidal causeway, the estuarine vegetation along the TLB widened slightly and became more mixed with saltwater paspalum present again (Figure 71). Rushland still dominated (oioi, sea rush and three square) and the extensive seagrass beds covering the main tidal flats extended in to the coastal edge in places.

Rushland and the occasional mangrove were present between the one-lane bridge and the **Wainui Stream arm**. A few patches of seagrass were found immediately upstream of the bridge at the mouth of the Wainui Stream arm and in the indent along the TRB. Apart from a mixed patch of rushland and saltwater paspalum at the bridge, no saltwater paspalum was found within the Wainui Stream arm. Thin rushland was the only feature up along the TLB until a large mosaic of rushland and saltmarsh ribbonwood was reached near a pipe line crossing the stream (Figure 72). Immediately downstream of the rushland/saltmarsh ribbonwood mosaic area on the TRB was a restored estuarine/freshwater area that had previously been a treatment pond (Figure 73). Here there was a weak salt influence that didn't seem to extend much past the culvert to the river. Plantings included some oioi and sea rush as well as freshwater wetland/forest species. Bachelor's button and what appeared to be Mercer grass (*Paspalum distichum*), rather than saltwater paspalum, had self-established. Back in the main stream channel and upstream of the rushland and saltmarsh ribbonwood mosaic, the rushland peters out and extensive sea primrose beds were found on the river bend at the upper salt influence.

Moving downstream along the TLB, there were small scattered areas of saltmarsh ribbonwood, and rushland (three square and sea rush) and the odd mangrove. Bands of sea meadow (sea primrose, remuremu and slender clubrush) were common. Towards the bridge there were some larger areas of saltmarsh ribbonwood and the rushland became wider and more dominant. A couple of stoats were seen along the estuarine edge.

Downstream of the bridge there was a little bit of saltwater paspalum and sea rush near the bridge but otherwise the estuarine edge was characterised by a band of sea meadow including glasswort, remuremu, bucks horn plantain, sea primrose, and then a solid strip of coast spear grass out to the boat ramp (Figure 74). The occasional mown pohuehue plant was noted above the coast spear grass. The last estuarine vegetation mapped along the TLB were bands of seagrass patches that extended along the low tide mark upstream and downstream of the boat ramp.



Figure 1a: Map of western Raglan (Whaingaroa) Harbour with place names and photo points



Figure 2b: Map of eastern Raglan (Whaingaroa) Harbour with place names and photo points



Figure 3: View looking into the head of Maratoka Point Bay with saltwater paspalum lining the left foreshore and more diverse native estuarine vegetation visible in the middle background.



Figure 4: This view of remnant coastal forest along an exposed limestone coastline is similar to photo 2 in Graeme (2004). The limestone does not support any estuarine vegetation.



Figure 5: Raupo debris washed downstream onto the intertidal flats of Ponganui Creek.



Figure 6: The upper tidal reaches of the Ponganui Creek .



Figure 7: A flowering cottonwood surrounded by manuka, flax and coastal daisy behind and sea rush and saltmarsh ribbonwood in the foreground.



Figure 8: Sea rush fringing an indent along the TLB of Paihere Creek with a band of saltmarsh ribbonwood and some sea meadow and saltwater paspalum in behind.



Figure 9: A small group of mangroves (~2m tall) in the lee of limestone rock stacks at the entrance to Paihere Creek. A slip is visible in the left foreground of the photo with an eroded edge of sea rush behind. Coast spear grass and glasswort occur amongst the rocks.



Figure 10: A view from a limestone block looking over sea rush and some oioi and three square, densely mixed with saltwater paspalum. Along the front is sea primrose, remuremu and sea celery. There is a fenced raupo wetland in the left background.



Figure 11: A view looking over a fenced coastal edge of Patikirau Bay towards the steep eroding headland dominated by pampas. In the foreground a saltwater paspalum sward includes three square, sea rush and native celery.



Figure 12: Saltwater paspalum dominates this band of estuarine vegetation at Waiwhara Bay. Other species present include sea rush and oioi, with a mangrove, saltmarsh ribbonwood and marsh clubbrush by the stream mouth.



Figure 13: View showing an old fenceline in the CMA and foreshore dominated by saltwater paspalum intermingled with rushland. The riparian margin has now been fenced off to include some of the remnant kanuka.



Figure 14: Mangroves here at the top of Te Tarata Creek bay are about 2m tall. Stock graze under the background riparian vegetation which is predominantly totara, tawa, karaka, cabbage tree and kowhai.



Figure 15: Looking out from Mokoroa Creek over sea rush with young mangroves established within the outer edge. Round Island is in the background.



Figure 16: Saltmarsh ribbonwood and oioi along the upper tidal reaches of the Te Kotoku Stream. The riparian edge is not fenced and stock have access to the waterway.



Figure 17: Stock have severely damaged the raupo at the back of the estuarine vegetation (sea rush, oioi, saltmarsh ribbonwood and saltwater paspalum). The riparian kanuka has been sprayed but not the willows invading the freshwater wetland.



Figure 18: A view showing an area of mixed sea rush, sea meadow and saltwater paspalum up the Tawatahi River arm that appears to be pugged by stock or goats. Tall fescue and coastal daisy are present on the higher foreground. The coastal edge is fenced in the background.



Figure 19: A wide rush band grading into native forest in the Tawatahi River arm. The rushland is predominantly sea rush except for a patch of oioi left of the fenceline.



Figure 20: A narrow band of sea rush and oioi line the outer Tawatahi River coastline here with tall fescue, marsh clubbrush and saltmarsh ribbonwood in behind.



Figure 21: A panorama view around the bay at the head of the Waingarua River.



Figure 22: Pugging and dung amongst sea meadow on the sand spit in the Waingaro River arm.



Figure 23: A single mature mangrove growing along a water course through a sea rush community.



Figure 24: A view of the upper most embayment of the Kerikeri River arm on the TRB showing wide riparian margins fenced off and planted. Estuarine vegetation in the foreground includes a mosaic of oioi, some sea rush, short marsh clubrush (*Bolboschoenus medianus?*) and raupo.



Figure 25: An unfenced margin along the TLB of the Kerikeri River arm with regenerating kanuka visible on toe of slope. A small area of saltwater paspalum is present in the pugged indent to the right of the photo.



Figure 26: Goat tracks and rubbish are found between the rushland and mangroves in this photo. The sea meadow in the foreground is predominantly arrow grass and sea primrose mixed with mangrove propagules. The sediment in this area smells putrid.



Figure 27: A stock access point to the harbour with associated pugging of tidal flats and browsing of mangroves. Saltwater paspalum is mixed with sea rush in the foreground. Larger mangroves are lining the creek edge with a smaller mangrove cohort landward.



Figure 28: An area of sea rush with cattle tracking through it. A fragment of saltwater paspalum has established within the circled area.



Figure 29: An area of sea rush die-back along the front of the rush band. A lot of goat prints were noted amongst the dead root masses.



Figure 30: The head of a small embayment with riparian kanuka sprayed on the left and not on the right. No stock fencing.



Figure 31: Two large mangroves (one behind the other) about 3m tall in a small embayment with sea rush some oioi and sea meadow (arrow grass, sea primrose, *Lilaeopsis novae-zelandiae* and *Leptinella dioica* in background.



Figure 32: Sea rush backed by saltmarsh ribbonwood and coastal forest, and sea primrose and some arrow grass in front and on the sand spit (right of photo). Note the saltwater paspalum starting to establish (light green patch middle left of the photo).



Figure 33: A view looking upstream along the TRB with a flax lined edge fringed with marsh clubrush and thin oioi frontage.



Figure 34: A patch of saltwater paspalum establishing amongst oioi and raupo along the TRB.



Figure 35: A view looking upstream along the eastern banks of Totara Point over a band of saltmarsh ribbonwood on a sandy ridge. Rushland and sea meadow (coast spear grass, sea primrose, glasswort and remuremu) are found along the seaward edge with a patch of saltwater paspalum establishing half way along (arrowed light green patch).



Figure 36: A repeat of photo 13 from the 2004 report. A similar thin band of sea rush with saltwater paspalum is present with gorse in the background. Mahoe is present along the TLB and help provide native seed to revegetate the gorse areas. Note the cow skeleton in the left of the photo.



Figure 37: A washout area (?) where stock have accessed the CMA (pugging and dung present) via a dip in the land where the fence line crosses at height allowing stock access underneath (arrowed).



Figure 38: There is little opportunity for estuarine vegetation to establish along this exposed coastline. A small patch of oioi can be seen in the middle left of the photo and saltwater paspalum is growing in the middle background.



Figure 39: This photo shows cattle damage to a regenerating coastal bank. Dung was common along the foreshore as was tracking up through the bank. Flaxes and bushes were heavily browsed. Saltwater paspalum is visible along the foreshore.



Figure 40: More dung and pugging at the back of a rush band. Saltwater paspalum is common along the back associated with the tracking.



Figure 41: An area of limestone outcrops within Okete Bay that has saltmarsh ribbonwood, rushland, sea meadow and saltwater paspalum heavily tracked and grazed by cattle. Muehlenbeckia grows on the higher ground.



Figure 42: Mangroves along the seaward edge of sea rush with young oioi growing in front of the mangroves. Marsh clubrush grows in behind the sea rush.



Figure 43: A repeat of photo 15 from the 2004 report with a white sediment monitoring pole visible. Still decaying spartina roots cover the flats with a mangrove, saltwater paspalum, sea rush, eleagnus and saltmarsh ribbonwood along the back foreshore and marsh clubrush to the middle right.



Figure 44: A close up view of the eleagnus growing out over sea rush and with a saltmarsh ribbonwood surviving in front.



Figure 45: A lone mangrove with an exposed base seaward of a decaying spartina root base.



Figure 46: A view similar to that of photo 16 in the 2004 report looking over a chenier ridge with sea meadow and large patches of saltwater paspalum.



Figure 47: Another view over the shell spit and sea meadow community. Saltwater paspalum has invaded along the shell spit and small patches are establishing in the sea primrose next to the sea rush.



Figure 48: Poor fencing within the CMA. Little plants of glasswort are present amongst the saltwater paspalum band. The hooked sand spit is visible in the background.



Figure 49: An area of dead sea rush roots and surviving small mangroves with eroded bases (arrowed). Healthy mangroves are present to the right of the photo.



Figure 50: A view looking upstream from the end of the forest peninsula over a pacific oyster bed to great examples of retired coastal edges on TRB. Note the new house on the headland with associated native plantings.



Figure 51: A photo of a seagrass patch on a rubble area. The inner rubble area visible supports blue tubeworms.



Figure 52: - Repeat of photo 21 from the 2004 report at Lorenzen Bay. Seagrass is just visible out past the pohutukawa on the left of the photo.



Figure 53: A view of seagrass on the flats from the top of the access stairs at Daisy Street with the tide mid way in.



Figure 54: An armoured corner of Cox Bay showing varying styles of armouring and the natural coastal edge of the far side of the bay. Seagrass beds are visible in the middle ground and on the distant flats.



Figure 55: An overview of the causeway wetland with freshwater species dominating around the open water inflow area visible in the middle left of the photo.



Figure 56: Another view over seagrass from reserve at the end of James Street.



Figure 57: View of seagrass from town boardwalk



Figure 58: The view over thick seagrass from the picnic table at the fishing jetty reclamation looking towards the foot bridge



Figure 59: Saltwater paspalum in the upstream corner of the one-way bridge and seagrass patches extending up the TRB of the Oporuru River arm below the school.



Figure 60: A large boneseed shrub along the coastal edge mixed with native species but also pampas, cotoneaster and tree privet. The exposed rocky upper intertidal zone doesn't support any estuarine vegetation.



Figure 61: A patch of oioi that has receded at its point. The end of an extensive band of rushland and saltmarsh ribbonwood is visible in the background.



Figure 62: Sea primrose with glasswort, slender clubrush, remuremu, coast spear grass and *Leptinella dioica* above. Saltwater paspalum is invading the sea primrose in background.



Figure 63: The upper estuarine influence is restricted to thin bands of oioi along the river banks with stands of *Coprosma propinqua* (darker bushes) and manuka behind.



Figure 64: A couple of mangroves have established in front of a wide oioi and sea rush community at the mouth of the Opotoru River (TRB). In the background is a *Coprosma propinqua*/manuka wetland coastal forest remnant.



Figure 65: Two mangroves are visible out in front of a small fringe of sea rush and oioi backed by some raupo, coastal daisy and manuka and then kanuka, rewarewa, mahoe, kowhai, matipo and lancewood.



Figure 66: A band of large mangroves about 3m high



Figure 67: This view looking upstream shows a mosaic estuarine vegetation margin with sea primrose and slender clubrush in the foreground, saltwater paspalum in the mid-ground and then sea rush in the background.



Figure 68: Coast spear grass and glasswort along the rocky intertidal platform near the causeway point with boneseed, wattle and pampas dominating the coastal forest edge.



Figure 69: Extensive riparian fencing and planting around head of bay.



Figure 70: A fenced coastal bank with a patch of rushland in the foreground.



Figure 71: Saltwater paspalum growing amongst three square sedge.



Figure 72: Extensive saltmarsh ribbonwood lines the TRB (left of photo with flax in behind. Oioi lines the lower TLB with estuarine vegetation becoming sparser along the banks upstream of the pipe line. Coastal daisy, karo, flax, pampas and gorse are the common riparian species.

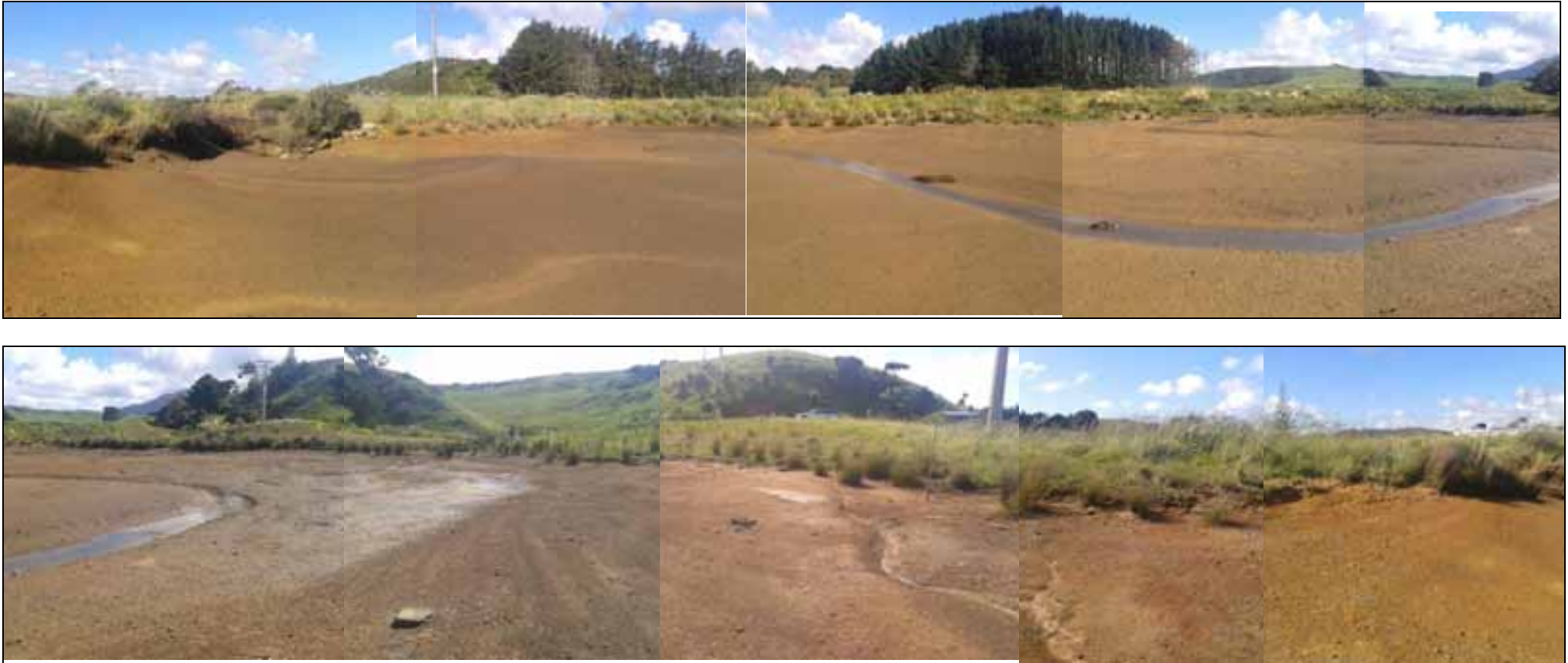


Figure 73: A recreated wetland area where there used to be treatment ponds. Plants around the edge of the open flats include oioi, sea rush, a few mangroves and saltmarsh ribbonwood, flax, and bachelors button.



Figure 74: Coast spear grass lines the coastal edge along the campground/airfield road.

4.1. Birds

Birds seen/heard during the estuarine vegetation survey:

Banded rail	Little black shag
Barnyard goose	Mallard duck
Australasian bittern	Paradise duck
Black-backed gulls	Pied oystercatcher
Canadian goose	Pied shag
Fernbird	Pied stilt
Bar-tailed godwit	Spur-winged plover
Kingfisher	Red-billed gull
Kotoku	Welcome swallow

4.2. Threats

Sedimentation of the harbour from the catchment is an ongoing issue. Measures such as fencing stream banks and seepage areas and stabilisation of erodable slopes with protective forest cover need to be implemented throughout the catchment. There has been some good progress with this since the previous survey in 2004.

Direct stock damage to the estuarine vegetation has significantly reduced since the last survey, however there are still areas where improved riparian protection measures are needed. Stock pugging, browsing and the transferral of saltwater paspalum are all threats to the health of estuarine vegetation and the other values of the harbour.

Goats are a wide ranging problem along the coastal edge. They are having a detrimental effect on the regeneration of the riparian coastal forest, however trampling and browsing of estuarine vegetation communities by goats was also noted in a number of areas. They will also be another possible vector for the further spread of saltwater paspalum.

The spread of saltwater paspalum is the most pressing threat to the ongoing health of estuarine vegetation communities within the harbour. The priority management focus should be to keep saltwater paspalum out of the biodiversity hotspots (e.g. Waingaro River, Ohautira River, Waitetuna River and Pokohui Creek arms, and plan how to limit the loss of sea meadow communities around the exposed coast line.

A number of weed species were noted during this survey within the coastal riparian margins. These are an increasing threaten to the ecological integrity of the coastal forest.

5. Discussion and Recommendations

The results from this GIS survey will be useful to highlight changes in the spatial extent of the estuarine vegetation communities since the 2004 survey, keeping in mind the difference in survey techniques.

Of particular note during this survey was the successful near-elimination of spartina within the harbour, the prevalence of saltwater paspalum, and the healthy condition of the seagrass beds.

The largest and most diverse areas of estuarine vegetation were associated with sheltered arms within the harbour – in particular up the Waingaro River, Ohautira River and Waitetuna River arms. The more exposed areas of the harbour were characterised by thin bands of rushland and sea meadow communities or were too exposed to support any estuarine vegetation.

ESTUARINE VEGETATION MAPPING

The 2007 aerial photographs provided were taken at mid to high tide which made it difficult to map the extent of seagrass. Seagrass beds in the lower harbour are difficult to map anyway as they are associated with coarse and varying sediment material which looks similar on the aerial. Seagrass mapping around Raglan township was refined in the office using low tide, higher resolution aerial photography that more clearly showed the location of seagrass beds.

As mentioned earlier in the report, marsh clubrush often formed a mosaic with oioi and sometimes raupo in the upper reaches of some of the larger stream arms (e.g. Waingaro). Where oioi was still a dominant part of the rushland the marsh clubrush was mapped as 'rushland' but pure stands were not mapped where it formed large enough patches that could be identified on the aerial. This differed from the mapping methodology in 2004 when all the marsh clubrush was included in the mapping due to the mapping detail and scale used at the time.

Mapping of the saltmarsh ribbonwood community was refined around the mouth of the Opotoru River. This more clearly distinguishes the boundary where *Coprosma propinqua* becomes dominant but had been included with the saltmarsh ribbonwood community in 2004.

Getting access around the whole harbour can be difficult and the best method is to use high tides to survey by boat the upper arms and then walk lower reaches when the tide recedes and where proximity of channels allows for pick up by boat. This however means that some areas are surveyed only during high tide and there is greater potential for submerged seagrass and sea meadow communities to be missed in the mapping.

ADDRESSING THREATS / POTENTIAL BIODIVERSITY PROJECTS

The continuation of the excellent riparian and wetland protection works throughout the catchment is a priority to help minimise sedimentation and direct stock access to the harbour and waterways. The further retirement of coastal edges from farming would greatly benefit the water quality and natural character of the harbour.

Natural revegetation of the coastal forest around the margins of the harbour is occurring where there is no stock browsing and there isn't a thick grass sward. Mahoe in particular was regenerating well through gorse within riparian margins. However the comprehensive and ongoing control of wild goats around the harbour is necessary as their browsing is limiting the successful re-establishment of riparian vegetation.

A number of sites were noted where household and/or farming rubbish had been dumped into the harbour. A lot of rusting rubbish was encountered while walking around the upper tidal zone. This indicates a surprising lack of regard for the harbour especially given the great coastal riparian protection that landowners have been undertaking.

The spread of saltwater paspalum is the most pressing threat to the ongoing health of estuarine vegetation communities within the harbour. A focus on keeping saltwater paspalum out of the biodiversity hotspots (such as the Waingaro River, Waitetuna River, Ohautira River, and Pokohui Creek) and a plan for how to deal with the widespread loss of sea meadow communities around the exposed coast line is needed.

The bay protected by a sand spit at the mouth of the Waingaro River on the true right bank supports a diverse estuarine vegetation community. Sea rush, sea meadow and one mature mangrove is backed by saltmarsh ribbonwood and coastal forest. Old coastal daisy scrub is a feature on the coastal flats behind the frontal shell bank. The health of these estuarine-coastal vegetation communities could be enhanced by controlling the dense band of gorse, scattered pampas and the tall fescue along the shell bank. Removal of stock and goats from the harbour and coastal forest would also be hugely beneficial. Very little saltwater paspalum was found here so it would be a good idea to control this weed too before it becomes widely established in the bay.

The Waitetuna River mouth has an under-represented estuarine/freshwater wetland vegetation sequence and supports bittern, fernbird and banded rail. Saltwater paspalum is beginning to establish and prompt action to control it is necessary while the infestations are small. Protection of the remaining freshwater wetland communities (swamp coprosma and kahikatea dominated) should be encouraged. There are also opportunities for restoration of associated degraded wetland areas. The Oporuru River arm is another area with a significant estuarine/freshwater wetland vegetation sequence remaining that would benefit from formal protection and restoration works.

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7. Appendix A – Photo waypoints

Figure No.	Latitude	Longitude
2	-37.791469	174.862273
3	-37.791199	174.865622
4	-37.775996	174.858816
5-6	-37.773545	174.858187
7	-37.779580	174.881075
8	-37.785417	174.877202
9	-37.782396	174.885134
10	-37.783515	174.886345
11	-37.774961	174.901335
12	-37.765916	174.908574
13	-37.764284	174.898874
14	-37.758910	174.911004
15	-37.743765	174.909813
16	-37.743442	174.909342
17	-37.739360	174.939450
18	-37.745134	174.938367
19	-37.748007	174.937560
20	-37.748797	174.947338
21	-37.748940	174.948307
22	-37.747967	174.946405
23	-37.725537	174.948981
24	-37.736664	174.955504
25	-37.744788	174.953853
26-27	-37.748914	174.956044
28	-37.749633	174.956167
29	-37.777297	174.919749
30	-37.793055	174.931311
31	-37.790929	174.932002
32	-37.795446	174.969698
33	-37.800972	174.973372
34	-37.802297	174.973426
35	-37.788896	174.938874
36	-37.800000	174.929856
37	-37.798536	174.923671
38	-37.796936	174.920276
39	-37.797722	174.920910
40	-37.799721	174.920493
41	-37.801849	174.920443
42	-37.806628	174.928628
43	-37.808644	174.919747
44	-37.808872	174.919980
45	-37.808527	174.919508
46	-37.804270	174.914767
47	-37.804268	174.914571
48	-37.802257	174.909887
49	-37.806572	174.901040

50	-37.809788	174.898404
51	-37.800522	174.894656
52	-37.800494	174.887636
53	-37.798436	174.883613
54	-37.795068	174.875890
55	-37.798878	174.874199
56	-37.796863	174.870423
57	-37.798593	174.867363
58	-37.799655	174.866884
59	-37.806974	174.864688
60	-37.808188	174.874410
61	-37.815810	174.872815
62	-37.819021	174.876938
63	-37.831769	174.870723
64	-37.830193	174.871023
65	-37.830265	174.870187
66	-37.821725	174.873732
67	-37.818385	174.871865
68	-37.812752	174.866270
69	-37.819869	174.862572
70	-37.821384	174.862726
71	-37.810458	174.863171
72	-37.810861	174.848437
73	-37.812038	174.848414
74	-37.804992	174.862651