

Estuarine vegetation survey : Coromandel and Te Kouma Harbours

Prepared by:
Meg Graeme M.Sc (Marine Science)
Natural Solutions – Marine and Terrestrial Ecologists Ltd

For:
Waikato Regional Council
Private Bag 3038
Waikato Mail Centre
HAMILTON 3240

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Estuarine Vegetation Survey - Coromandel & Te Kouma Harbours

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Report prepared for:

Catherine Beard
Resource Information Group
Environment Waikato
PO Box 4010
HAMILTON EAST

Report prepared by:

Meg Graeme M.Sc (Marine Science)
Natural Solutions – Marine and Terrestrial Ecologists Ltd
RD 2
COROMANDEL 3582
Ph: (07) 866 0770
Email: natural.solutions@wave.co.nz

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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 surveyed harbours, Whangamata, Otahu, Wharekawa, Tairua, Manaia and Whitianga have been now been re-surveyed to determine changes in vegetation communities over time.

The mapped vegetation is within 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.

The estuarine vegetation of Coromandel and Te Kouma harbours was first mapped in 1998. This report details the results from a re-survey of estuarine vegetation in these two harbours. 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 surveys were undertaken over 5 days between the 15th and the 19th June 2009. The survey was undertaken using a combination of boating and walking. The same methodology for mapping saltmarsh, mangrove, seagrass and weed communities was followed as that previously used to map Coromandel Peninsula estuaries (e.g. see Graeme, 1998a), 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 aerals were used as a backup for when the PDA battery ran out, or sun lighting made it too difficult to see the PDA screen clearly in the field. Coded polygons were drawn directly onto the PDA aerial photographs to define the spatial extent of wetland vegetation types as they were ground-truthed in the field.

The upper saltwater influence is usually indicated by the upstream limit of oioi, saltwater paspalum 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:

1. **Saltmarsh** - a multi-species community in which three sub-communities are distinguishable in the Waikato Region. They are:
 - a) 'Rush/sedge community' – This is generally sea rush (*Juncus kraussii* subsp. *australiensis*), oioi (*Apodasmia similis*), and generally only common on the West Coast, three-square sedge (*Schoenoplectus pungens*). Marsh clubrush (*Bolboschoenus fluviatilis*) is commonly found up streams and rivers at the upper estuarine limit in some harbours, although it is not mapped within this survey as it is a species of brackish-freshwater.
 - b) 'Saltmarsh ribbonwood community' - Saltmarsh ribbonwood (*Plagianthus divaricatus*) dominates this zone, although rushes are often common giving a patchy appearance compared with the uniformity of the 'rush/sedge community'. Small areas of sea primrose (*Samolus repens*), remuremu (*Selliera radicans*), the coast spear grass (*Austrostipa stipoides*), and glasswort (*Sarcocornia quinqueflora*) can also be present.

- c) 'Sea meadow community' - This is devoid of tall plants such as rushes and saltmarsh ribbonwood, with the exception of coast spear grass. The sea meadow community can include sea primrose, remuremu, glasswort, , slender clubrush (*Isolepis cernua*), and arrow grass (*Triglochin striata*), and in more brackish areas bachelor's button (*Cotula coronopifolia*), leptinella (*Leptinella doica*) and sharp spike-sedge (*Eleocharis acuta*)
2. **Mangrove** (*Avicennia marina* subsp. *australasica*) – This is usually a monospecific community although seagrass, spartina (*Spartina* spp.), saltwater paspalum (*Paspalum vaginatum*) and sea meadow beds can sometimes be found underneath mature mangrove stands.
 3. **Seagrass** (*Zostera capricorni*) – This is usually a monospecific community, and is the vegetation which occurs at the lowest level in the tide.
 4. **'Weed community'** - In the Waikato Region the most significant estuarine weeds are saltwater paspalum and spartina. Both of these grasses generally grow in the open estuary and trap sediment, greatly increasing the harbour's infilling rate. These weeds also compete with the native wetland communities.

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

For the purpose of mapping, additional vegetation categories have also been added to more accurately portray the increasing prevalence of 'mixed' short-stature communities. Saltwater paspalum in particular is spreading and mixing with rush/sedge, sea meadow and saltmarsh ribbonwood communities. Where two differently layers co-exist (e.g. seagrass or saltwater paspalum under mangroves) these are mapped as individual layers.

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

Table 1: Check list of common estuarine plant species found in either Coromandel or Te Kouma Harbours.

| Common/Maori name | Scientific name | Estuarine Vegetation Community |
|--------------------------|--|---------------------------------------|
| arrow grass | <i>Triglochin striata</i> | sea meadow |
| coast spear grass | <i>Austrostipa stipoides</i> | sea meadow |
| glasswort | <i>Sarcocornia quinqueflora</i> | sea meadow |
| 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 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 spp.</i> | weed |

* denotes an exotic species

3. Field Notes

3.1 Coromandel Harbour

SUMMARY

The following observations provide a general overview of estuarine vegetation in the Coromandel Harbour following the field visit.

- There are extensive seagrass beds along the low-mid tide zone of the harbour.
- Large mangals (mangrove forests) are found within the main town embayment and between Preece's Point and the Waiau River mouth.
- Mangroves are relatively short, ranging in height from 0.5m – 4.0m.
- Chenier ridges are a characteristic of Coromandel Harbour, greatly enhancing the physical and floral diversity of the estuarine area. These are mobile features that form from coarse material (sand and shell) offshore in the harbour and move exonerably onshore.
- Wide beds of sea rush and oioi dominate sheltered areas behind mangroves and chenier ridges in the main town embayment and around the mouth of stream mouths between Preece's Point and Waiau River mouth.
- Narrow bands of saltmarsh ribbonwood occur along the landward edge of the mangrove and rush/sedgeland communities where they are not disturbed by land activities.
- In a few areas unaffected by farming, the saltmarsh ribbonwood zone grades 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*).
- Sea meadow communities of notable size are found on shingle outwash fans of rivers and streams. Sea meadow species present include glasswort, sea primrose, remuremu and coast spear grass.
- The main spartina sites identified in the previous survey have been successfully controlled. However small remnants at some of these control sites are still alive, and further small infestation sites were found.

- Saltwater paspalum is found scattered in small patches around much of the harbour.
- Saltwater paspalum generally occurs in small patches mixed most commonly with sea meadow, but also rush/sedge, mangrove or saltmarsh ribbonwood communities.
- The steeper margins of the harbour are predominantly covered in regenerating native bush. In contrast, the flatter areas are highly developed either as urban areas or for agriculture.
- Stock access into the CMA is an issue just north of the Waiau River mouth, on the seaward flats near the airfield, and on the flats beside the turn-off to Wyuna Peninsula.
- Many of the stream banks upstream of the CMA are not adequately fenced to restrict stock pollution entering the waterways and harbour.

SITE DESCRIPTION

Coromandel Harbour is described clockwise from the north (Wyuna Peninsula). 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. True left bank (TLB) and true right bank (TRB) refer to the side of a river when facing downstream.

There is very little estuarine vegetation along the harbour side of **Wyuna Peninsula** except for a couple of mangroves. Exposed bedrock and cobble substrate is common. Mangroves are not found in any significant density until the junction of the Peninsula with the mainland. Inland across the causeway is the '**Long Bay wetland**'. This wetland is hydrologically altered by the causeway and associated floodgate. The wetland here is dominated by rushland with mangroves along the waterways. Areas of sea rush uprooted by pukeko were found (Figure 2). Glasswort and sea primrose communities occur in open patches amongst the sea rush. To the east and south of the Long Bay wetland, saltmarsh ribbonwood lines higher ground before being truncated by farmland. The tidal influence is reduced to the south end of the wetland where flax, tall fescue and pampas become common amongst the rushland (Figure 3). Casuarina and common alder were noted within the wetland, which is a concern as they can become a weed problem.

Seaward of the causeway, a narrow band of mangroves lines the armoured coastline around to the oyster processing factory. Inappropriate disposal of inorganic and garden rubbish is a big issue in this area (see Figure 4). Mangroves extend around the foreshore to the wharf. Mangroves then are not encountered until **Jack's Point** where the main town mangal (mangrove forest) starts. There is little back-swamp vegetation due to the reclamation that abuts up hard into the mangroves. Infilling is still continuing here with a number of small sites found where sediment had been dumped into the mangrove edge (see Figure 5 and Figure 6).

South of the **Whangarahi Stream** mouth, a diverse estuarine vegetation sequence develops. An extensive area of seagrass occurs between the low to mid tide level, extending almost to Preece's Point and inland between the two main mangals (on the southern outwash fan of the Whangarahi Stream mouth and either side of the Huaroa Stream mouth). New Zealand dotterel were noted feeding on the open sandy mudflats and inshore patchy seagrass beds. Banded rail footprints were seen along and within the outer mangrove edge. Behind the protection of the mangroves is a mosaic of rush/sedgeland, sea meadow, spartina and saltwater paspalum communities. The largest areas of sea meadow are found on open shingle outwash fans (Figure 7) and chenier banks (Figure 8). Scattered mangroves occur within the outer rush/sedgeland fringe presumably where waves have washed seedlings in. Spartina has been sprayed

here (Figure 9 and Figure 10), and there has generally been a good kill with only scattered plants still remaining within the sprayed areas (e.g. Figure 11). In some cases, mangroves have colonised the raised beds left behind by the sprayed spartina, and have also established in the lee of spartina patches (e.g. Figure 12). A number of small uncontrolled spartina sites were also found. Saltmarsh ribbonwood is found as thin bands along the back of the rush/sedgeland from the Whangarahi Stream around to the base of Preece's Point. Fernbird were heard within the saltmarsh ribbonwood. A remnant patch of manuka swamp still survives as a point extending out into the harbour but is threatened by the infilling that has occurred around it.

At the mouth of the **Huaroa** and neighbouring streams a mosaic of freshwater and estuarine species intermingle behind the main mangal (Figure 13). A large area of straggly glasswort is mixed with short mangroves, before the open mud flats at the junction with **Preece's Point**. Along the side of Preece's Point and behind the open mudflats is a band of rushland that grades into freshwater coastal swamp forest (Figure 14). The common species here are coastal daisy, swamp coprosma, manuka and cabbage trees. More chenier ridges occur along the edge of Preece's Point. Figure 15 shows coastal spear grass dominating a chenier with saltwater paspalum along the lower edge of the chenier. Patches of saltwater paspalum here were frosted. Saltmarsh ribbonwood is present amongst the rushland behind the cheniers. The estuarine vegetation narrows dramatically at the westward end of the cheniers, with only sporadic patches of sea rush, oioi or a few mangroves noted along the outer coastal edge of the point. Aquaculture development has infilled some of the CMA and created an artificial edge (Figure 16).

Around Preece's Point to the south is an embayment that is characterised by active and relict chenier ridges. To the north of the main stream channel, open mud flats separate the heavily vegetated relict cheniers (Figure 17). The outer active cheniers are still moving landward and generally have sparse vegetation and an eroding seaward edge (Figure 18). Scattered patches of spartina occur along the channel edge of the main stream (Figure 19) or between the mangrove and rush zones of the southern side of the embayment. The coastal edge is affected by neighbouring land uses around the north-eastern edge of the embayment. Figure 20 shows tyres and cars dumped along the coastal edge and within the CMA, while Figure 21 show infilling of the coastal edge. Cat and banded rail footprints were noted in the vicinity of Figure 20. Banded rail footprints were commonly seen around the southern half of the embayment amongst mangroves. Stock have historically had access to the entire embayment but are now fenced out, with the exception of the seaward land edges at the mouth of the **Waiau River**. Here, stock have preferentially grazed mangroves and pugged the harbour sediments (Figure 22). Stock are also known to preferentially graze spartina and saltwater paspalum, increasing the risk of spreading these weeds. Figure 23 shows saltwater paspalum mixed with sea primrose, however, saltwater paspalum is not highly prevalent yet in the area. Sea rush,

coast spear grass, glasswort, spartina and saltmarsh ribbonwood are all present at the mouth of the Waiau River. A large patch of seagrass occurs offshore between Preece's Point and the Waiau river channel.

South of the Waiau River much of the relict chenier ridge complex is farmed, including the low-lying swales with sea rush and sea meadow (Figure 24). The land edge is often eroded where it is not buffered by mangroves or a chenier. There are active cheniers offshore with large seagrass beds generally seaward, and mangroves landward within their shelter (Figure 25). Around the mouth of a stream, a dense mangal has established. Sign of small-scale mangrove clearance is evident along the inner northern edge. Along the southern bank of the stream mouth, tall fescue grades into knobby clubbrush, sea rush and oioi, which grades into sea meadow. The lower tidal limit of the sea meadow is invaded by saltwater paspalum, which in turn grades into mangroves (Figure 26). Nearby is a patch of dead mangroves with no obvious reason for their death (Figure 27). Spartina is also intermingled with the mangroves and sea meadow here. A patch of grass/sedge was found at the mouth of a small stream south of Figure 27. This could be the invasive *Carex divisa*, but without a seed head it was hard to identify.

Further south a narrow stretch of land lies between the state highway and the coastal edge. There are only a few mangroves here and the coastal edge is subsequently open to erosion. Concrete rubble has been placed along this eroded edge (Figure 28). A high mound of sediment with decaying root masses is still present where a large spartina patch was sprayed. Mangroves are more prevalent around the mouth of the **Awakanae Stream**. The oyster farm base is sited on the TLB of the stream. Activity and storage of equipment directly on the coastal edge has resulted in the loss of the saltmarsh ribbonwood zone (Figure 29).

Seagrass beds (of varying patchiness) extend along from the oyster factory point to the offshore cheniers out from the **Te Kouma Road turnoff**. Mangroves extend out either side of stream channels and shingle fans, either surrounded with deep mud and oysters (Figure 30) or as scattered old trees (Figure 31). The farmland beside the road turnoff has included the inland chenier complex so that the estuarine vegetation here is grazed and sediment pugged (Figure 32). Estuarine vegetation then only occurs in small scattered patches out towards Te Kouma settlement.

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





Figure 2: Patches of sea rush were found pulled up by pukeko in the Long Bay wetland. Here mangroves line a minor watercourse through the rushland.



Figure 3: Rushland at the south end of 'Long Bay wetland' becomes interspersed with tall fescue, flax and pampas as the tidal influence reduces.



Figure 4: Plastic rubbish, machinery, metal and weeds form the coastal edge around housing and the oyster processing plant.



Figure 5: Mud (cleared from the boat ramp?) dumped along the mangrove edge over a thin sea meadow zone.



Figure 6: More sediment dumped along the edge of mangroves.



Figure 7: Sea meadow (including sea primrose and glasswort) are common on these coarse outwash fans. The light green grass was unidentified but could be young saltwater paspalum.



Figure 8: Native iceplant, glasswort and knobby clubrush on a chenier bank.



Figure 9: The eroding frontal edge of a sprayed spartina patch that established either side of a chenier.



Figure 10: A sprayed spartina patch showing the level of sediment build up within the root mass. Mangroves are also common around the edge of the spartina patch and rushland behind where their seedlings would have been washed and lodged by the tides.



Figure 11: Spartina has invaded a small patch (~8x6m) of rush/sedgeland and scattered mangroves.



Figure 12: Mangroves established in the lee of a spartina patch (now sprayed and disintegrating).



Figure 13: A mosaic of marsh clubrush, *Baumea juncea*, giant umbrella sedge, bachelors button, mercer grass, oioi, mangroves, saltmarsh ribbonwood, pampas and casuarinas are found near the mouth of the Huaroa Stream.



Figure 14: scattered mangroves and a band of sea rush front coastal swamp forest (coastal shrub daisy, swamp coprosma, manuka and cabbage trees).



Figure 15: Silver spear grass on a chenier with saltwater paspalum (some frosted) in the foreground.



Figure 16: The northern side of Preece's Point generally has steep edges to the harbour and as shown here infilling and an artificial edge around the land base aquaculture site.



Figure 17: View over relict chenier ridges with coastal forest and wilding pine along Preece's Point as a backdrop.



Figure 18: An eroding outer chenier edge. Mangroves and sea rush are eroding out of the front of the chenier as it moves landward.



Figure 19: Spartina growing under tall mangroves along the lower bank of the stream channel immediately south of Preece's Point.



Figure 20: Dumped cars and tyres along the harbour edge.



Figure 21: Fill being placed along the coastal edge into oioi and mangroves.



Figure 22: Mangroves have been selectively grazed out here and the ground deeply pugged.



Figure 23: Saltwater paspalum (light green) invading sea primrose (bronze low vegetation). Sea rush, coast spear grass and glasswort are also present at the mouth of the Waiiau River.



Figure 24: The remnant chenier complex near the Coromandel airfield is partially being farmed. This photo shows the effect of grazing on the estuarine vegetation.



Figure 25: A shell chenier moving onshore over mud flats. Mangroves have established along the mainland edge sheltered by the chenier.



Figure 26: This photo shows a coastal sequence from mangroves to saltwater paspalum, which then intermingles with sea meadow (remuremu, sea primrose and arrow grass, then sea rush, oioi and knobby rush, with tall fescue on the higher ground.



Figure 27: Spartina is present between the patch of dead mangroves and live mangroves and extends inland into sea meadow.



Figure 28: Concrete rubble has been dumped along this section of eroding coastal edge where mangroves are not present to buffer the wave energy. Note the old fence line and gravel ridges.

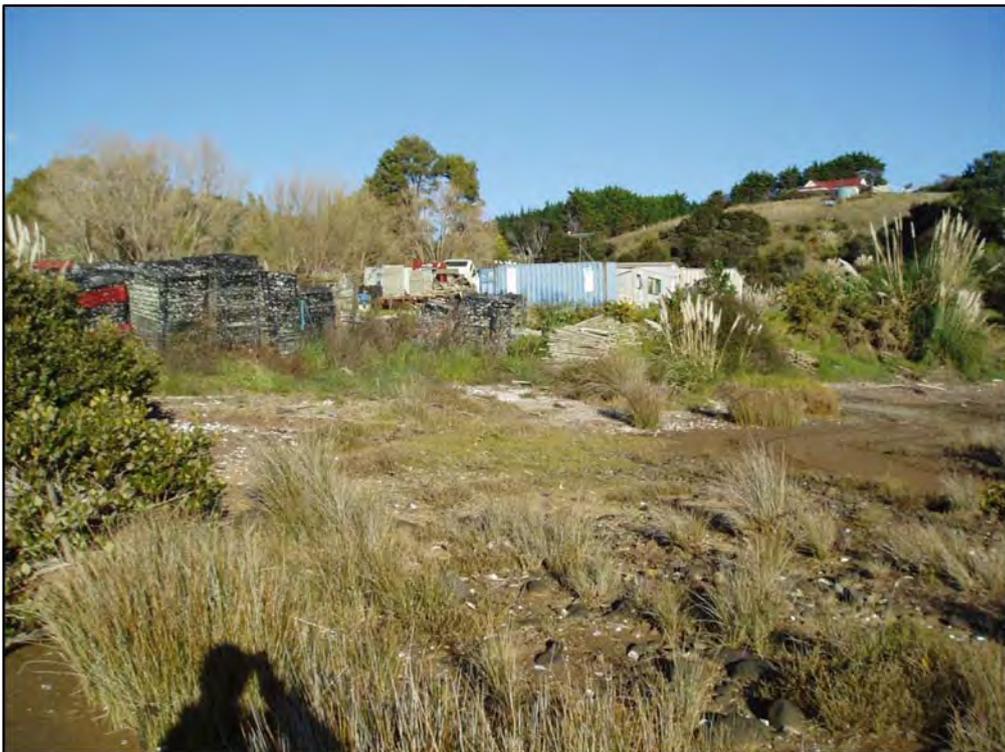


Figure 29: Activity here is associated with oyster farming. Note the inappropriately placed equipment right on the foreshore over the saltmarsh ribbonwood zone.



Figure 30: Pacific oysters amongst mangrove pneumatophores (breathing roots).



Figure 31: Old mangroves with eroded bases probably due to a combination of chenier landward movement and wave erosion.



Figure 32: Grazing within the CMA beside the Te Kouma Road turnoff.

3.2 Te Kouma Harbour

SUMMARY

The following observations provide a general overview of estuarine vegetation in the Te Kouma Harbour following the field visit.

- Seagrass is generally restricted to the upper mid-tide flats above the oyster racks.
- The only extensive mangal (mangrove forest) is found at the head of the harbour.
- Mangroves range in height from 0.3m - 0.5m dwarf plants at the back of the mangal to taller trees of up to 6m high along the seaward mangal edge. Other scattered mangroves further out around the harbour are generally 1-3m tall.
- A wide band of sea rush and oioi occurs behind the main mangal.
- Very little saltmarsh ribbonwood was found.
- The main estuarine wetland at the head of the harbour extends into two freshwater wetland arms. These were dominated by raupo, manuka or willows.
- Small patches of sea meadow are scattered around the inner harbour along the land edge. These communities are often sheltered by mangroves. Sea meadow species present include glasswort, sea primrose, remuremu, arrow grass, slender clubrush, bachelors button and a few coast spear grasses.
- No spartina was found.
- Small patches of saltwater paspalum occur, often mixed with sea meadow species.
- The southern margins of the harbour are predominantly covered in regenerating native bush. The coastal forest is characterised by pohutukawa and kowhai. In contrast, the northern side of the harbour is used for farming and only thin fringes of coastal forest remain along steep banks.
- Stock access into the CMA is an issue along the northern side of the harbour.

SITE DESCRIPTION

Te Kouma Harbour is described clockwise from the harbour mouth. See Figure 33 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. True left bank (TLB) and true right bank (TRB) refer to the side of a river when facing downstream.

A boulder bank and pa site marks the northern entrance to the harbour (Figure 34). Only the occasional small mangrove occurs along the rocky northern outer bays. A family of seven bottlenosed dolphins (with a young animal) were encountered out here. No other estuarine vegetation was noted until the main mangal at the head of the harbour. Farm fencing needs addressing here as stock have free access to the CMA. Figure 35 shows an area of CMA which is pugged and grazed by stock.

Sea meadow occurs along the land edge and either side of the stream channel draining the northern end of the wetland (Figure 38). The sea meadow and mangroves grade into some sea rush, a few bushes of saltmarsh ribbonwood and then freshwater wetland and a patch of coastal forest. Figure 36 shows a sedge (the invasive *Carex divisa*?) at the freshwater boundary with the estuary. Saltwater paspalum is present amongst the sea meadow and under mangroves (Figure 37). It appears the saltwater paspalum out in the open has been frosted, with the majority of the plants looking dead, although the sea meadow species seem to have been unaffected.

A band of sea rush and oioi extends around to a pine island (Figure 39) and into the southern half of the main wetland. A raupo and manuka wetland, invaded by willow, occurs landward of the rush/sedgeland (Figure 40). Open dwarf mangroves (~0.3-0.5m high) occur seaward of the rush/sedgeland, grading into taller mangroves ~6m high along the seaward edge of the mangal. A shell chenier ridge shelters mangroves behind it (Figure 41). Banded rail footprints were seen in the mangroves here.

Heading seaward along the southern coastline, scattered individual mangroves occur until a small embayment west of the aquaculture boat ramp. The embayment has mangroves backed by a shell beach which supports saltmarsh ribbonwood, scattered patches of sea rush, and dense beds of glasswort and remuremu backed by coastal forest (Figure 42). Buffalo grass is invading the sea meadow communities here.

Figure 33: Te Kouma Harbour site localities mentioned in this report. The numbers refer to the location of the following figures.





Figure 34: A boulder beach and old pa site at the mouth of Te Kouma harbour.



Figure 35: Uncontrolled stock access to the CMA has resulted in pugging, vegetation disturbance and bank erosion along the northern side of the harbour.



Figure 36: The invasive *Carex divisa*? along the salt-freshwater interface (note the yellow-green bachelors button in the foreground).



Figure 37: Frosted saltwater paspalum intermixed with sea meadow is backed by sea rush and then saltmarsh ribbonwood before grading into regenerating coastal forest.



Figure 38: Sea meadow (sea primrose, remuremu, slender clubrush, arrow grass and bachelors button) forms a carpet backed by oioi and sea rush.



Figure 39: A lone wilding pine grows on a spit protruding into an open mangrove zone.



Figure 40: View over mangroves and sea rush to a raupo, manuka and willow freshwater swamp.



Figure 41: This shell chenier ridge provides shelter for mangroves to establish in its lee. Banded rail footprints were found in the mangroves here.



Figure 42: This shell beach collects a lot of driftwood and supports saltmarsh ribbonwood, sea rush, glasswort, remuremu and is being invaded by buffalo grass. Mangroves are found seaward and within the beach complex. The coastal forest is characterised by kowhai and pohutukawa.

3.3 Threats

There are three significant existing threats to the native estuarine vegetation communities of Coromandel and Te Kouma Harbours.

Weeds

Estuarine weeds such as spartina and saltwater paspalum can dominate large areas of the intertidal harbour at the expense of native estuarine vegetation and wildlife habitat. There will be further degradation of native intertidal vegetation communities if they continue to expand, including the loss of plant and animal biodiversity. It is therefore encouraging to see the successful control of spartina in Coromandel Harbour by the Department of Conservation. Such control work needs ongoing monitoring and follow-up control.

Saltwater paspalum has not yet established large infestations in either harbour. This weed is of particular concern as it can grow amongst all of the estuarine vegetation communities. Saltwater paspalum is an introduced grass that, like spartina, is extremely efficient at stabilising sediments and building up bed levels, which can affect flood control in the area. Saltwater paspalum competes for space with native estuarine vegetation and colonises open mudflats. Due to its climbing ability and formation of dense beds up to half a metre deep, it can smother sea meadow, saltmarsh ribbonwood and rush/sedgeland communities to form dense mono-specific mats. Observations made in other Coromandel Peninsula estuaries and harbours indicate that saltwater paspalum may also affect the health of mature mangroves. Saltwater paspalum mats on open mudflats may also enhance mangrove seedling settlement in open areas.

Currently no control of saltwater paspalum is being undertaken in Coromandel or Te Kouma Harbours.

Spartina is widely present (although in reduced area following the control programme) throughout Coromandel Harbour. Spartina was not found in Te Kouma Harbour. Spartina is an introduced grass that can colonise vegetated and non-vegetated estuarine flats. It is extremely efficient at stabilising sediments and building up bed levels. Spartina competes for space with native estuarine vegetation (e.g. mangroves and rush/sedgeland) or changes an open mudflat into a vegetated flat.

The Department of Conservation has been controlling spartina in other Coromandel estuaries by spraying the grass with the grass-specific herbicide Gallant.

Coastal edge weeds – The usual weeds of concern are found scattered along the coastal edge (i.e. immediately above the saltmarsh ribbonwood zone). These include pampas, wattle, wilding pine and tall fescue. These weeds can suppress natural regeneration of the native communities along the harbour edge, and break the contiguity of estuarine to freshwater/terrestrial native vegetation sequences.

Stock

Stock still have access to the CMA north of the Waiau River mouth, in places along from the Coromandel airfield, and at the turnoff to Te Kouma settlement. Where stock have access to estuarine vegetation they have damaged it directly through trampling and pugging. Disturbance encourages the establishment and spread of weeds such as saltwater paspalum. Pugging creates habitat suitable for the Southern saltmarsh mosquito (*Aedes camptorhynchus*), for which there is recently been an eradication programme on the Coromandel Peninsula. Stock also increase the levels of sedimentation in the estuary via pugging and stream bank erosion, and they pollute water with faecal matter.

Infilling

Infilling around the Coromandel town coastal edge and south of Preece's Point is an ongoing issue. Rare remnant coastal swamp forest/scrub is particularly threatened by infilling. No further infilling should be allowed to occur, and opportunities taken to restore lost wetland areas wherever possible.

3.4 Birds

Birds seen or heard in the Coromandel and Te Kouma harbour environment during this survey include: white-faced heron, kingfisher, New Zealand dotterel, variable oystercatcher, fernbird, banded rail, pukeko, pied shag, paradise duck, mallard duck.

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. The decrease in spartina cover following control work will be noticeable.

Chenier ridges are a characteristic estuarine feature of Coromandel Harbour. They form from coarse material e.g. shell and move slowly inland to eventually join up with the mainland. New ridges continually form out in the harbour to repeat the process.

Excessive sedimentation of the harbour is an ongoing issue for the harbours. This could be relatively simply addressed for Te Kouma Harbour which already has a good proportion of its coastal and stream margins protected and vegetated. Fencing of the coastal margin and any streams and wetlands/seepages on the Te Kouma peninsula farm would address the sedimentation issues arising from that property. Coromandel Harbour however has many varied and wide spread land activities that are contributing to the elevated sediment levels entering the harbour. The protection of waterways and wetlands throughout the harbour catchment is needed whether the land is used for housing, agriculture or forestry.

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

General:

1. Continue encouraging and requiring the protection of riparian edges to limit bank erosion and land run-off of sediment and nutrients. In particular, all of the Coastal Marine Area adjacent to farmed land needs to be fenced.
2. Stop infilling, and restore natural edge wherever there is an opportunity.
3. Undertake a feasibility study to control saltwater paspalum within both harbours.
4. Encourage property owners and community groups to control wilding pines, willow, wattle and other weeds around the coastal harbour margins.
5. Encourage animal pest control around the harbour margins to protect estuarine wildlife (New Zealand dotterel, oystercatcher, fernbird, bittern and banded rail populations) where there is property owner and/or community support to do so.
6. Encourage landowners to protect and restore pockets of historic coastal wetland and floodplain forest.
7. Identify the sedge found south of Figure 27 (Coromandel Harbour) and in Figure 36 (Te Kouma Harbour) to determine whether it is the highly invasive *Carex divisa*.

Coromandel:

8. Look at weed control options for 'Long Bay wetland' including opening the floodgate to restore the natural extent of saltwater influence (and thus excluding terrestrial plants such as pampas); followed by herbicide spraying of the southern end with Gallant to control any remaining exotic grasses and pampas.
9. Plant the seaward edge of the town reclamation with flax and scattered taller trees such as pohutukawa, karo and ngaio to enhance the natural character of this highly modified area.
10. Investigate restoring native vegetation along the low-lying coastal edge between Strongman Road and Huaroa Street.
11. Support community pest control initiatives – particularly on chenier ridges and the coastal margin to protect wading and marsh birds. A stripped oystercatcher carcass was found out from Strongman Road.
12. Work with landowners to protect and restore degraded estuarine areas north of the Waiau river mouth and at the turnoff to Te Kouma settlement.
13. Monitor the shingle fan shown in Figure 7 to determine the species of the light green grass/sedge and its interaction with the sea meadow species also present.

Te Kouma:

14. Work with the landowner/s to protect and restore the degraded northern coastal edge.

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Appendix 1 – GPS locations of figures

Figure

| No. | Latitude | Longitude |
|------------|-----------------|------------------|
| 2 | 175.4801 | -36.7521 |
| 3 | 175.4818 | -36.7526 |
| 4 | 175.4862 | -36.76 |
| 5 | 175.4921 | -36.7623 |
| 6 | 175.4938 | -36.7618 |
| 7 | 175.496 | -36.7627 |
| 8 | 175.497 | -36.7647 |
| 9 | 175.4969 | -36.7674 |
| 10 | 175.4976 | -36.7647 |
| 11 | 175.4971 | -36.7688 |
| 12 | 175.4961 | -36.7671 |
| 13 | 175.5007 | -36.769 |
| 14 | 175.4985 | -36.7733 |
| 15 | 175.4968 | -36.773 |
| 16 | 175.4934 | -36.7747 |
| 17 | 175.5035 | -36.7804 |
| 18 | 175.4987 | -36.7804 |
| 19 | 175.504 | -36.7815 |
| 20 | 175.5093 | -36.7801 |
| 21 | 175.5096 | -36.7805 |
| 22 | 175.5069 | -36.7842 |
| 23 | 175.5058 | -36.7864 |
| 24 | 175.504 | -36.7894 |
| 25 | 175.5003 | -36.7904 |
| 26 | 175.5053 | -36.7943 |
| 27 | 175.5053 | -36.7947 |
| 28 | 175.5031 | -36.7979 |
| 29 | 175.4996 | -36.7988 |
| 30 | 175.4937 | -36.8043 |
| 31 | 175.4932 | -36.8066 |
| 32 | 175.4929 | -36.8073 |
| 34 | 175.4241 | -36.8254 |
| 35 | 175.4626 | -36.8276 |
| 36 | 175.4655 | -36.8284 |
| 37/38 | 175.4658 | -36.8284 |
| 39 | 175.465 | -36.8292 |
| 40 | 175.4643 | -36.8301 |
| 41 | 175.4605 | -36.8321 |
| 42 | 175.4474 | -36.8329 |

Appendix 2 – GPS locations of spartina sites

| Latitude | Longitude |
|-----------------|------------------|
| 175.4976 | -36.7647 |
| 175.4961 | -36.7671 |
| 175.4974 | -36.7681 |
| 175.4971 | -36.7688 |
| 175.4982 | -36.768 |
| 175.509 | -36.7822 |
| 175.5086 | -36.782 |
| 175.5084 | -36.7819 |
| 175.5077 | -36.782 |
| 175.5077 | -36.7819 |
| 175.5082 | -36.7823 |
| 175.5067 | -36.7843 |
| 175.5055 | -36.7854 |
| 175.5061 | -36.7859 |
| 175.5068 | -36.7816 |
| 175.5066 | -36.7818 |
| 175.5066 | -36.7821 |
| 175.5067 | -36.7825 |
| 175.5063 | -36.7826 |
| 175.5062 | -36.7828 |
| 175.5039 | -36.7814 |
| 175.5037 | -36.7816 |
| 175.5036 | -36.7821 |
| 175.5032 | -36.7833 |
| 175.5031 | -36.7834 |
| 175.5033 | -36.784 |
| 175.5033 | -36.7843 |
| 175.5036 | -36.7845 |
| 175.5039 | -36.7896 |
| 175.5056 | -36.7928 |
| 175.5053 | -36.7947 |
| 175.5052 | -36.7949 |
| 175.5044 | -36.7962 |
| 175.5021 | -36.7966 |