

# Estuarine Vegetation Survey : Whangamata Harbour and Otahu Estuary

Prepared by:  
Meg Graeme (Natural Solutions - Marine and Terrestrial Ecologists Ltd.)  
RD 2  
COROMANDEL  
Ph: (07) 866 0770  
Email: [natural.solutions@wave.co.nz](mailto:natural.solutions@wave.co.nz)

Natural Solutions Contract Report 07/067

For:  
Environment Waikato  
PO Box 4010  
HAMILTON EAST

30 May 2007

ISSN: 1172-4005

Document #: 1193164

Peer reviewed by:  
Dr. Catherine Beard

Date June 2007

Approved for release by:  
Dr. Peter Singleton

Date June 2007

### **Disclaimer**

This technical report has been prepared for the use of Waikato Regional Council as a reference document and as such does not constitute Council's policy.

Council requests that if excerpts or inferences are drawn from this document for further use by individuals or organisations, due care should be taken to ensure that the appropriate context has been preserved, and is accurately reflected and referenced in any subsequent spoken or written communication.

While Waikato Regional Council has exercised all reasonable skill and care in controlling the contents of this report, Council accepts no liability in contract, tort or otherwise, for any loss, damage, injury or expense (whether direct, indirect or consequential) arising out of the provision of this information or its use by you or any other party.



# Table of Contents

<b>1</b>	<b>Introduction</b>	<b>1</b>
<b>2</b>	<b>Methodology</b>	<b>1</b>
2.1	Wetland vegetation classification	1
2.1.1	Saltmarsh	1
2.1.2	Mangrove	2
2.1.3	Seagrass	2
2.1.4	'Weed community'	2
<b>3</b>	<b>Field notes</b>	<b>2</b>
3.1	Summary	2
3.2	Site descriptions	4
<b>4</b>	<b>Discussion</b>	<b>56</b>
4.1	Whangamata Harbour	56
4.2	Otahu Estuary	56
4.3	Recommended action points / restoration projects	57
<b>5</b>	<b>References</b>	<b>59</b>
<b>6</b>	<b>Appendices</b>	<b>60</b>



# 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 and Whitianga estuaries were mapped in 1998 and 1999. Port Waikato, Raglan, Aotea, Kawhia estuaries and the inner Firth of Thames have recently been mapped between 2004 and 2006.

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

This report details the results from a survey of estuarine vegetation in the Whangamata Harbour and Otahu Estuary. These are the first estuaries to be re-surveyed using this methodology. Comments are included on the threats to estuarine vegetation, and other field notes of interest. This report is accompanied by digitised aerial maps of the survey site with vegetation community overlays.

## 2 Methodology

The field survey was undertaken over 6 days between the 2<sup>nd</sup> and 16<sup>th</sup> April 2007. 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 earlier surveyed estuaries (see Graeme, 1997, 1998a, 1998b, 1999) except that a personal digital assistant (PDA) loaded with 2006 aerial maps of the survey sites was used as the primary mapping device. The PDA replaced notations on hard copy aerial maps, although hard copy aerials were used as a backup for when the PDA battery ran out or lighting made it too difficult to see the PDA screen clearly in the field. Colour-coded lines were drawn directly onto the PDA aerials to define the spatial extent of wetland vegetation types as they were ground-truthed in the field.

The upper saltwater influence is usually indicated by the upstream limit of oioi, and this is generally the case for Whangamata and Otahu. Exceptions are sites at which oioi is not present or is uncommon. In such cases the upper estuarine limit is indicated by the extent of mangroves, spartina, saltwater paspalum or bachelor's button.

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

### 2.1 Wetland vegetation classification

For the purposes of this investigation, wetland vegetation species influenced by the tidal cycles are split into four groups: saltmarsh, mangrove, seagrass and weed communities.

#### 2.1.1 Saltmarsh

A broad-species community in which three sub-communities are distinguishable. They are:

- a) '**Rush/sedge community**' – this is generally sea rush (*Juncus kraussii* subsp. *australiensis*), oioi (*Apodasmia similis*), and 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 but is not mapped within this study as it is a brackish-freshwater species.

- b) **'Saltmarsh ribbonwood community (SMR)'** - this includes areas where rushes are interspersed with saltmarsh ribbonwood (*Plagianthus divaricatus*), 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.
- 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 includes sea primrose, remuremu, glasswort, and in more brackish areas bachelor's button (*Cotula coronopifolia*), leptinella (*Leptinella doica*), sharp spike-sedge (*Eleocharis acuta*), slender clubrush (*Isolepis cernua*), and arrow grass (*Triglochin striata*).

## 2.1.2 Mangrove

(*Avicennia marina* subsp. *australasica*) – this is usually a monospecific community although seagrass, spartina, saltwater paspalum and sea meadow beds can sometimes be found below mature mangrove stands

## 2.1.3 Seagrass

(*Zostera capricorni*) – this is usually a monospecific community

## 2.1.4 'Weed community'

In the Waikato Region the most significant estuarine weeds are saltwater paspalum (*Paspalum vaginatum*) and cord grass (*Spartina* spp.). Both of these weeds 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, particularly saltwater paspalum which vigorously competes with all vegetation types.

There are other weed species which can tolerate salty environments but for clarity of mapping have not been included in the surveys due to their presence above the spring high tide mark.

# 3 Field notes

## 3.1 Summary

The following observations give a general overview of estuarine vegetation in the Whangamata Harbour and Otahu Estuary.

### WHANGAMATA HARBOUR

- Extensive seagrass beds occur throughout the middle reaches of the harbour.
- Extensive mangals dominate the upper harbour embayments.
- Large oioi and sea rush beds are limited mainly to the Moananuanu arm and the embayment enclosed by the Papamaire Island causeway.
- Sizeable sea meadow communities are also mainly limited to the Moananuanu arm and the embayment enclosed by the Papamaire Island causeway.
- An unidentified grass is present in the sea rush/oioi band at the end of Allan Place. This will need to be identified when flowering in summer to establish whether it is an exotic species of concern.
- No spartina was found.

- Saltwater paspalum is scattered around the harbour. The largest infestation was found at the mouth of the Kaupeka Stream. The overall extent of saltwater paspalum seems to have increased dramatically since the 1995 survey.
- Sea meadow and rushland communities are the most threatened by the expansion of saltwater paspalum.
- There is often sign of cleared mangroves in front of residential land – notably the southern side of the Allan Drive peninsula, the tip of Durrant Drive, north-west and south of Tukere Drive and south of the Moanaanuanu arm causeway.
- The Moanaanuanu arm and the embayment enclosed by the Papamaire Island causeway had the highest diversity of estuarine vegetation communities. This is due to the riverine influence and lack of infilling or drainage that is often common at the upstream salt wedge zone.
- The predominant land uses around the harbour margin are pine forestry (with and without native riparian buffers) and residential housing.
- The upper and western side of the harbour has very narrow (or non-existent) forestry riparian set-backs compared to the riparian margins around the eastern side of the harbour.
- Grazed farmland abutting the harbour margin is only present on the two small peninsulas on the upper north-western side of the harbour. Stock damage to the harbour edge is limited to a few small areas.
- The debris build up and die-back of mangroves around a number of stream mouths was evidence of flash flooding.

#### OTAHU ESTUARY

- Seagrass is limited to the margins of the lower estuary and commonly associated with overhanging pohutukawa. Seagrass is also present at the head of the estuary where the river channel is still confined.
- Mangroves are restricted to the mid-estuary with recent expansion being limited to along the true right bank (TRB).
- Sea meadow communities are rare.
- Saltmarsh ribbonwood and rushland communities are common.
- Saltwater paspalum is prevalent and dominant throughout the estuary and expanding its extent.
- Saltwater paspalum appears to have almost completely out-competed the natural sea meadow communities. Small remnant sea meadow areas are intermixed with saltwater paspalum.
- Saltwater paspalum is restricting and reducing the extent of saltmarsh ribbonwood and rushland communities.
- The estuarine-freshwater-coastal forest vegetation sequence along the majority of the true right bank, and a 13ha strip extending 750m inland (occurring mainly in the 'Maori Whangamata' land title) on the TLB, is highly significant due to the vegetation communities' intactness, sequence continuity, diversity and habitat value for threatened wetland birds.
- The diverse mosaic of estuarine and freshwater wetland communities in the upper estuary supports a high fernbird population. Australasian bittern are also present, and banded rail and spotless crane (freshwater) are likely to be.
- Stock grazing within the CMA and further upstream along the river banks is occurring in places. However some landowners have undertaken good riparian protection with stock-proof fencing.
- There are many opportunities for riparian vegetation restoration along the upstream pastoral farm edges and the lower TLB margins.

Table 1 lists common plant species found during the surveys (See Appendix 6 for a full list of species mentioned in this report). The 'estuarine vegetation community' category for the estuarine species corresponds to the colour-coded vegetation boundaries of the aerial map.

Table 1: Check list of common estuarine and freshwater plant species of Whangamata Harbour and Otahu Estuary.

Common/Maori name	Scientific name	Estuarine Vegetation Community
arrow grass	<i>Triglochin striata</i>	sea meadow
blue-green sedge	<i>Baumea juncea</i>	
coastal shrub daisy	<i>Olearia solandri</i>	saltmarsh ribbonwood
glasswort	<i>Sarcocornia quinqueflora</i>	sea meadow
mangrove	<i>Avicennia marina</i> subsp. <i>australasica</i>	mangrove
manuka	<i>Leptospermum scoparium</i>	
mingimingi/swamp coprosma	<i>Coprosma propinqua</i>	
oioi	<i>Apodasmia similis</i> (= <i>Leptocarpus similis</i> )	rush/sedge
pampas	<i>Cortaderia selloana</i> , <i>C. jubata</i>	
raupo	<i>Typha orientalis</i>	
remuremu	<i>Selliera radicans</i>	sea meadow
saltmarsh ribbonwood	<i>Plagianthus divaricatus</i>	saltmarsh ribbonwood
saltwater paspalum	<i>Paspalum vaginatum</i>	weed
sea primrose	<i>Samolus repens</i>	sea meadow
sea rush	<i>Juncus kraussii</i> subsp. <i>australiensis</i>	rush/sedge
seagrass	<i>Zostera capricorni</i>	seagrass
coast spear grass	<i>Austrostipa stipoides</i> (= <i>Stipa stipoides</i> )	sea meadow
slender clubrush	<i>Isolepis cernua</i>	sea meadow
tall fescue	<i>Schedonorus phoenix</i>	

## 3.2 Site descriptions

### WHANGAMATA HARBOUR

Whangamata Harbour is described anticlockwise from the harbour mouth opposite the wharf. See Figures 1a and 1b for a map showing the site localities (in bold) and figure numbers mentioned below.

Small sand dunes within the outer embayments are characterised by open coast dune vegetation (Figure 2) until saltwater paspalum and small patches of oioi and ribbonwood are found near the **Waiariki Stream** mouth (Figure 5). The land rises steeply from the harbour to coastal forest dominated by a pohutukawa canopy and a coastal five finger understorey (Figure 3). The health of this forest is improving with the control of wilding pines and possums. This native forest riparian edge helps provide coastal edge stabilisation and good protection against the adverse effects of the pine forestry above (i.e. erosion filtration, loss of natural character). This native forest riparian edge narrows further up the harbour until it is non-existent at the head of the harbour (Figures 4, 15 -17).

Small patches of oioi occur further north along the coast, with individual mangroves (Figure 6). Further up the harbour, mangroves begin to form a band along more sheltered edges, and the saltwater paspalum patches become thicker. Coast spear grass occurs in small clumps on exposed rocky edges.

A large seagrass bed extends along the north-eastern side of the main harbour channel past the upstream extent of moored boats (Figure 7).

A dense patch of saltwater paspalum (knee high) has invaded the oioi band behind the mangroves at the mouth of the **Te Wharawhara Stream** (Figures 8, 9).

Some of the tallest mangroves (~5.5m) in the harbour were found near the point west of Te Wharawhara Stream (Figure 10). Other tall mangroves were found at the mouth of the **Waikoura Stream** which were mostly 2-4m tall (Figure 11). Seagrass occurs beneath the mangroves in the Waikoura Stream channel and infrequently in small patches between the mangal and rushland zone. Figure 12 shows the upper estuarine

extent of mangroves and oioi as the Waikoura Stream narrows. The rush/sedge zone varies from usually non-existent or narrow bands, to 20-30m wide bands. The infrequent wider areas of rushland occur at the head of embayments with wide mangals seaward. Commonly, the rush zone along more exposed edges is limited to the foot of the land margin (Figure 13).

The upper harbour is characterised by a land margin of pines that over-shadow and often fall into the harbour (Figures 14 - 17). Where riparian margins are not planted in pine they are usually too narrow or disrupted for native coastal forest to be able to dominate, and wattle (*Racosperma decurrens*) often dominates instead.

The mud flats under the wide mangals support titiko (a mud snail: *Amphibola crenata*), and in places also the small *Potamopyrgus* snail species (Figure 18). Mud at the head of these bays is usually 3-4cm deep (Figure 19). However in isolated areas associated with streams the mud can be as deep as 10cm (Figure 21). An area affected by recent silt deposits from upstream flooding occurs at a small stream mouth west of Waikoura Stream, where thick mud surrounds dead mangroves (Figure 20).

The **Papamaire Island embayment** cut off by the State Highway is characterised by a mosaic of rushland (oioi and sea rush), saltmarsh ribbonwood patches and both healthy and dead/sick mangroves interspersed with arrow grass (Figures 22-25). There are also small patches of glasswort and sea primrose and one patch of remuremu. The mud is deeply cracked and has a green algal mat where wet. The large cracks in the mud and thick algal mats seem to indicate a recent change in the hydrology of the site, probably due to a flood event and impoundment of water. The mangroves have a lot of flood debris in their branches.

A wide band of oioi and sea rush backed by a narrower band of saltmarsh ribbonwood dominates the embayment near the old Whangamata pub (Figure 26). Fernbird were heard in the ribbonwood here. Surrounding this embayment is a dense mangal that extends north of the 'horticultural' peninsula towards Papamaire Island. The peninsula (Allan Drive & Allan Place) was a horticultural farm and is now mainly developed as lifestyle blocks. A number of small patches of an unidentified grass occur at the end of Allan Place (Figures 27-28).

The clearance of mangroves has occurred in areas near housing. This is particularly obvious on the southern side of the **horticultural peninsula**. Figure 29 is a view along the esplanade reserve towards the tip of the peninsula showing an abrupt mangrove line where mangroves have been cleared in the mid-foreground. Figure 30 is looking south west along the esplanade reserve and shows the degraded natural character of the coastal margin in front of the adjacent housing. Further mangrove clearance has occurred in the embayment to the west (Figures 31-32). Similar natural character issues of the coastal margin occur here too as vegetation removal has severely modified the bank.

The largest infestation of saltwater paspalum found in the harbour is at the mouth of the **Kaupeka Stream**. The saltwater paspalum has established over an area of ~0.3ha that extends upstream to a raupo swamp, invading the oioi band and extending out under the mangrove canopy (Figures 33-35). Fernbird were heard around the embayment edge.

There are a few small areas around **Te Weiti Stream** and around the point towards Waikiekie Stream where farm stock have access to the harbour and rubbish has been dumped in the CMA (Figure 36). Immediately north of the Waikiekie Stream mouth is an area of rushland within paddocks that is being grazed and could potentially be degraded through drainage or infilling (Figure 37).

The estuarine channel of the **Waikiekie Stream** has been modified in an effort to minimise flooding impacts on the road upstream (Figure 38). Flood debris was evident

amongst the rushland and mangroves (many of which were dead) (Figures 39-40). A dense patch of saltmarsh ribbonwood has survived along the edge of the Everitt Crescent esplanade reserve (Figure 40), however further to the east the ribbonwood band is threatened by garden weeds and waste such as grass clippings, as well as being physically infilled by recent drainage spoil dumping (Figure 41). Fernbird are present in the ribbonwood but are known by local residents to be predated by neighbourhood cats.

At the tip of the Durrant Drive headland an area of mangroves has been cleared (Figure 42). Further around the tip beside the Waikiekie Stream channel another smaller area of mangroves has been cleared.

Mangroves have been removed from the southern half of **Patiki Bay** (with and without consent). Figure 43 shows an eroding coast line at the head of the bay with saltmarsh ribbonwood. This exposed edge used to be protected by mangroves. A thin band of seagrass extends around the southern side of the bay abutting the land edge.

The next narrow indented bay to the south has also had mangroves removed. A small patch of seagrass and a band of oioi and sea rush are present. Remuremu is common on the low-lying mown part of the walkway (Figure 44). A large seagrass patch extends from the point southward to the Wentworth River channel as it leaves the Moanaanuanu estuary. This seagrass also extends into the bay at the end of Awarua Place. Here a patch of saltwater paspalum has established on the sandy beach.

Old large pohutukawa trees lean from the harbour edge over the mudflats from **Moana Point** around to the causeway and up most of the Moanaanuanu estuary arm. These trees are remnants of the original coastal forest that would have characterised the steep coastal edges of the harbour.

The lower northern side of the **Moanaanuanu estuary** is characterised by mangroves abutting the pohutukawa edge. Just upstream of the causeway small islands of mangroves have been cut down. The mangroves thicken into the **Okauanga Stream** arm and grade into a small area of rushland before reaching a drain and becoming farmland (near the wastewater treatment plant).

Further upstream on the northern side the river channel swings in close to the steep coastal edge before swinging away to the other side. As the channel moves away from the land edge, the estuarine vegetation forms a diverse mosaic of sea meadow (mainly glasswort), mangroves, rushland, saltmarsh ribbonwood and coastal forest islands (Figures 45, 50). Fernbird were heard and banded rail footprints seen here. Saltwater paspalum is beginning to invade the glasswort mats on this bank (Figures 48, 49). Tree privet, pampas and wattle are particularly common on higher ground.

The estuarine vegetation zone thins as it reaches the **Tairua Road bridge**. Upstream of the bridge the uppermost estuarine community is a wide patch of ribbonwood that ends at the next bend (Figure 46).

The estuarine vegetation along the upper true right bank (TRB) of the Moanaanuanu estuary is restricted immediately upstream and some way downstream of the Tairua Road bridge due to the neighbouring land activity and stopbank (Figures 46-47). The mixed rushland and saltmarsh ribbonwood communities expand down towards where the housing property boundaries extend out into the CMA. The ribbonwood zone includes flax and coastal shrub daisy, and at the junction with the houses, mangroves begin to mix in. Seagrass occurs in behind a small mangrove island against the reserve edge (Figure 48). Saltwater paspalum is invading the glasswort and sea primrose around this island (Figure 49). As the river channel curves away to the TLB a wide rushland band forms against the landward edge, fronted by a wide mangrove band out to the channel. A large sea meadow community (mixed glasswort, sea primrose and coast spear grass) occurs on the inner bend as the channel straightens

downstream towards the SH25 causeway (Figure 50). Saltwater paspalum is also invading this community.

The rushland band diminishes towards the SH25 causeway while the mangrove band expands. Adjacent to the causeway a large area of mangroves (~ 3ha) has been cleared (Figure 51). Birds were noted feeding in the cleared area and fish were also observed feeding at high tide. A strong unnatural sulphur smell was present when the sediment was disturbed and a lot of rubbish was caught up amongst debris. A white mould was common on woody debris and sediments. More mangroves had been removed since the 2006 aerial photo used for this survey. Adjacent to the Firth cement works and next to a manuka remnant (Figure 53) there is a large amount of fill along the coastal edge (Figure 52).

A wide mangrove band flanks the downstream edge of the causeway and abuts a large seagrass patch. Inland of the seagrass and mangroves is an embayment of rushland (Figure 54). Both the rushland embayment and the open mangrove and seagrass beds will be lost to a marina development.

The only estuarine vegetation found further around along the open sandy coastline towards the harbour mouth is two patches of saltwater paspalum.

**Figure 1a:** Whangamata site localities mentioned in this report – upper harbour. The numbers refer to the location of the following figures.



**Figure 1b:** Whangamata site localities mentioned in this report – lower harbour. The numbers refer to the location of the following figures.





Figure 2: Knobby clubrush (*Ficinia nodosa*), spinifex, flax and buffalo grass often characterise dunes, such as this example found near the harbour mouth. Whangamata 2/4/07



Figure 3: The south-eastern side of Whangamata Harbour is characterised by a wide band of regenerating coastal forest along the steep harbour edge. Dead pines that have been controlled on the headland in the middle of the picture are just visible. Whangamata 2/4/07



Figure 4: A view from the middle of the harbour over seagrass. The coastal riparian edge narrows towards the head of the harbour. Whangamata 2/4/07



Figure 5: The closest estuarine vegetation to the open sea (harbour mouth) includes this saltwater paspalum, ribbonwood, oioi and tall fescue at Waiariki Stream. Whangamata 2/4/07



Figure 6: Mangroves with oioi and coastal daisy behind. Whangamata 2/4/07



Figure 7: Seagrass and individual mangroves along the eastern harbour edge. Whangamata 2/4/07



Figure 8: Saltwater paspalum invading an oioi band at the mouth of the Te Wharawhara Stream. Whangamata 2/4/07



Figure 9: The edge of the saltwater paspalum patch in Figure 8 above, showing it expanding and intermingling with surrounding oioi. Whangamata 2/4/07



Figure 10: A 5.5m high mangrove at Te Wharawhara Stream. Whangamata 2/4/07



Figure 11: Mangroves at the Waikoura Stream mouth. Whangamata 3/4/07



Figure 12: Oioi along the upper Waikoura Stream mouth. Seagrass is present in the stream bed. Whangamata 3/4/07



Figure 13: Sea rush, oioi and saltmarsh ribbonwood along a steeply rising harbour edge margin with mangroves seaward. Head of the harbour, Whangamata 3/4/07



Figure 14: A fallen pine at mouth of Waikoura Stream. Whangamata 3/4/07



Figure 15: Pine and wattle slash along the harbour edge. Whangamata 3/4/07



Figure 16: Pines severely restricting riparian vegetation along the harbour edge. Whangamata 3/4/07



Figure 17: Wattle and pine dominating the harbour edge. Whangamata 3/4/07



Figure 18: Coastal swamp forest has been eliminated by pines planted up to the saltmarsh ribbonwood zone. Whangamata 3/4/07



Figure 19: A close up of the mudflats in Figure 18 show titiko (mud snail) beneath the short mangroves. Footprints in the back-swamp mud usually sink 3-4cm deep in the soft rich orange silt. Whangamata 3/4/07



Figure 20: Dead mangroves amongst deep silt adjacent to a small river mouth (west of Waikoura Stream). Whangamata 3/4/07



Figure 21: Deep silt (~10cm) around dead mangroves adjacent to a small river mouth (west of Waikoura Stream). Whangamata 3/4/07



Figure 22: A young patch of oioi is backed by sea rush, with the State Highway and Papamaire Island in the background. Whangamata 3/4/07



Figure 23: A finger of healthy and dying mangroves line a channel which intersects rushland in the Papamaire Island embayment, as viewed from the State Highway. Whangamata 3/4/07



Figure 24: Flood debris amongst dead or sick mangroves, arrow grass and sea rush. Embayment west of Papamaire Island. Whangamata 3/4/07



Figure 25: Dead or dying mangroves in the embayment west of Papamaire Island. Whangamata 3/4/07



Figure 26: A wide oioi/sea rush band backed by a narrower band of saltmarsh ribbonwood dominates the embayment near the old Whangamata pub. Small scattered patches of sea primrose are also present between the rush and mangroves. Whangamata 4/4/07



Figure 27: An unidentified grass found at the end of Allan Place. Whangamata 15/4/07



Figure 28: A close up of the unidentified grass found at the end of Allan Place. Whangamata 15/4/07



Figure 29: An abrupt edge to a mangal where mangroves (some ~ 30 years old) have been chopped down. Note the saltwater paspalum along the foreshore. A thin patch of seagrass is present adjacent to the paspalum. 'horticultural' peninsula, Whangamata 15/4/07



Figure 30: A highly modified coastal edge with native coastal edge vegetation removed and estuarine vegetation disrupted. Note the cut mangroves dumped along the foreshore over the sea meadow/rush/saltmarsh ribbonwood zone. Whangamata 15/4/07



Figure 31: Cut mangrove debris dumped along the coastal edge over rushes. 'horticultural' peninsula, Whangamata 15/4/07



Figure 32: Extensive mangrove clearance associated with housing. Mangrove seedlings are re-establishing. The natural character of the harbour margin has also been severely degraded with vegetation clearance along the land edge also. East of Kaupeka Stream, Whangamata 16/4/07



Figure 33: This is the largest infestation of saltwater paspalum found in the harbour. The Kaupeka Stream channel is in the foreground. The saltwater paspalum mat is knee deep. Whangamata 16/4/07



Figure 34: Saltwater paspalum underneath mangroves at the edge of the largest infestation found in the harbour. Kaupeka Stream mouth. Whangamata 16/4/07



Figure 35: Looking up towards the mouth of the Kaupeka Stream. Saltwater paspalum is invading the oioi to the left and mangroves to the right. Whangamata 16/4/07



Figure 36: Farm rubbish dumped in the CMA. Waikiekie Stream mouth is in the background. Whangamata 16/4/07



Figure 37: Sea rush and some oioi (golden) within a paddock. The Waikiekie Stream mouth and housing along Everitt Crescent is in the background. Whangamata 16/4/07



Figure 38: The modified Waikiekie Stream mouth. Whangamata 16/4/07



Figure 39: Flood debris and dead mangroves. Near the Waikiekie Stream mouth, Whangamata 16/4/07



Figure 40: A view from Everitt Crescent esplanade reserve overlooking a saltmarsh ribbonwood, rushland, mangrove and sea meadow mosaic. Whangamata 16/4/07



Figure 41: A recent infill associated with the dredging of the Waikiekie Stream mouth. Whangamata 16/4/07



Figure 42: Cleared mangroves at the tip of Durrant Drive. Note the saltwater paspalum overtaking the saltmarsh ribbonwood and oioi in the foreground. Whangamata 16/4/07



Figure 43: Saltmarsh ribbonwood lining an exposed and eroding land edge. Mangroves were removed from in front of this coastal edge between July and September 2000. Patiki Bay, Whangamata 16/4/07



Figure 44: This photo shows an area of mown sea meadow (remuremu) along part of the Moana Point town walkway. Undisturbed estuarine vegetation is visible along the unmown edge. Whangamata 16/4/07



Figure 45: Coastal forest between the Tairua Road and Wentworth River channel includes flax, akeake, coastal daisy and cabbage tree. Moanaanuanu arm, Whangamata 15/4/07



Figure 46: Wetland along the TRB upstream of the Tairua Road bridge is constricted by a stopbank. The saltmarsh ribbonwood swamp in the background (TLB) is at the upper limit of the saltwater influence. Moanaanuanu arm, Whangamata 15/4/07



Figure 47: A view looking downstream from the Tairua Road bridge showing the mix of pampas, flax and saltmarsh ribbonwood and the unnatural landward edge of the estuarine vegetation on the TRB. Moanaanuanu arm, Whangamata 15/4/07



Figure 48: A view from the Mayfair Avenue reserve looking upstream over a small island with seagrass in the foreground and a mosaic of saltmarsh ribbonwood, rushland, mangroves and coastal forest in the background. Moanaanuanu arm, Whangamata 15/4/07



Figure 49: Saltwater paspalum is invading glasswort at the downstream end of the island in Figure 48 and along the TLB of the river. Moanaanuanu arm, Whangamata 15/4/07



Figure 50: A view looking from Tairua Rd over toward the reserve at Mayfair Av. Large sea meadow communities on both sides of the river bend below are obscured from view by the roadside vegetation. Moanaanuanu arm, Whangamata 16/4/07



Figure 51: A view from the causeway looking over an area of cleared mangroves. Birds were feeding amongst the remaining pneumatophores. The mud was very smelly, and rubbish and a white mould were common. Whangamata 16/4/07



Figure 52: Infilling in the CMA causes loss of estuarine edge vegetation. The Firth concrete town is in the background. Moanaanuanu arm, Whangamata 16/4/07



Figure 53: A remnant manuka stand along the harbour edge downstream from Figure 50 above. Moanaanuanu arm, Whangamata 16/4/07



Figure 54: A view looking over the oioi and sea rush embayment soon to be filled in for marina car parking. Whangamata 16/4/07

## OTAHU ESTUARY

Otahu Estuary is also described moving anticlockwise around the coastal edge from the downstream true left bank (TLB) to the true right bank (TRB). See Figure 55 for a map showing site localities mentioned below.

The first estuarine vegetation encountered is patches of saltwater paspalum downstream and immediately out from Kotuku Street. A small patch of seagrass is also present out from the boat ramp. Saltwater paspalum, rushland, saltmarsh ribbonwood and a few patches of seagrass extend in a thin band upstream from the housing towards the steep bush-lined coastal edge (before the stream south of the refuse tip) (Figures 56, 57). Fernbird are present in the saltmarsh ribbonwood. Grazing has limited the inland extent of estuarine vegetation in places (Figure 58).

Mangroves and extensive areas of saltwater paspalum dominate the stream mouth south of the refuse tip (Figure 59). Major earthworks are being undertaken for a new subdivision alongside this stream (Figure 60). Mangroves extend in a wide band further upstream alongside the main channel, with scattered thin bands of saltmarsh ribbonwood behind and thick saltwater paspalum mats at the channel edge (Figure 61).

The estuarine vegetation then thins as the channel moves in closer to the land edge before widening again around the **Parakiwai** headland. Mangroves disappear at this point. Figure 62 shows some old dead mangroves amongst saltwater paspalum that were alive when mapped in 1996. A band of seagrass extends along the channel edge either side of the headland. Where the tidal flats have been disturbed in the past for farming, or still are grazed, saltwater paspalum is dominating amongst the rushland and the natural inland extent of estuarine vegetation is restricted (Figure 63 - 64). However south east and west of the headland, the estuarine and freshwater wetland sequence is intact with scattered coastal swamp forest on the more raised ground (Figure 65). Saltwater paspalum is mainly restricted to the channel edge. A bittern was disturbed along the channel edge and fernbird were common here.

Further upstream the estuarine vegetation ends suddenly at a boundary drain and the low-lying land is farmed from here up. Saltwater paspalum is common in hollows within the paddock near the river and dominates the river edge to just past the confluence of the Otahu River and Waiharakeke Stream. Figure 66 shows a section of riverbank planted in flaxes that are surrounded by saltwater paspalum. There is a notable lack of sea meadow species in this zone. Upstream of the confluence saltwater paspalum grades into its freshwater equivalent Mercer grass (*Paspalum distichum*). A significant length of the riverside has been fenced off from stock, however some banks are still unstable due to unrestricted grazing. These areas tend to be on bends without steep banks (Figure 67).

On the TRB, the furthest upstream rushland community occurs about 450m downstream of the confluence, and extends some way inland either side of a drain. Further downstream, patches of rushland and saltmarsh ribbonwood are scattered in low points along the bank and compete with saltwater paspalum (Figure 68 - 69). Seagrass occurs along the channel bank in long bands extending down past Parakiwai headland.

Behind the estuarine edge, extensive freshwater swampland extends inland to the regenerating coastal forest. Common freshwater swamp species include red mapou, manuka, knobby clubrush, blue-green sedge, cabbage tree, flax, large-leaved mingimingi, toetoe, swamp daisy, koromiko and native broom. Weed species included pampas, casuarina and wilding pine.

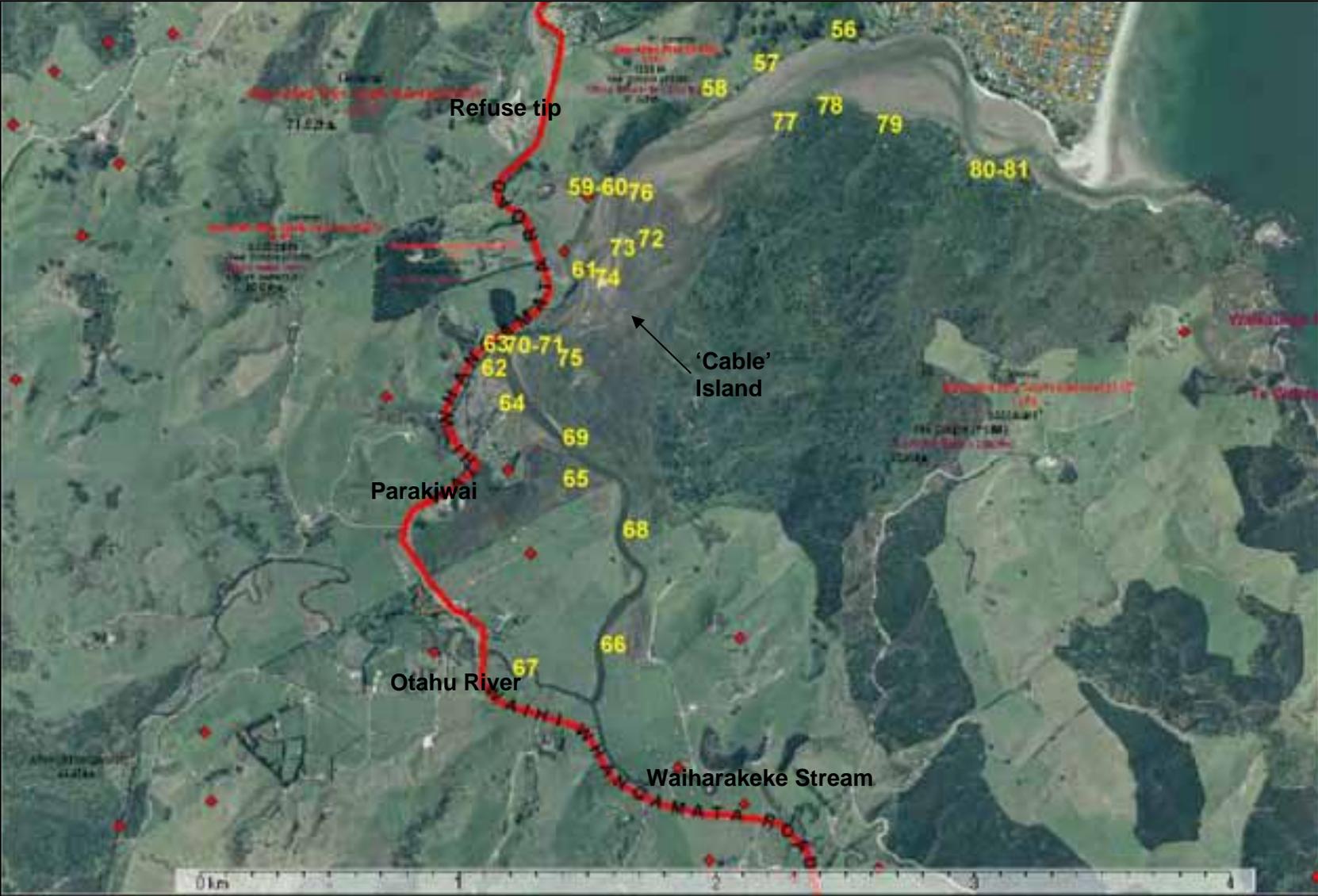
The estuarine vegetation expands out to a mosaic of ribbonwood fingers dissected by rushland and saltwater paspalum on the inside bend downstream and opposite Parakiwai headland. Saltwater paspalum is particularly dominant here on the inside

bend and **'cable' island**. Here, remnant sea meadow communities of remuremu, glasswort and coast spear grass are intermingled with saltwater paspalum where the paspalum has not yet formed dense closed canopy (Figures 70 - 71). Figures 72 and 73 show other examples of saltwater paspalum out-competing estuarine species. In places the saltwater paspalum is over knee high. The upper limit of the main mangrove band is just upstream of 'cable' island (Figure 74). Fingers of rushland lined by saltmarsh ribbonwood extend into the freshwater wetland/coastal forest (Figure 75). Fernbird were common throughout this estuarine and freshwater wetland mosaic.

Downstream of 'cable' island, saltwater paspalum is restricted to patches near the channel edge and has yet to significantly invade the dense mangrove, rushland, ribbonwood, swamp forest mosaic (Figure 76). Titiko (mud snail) are common amongst the mangroves. Young mangroves have established and extend the mangrove community downstream on open flats along the channel edge (Figure 77).

The mangroves peter out toward the main headland opposite the edge of the housing and only a thin band of rushland, saltwater paspalum and isolated saltmarsh ribbonwood continue along the foreshore towards the estuary mouth (Figures 78-81). A band of seagrass also extends along the foreshore edge abutting large pohutukawa. A small patch of three-square (*Schoenoplectus pungens*) is found amongst the seagrass towards the estuary mouth (Figure 80). Three-square is uncommon in Coromandel Peninsula harbours

Figure 55: Otahu site localities mentioned in this report. The numbers refer to the location of the following figures



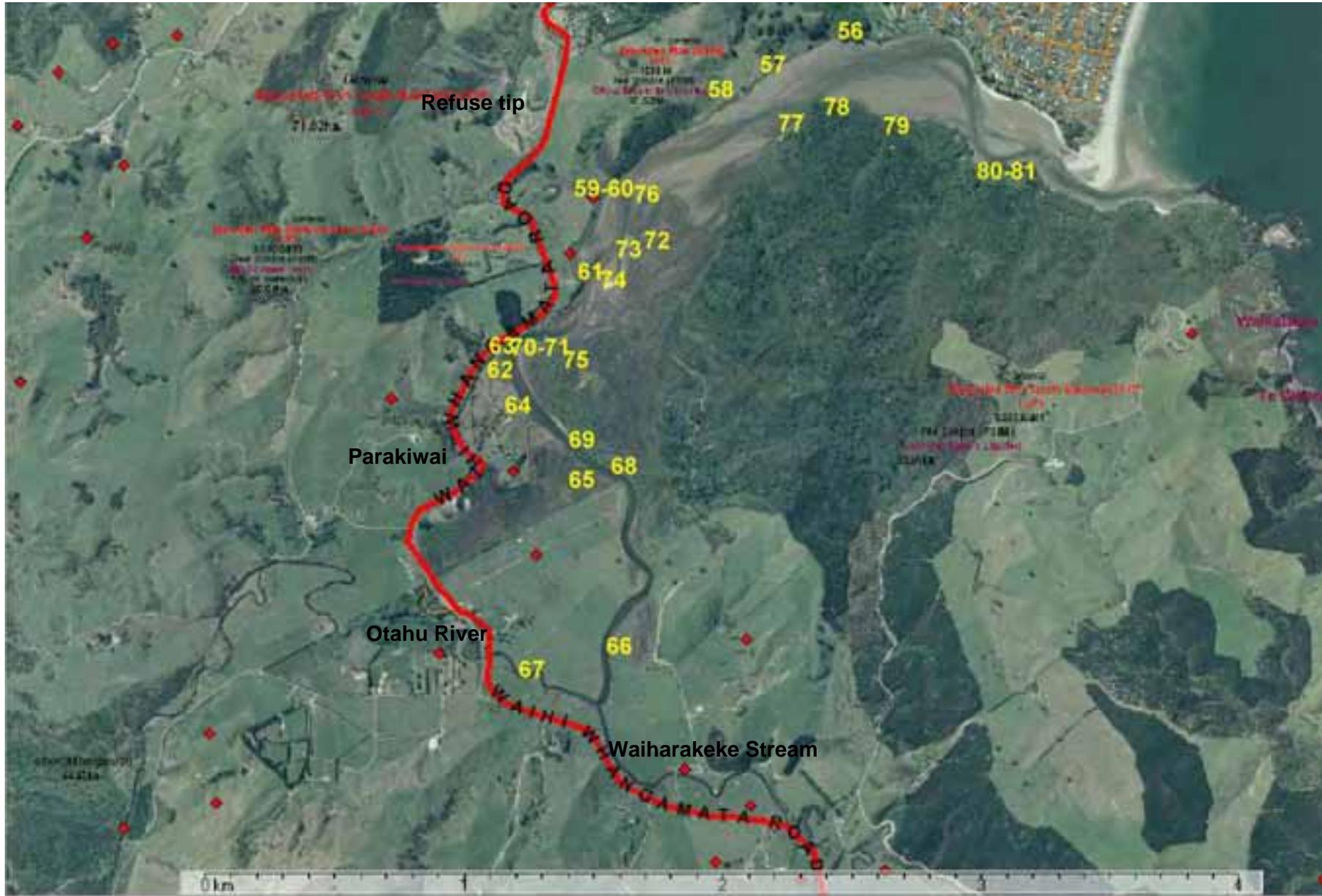




Figure 56: The foreshore at the edge of the housing is dominated by saltwater paspalum with sea rush, oioi, mangroves and saltmarsh ribbonwood also present. Various weed species are present along the land edge. Otahu 4/4/07



Figure 57: Further upstream on the TLB the inland extend of rushland and saltmarsh ribbonwood is restricted by farming development, while the seaward extent is restricted by saltwater paspalum. Otahu 4/4/07



Figure 58: Saltwater paspalum and sea rush extend into a paddock. Saltmarsh ribbonwood however is restricted to seaward of the fence. Otahu 4/4/07



Figure 59: Saltwater paspalum dominates this small side creek on the TLB. Oioi, sea rush and saltmarsh ribbonwood are restricted to a narrow band behind. Otahu 4/4/07



Figure 60: Large scale earthworks for urban development being undertaken beside the small creek shown in Figure 58. Otahu 4/4/07



Figure 61: Saltwater paspalum lining the river edge with mangroves, sea rush and saltmarsh ribbonwood in behind. Otahu 4/4/07



Figure 62: Dead mangroves amongst thick saltwater paspalum. Sea rush is in the background. Otahu 4/4/07



Figure 63: Grazed and ungrazed rushland. Saltwater paspalum is dominating on the inland disturbed (grazed) side of the fence. Otahu 4/4/07



Figure 64: A grazed stretch of estuary bank with oioi (and submerged seagrass) in the foreground, saltwater paspalum in the middle ground, and sea rush and manuka swamp in the background. Otahu 4/4/07



Figure 65: Sea rush saltmarsh ribbonwood grading back to freshwater swamp forest. Otahu 4/4/07



Figure 66: A recent river bank planting of flax amongst saltwater paspalum. Otahu 4/4/07



Figure 67: Unrestricted grazing along the Otahu River just upstream of the confluence. Otahu 4/4/07



Figure 68: Near the top of the saltwater influence the river banks steepen. Patches of rushland and saltmarsh ribbonwood are scattered in low points along the bank competing with saltwater paspalum. Otahu 4/4/07



Figure 69: Saltwater paspalum dominating the river bank with saltmarsh ribbonwood and freshwater swamp forest in behind. Otahu 4/4/07



Figure 70: Coast spear grass, saltmarsh ribbonwood, sea rush and mangrove surviving amongst saltwater paspalum. Weed species on the higher ground include wilding pine and casuarina. Otahu 5/4/07



Figure 71: Remuremu (light green) and glasswort (purple orange) compete with saltwater paspalum near the coast spear grass shown in Figure 70 above. Otahu 5/4/07



Figure 72: Dead saltmarsh ribbonwood and sea rush amongst saltwater paspalum. Otahu 5/4/07



Figure 73: A mangrove subsumed in saltwater paspalum. Glasswort has been similarly subsumed on the hump behind. Otahu 5/4/07



Figure 74: A view looking upstream along 'cable' island showing the expanse of saltwater paspalum, scattered mangroves and patches of sea rush and saltmarsh ribbonwood. Otahu 5/4/07



Figure 75: A sea rush arm edged with saltmarsh ribbonwood extending into freshwater swamp forest. Otahu 5/4/07



Figure 76: At the downstream extent of the rushland fingers there are isolated patches of saltwater paspalum (light green). Here the saltwater paspalum is surrounded by a patch of sea meadow (darker brown on mud) with coast spear grass on the higher ground above the sea rush. Otahu 5/4/07



Figure 77: Looking upstream from the point opposite the edge of the housing. Young mangroves are visible in a finger extending downstream along the river edge. Otahu 5/4/07



Figure 78: Saltwater paspalum, oioi and sea rush line the coastal edge on the point opposite the end of the housing. Ngaio are present with the large pohutukawa. Otahu 5/4/07



Figure 79: A narrow band of oioi and sea rush lining the coastal edge with wild ginger established between the rushes and regenerating coastal forest. Otahu 5/4/07



Figure 80: Saltwater paspalum extending out to seagrass and three-square, and inland up through oioi, sea rush and saltmarsh ribbonwood. Otahu 4/4/07



Figure 81: A close up of the saltwater paspalum invading saltmarsh ribbonwood pictured above. Otahu 4/4/07

## BIRDS

Birds seen or heard during the survey:

White faced heron, variable oyster catcher, South Island pied oyster catcher, pied stilt, black backed gull, red billed gull, spur-winged plover, kingfisher, fernbird, bittern, pukeko, pied shag, paradise duck, mallard duck.

## WEEDS

Tree privet, pampas and wattle were the most common coastal edge weeds – particularly on the TLB downstream of the Tairua Road bridge, and where pine plantation set-backs were too narrow to allow undisturbed native forest to establish.

Wilding pines are a problem around the Otahu estuary. Another tree noted at Otahu that is becoming a concern is the casuarina. Casuarina (*C. glauca* swamp oak/swamp she-oak and *C. equisetifolia* Australian pine/beach she-oak) are from eastern Australia. *C. glauca* inhabits saline swamps and spreads by root suckers forming dense thickets. *C. equisetifolia* can tolerate the full blast of salt-laden winds and could become a problem on dunes (Paddison & Bryant 2001).

## 4 Discussion

### 4.1 Whangamata Harbour

The Whangamata Harbour has two predominant estuarine vegetation communities – seagrass and mangroves. These two communities provide specific and overlapping value to estuarine wildlife and the functioning of the harbour. Both communities stabilise sediments, enhance water quality, and add to the nutrient inputs of the harbour. Each community provides food and refuge for a variety of fish and invertebrates. Seagrass beds are valuable feeding grounds for many wading birds, while mangroves are valuable feeding, refuge, roosting/nesting grounds for banded rail, pukeko, heron and shag.

The Moanaanuanu arm contains by far the most diverse collection of vegetation communities, and therefore has significant value in terms of estuarine vegetation. This floral diversity is in part due to a mosaic of different bed level heights allowing the establishment of ribbonwood and coastal swamp forest communities (which have generally not been interfered with by land development).

Excluding the Te Moanaanuanu arm, large areas of rushland within the rest of the harbour are restricted to the heads of embayments. It may be that less sheltered margins have been too exposed (before mangroves established) for sea rush and oioi to establish. A possible future scenario might see the rushland expanding behind the protection of the mangroves and consolidating the silt that has built up in the harbour.

A large variety of weeds characterise the western margin of the harbour, whereas the coastal margin of the eastern side is predominantly regenerating coastal forest. Pine forestry and its associated weeds characterise the harbour margin at the head of the harbour.

If resources were available to control saltwater paspalum in Whangamata, the Moanaanuanu arm would be a priority site due to its floral diversity. Also the Kaupeka Stream mouth provides an opportunity to research the colonisation of native estuarine vegetation following control of saltwater paspalum. Here either rushes/sedges or mangroves would colonise the open ground exposed after the removal of saltwater paspalum there. However, the saltwater paspalum may have built up the sediment to an extent that, together with the slow water movement of the 'back swamp', rush/sedge establishment is favoured over mangroves.

Two small recent infills associated with the dredging of the Waikiekie Stream mouth are unnecessary and contrary to outcomes promoted by the Regional Plan. These infills should be promptly removed and the area rehabilitated, as they send the wrong signals to the community regarding the value of the saltmarsh ribbonwood, rushland and mangrove communities they have covered. More considerate planning is required of the Regional Council for future waterway management works.

### 4.2 Otahu Estuary

Saltwater paspalum has significantly increased in the area it dominates since the last survey and is severely threatening the long-term survival of the sea meadow communities. The saltmarsh ribbonwood community is also under pressure from the saltwater paspalum invasion. Figure 63 (grazed and non-grazed rushland) indicates that vegetation disturbance may play an important role in the spread and dominance of saltwater paspalum. Control of saltwater paspalum is highly recommended if the vegetation diversity and habitat values of the estuary are to be protected.

Tall fescue was notably absent, particularly on the TRB. This may be due to the intactness of the coastal vegetation sequence here.

The zone of mangroves is quite compact. Wave, wind and current exposure may explain the downstream limit however the absence of mangroves along the bank margins further upstream is unexpected. A possible reason may be the loss of habitat to dense banks of saltwater paspalum. The only obvious area of mangrove expansion is a finger of new plants along the edge of the river channel extending downstream from the end of the rushland-ribbonwood-saltwater paspalum mosaic (Figure 77).

### **4.3 Recommended action points / restoration projects**

1. Collect a specimen of the unidentified grass in the saltmarsh near Allan Place in summer when it is flowering to help identify the species
2. Control the pampas and wattle in the coastal swamp within the Moananauanu arm and Otahu Estuary.
3. Undertake a feasibility study to control saltwater paspalum at Otahu and Whangamata. Work undertaken in the Matua estuary (Tauranga Harbour) indicates that eradication is only possible with long-term sustained control over at least a 5 year period and then ongoing monitoring and eradication of re-establishment areas. A trial could be undertaken whereby saltwater paspalum is sprayed to 3m out from existing saltmarsh ribbonwood, rush and sea meadow to encourage their expansion. If successful the spray zone could then be expanded. However it is probably more economical initially to helicopter spray all infestations as is done for spartina control.
4. Undertake saltwater paspalum control in the Moananauanu arm.
5. The Moananauanu arm and Otahu Estuary have particularly high biodiversity values. Apart from the threat from invading saltwater paspalum, it is unclear if the wetland bird populations may be threatened by animal pests. It may be beneficial to undertake animal pest control around the wetland edges to help sustain the wetland bird populations.
6. Aim to exclude all farming activities from the CMA and river margins.
7. A particular focus should be given to the protection of the remaining estuarine to freshwater wetland sequences around the Otahu Estuary as this is a highly significant wetland site. It is a remnant of a once extensive habitat that would have dominated the low-lying coastal floodplains. These productive floodplains have now generally been converted to farmland. Strong and meaningful (including financial) support should be offered to the landowners of the remaining remnant wetland habitat around the Otahu Estuary and its tributaries to enhance their protection.
8. Remove the Waikiekie Stream mouth fill ('dredgings') along the Durrant Drive esplanade reserve immediately and rehabilitate the site with locally sourced saltmarsh ribbonwood.
9. Initiate a project to clearly identify all esplanade reserves and extend the walkway system already well set up around Waireka Place and Moana Anu Anu Ave etc where suitable. Identify areas of high wildlife value and ensure walkways (and associated cats and dogs) are directed away from such areas

10. Public education is needed regarding the dumping of garden waste and planting of exotic garden species in public reserves. Work towards eliminating weed species from the coastal margin.
11. Identify public reserves and active recreation areas (e.g. boat/canoe launching sites) where it would be suitable to enhance access to open water. This could include small-scale consented mangrove removal or boardwalks through mangals. An example of where very small scale mangrove clearance may be appropriate is at the tip of the Durrant Drive headland (southern side) to provide access to the Waikiekie Stream channel. (Note: not the unconsented illegal clearance that has been undertaken recently. Any clearance should be via a harbour plan).
12. Illegal mangrove destruction usually occurs where mangroves 'block' views of open water or restrict access to open water. Effective enforcement action against illegal mangrove removal is required as well as careful planning of housing near mangrove habitat.

## 5 References

- Graeme, M. 1997: Estuary Vegetation Survey Pilot Study: Whangamata, Otahu, Wharekawa. Report prepared for Environment Waikato.
- Graeme, M. 1998a: Estuary Vegetation Survey: Coromandel & Tairua Harbours. Report prepared for Environment Waikato.
- Graeme, M. 1998b: Estuary Vegetation Survey: Te Kouma & Manaia Harbours. Report prepared for Environment Waikato.
- Graeme, M. 1999: Estuary Vegetation Survey: Whitianga Harbour. Report prepared for Environment Waikato.
- Graeme, M. 2004: *Estuarine Vegetation Survey: Port Waikato*. Environment Waikato Technical Report 2005/41. Waikato Regional Council (Environment Waikato), Hamilton
- Graeme, M. 2004: *Estuarine Vegetation Survey: Raglan*. Environment Waikato Technical Report 2005/44. Waikato Regional Council (Environment Waikato), Hamilton
- Graeme, M. 2004: *Estuarine Vegetation Survey: Aotea*. Environment Waikato Technical Report 2005/43. Waikato Regional Council (Environment Waikato), Hamilton
- Graeme, M. 2006: *Estuarine Vegetation Survey: Inner Firth of Thames*. Environment Waikato Technical Report 2006/40. Waikato Regional Council (Environment Waikato), Hamilton
- Graeme, M. and Kendal, H. 2001: Saltwater Paspalum (*Paspalum vaginatum*) – a weed review. Report prepared for Environment Waikato.
- Paddison, V. and Bryant, G. (Eds). 2001: *Botanica's Trees & Shrubs*. Random House, New Zealand.

## 6 Appendices

Plant species mentioned in this report. (\* denotes an exotic species)

Common/Maori name	Scientific name
arrow grass	<i>Triglochin striata</i>
blue-green sedge	<i>Baumea juncea</i>
broom	<i>Carmichaelia aligera</i>
buffalo grass *	<i>Stenotaphrum secundatum</i>
cabbage tree	<i>Cordyline australis</i>
casuarina/swamp oak/swamp she-oak *	<i>Casuarina glauca</i>
coast spear grass	<i>Stipa stipoides</i>
coastal five finger	<i>Pseudopanax lessonii</i>
coastal shrub daisy	<i>Olearia solandri</i>
flax	<i>Phormium tenax</i>
Ginger *	<i>Hedychium gardnerianum</i>
glasswort	<i>Sarcocornia quinqueflora</i>
knobby clubrush	<i>Ficinia nodosa</i>
koromiko	<i>Hebe stricta</i>
large-leave mingimingi	<i>Leucopogon fascicularis</i>
leptinella	<i>Leptinella doica</i>
mangrove	<i>Avicennia marina</i> subsp. <i>australasica</i>
manuka	<i>Leptospermum scoparium</i>
mapou	<i>Myrsine australis</i>
Mercer grass *	<i>Paspalum distichum</i>
mingimingi/swamp coprosma	<i>Coprosma propinqua</i>
ngaio	<i>Myoporum laetum</i>
oioi	<i>Apodasmia similis</i>
Pampas *	<i>Cortaderia selloana</i> , <i>C. jubata</i>
pohutukawa	<i>Metrosideros excelsa</i>
raupo	<i>Typha orientalis</i>
remuremu	<i>Selliera radicans</i>
saltmarsh ribbonwood	<i>Plagianthus divaricatus</i>
saltwater paspalum *	<i>Paspalum vaginatum</i>
sea primrose	<i>Samolus repens</i>
sea rush	<i>Juncus kraussii</i> subsp. <i>australiensis</i>
seagrass	<i>Zostera capricorni</i>
slender clubrush	<i>Isolepis cernua</i>
spinifex	<i>Spinifex sericeus</i>
tall fescue *	<i>Schedonorus phoenix</i>
three-square	<i>Schoenoplectus pungens</i>
toetoe	<i>Cortaderia fulvida</i>
tree privet *	<i>Ligustrum lucidum</i>
Unidentified grass (end of Allan PI)	
wattle - green	<i>Racosperma decurrens</i>
wattle - brush	<i>Paraserianthes lophantha</i>
wilding pine	<i>Pinus pinaster</i> , <i>P. radiata</i>