

Estuarine Vegetation Survey Manaia Harbour

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Table of contents

1	Introduction	1
2	Methodology	1
2.1	Wetland vegetation classification	1
3	Field notes	2
3.1	Summary	2
3.2	Site descriptions	5
3.3	Threats	29
3.4	Birds	30
4	Discussion and recommendations	30
	Bibliography	32
	Appendix 1 – GPS locations of figures	33

List of figures

Figure 1:	Manaia Harbour site localities mentioned in this report. The numbers refer to the location of the following figures	4
Figure 2:	This photo is a near-repeat of the 1998 photo [17] in the second bay east of Hikurangi Point at the harbour mouth. Coast spear grass, glasswort, sea rush and saltmarsh ribbonwood dominate the shell bank and landward edge, while mangroves dominate the seaward flats.	8
Figure 3:	This large sea blite colony is on a shell bank within the second sheltered mangrove-filled bay. The surrounding land is covered in coastal bush which includes kowhai, rata and puriri.	8
Figure 4:	A few small plants of saltwater paspalum were found along the rocky outer western side of the third bay east of Hikurangi Point at the harbour mouth.	9
Figure 5:	Tall mangroves at the back of a sheltered bay with saltwater paspalum beginning to establish in the sea meadow along the bay edge.	9
Figure 6:	A close up of the sea meadow shown in Figure 5, showing saltwater paspalum amongst glasswort to the top right and sea primrose to the bottom left of the photo.	10
Figure 7:	A large mangrove surrounded by seedlings. Rata, kowhai and puriri occur in the coastal forest on the land behind the mangal.	10
Figure 8:	This photo shows the outer east side of the third embayment. The mangrove band stops in line with the shelter of the bay's headlands.	11
Figure 9:	Saltwater paspalum is growing over sea primrose on the eastern side of the fourth bay (east of Hikurangi Point at the harbour mouth).	11
Figure 10:	The photo is a repeat of the 1998 photo [20], showing mangroves edging a cliff with kowhai, kanuka (<i>Kunzea ericoides</i>) and coastal astelia (<i>Astelia banksii</i>).	12
Figure 11:	This photo is a repeat of [19]. It shows the impressive Tikouma bluff with regenerating coastal forest on its flanks and mangroves lining the channel below.	12
Figure 12:	This photo is a near-repeat of the 1998 photo [24]. Patches of young oioi and sea rush are found along the saltmarsh/mangrove interface. Wattle (<i>Racosperma decurrens</i> or <i>Paraserienthes lophantha</i>) and willow (<i>Salix fragilis</i> or <i>S. cinerea</i>) are a problem in the freshwater wetland behind the saltmarsh and along the coastal forest edge.	13
Figure 13:	The embayment on the northern side of the harbour near SH25 has a relatively intact estuarine/freshwater/coastal forest sequence. Cattle	

	have access to the harbour (note grazed mangroves fringing the wide rush band). Wilding pines (<i>Pinus pinaster</i> , <i>P. radiata</i>) are in the coastal forest and willow in the freshwater wetland.	13
Figure 14:	A pugged shingle outwash supporting sea meadow species and surrounded by sea rush landward and mangroves seaward.	14
Figure 15:	A pugged area of the shingle out-wash plain (previous photo) showing sea meadow species and saltwater paspalum.	14
Figure 16:	A close up view of Figure 15 showing sea primrose and saltwater paspalum.	15
Figure 17:	A repeat of the 1998 photo [26]. The band of manuka in the mid-ground screens SH25 behind. Saltmarsh ribbonwood edges the harbour margin, with patches of sea primrose in open areas amongst the sea rush. Note the rock for reference in the mid-ground near a patch of raupo.	15
Figure 18:	The site near a bend in SH25 where low-stature spartina is scattered between mangroves, sea rush and sea primrose	16
Figure 19:	This photo is taken from the toe of a pampas-lined stopbank near a small pohutukawa. The near flats are covered with sea meadow patches (mainly glasswort with sea primrose and remuremu) and a patch of sea rush. Mangroves dominate the distant flats.	17
Figure 20:	A view looking towards the road bend north of the long road straight. A band of old dead mangroves stand along the outer rush edge. Rush and mangrove mix in a transitional zone between the two communities.	18
Figure 21:	A patch of spartina (orange green grass in middle left of photo) and tall fescue occur near swamp oak trees on the TRB bank of lower Te Mata Stream.	18
Figure 22:	Cattle dung amongst spartina, sea rush, tall fescue and saltmarsh ribbonwood.	19
Figure 23:	A view from the TLB of the lower Te Mata Stream looking over to the swamp oaks and spartina site shown in Figure 21. SH 25 is in the background.	19
Figure 24:	Cattle tracks amongst saltmarsh along the banks of the lower Te Mata Stream. Banded rail and fernbird are present in this area.	20
Figure 25:	A cow grazing in the saltmarsh (photo taken from a broken fence line). Swamp coprosma is common in behind the saltmarsh ribbonwood to the left.	20
Figure 26:	This is a near-repeat of 1998 photo [14]. The gravel bank in the middle left of the photo is covered with sea primrose. The earlier 1998 photo was taken closer up from the middle of this photo so there is a greater expanse of shingle outwash plain, scattered mangroves and sea rush/saltmarsh ribbonwood ridge visible here.	21
Figure 27:	This is a repeat of 1998 photo [15] still showing an open area with glasswort patches amongst sea rush. A ridge of saltmarsh ribbonwood and the back edge of the main central mangrove forest is in the background. Banded rail and fernbird are present here.	22
Figure 28:	This photo shows stock tracking through the saltmarsh. This type of damage is extensive in Manaia Harbour.	23
Figure 29:	Looking south over Manaia River at stock damage to the river banks and vegetation.	23
Figure 30:	This photo shows a fence that has been flattened by flood debris, allowing stock direct access to the harbour.	24
Figure 31:	This shows saltwater paspalum near its upstream limit, where it mixes with tall fescue (taller yellow green grass) and remuremu (lower bank edge).	24
Figure 32:	This is a repeat of 1988 photo [22]. Glasswort, sea primrose, oiio and coast spear grass are still present on this bank. Sea rush and mangroves are found along the river edge.	25

Figure 33: This photo shows a narrow coastal bush edge next to SH25. Native species here include pohuehue, mahoe, hangehange, raupo, manuka, flax, mapou, karamu, silver fern and bamboo grass. Pampas and kikuyu grass are present also.	25
Figure 34: Small patches of saltwater paspalum occur along the seaward edge of sea rush between the boat ramp and jetty on the southern side of the harbour.	26
Figure 35: This photo is looking east from Ohoni Stream over a raised tongue of sea rush through stunted mangroves. The taller mangroves (left background) are lining the channel edge.	26
Figure 36: Sea blite occurs with coast spear grass along the edge of this shell bank. This picture is taken from the Ohoni Stream edge looking north-west along the curve of the shell bank.	27
Figure 37: This photo is looking east along a shell bank near the seaward extent of the mangrove band. Species present on the shell bank include coast spear grass, sea blite, glasswort and sea primrose.	27
Figure 38: A single live spartina plant was found here at the site mapped in 1998. The Department of Conservation has been controlling this weed.	28
Figure 39: A lone mangrove seaward of the main mangal edge with oysters growing around its base. Seagrass extends in to the main mangal edge either side of this mangrove.	28
Figure 40: The edge of a seagrass patch showing healthy plants.	29

List of tables

Table 1: Check list of common estuarine plant species found in Manaia Harbour	3
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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 harbours and the inner Firth of Thames have since been surveyed and mapped. Of these harbours, Whangamata, Otahu, Tairua and Wharekawa have recently been re-surveyed to determine changes in vegetation communities over time.

The mapped vegetation 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 re-survey of estuarine vegetation in the Manaia Harbour. 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 3 days between 19 and 26 June 2008. 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 photographs of the survey site was used as the primary mapping device. The PDA replaced the use of colour pen notations on hard copy aerial photographs, 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 aerial photographs 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, sea rush or saltmarsh ribbonwood.

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: saltmarsh, mangrove, seagrass and weed communities.

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

'Rush/sedge community' – This is generally sea rush (*Juncus maritimus* var. *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, although it is not mapped within this survey as it is a species of brackish-freshwater.

'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.

'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, 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. **Mangrove** (*Avicennia marina* subsp. *australasica*) – This is usually a monospecific community although seagrass, *Spartina*, saltwater paspalum and sea meadow beds can sometimes be found underneath mature mangrove stands.
3. **Seagrass** (*Zostera capricorni*) – This is usually a monospecific community.
4. **Weed communities** – In the Waikato region the most significant estuarine weeds are saltwater paspalum (*Paspalum vaginatum*) and spartina (*Spartina* spp.). 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, particularly saltwater paspalum which vigorously competes with all vegetation types, except seagrass.

There are other weed species (such as tall fescue) 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.

3 Field notes

3.1 Summary

The following observations give a general overview of estuarine vegetation in the Manaia Harbour following the recent field visit.

- Large seagrass beds occur seaward of the main mangrove band in the harbour.
- Extensive mangals (mangrove forests) dominate the middle harbour.
- Mangroves range in height from 3-4m (generally along seaward or channel edges) to stunted forests of less than 0.5m high away from regular tidal flushing.
- Sea rush and oioi beds of varying widths fringe sometimes extensive areas of saltmarsh ribbonwood swamp.
- In a few areas unaffected by farming, the saltmarsh ribbonwood zone extends back into freshwater swamp communities characterised by swamp coprosma (*Coprosma propinqua*), manuka (*Leptospermum scoparium*), pohuehue (*Muehlenbeckia complexa*), coastal shrub daisy (*Olearia solandri*), blue-green sedge (*Baumea juncea*), tall fescue (*Schedonorus phoenix*) and pampas (*Cortaderia selloana*).
- Sizeable sea meadow communities are found along stream edges; in patches amongst rushland or between mangals and rushland; and on shell banks.
- Sea meadow species present include glasswort, sea primrose, remuremu, coast spear grass and the locally uncommon sea blite.

- One spartina plant was found upstream of the 1998 patch (and pulled out) and two other new infestations were found.
- Saltwater paspalum is uncommon and only found in small patches (usually associated with sea meadow) scattered around the harbour.
- The northern margins of the harbour are predominantly regenerating native bush. The upper harbour is dominated by farmland on the flats with conservation forest and pine forestry in the upper catchments. The southern margins of the harbour are predominantly in pasture.
- Stock access to the CMA is the biggest immediate threat to the health of the estuarine vegetation and water quality. Sedimentation from pine forestry activities is a long-term cumulative threat to the harbour through the effects of accelerated infilling of the harbour.

Table 1 lists common estuarine plant species found during the surveys. The 'estuarine vegetation community' category for the estuarine species corresponds to the colour-coded vegetation boundaries of the aerial map.

See Figure 1 for a map showing the site names and figure numbers mentioned below. A table of GPS points of the figure locations is in Appendix 1.

Table 1: Check list of common estuarine plant species found in Manaia Harbour

Common/Maori name *denotes exotic species	Scientific name	Estuarine Vegetation Community
buck's horn plantain *	<i>Plantago coronopus</i>	sea meadow
coast spear grass	<i>Austrostipa stipoides</i>	sea meadow
glasswort	<i>Sarcocornia quinqueflora</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
sea blite	<i>Suaeda novae-zelandiae</i>	sea meadow
sea primrose	<i>Samolus repens</i>	sea meadow
sea rush	<i>Juncus krausii</i> subsp. <i>australiensis</i>	rush/sedge
seagrass	<i>Zostera capricorni</i>	seagrass
slender clubrush	<i>Isolepis cernua</i>	sea meadow
spartina/cord grass *	<i>Spartina</i> spp.	weed

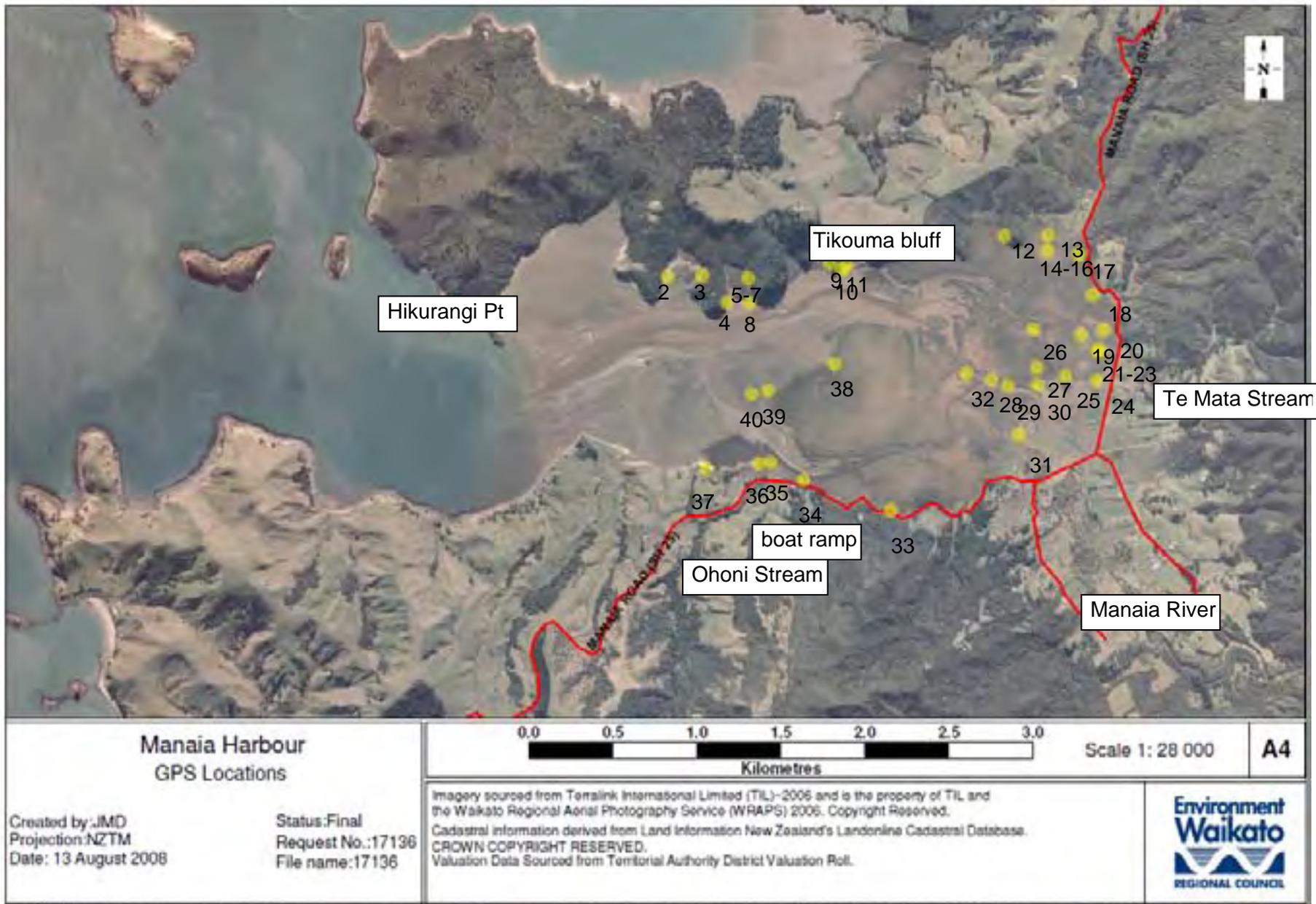


Figure 1: Manaia Harbour site localities mentioned in this report. The numbers refer to the location of the following figures

3.2 Site descriptions

Manaia Harbour is described clockwise from the north side of the harbour mouth. See Figure 1 for a map showing the site names and figure numbers mentioned below. A table of GPS points of the figure locations is in Appendix 1.

The first embayment sheltered by **Hikurangi Point** has a number of water access-only baches along the coastal edge has minimal estuarine vegetation. Small areas of mangrove and rush/sedgeland are found in the eastern corner of the bay and sea meadow occurs nearer the eastern headland.

It is not until the second embayment that a significant band of mangroves is encountered encompassing a shell bank, with coast spear grass common along the inner shell bank (Figure 2). In the shelter of the shell bank is a band of sea rush lined behind by saltmarsh ribbonwood. Mangroves extend right to the centre-back of the bay and another shell bank lines the eastern side of the bay. Of particular note is a healthy wide band of sea blite along this eastern shell bank (Figure 3).

The third embayment is almost completely full of mangroves, edged with sea meadow and thin bands of rush/sedgeland. A small area of saltwater paspalum occurs on the rocky western edge near the outer mangrove fringe (Figure 4). More saltwater paspalum was found intermingled with sea primrose and remuremu along the eastern side of the bay (Figures 5 and 6). Figure 7 shows a large old mangrove surrounded by new seedlings in the sheltered backwaters of the bay. Figure 8 shows the outer mangrove edge and a fringe of small mangroves extending out along the rocky eastern headland of the bay.

The next embayment has a double indent which is filled with mangroves, with thin strips of sea meadow and saltmarsh ribbonwood around the edges and sea rush at the back. Again saltwater paspalum is found amongst sea meadow on the eastern side of the bay (Figure 9). Around the next headland, Figure 10 shows a few mangroves at the toe of the cliff edge. From here the mangroves form extensive mangals over the upper harbour flats. The mangal thickens along the channel beneath the imposing **Tikouma bluff** and out into the tidal flats (Figure 11). This mangal fringe appears to have remained relatively unchanged over the last 10 years.

The coastal forest on the northern side of the harbour extends down to the high tide mark and includes titoki (*Alectryon excelsus* subsp. *excelsus*), rata (*Metrosideros robusta*), broadleaf (*Griselinia littoralis*), kohekohe (*Dysoxylum spectabile*), karaka (*Corynocarpus laevigatus*), kowhai (*Sophora chathamica*), puriri (*Vitex lucens*), tawa (*Beilschmiedia tawa*). Past land activities (logging, burning and so on) have removed most of the old trees and the coastal forest is now regenerating.

The north eastern bays around the upper harbour are characterised by large areas of rushland in behind the mangroves. Figure 12 is a near repeat photo of the earlier 1998 photo [24]. Patches of young oioi and sea rush were found along the saltmarsh/mangrove interface. The rushland grades inland into freshwater wetland and then coastal forest.

The next embayment shown in Figure 13 is affected by stock grazing, pugging and defecation. A shingle outwash plain with sea meadow and small areas of saltwater paspalum has been severely pugged (Figures 14, 15 and 16). Significant areas of saltmarsh ribbonwood occur along this coastal edge which grade into freshwater wetland communities before reaching the state highway (SH25). Fernbird were heard in this area. The Figure 17 photo is taken looking towards SH25 over a patchwork of rushland, open flats and sea meadow to the coastal edge vegetation screening the road.

South of the Figure 17 photo point mangroves abut the harbour edge with little rushland or saltmarsh ribbonwood present until the next road bend. The coastal edge below this bend has a thin band of rushland and saltmarsh ribbonwood, and a small infestation of spartina (Figure 18).

Figure 19 shows sea meadow dominating the open flats behind a pile of dredgings along the lower reaches of the **Te Mata Stream**. Tall dead mangroves stand out amongst the thick band of live short mangroves at the back of the harbour, possibly indicating some sort of disruptive event (Figure 20). These dead mangroves are on the landward interface between the mangal and rushland. The stunted nature of the short mangroves indicates that they are being inhibited by some environmental condition. A dense patch of spartina was found near signs of a cattle camp along the banks of the lower Te Mata Stream (Figure 21, 22 and 23). This area has a lot of cattle paths through it and the cattle may have transported spartina from this site to the site in Figure 18 above. Figure 24 also shows stock damage. Two adult swamp oaks (*Casuarina glauca*) and some seedlings were found in this area (Figure 23). Pampas is generally not a big problem except in patches along disturbed stream banks and farm/road edges.

The saltmarsh becomes very diverse around the lower Te Mata Stream and Manaia River, reflecting varying bed elevations resulting from outwash plains associated with the waterways. Sea meadow along the banks of the Te Mata Stream and Manaia River includes glasswort, remuremu, sea primrose, coast spear grass and buck's horn plantain. Within this wetland there is a lot of pugging, grazing of mangroves and coast spear grass, trampling of sea meadow, and defecation. There are wide bands of rushland and extensive fingers of saltmarsh ribbonwood backed by freshwater swamp behind the mangroves. This area supports a number of fernbird, and banded rail foot prints were observed. Figure 25 shows a cow amongst freshwater swamp on the higher ground above the saltmarsh and mangroves. The freshwater swamp includes coastal shrub daisy (*Olearia solandri*), swamp coprosma, manuka, pohuehue, tall fescue, blue-green sedge and pampas. These saltmarsh ribbonwood and coastal swamp communities are significant for their size and associated wildlife habitat values. Isolated trees within areas of pasture grass give an indication of the type of coastal floodplain forest that would have historically been present along the river plains above the salt influence. A couple of old kowhai and totara (*Podocarpus totara*) were noted in the paddocks.

Below the elevated fingers of saltmarsh ribbonwood, the lower plains and their vegetation are often affected by flood waters and debris. Figure 26 shows such an outwash plain with associated sea meadow, sea rush and mangroves. Given that the substrate is fairly mobile due to storm events, the vegetation is surprisingly unchanged from that in the corresponding 1998 photo [14]. Figure 27 is away from the vicinity of watercourses and the patch of sea meadow surrounded by a wide band of sea rush, with saltmarsh ribbonwood in the background. These vegetation communities appear unchanged from 1998. Banded rail and fernbird are present in the surrounding area.

Stock damage to the harbour environment continues to be a serious problem all the way around this coast line to the banks of the **Manaia River** (see Figures 28 and 29) and further south of the river. Figure 30 shows a section of fence alongside the Manaia River that has been flattened by flood debris. Unkempt fences are allowing stock access to the harbour at various places.

The upper extent of saltwater paspalum along the Manaia River occurs on the TLB (true left bank) downstream of the SH25 road bridge (Figure 31). The introduced common alder (*Alnus glutinosa*) is spreading and dominating the freshwater wetland immediately upstream of the salt influence on the Manaia River.

Figure 32 is a repeat of 1998 photo [22]. The vegetation community seems relatively unchanged with glasswort, sea primrose, young oioi and coast spear grass present

along the Manaia River bank here. Sea rush and mangroves occur along the river edge, and the main mangrove band begins seaward of this point. A lot of cattle tracks were observed here.

There are fingers of saltmarsh ribbonwood extending to the south of the Manaia River mouth within the curve of the last downstream bend. South of this bend saltmarsh ribbonwood becomes less common as farmland generally extends out to the edge of the wide sea rush band. Oioi patches are infrequent and scattered.

The wide sea rush and scattered oioi beds thin out where SH25 joins the southern harbour edge. Figure 33 shows a typical narrow coastal bush edge between the harbour and SH25. Native species occurring along this edge include pohuehue, mahoe (*Melicactus ramiflorus*), hangehange (*Geniostoma ligustrifolium*), raupo (*Typha orientalis*), manuka, flax (*Phormium tenax*), mapou (*Myrsine australis*), karamu (*Coprosma robusta*), silver fern (*Cyathea dealbata*) and swamp millet (*Isachne globosa*). Kikuyu grass (*Pennisetum clandestinum*) is often dominant in this edge vegetation and pampas is found in patches.

Near the **boat ramp** there is a narrow strip of sea rush and sea meadow (glasswort, remuremu and sea primrose), and a few small patches of saltwater paspalum (Figure 34).

SH25 leaves the harbour edge at the point where the saltmarsh vegetation becomes more diverse with the presence of shell banks. Banded rail footprints were seen in the vicinity of **Ohoni Stream** (Figure 35). The main shell bank extends west from Figure 35, fringed by coast spear grass and sea blite (Figure 36), with tall fescue, knobby clubrush (*Ficinia nodosa*) and other exotic grass species on the higher ground. A track from the highway leads to where outrigger canoes (waka ama) are stored on the shell bank near the stream. Sea rush and mangroves are present in the lower and wetter swales. Other sea meadow species also present in this area are buck's horn plantain and slender clubrush. Further west there is a large patch of saltmarsh ribbonwood near the pine trees (visible in Figure 37) where fernbird are present. Further west the shell bank supports coast spear grass, sea blite, glasswort and sea primrose (Figure 37). Mangroves inhabit the lower muddy flats and a thin band of sea rush is present along the landward edge (behind the shell bank) grading quickly into the brackish water species marsh clubrush (*Bolboschenus* sp.) and blue-green sedge. The shell bank continues west to join with the land edge and form a shelly beach along the outer harbour edges with no further estuarine vegetation except an isolated clump of mangroves within the outer most embayment.

During the 1998 survey, an infestation of spartina was mapped along the seaward edge of the central mangal. This patch has since been sprayed by DoC. During this current survey a small spartina plant was found (and pulled out) at this site at the junction where the watercourse splits in two around mangroves (Figure 38). Mangroves in the area are growing on submerged oyster beds along the watercourse edge. Figure 39 shows the seaward extent of the central mangal with the occasional lone tree out from the edge.

The central flats of the harbour are dominated by large beds of seagrass seaward of the mangrove fringe (Figures 39 and 40).



Figure 2: This photo is a near-repeat of the 1998 photo [17] in the second bay east of Hikurangi Point at the harbour mouth. Coast spear grass, glasswort, sea rush and saltmarsh ribbonwood dominate the shell bank and landward edge, while mangroves dominate the seaward flats.



Figure 3: This large sea blite colony is on a shell bank within the second sheltered mangrove-filled bay. The surrounding land is covered in coastal bush which includes kowhai, rata and puriri.



Figure 4: A few small plants of saltwater paspalum were found along the rocky outer western side of the third bay east of Hikurangi Point at the harbour mouth.



Figure 5: Tall mangroves at the back of a sheltered bay with saltwater paspalum beginning to establish in the sea meadow along the bay edge.



Figure 6: A close up of the sea meadow shown in Figure 5, showing saltwater paspalum amongst glasswort to the top right and sea primrose to the bottom left of the photo.



Figure 7: A large mangrove surrounded by seedlings. Rata, kowhai and puriri occur in the coastal forest on the land behind the mangal.



Figure 8: This photo shows the outer east side of the third embayment. The mangrove band stops in line with the shelter of the bay's headlands.

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Figure 9: Saltwater paspalum is growing over sea primrose on the eastern side of the fourth bay (east of Hikurangi Point at the harbour mouth).



Figure 10: The photo is a repeat of the 1998 photo [20], showing mangroves edging a cliff with kowhai, kanuka (*Kunzea ericoides*) and coastal astelia (*Astelia banksii*).



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Figure 13: The embayment on the northern side of the harbour near SH25 has a relatively intact estuarine/freshwater/coastal forest sequence. Cattle have access to the harbour (note grazed mangroves fringing the wide rush band). Wilding pines (*Pinus pinaster*, *P. radiata*) are in the coastal forest and willow in the freshwater wetland.



Figure 14: A pugged shingle outwash supporting sea meadow species and surrounded by sea rush landward and mangroves seaward.



Figure 15: A pugged area of the shingle out-wash plain (previous photo) showing sea meadow species and saltwater paspalum.



Figure 16: A close up view of Figure 15 showing sea primrose and saltwater paspalum.



Figure 17: A repeat of the 1998 photo [26]. The band of manuka in the mid-ground screens SH25 behind. Saltmarsh ribbonwood edges the harbour margin, with patches of sea primrose in open areas amongst the sea rush. Note the rock for reference in the mid-ground near a patch of raupo.



Figure 18: The site near a bend in SH25 where low-stature spartina is scattered between mangroves, sea rush and sea primrose



Figure 19: This photo is taken from the toe of a pampas-lined stopbank near a small pohutukawa. The near flats are covered with sea meadow patches (mainly glasswort with sea primrose and remuremu) and a patch of sea rush. Mangroves dominate the distant flats.



Figure 20: A view looking towards the road bend north of the long road straight. A band of old dead mangroves stand along the outer rush edge. Rush and mangrove mix in a transitional zone between the two communities.



Figure 21: A patch of spartina (orange green grass in middle left of photo) and tall fescue occur near swamp oak trees on the TRB bank of lower Te Mata Stream.



Figure 22: Cattle dung amongst spartina, sea rush, tall fescue and saltmarsh ribbonwood.



Figure 23: A view from the TLB of the lower Te Mata Stream looking over to the swamp oaks and spartina site shown in Figure 21. SH 25 is in the background.



Figure 24: Cattle tracks amongst saltmarsh along the banks of the lower Te Mata Stream. Banded rail and fernbird are present in this area.



Figure 25: A cow grazing in the saltmarsh (photo taken from a broken fence line). Swamp coprosma is common in behind the saltmarsh ribbonwood to the left.



Figure 26: This is a near-repeat of 1998 photo [14]. The gravel bank in the middle left of the photo is covered with sea primrose. The earlier 1998 photo was taken closer up from the middle of this photo so there is a greater expanse of shingle outwash plain, scattered mangroves and sea rush/saltmarsh ribbonwood ridge visible here.



Figure 27: This is a repeat of 1998 photo [15] still showing an open area with glasswort patches amongst sea rush. A ridge of saltmarsh ribbonwood and the back edge of the main central mangrove forest is in the background. Banded rail and fernbird are present here.



Figure 28: This photo shows stock tracking through the saltmarsh. This type of damage is extensive in Manaia Harbour.



Figure 29: Looking south over Manaia River at stock damage to the river banks and vegetation.



Figure 30: This photo shows a fence that has been flattened by flood debris, allowing stock direct access to the harbour.



Figure 31: This shows saltwater paspalum near its upstream limit, where it mixes with tall fescue (taller yellow green grass) and remuremu (lower bank edge).



Figure 32: This is a repeat of 1988 photo [22]. Glasswort, sea primrose, oioi and coast spear grass are still present on this bank. Sea rush and mangroves are found along the river edge.



Figure 33: This photo shows a narrow coastal bush edge next to SH25. Native species here include pohuehue, mahoe, hangehange, raupo, manuka, flax, mapou, karamu, silver fern and bamboo grass. Pampas and kikuyu grass are present also.



Figure 34: Small patches of saltwater paspalum occur along the seaward edge of sea rush between the boat ramp and jetty on the southern side of the harbour.



Figure 35: This photo is looking east from Ohoni Stream over a raised tongue of sea rush through stunted mangroves. The taller mangroves (left background) are lining the channel edge.



Figure 36: Sea blite occurs with coast spear grass along the edge of this shell bank. This picture is taken from the Ohoni Stream edge looking north-west along the curve of the shell bank.



Figure 37: This photo is looking east along a shell bank near the seaward extent of the mangrove band. Species present on the shell bank include coast spear grass, sea blite, glasswort and sea primrose.



Figure 38: A single live spartina plant was found here at the site mapped in 1998. The Department of Conservation has been controlling this weed.



Figure 39: A lone mangrove seaward of the main mangal edge with oysters growing around its base. Seagrass extends in to the main mangal edge either side of this mangrove.



Figure 40: The edge of a seagrass patch showing healthy plants.

3.3 Threats

There are three significant threats to the native estuarine vegetation communities of Manaia Harbour.

Stock

Where cattle have access to the estuarine vegetation they have damaged it directly through trampling and pugging. The trampling and pugging of estuarine vegetation also encourages the establishment of weeds such as saltwater paspalum. Weeds can be spread in the hooves of stock or by fragments being dislodged by stock. Pugging also creates habitat suitable for the Southern saltmarsh mosquito (*Aedes camptorhynchus*), for which there is currently an eradication programme on the Coromandel Peninsula. Stock increase harbour sedimentation via pugging and stream bank erosion, and they pollute water through faecal contamination. These effects can be detrimental to the habitat of threatened species of plants and animals in these areas.

Sedimentation

The sediment run-off from forestry clear-felling activities and stock access to stream banks will have increased suspended sediment levels entering the harbour above the natural level. Elevated suspended sediment levels can be detrimental to the health of seagrass beds and filter-feeding animals such as shellfish. Harbours are naturally infilling over time, although un-naturally high sediment levels entering the harbour can accelerate this infilling. This can result in relatively rapid changes to estuary bed heights, which in turn affects the vegetation communities that will grow there. In particular, elevated sedimentation can increase the amount of habitat suitable for mangrove colonisation over very short time periods.

Weeds

Estuarine weeds threaten the ecological integrity of the harbour vegetation communities and can lead to a loss of plant and animal biodiversity if they are allowed to dominate. Particular weed species of concern in Manaia Harbour are:

Saltwater paspalum – This grass can colonise vegetated and non-vegetated estuarine flats. It is extremely efficient at stabilising sediments and building up bed levels. Saltwater paspalum competes for space with native estuarine vegetation, often

smothering sea meadow, saltmarsh ribbonwood and rush/sedgeland communities to form dense mono-specific mats. Observations made in other Coromandel Peninsula harbours indicate that saltwater paspalum may also affect the health of landward mature mangroves. Saltwater paspalum mats on open mudflats may also enhance mangrove seedling settlement. Saltwater paspalum was found at 5 sites scattered around the harbour margins (see Figures 4, 8, 14, 30 and 33).

Spartina – The Department of Conservation (DoC) has been spraying the spartina patch found in the late 1990's in the middle of the harbour. During the current survey one healthy spartina plant was found at this site and pulled out (Figure 37). Two other new sites were found within the harbour, one about 100m from the main highway straight (Figure 20), and another immediately next to the road at the top of the bend north of the straight (Figure 17).

Swamp oak – This is a salt tolerant tree from Australia where it forms dense thickets in salt marshes. Two adult trees were noted along the stream edge in Figure 22 with seedlings nearby (a number of these were hand pulled). Wild swamp oak plants have also been noted in the saltmarsh ribbonwood zone in the nearby Coromandel Harbour.

Coastal edge weeds – Weeds of concern along the coastal edge (i.e. immediately above the saltmarsh ribbonwood zone) include wattle, wilding pine and pampas. These species can out-compete native coastal forest species and suppress natural regeneration of the forest along the harbour edge.

3.4 Birds

Birds seen or heard in the harbour environment during the survey include - White faced heron, kingfisher, fernbird, pukeko, pied shag, paradise duck, mallard duck. Banded rail footprints were often seen along the boundary between sea rush and mangroves.

4 Discussion and recommendations

Comparison of this survey's results with those of the 1998 survey will highlight any changes in the spatial extent of the estuarine vegetation communities. No significant changes were immediately apparent in the field except for an increase in area (and number of sites) of sea blite and saltwater paspalum. The 1998 survey found only one small patch of sea blite on the shell bank near the Ohoni Stream, however this current survey found a large and healthy population over a stretch of 50m of shell bank west of Ohoni Stream. Another large patch of sea blite was found in the second outer bay on the northern side of the harbour. This is most likely a new population as it seems unlikely such a large colony was overlooked in the last survey. This survey may show a decrease in the 'saltmarsh ribbonwood' community around the mouth of the Manaia River, as the 1998 survey included areas of coastal swamp forest (manuka, swamp coprosma, etc.) in the 'saltmarsh ribbonwood' community. The boundary for the change in vegetation community types has been more clearly defined in this survey.

Historically, the extensive native forest clearance (logging and burning) in the Manaia Harbour catchment would have delivered huge amounts of sediment into the harbour, and this would have encouraged the expansion of mangroves over the central harbour flats. The current main contributor of elevated sediment delivery to the harbour is most likely the plantation pine forestry in the upper catchments.

Where any stream and wetland edges are not protected from stock access they will be contributing sediment to the harbour, as well as elevated nutrient and faecal run-off. Fenced and well-vegetated riparian edges are efficient at stabilising banks and intercepting land run-off. The direct effects of stock access to the harbour are a

major concern. The saltmarsh communities in particular are highly significant, providing high biological diversity and habitat for threatened species.

Plant pests such as spartina and saltwater paspalum can severely threaten the functioning and biodiversity of estuarine ecosystems.

The following are recommended actions to maintain and restore the native estuarine vegetation communities of Manaia Harbour.

Develop a harbour catchment plan that considers the effects of catchment activities, and the current and potential threats on native estuarine vegetation communities. This includes the management of sediment and floodwaters from the catchment, floodplain management, stock management, weed management and the effects of projected sea level rise.

Undertake weed control for saltwater paspalum, spartina and swamp oak within the harbour.

Undertake a feasibility study to control wilding pines, willow, common alder, and wattle around the coastal harbour margins.

Encourage animal pest control around the harbour margins to protect the fernbird and banded rail, where there is community support to do so.

Aim to exclude all stock from the Coastal Marine Area and river margins. Provide assistance with fencing in difficult flood prone areas.

Encourage landowners to protect and restore pockets of historic coastal floodplain forest, and the native vegetation sequences from the sea to land.

Sea blite is an uncommon sea meadow species in Coromandel harbours. The local community should be informed about this species so that they can take care when parking their waka ama.

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Appendix 1 – GPS locations of figures

Figure No.	/wpt/@lat	/wpt/@lon
2	-36.8410	175.4490
3	-36.8409	175.4513
4	-36.8423	175.4530
5-7	-36.8410	175.4544
8	-36.8423	175.4545
9	-36.8401	175.4598
10	-36.8404	175.4606
11	-36.8402	175.4609
12	-36.8384	175.4714
13	-36.8383	175.4743
14-16	-36.8391	175.4743
17	-36.8393	175.4764
18	-36.8414	175.4774
19	-36.8436	175.4767
20	-36.8433	175.4782
21-22	-36.8444	175.4780
23	-36.8444	175.4778
24	-36.8460	175.4778
25	-36.8458	175.4757
26	-36.8434	175.4735
27	-36.8454	175.4738
28	-36.8461	175.4708
29	-36.8464	175.4719
30	-36.8463	175.4739
31	-36.8490	175.4727
32	-36.8458	175.4691
33	-36.8532	175.4643
34	-36.8517	175.4584
35	-36.8508	175.4562
36	-36.8509	175.4554
37	-36.8512	175.4519
38	-36.8455	175.4603
39	-36.8470	175.4559
40	-36.8472	175.4548