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Estuarine Vegetation Survey

Waikawau Estuary

December 2008

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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, Wharekawa, Tairua and Manaia have 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 saltmarsh, mangrove, seagrass, and weed 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.

It was recently decided to add Waikawau Estuary to the monitoring list due to its high wildlife values and the community support. This report details the results from the first spatial mapping survey of estuarine vegetation in the Waikawau Estuary. 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 completed over 3 days on the 20th, 21st and 26th November 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. 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 saltwater paspalum, 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:

   a) **'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.

   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, 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 community'** - 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 Waikawau Estuary following the recent field visit.

- There is only one small seagrass bed in the estuary.
- Mangroves are generally restricted to along the Waikawau River and Waikanae Stream edges, but they are also establishing and expanding in extent along raised banks on the mid-tidal flats. Mangroves range in height from 0.5-2m, with the occasional tree estimated at 3m in height.
- Extensive sea rush and oioi beds occur in the relative shelter of landforms or mangroves in the upper estuary.
- Sizeable sea meadow communities are found along stream edges and fringing the outer rush/sedgeland edge; in patches amongst rush/sedgeland or on sand banks. Sea meadow species present include glasswort, sea primrose, remuremu and coast spear grass.
- Saltwater paspalum was found throughout most of the estuary and is invading large areas of rush/sedgeland, and is often intermingled with sea meadow communities.
- Spartina is common within the Waikanae Stream embayment, and a few smaller sites occur along the lower rush/sedgeland margins inland of the true left bank (TLB) of the Waikawau River mouth.
- East of the Waikanae Stream embayment, the estuary margin is more exposed to the coastal elements and is characterised by pohuehue (*Muehlenbeckia complexa*), sand convolvulus (*Calystegia soldanella*.) and knobby clubrush (*Ficinica nodosa)* further out towards the estuary mouth.
- The rush/sedge land communities have behind them sometimes extensive saltmarsh ribbonwood zones that extend back into freshwater swamp communities (where the sequence is not truncated by farming activity).
- The blue-green sedge *Baumea juncea* is commonly intermingled with the inland extent of oioi and sea rush, and also mixed with saltmarsh ribbonwood.
- The coastal shrub daisy *Olearia solandri* often occurs at the back of the saltmarsh ribbonwood zone.
- In most cases the extent of the estuarine influence is restricted inland by farming activities, although remnant patches of estuarine and freshwater vegetation indicates the extent of the historical natural vegetation community.

- The most unmodified and ecologically significant sequence from estuarine to freshwater communities occurs along the true right bank (TRB) of the Waikawau River downstream of the Waimanu Road bridge.
- Where the sequence is intact, estuarine vegetation grades into freshwater swamp characterised by manuka (*Leptospermum scoparium*), flax (*Phormium tenax*), cabbage tree (*Cordyline australis*) and toetoe (*Cortaderia fulvida).*
- Pampas (*Cortaderia selloana*) is a significant weed species of the upper estuarine edge as well as in the coastal freshwater wetland areas.
- There is little stock access into the CMA except where fencing includes highly tidal land within paddocks.

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

See Figure 1 for a map showing place names and figure numbers that are mentioned in the following text. A table of GPS waypoints of the figure locations is in Appendix 1.

Table 1: Common estuarine plant species found in Waikawau Estuary.

Common/Maori name	**Scientific name**	**Estuarine Vegetation Community**
buck's horn plantain *	*Plantago coronopus*	sea meadow
coast spear grass	*Austrostipa stipoides*	sea meadow
glasswort	*Sarcocornia quinqueflora*	sea meadow
mangrove	*Avicennia marina* subsp. *australasica*	mangrove
oioi	*Apodasmia similis*	rush/sedge
remuremu	*Selliera radicans*	sea meadow
saltmarsh ribbonwood	*Plagianthus divaricatus*	saltmarsh ribbonwood
saltwater paspalum *	*Paspalum vaginatum*	weed
sea primrose	*Samolus repens*	sea meadow
sea rush	*Juncus krausii* subsp. *australiensis*	rush/sedge
seagrass	*Zostera capricorni*	seagrass
slender clubrush	*Isolepis cernua*	sea meadow
spartina *	*Spartina* spp.	weed

* denotes an exotic species

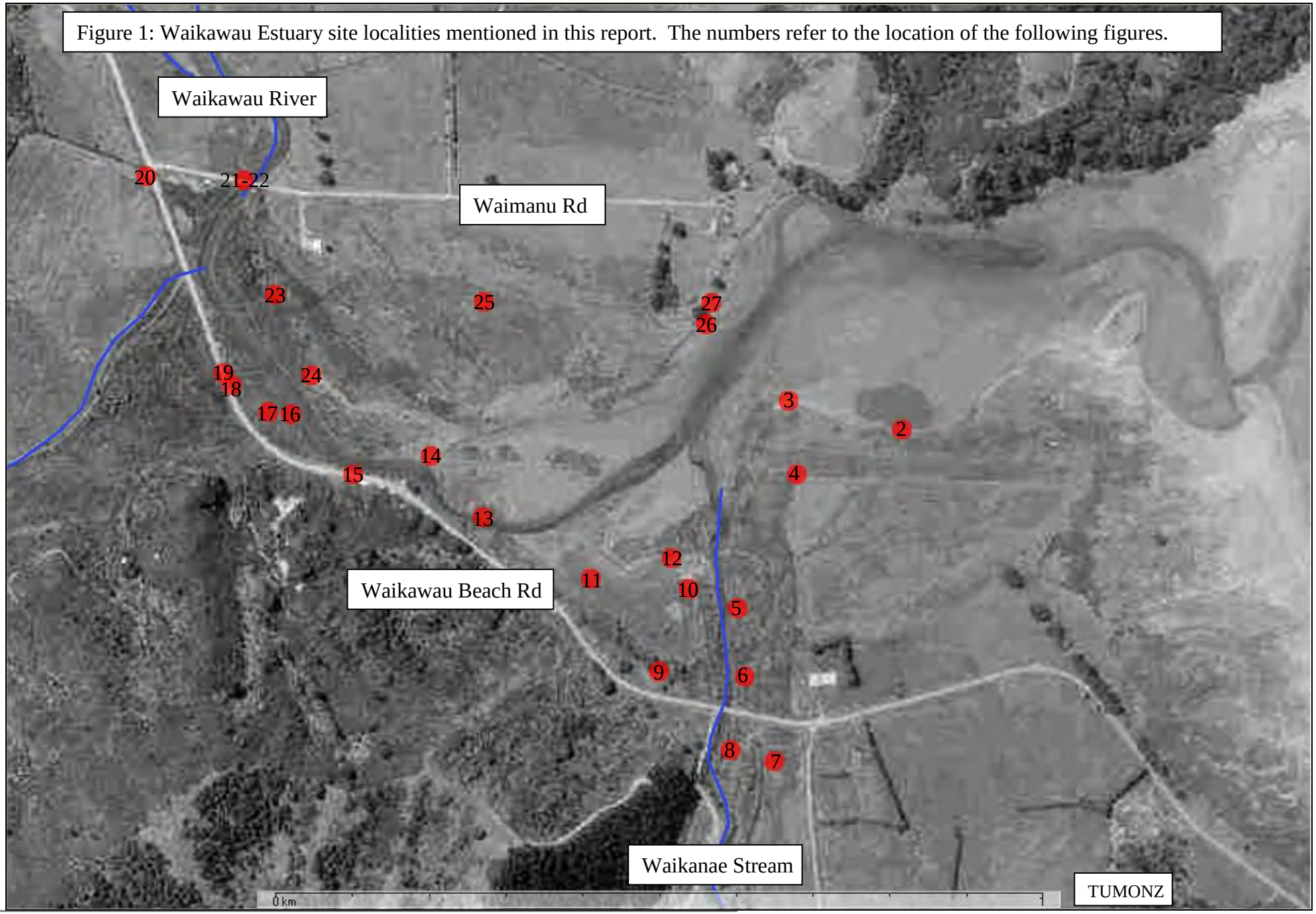

Figure 1: Waikawau Estuary site localities mentioned in this report. The numbers refer to the location of the following figures.

3.2 Site descriptions

Waikawau Estuary is described clockwise from the estuary mouth. See Figure 1 for a map showing place names and figure numbers mentioned in the text. A table of GPS points of the figure locations is in Appendix 1.

The first occurrence of estuarine vegetation is behind the shelter of the main beach dunes and is a thin band of sea meadow along the foreshore with a patch of rushland behind in low-lying swales within the paddock. Figure 2 shows a section of coastal fringe that has been sprayed with Gallant, a grass-specific herbicide used to control spartina. Saltwater paspalum was present but has died back, allowing the sea meadow species to dominate. Outside the sprayed zone the saltwater paspalum dominates the sea meadow. Out on the open tidal flats is the remnant of a large spartina patch that has been sprayed with Gallant by the Department of Conservation. A few spartina plants survive. Figure 3 shows the introduced sickle grass (*Parapholis incurva*) and saltwater paspalum together with knobby clubrush (*Ficinia nodosa*) and shore bindweed (*Calystegia soldanella*) covering a sand bank. These species (apart from the saltwater paspalum) are not mapped as 'estuarine' as they are more characteristic of loose dune sand and the open rocky coast.

Around the corner towards the south is the mouth of the **Waikanae Stream**. This embayment has extensive areas of rush/sedgeland, with pampas dominating higher or disturbed ground above scattered patches of saltmarsh ribbonwood. Some inland estuarine areas along the TRB are included within paddocks (Figures 4 and 7). Several fernbird were heard in this area. Saltwater paspalum is common along the stream edge and extends into the rush/sedgeland in places. Spartina is also common, particularly along the TRB and up half of the excavated 'curved' water course (Figure 5). Mangroves extend some of the way up the river bank.

A few kowhai (*Sophora chathamica*) are found growing at surprisingly low levels amongst pampas and saltmarsh ribbonwood (Figure 6). Coastal shrub daisy is commonly found mixing with the landward saltmarsh ribbonwood zone. Of special note is the large amount of 'yellowing' flax suffering from the phormium yellow leaf phytoplasma (Figure 8). This yellow leaf disease is common amongst flax around the estuary.

Upstream of the road bridge over the Waikanae Stream the stream banks are either grazed (TRB) or invaded by pampas and other weeds (TLB) (Figure 8). The grazed saltwater paspalum stream banks are used by ducks and in particular brown teal. Two brown teal carcasses were seen on the banks upstream of the river, probably killed by a cat or stoat. A flock of 10 or more brown teal were observed downstream on the water between the bridge and stream mouth.

Figure 9 shows a typical example of a disturbed brackish-freshwater vegetation community that includes oioi, manuka, giant umbrella sedge (*Cyperus ustulatus*), sharp spike-sedge (*Eleocharis acuta*), Mercer grass (*Paspalum distichum*), soft rush (*Juncus pallidus*), sharp-fruited rush (*Juncus acuminatus?*), *Carex virgata*, pampas, Tasmanian blackwood (*Racosperma melanoxylon*) and mingimingi (*Cyathodes juniperina*).

Spartina patches were common out on the flats and in the shelter of sea rush between the TLB of the Waikanae Stream and Waikawau Beach Road (Figures 10 and 11). The kill from herbicide spray seems to have been more successful out on the open flats compared with the plants in more sheltered sites. It is likely that the spartina has helped build up sediment bed levels, and this together with the protection they provide from wave action has probably encouraged mangrove seedlings to establish out on the flats. Sea rush fringes the embayment with a low edge of sea primrose and silver tussock often occurring along the landward edge of the sea rush. The vegetation communities mingle together in places and are therefore mapped as mixed communities (see Figure 12 for an example).

Another dead brown teal was found along the lower Waikanae Stream edge and a dead mallard duck out by the stream mouth, evidently from predation. The Moehau Environment Group have been undertaking pest control for rodents and mustelids which is helping protect and expand the existing fernbird and brown teal populations (pers. comm. W. Todd).

Large patches of saltwater paspalum have established along the immediate TLB of the Waikawau River channel. The saltwater paspalum is up to 25cm deep surrounding a few scattered mangroves which occur along the edges of the main stream and small side channels (Figure 13). Very little sea meadow was found amongst these saltwater paspalum beds, where they would be expected if the paspalum was not present. Gladioli were found growing in a number of areas of saltmarsh or saltwater paspalum (Figure 14).

Further upstream the Waikawau Beach Road bisects the estuarine vegetation along the TRB of the Waikawau River. Saltwater paspalum lines both sides of the river channel (Figure 15). Further back from the TRB is a line of large old mangroves with a band of younger and shorter mangroves in front (Figure 16). Saltwater paspalum surrounds the old mangroves and extends out through the shorter mangroves to form the bank edge.

Behind and further upstream from the old tall mangroves is an area of mixed rush and sedgeland, saltwater paspalum and dwarf mangrove community (Figure 17). A spotless crake was heard in the dwarf mangroves and oioi/sea rush to the right of the power pole shown in Figure 18. Upstream of the road bridge that crosses the lower tributary of the

Waikawau River, the estuarine-freshwater wetland is still intact and maintains significant vegetation and wildlife habitat values (Figure 19). The estuarine plants present here are oioi, sea rush, saltwater paspalum, mangroves, saltmarsh ribbonwood and coastal daisy. Fernbird are present in the area. The freshwater wetland is composed mostly of flax, pampas, manuka, raupo, toetoe and cabbage tree.

Further upstream the northern portion of this valley's floodplain is farmed. The grazed floodplain has estuarine wetland plants present adjacent to the intact neighbouring wetland, and freshwater wetland rushes cover the majority of the remainder of the floodplain (Figure 20). Fernbird are present in the saltmarsh ribbonwood in the drains.

The upper extent of the saltwater influence occurs just above the Waimanu Road bridge where grazed sea rush and saltwater paspalum are prevalent in low-lying areas connected to the river (Figure 21). A flock of about 20 brown teal (pateke) was observed downstream of the Waimanu Road bridge (Figure 22).

Downstream of the Waimanu Road bridge the embayment on the TLB has been split by an old stopbank that joins islands of higher ground. This higher ground is covered mostly by manuka and pampas. Between the river and the stopbank are extensive saltmarsh ribbonwood communities in behind the rush/sedgeland. In Figure 23 a line of old fence posts is still present in the middle of the photo indicating that the saltmarsh has been grazed in the past. Downstream of the main rush/sedge band are scattered areas of sea meadow and some mangroves (Figure 24). Further east of the old stopbank, farming activity has artificially truncated the natural wetland sequence. The rush/sedgeland backs straight on to pasture with little or no saltmarsh ribbonwood present (Figure 25). Saltwater paspalum has extensively invaded this area of rush/sedgeland. A couple of large sand barriers at the mouth of this embayment have a fringe of either sea meadow or saltwater paspalum (or a mix), then a band of sea rush or oioi, and then saltmarsh ribbonwood with manuka and flax above where the island is high enough.

Further north-east of this embayment the estuary edge is exposed to the open coastal environment. The native estuarine plant communities are quite narrow, restricted to a thin band of sea rush and scattered saltmarsh ribbonwood with sea meadow fringing the seaward edge. Flax and pohuehue (*Muehlenbeckia complexa*) are common coastal edge plants. Figure 26 shows a wide band of saltwater paspalum that is strongly established on the flats at the end of Waimanu Road. This band of saltwater paspalum is likely to continue to expand out towards the channel edge unless controlled. A close inspection revealed a band of sea meadow (sea primrose and remuremu) mixed in with the saltwater paspalum along the high tide mark (Figure 27).

Figure 2: Sea primrose, remuremu and silver tussock dominate the estuary edge in this area where Gallant herbicide has been sprayed. Saltwater paspalum dominates these sea meadow species along the unsprayed edge in the background.

Figure 3: Sickle grass, saltwater paspalum, knobby clubrush and shore bindweed characterise this sand ridge.

Figure 4: This grazed edge of saltmarsh includes remuremu, sea primrose and buck's horn plantain amongst sea rush. There are fernbird in the saltmarsh ribbonwood on the estuary side of the fence.

Figure 5: Spartina and saltwater paspalum have invaded this old dug-out watercourse.

Figure 6: Kowhai (*Sophora chathamica*) in between saltmarsh ribbonwood and pampas.

Figure 7: A grazed and mixed sea rush/saltwater paspalum/sea meadow community.

Figure 8: The upper saltwater influence is reached just upstream of the Waikanae Stream road bridge. Note the 'yellowing' flax with pampas in behind on the TLB.

Figure 9: A disturbed brackish-freshwater vegetation community that includes oioi, manuka, giant umbrella sedge, various *Juncus* spp., sharp spike-sedge, Mercer grass, *Carex virgata*, pampas, blackwood and mingimingi.

Figure 10: A partly-dead spartina patch in a sheltered rush embayment. A more complete spray kill was achieved further out on the open flats.

Figure 11: Mangroves are establishing in a patch of sprayed spartina. Sea primrose and silver tussock form a low edge around sea rush in the background.

Figure 12: This shows two different mixed community zones. The landward community here was mapped as a sea rush-sedgeland/sea meadow/saltwater paspalum mix; while the seaward vegetation (including the silver tussock) was mapped as a sea meadow/saltwater paspalum mixed community.

Figure 13: Saltwater paspalum in this bed is up to 25cm deep and surrounds mangroves scattered along the edge of the main stream and small side channels.

Figure 14: Gladioli were found growing in a number of patches of saltmarsh or saltwater paspalum (shown here).

Figure 15: Saltwater paspalum lining both side of the lower Waikawau River channel.

Figure 16: A line of old mangroves occurs along the edge of the lower Waikawau River with younger short mangroves in front. Saltwater paspalum surrounds the mangroves and extends through the shorter mangroves to the river bank edge (see figure above).

Figure 17: An example of a mixed rush and sedge/saltwater paspalum/dwarf mangrove community. Oioi is scattered through the saltwater paspalum in the foreground.

Figure 18: A spotless crake was heard in the dwarf mangroves and oioi/sea rush to the right of the power pole.

Figure 19: The view looking upstream from the road bridge over the extensive estuarine-freshwater wetland. Estuarine plant species present include oioi, sea rush, saltwater paspalum (in the rushes/sedges along road edge near bridge), mangroves, saltmarsh ribbonwood, coastal shrub daisy. The freshwater wetland community includes flax, pampas, manuka, raupo, toetoe and cabbage tree.

Figure 20: The view looking over the grazed floodplain adjacent to the intact wetland community shown in the previous figure. The majority of the grazed floodplain supports freshwater wetland rushes however there are also estuarine wetland plants present next to the intact neighbouring estuarine-freshwater wetland.

Figure 21: A view of grazed saltwater paspalum and scattered sea rush upstream of the Waimanu Road bridge.

Figure 22: A flock of brown teal (pateke) downstream of the Waimanu Road bridge.

Figure 23: Extensive saltmarsh ribbonwood communities in behind rush/sedgeland. A line of old fence posts is still present (but not clearly visible) in the middle of the photo.

Figure 24: A mangrove surrounded by flowering sea primrose. Saltwater paspalum is present amongst the sea primrose alongside the rush edge.

Figure 25: Saltwater paspalum is mixed with the sea rush in this area. The abrupt boundary between the rush/sedgeland and pasture communities can be seen in the background.

Figure 26: A wide band of saltwater paspalum has established on the estuary flats at the end of Waimanu Road.

Figure 27: This photo is a close-up of the figure above. A band of sea meadow (sea primrose and remuremu) mixed with saltwater paspalum occurs around the high tide mark, with pure saltwater paspalum further seaward.

3.3 Birds

Birds seen or heard in the estuarine environment during the survey:
White faced heron, kingfisher, swallow, fernbird, banded rail, spotless crake, pukeko, pied shag, paradise duck, mallard duck, brown teal.

3.4 Threats

There are two significant existing threats to the native estuarine vegetation communities of Waikawau Estuary.

Weeds
Weeds present the most significant threat to the native estuarine vegetation communities of Waikawau Estuary. Estuarine weeds already dominate large areas of the estuary at the expense of estuarine vegetation and wildlife habitat, and will lead to a further loss of plant and animal biodiversity in the estuary if they are allowed to expand.

Spartina is common throughout much of the estuary. 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 or changes an open mudflat into a vegetated flat. The Department of Conservation has been controlling spartina in the estuary by spraying with the herbicide Gallant. As with any weed control, repeat spraying is needed to ensure remnant populations are entirely controlled.

Saltwater paspalum is present throughout the estuary amongst all estuarine vegetation communities (except seagrass), and is of particular concern. Saltwater paspalum is another introduced grass with similar effects to spartina in that it is extremely efficient at stabilising sediments and building up bed levels. This can affect flooding 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.

Stock
While stock access to the CMA is not a huge issue in Waikawau estuary, there are still areas where fencing needs to be realigned to ensure estuarine areas are kept outside of grazing paddocks. Where stock have access to estuarine vegetation they have damaged it

directly through trampling and pugging. This encourages the establishment of weeds such as saltwater paspalum. Weeds can also be spread in the hooves of stock or by fragments being dislodged by stock. Pugging creates habitat suitable for the Southern saltmarsh mosquito (*Aedes camptorhynchus*), for which there is currently 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. These effects can be detrimental to the native vegetation communities and wildlife in these areas.

No pig damage was seen during the survey (as has been found in other harbours).

4. Discussion and Recommendations

Waikawau is one of the Coromandel Peninsula's most pristine natural coastal environments, mainly due to the lack of effects from human habitation. The estuary has significant and varied estuarine vegetation communities, but these communities are currently being dominated by weeds, and are at risk from further weed invasion. Historically, the extensive native forest in the catchments would have been cleared (logged and burnt) as was common practice on the Peninsula. This would have delivered huge amounts of sediment into the estuary, accelerating the infilling of the upper tidal arms. The current catchment activity is predominantly conservation forest (i.e. protected regenerating native forest) except for farming that occurs mostly on the floodplains. This farming activity will still be delivering sediment to the estuary system but on a much smaller scale. Fencing of all farmed stream reaches will help reduce sedimentation nearer to natural levels.

Waikawau estuary is ranked highly for wildlife value in the Protected Natural Areas Programme (Humphreys & Tyler, 1990) and the Department of Conservation's Sites of Special Wildlife Interest (SSWI) reports due to the presence of banded rail, North Island fernbird, Australasian bittern and brown teal. Spotless crake are also present. The continued presence of these species is associated with the high quality of their habitat as they are dependant on the estuarine and freshwater wetland vegetation communities and mudflats for their survival. However the availability of good habitat alone is not enough to ensure the survival of populations of these native species in the future. Ongoing predator control is an integral tool essential to assist with the survival of these threatened species' populations.

Spartina and saltwater paspalum threaten the ecological integrity of the estuary and its ability to provide suitable habitat for native wildlife (birds and fish) due to the resulting changes in hydrological regimes and vegetation diversity and structure. Also, flooding of upstream land may become more frequent if the saltwater paspalum is allowed to continue increasing in extent.

The following are recommended actions to maintain and restore the native estuarine vegetation communities of Waikawau Estuary:

1. Undertake a feasibility study to control saltwater paspalum within the estuary using Gallant herbicide. Combine this control work with the existing spartina control programme.

2. Encourage property owners and community groups to control wilding Tasmanian blackwoods, pines, willow and wattle around the estuary margins. Assistance could be given to prepare a funding application to undertake such weed control.

3. Fence all of the estuarine vegetation within farmed land from stock. This will avoid the pugging and grazing of estuarine vegetation by stock within the estuarine environment. For example, low-lying areas of the Department of Conservation paddocks adjacent to the estuary could be redesigned to restore areas of back-swamp native vegetation.

4. Continue encouraging and requiring the protection of all riparian edges from stock to limit bank erosion and agricultural inputs of sediment, nutrients and faecal matter.

5. Encourage landowners to protect and restore pockets of historic coastal floodplain forest, and native vegetation sequences that extend from the sea to land. For example the northern half of the Waikawau River lower tributary floodplain could be retired from grazing completely to restore a hugely significant area of coastal freshwater wetland. The fencing of swampy drainage paths, river banks and remnant coastal forest fragments up the Waikawau River would also have high ecological benefits. The Department of Conservation could consider offering to swap portions of good public grazing land for neighbouring private swampy land that has high ecological restoration potential.

6. Additionally, the continuation of animal pest control is recommended around the estuary margins to protect threatened wildlife such as fernbird, bittern, spotless crake and banded rail populations. A number of dead brown teal were found along the banks of the Waikanae Stream. Cat control may be needed around the main brown teal flocking sites.

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6. Appendix 1 – GPS locations of figures

Photo Point	Latitude	Longitude
2	-36.59358	175.517269
3	-36.59328	175.515614
4	-36.59414	175.515767
5	-36.59573	175.514952
6	-36.59652	175.515085
7	-36.5975	175.515563
8	-36.59738	175.514916
9	-36.59648	175.513849
10	-36.59551	175.514237
11	-36.59542	175.512819
12	-36.59515	175.513977
13	-36.59475	175.511209
14	-36.59404	175.51044
15	-36.59428	175.509307
16	-36.5936	175.508377
17	-36.59358	175.508049
18	-36.59328	175.507503
19	-36.59314	175.50738
20	-36.59085	175.506182
21-22	-36.59087	175.507605
23	-36.5922	175.508099
24	-36.59313	175.508657
25	-36.59222	175.511139
26	-36.59241	175.514387
27	-36.59215	175.514442