Waikawau Bay Wetland and Estuary
Freshwater Fish Surveys
November / December 2008 – February 2009[1].

1. Introduction:

The health, variety and abundance of native fish in rivers, streams and estuaries are indicators of the general health and quality of waterways.

Common to our native freshwater fish species is the fact that they spend part of their lifecycle at sea. Therefore, the quality of freshwater, rivers, streams and ponds is important, but equally important is the quality and access to the freshwater/saline interface which allows free access to the ocean.

The long-term survival of native fish species is dependant on protection and restoration of their natural habitats and retention of access up and down waterways to the sea.

However, "[p]rotection of our native freshwater fishes has attracted rather less attention from conservationists and environmentalists than other fauna. Many species have suffered decline in the 150 years since European settlement ….. Their decline can be attributed mostly to a combination of impacts of exotic species, deforestation, abstraction and damming of rivers and wetland drainage." [2]

1.1 Site description:

Waikawau Bay is situated on the Northern Coromandel on the eastern seaboard. The area surveyed comprises: the estuary/wetlands proper, of approximately 75ha, which is a remnant part of a much larger river/estuary/harbour/lagoon system, characterized by in-filled, coarse to fine grained silts, sands, and dune and marsh systems. The survey area encompasses both public and private lands.

The Northern Coromandel has a warm moist maritime climate, influenced by two bodies of water (Hauraki Gulf – western side, Pacific Ocean – eastern side). The prevailing winds are gusty southwesterlies (bringing little rain); or easterlies bringing intense and often severe rainstorms (200mm+/hr have been recorded). Heavy rainfall is common with frequent flooding and sea wash.

Tidal influences in association with heavy rainfall events cause severe flooding because valleys are long, narrow, and low lying with abrupt steep ranges behind them. Erosion is often severe with silt laden flood waters.

Salt laden winds during severe easterly storms damage vegetation and cause coastal erosion. These easterlies and the strong southwesters have caused noticeable changes to the dune systems at the northern end of the Bay over the past ten years.

[1] K.Parr and W. Todd. 2010.
[2] McDowall, R, M. 2001. pp.7.

The systematic stripping of riparian forest remnants in the farming valley behind the estuary, to the northwest has contributed to this damage, and there is now little vegetation to break the south-westerlies as they gust down the valleys. As a result of this lack of vegetation, a sand island of some 1200 cu. m (approx.) in the mouth of the estuary eroded away in two years 2006 - 2008. This has led to the mouth of the estuary being more exposed to the sea.

Geology is characterized by andesites with occasional basaltic extrusion plugs. Rhyolite clays are present behind the wetlands. Yellow clays are present throughout the rest of the estuarine area. Soils are of medium to poor fertility. There is some evidence of small peat deposits.

Thirteen streams feed into Waikawau Bay with two fourth order streams feeding the northern end wetland and estuary. Two third order streams also feed directly into the north end wetland system. The two largest stream watersheds are estimated to be in excess of 3,500ha (approx).

The Bay itself is dominated by the DOC Farm Park Reserve with a large dry stock beef and sheep farm lease. A long narrow fore dune reserve (100m wide) with regenerating native flora separates the agricultural lands from the beach. Farmlands are hard up on the southern edge of the estuary but with good fences to keep stock out. On the northern edge there are a couple of small lifestyle blocks and a large drystock farm (the Denize Farm). The Denize Farm and the Farm behind it “Three Stone Farm”, form a large part of the northwestern catchment with a large number of tributary streams feeding into the Waikawau ‘river’.

1.2 Human Occupation:

The Waikawau Bay area has a long history of human occupation and land modifications.
There is considerable evidence of Maori occupation throughout the Bay and includes all the common indicators (eg. kianga and pa sites, middens, fish traps, earthworks, gardens and mounds). There is evidence to suggest early occupation 850 – 950 AD.

Midden evidence suggests major occupation between 1300 –1600 AD. While there is no visible evidence of land clearance, there is evidence of several large garden sites and food storage pits, suggesting that some land was cleared for gardens. There is no way of knowing exactly how the ecosystem was modified due to Maori occupation.

Coromandel was renowned for the quality of its kauri timber and extraction took place from the early 1800’s right up into the early 1900’s. Other high quality timbers were also being removed at this time. Gum digging and gold mining followed and there is evidence throughout the Bay of adits, mine shafts, tramway beds, dams, tailings mounds and stamper batteries.

Traditional farming of sheep, beef and dairying was carried out from the late 1800’s to the early 1970’s. Dune stabilization was carried out in the early 1900’s and there is evidence still of ditches and berms, floodgates and tidal flood gates, which were installed to modify and drain the upper estuary and river systems. There are examples throughout the estuary of reclamations; however, most of these are now abandoned.

All farmed lands received significant government subsidies for fertilizers, clearance, fuels and stock transportation. Farm subsidies pre 1970 contributed to some major environmental impacts in the area. Farmers cleared land, dug ditches, diverted streams and drained wetlands in an effort to make the land more agriculturally productive (some of the continuing impacts of these modifications are detailed in Section 1.5, below). With the removal of subsidies much marginal agricultural land was retired, converted to forestry, or sub-divided into smaller lifestyle blocks. The more gently rolling hill country and valley floors remained in farms.

Almost all of this retired land is now in regenerating scrub and forest (and weeds); and is contributing positively to reduction of steep hill country erosion, the water purity of streams, and the subsequent health of wetland, estuary and ocean beach ecosystems. Forest remnants are all heavily modified. There are now only three major farms in the Bay, one of which is the DOC Farm Park lease. Farms are dry stock. Neither, the Three Stone property, the Denize Farm, nor most of the DOC lease[3], has riparian plantings or fencings. The stream banks, on one of these farms, have been regularly harvested by a firewood enterprise, denuding the stream sides, causing bank loss and considerable erosion.

There are also three large lifestyle blocks (175ha + each) which are mainly made up of regenerating forest and several small lifestyle blocks (20ha or less), two of which are small dry stock farms – the rest are regenerating forest lands.

1.3 Animal Pest Control[4] and Fauna Monitors:

Monitoring of rodent numbers, and pateke and fernbird census' have been carried out since 2006. Reptile and invertebrate monitoring, freshwater fish surveys, 5 minute bird counts, shore and wading bird counts, and shellfish surveys along with measurements of the growth of saltwater paspalum (*Paspalum vaginatum*) have been carried out since 2008/2009/2010.

In 1999, 35 traps were installed for trapping mustelids and hedgehogs[5] along the foreshore of the Bay and the northern margins of the estuary system[6]. Traps are serviced on a monthly basis, except over the summer period when they are checked weekly or fortnightly[7]. Further trap lines for mustelids were installed on the eastern, western and southern margins of the wetlands in 2005.

In 2006, 150 rat traps were installed around the margins of the wetlands. At this time 75 bait stations were also installed around the perimeter and one line in the heart of the wetlands, along with another 75 on the margins of the estuary system and the road.[8] Further rat traps were installed in 2010 and 2011, bringing the total number of traps to over 250. Rat traps are checked approximately every two weeks. Bait stations are serviced every six to nine months (depending on monitor results). Data is kept of all rats and mice trapped. Monitoring of the effectiveness of trapping is done every three months – often by independent auditors. To date, monitors show that rat numbers have declined significantly and skink, weta and other invertebrate numbers are increasing over time. More traps are presently being installed on the north western margin of the saltmarsh along the river banks and further into the north side of the swamp.

There is an intensive infrastructure for the control possums on all sides of the survey area. Some possum control was carried out on an intermittent basis, until late 2009 when control was stepped up and infrastructure improved. A 100m wide wetlands perimeter now has a bait station infrastructure to rodent control density. These bait stations are serviced every six months to one year.

1.4 The Estuary:

The physical environment of each side of the estuary is quite different. The south side is characterized by an established (modified) dune system. This area is exposed to coastal elements

[3] The DOC lease has good fencing around the estuary, but not along most waterways, ponds or streams.

[4] All animal pest control is carried out after full consultation with landowners. Only methods approved by each landowner (be they public or private) are utilized. Approval by all landowners to carry out pest control has been given.

[5] Hedgehogs are trapped along the foreshore and dune systems, as they are one of the main predators of New Zealand dotterels and Variable Oyster Catcher eggs and chicks.

[6] This trapping system was modified and expanded in 2009 – 2010.

[7] These traps were serviced by the authors and Dotteral volunteers, until late 2010, when DOC took over control of the lines and contracted them out.

[8] Rat traps were not placed in the heart of the wetlands, so that human impacts are minimized in this fragile environment.

and is comprised of sand convolvulus, muehlenbeckia, knobby clubrush, pingao and spinafex. Tidal mudflats and adjacent low lying sandy pastureland characterize the middle section of the surveyed area. The mouth of the Waikanae Valley stream feeds into this side of the estuary.

The survey area closest to the sea on the north side of the estuary is comprised of coastal forest, rocky banks and limited low lying land, covered in muddy tidal flats. Areas further inland are characterized by tidal mudflats, with low lying farmland and saltmarsh edges.

The main river channel of the Waikawau Stream and the Waikanae Valley Stream has for many years been closer to the north side of the estuary. This has meant that the north side is subject to greater environmental changes that result from flooding.

Both sides of the estuary have stands of pampas. In addition, much of the south side and also parts of the Northern saltmarsh have inundations of spartina. The spartina on the south side has been sprayed, by helicopter with Gallant, in the past, which has had impacts on saltwater paspalum growth in these areas. However, the spartina had begun to regenerate at a rapid rate in 2008-2009. DOC resprayed the spartina manually, in February 2010 and again in February 2011.

However, the major botanical threat to the integrity of the estuary is the rapid expansion of saltwater paspalum (*Paspalum.vaginatum*). Saltwater paspalum invades and changes the composition and structure of native ecosystems. It can reduce or exclude feeding and roosting sites for birds, and may alter fish spawning and feeding grounds. It can also change estuarine hydrology by accumulating sediment."[9] It has been documented that *P.vaginatum* has similar impacts to *spartina,* in that, it:

- "out-competes native estuarine plant species changing the composition and structure of natural vegetation associations, and endangers threatened species populations (Nuttal, 1993);
- has high stem and root density which excludes burrowing fauna, such as cockles (*Austrovenus stutchburyi*) (Nicholls 1998);
- reduces access to the food and roosting sites of birds (poorly used by estuarine birds – Owen 1994);
- alters fish spawning and feeding grounds (e.g. flounder), (Nuttall, 1993);
- alters estuarine hydrology patterns from the accumulation of sediments, and the associated ramifications of this (e.g. increased flooding which leads to further deposition of fine silts in the estuary, which may be to the detriment of filter-feeding shellfish and the growth of estuarine vegetation) (Swales et al. 2000, Nuttall, 1993)."[10]

The back of the estuary has a small grove of old mangroves. Smaller mangroves and mangrove seedlings are also evident along river margins and mudflats on both sides of the estuary. The area covered by mangroves has more than trebled in the last five years[11].

There are saltmarsh communities comprising rush/sedgelands and saltmarsh ribbonwood (*Plagianthus divaricatus*) on both the north and south sides of the estuary. Coastal tree daisy (*Olearia solandri*) is common at the back of these areas. Seameadow communities are found fringing the sedge/rushlands and stream edges.

1.5 Modifications to Waterways:

[9] www.nzpcn.org.nz/exotic_plant_life and weeds. Plant Conservation Network.
[10] Graeme, M. 2001. p9.
[11] Pers. observation. Authors.

a. The whole of the area surrounding the estuary and the wetlands has been completely modified through the construction of drainage ditches to contain seepages, wetlands, small streams, etc. In addition, the Waikanae Valley stream has been straightened from about 1.5 kilometres inland, right to the estuary mouth. Floodgates are found in both the north saltmarsh and paddocks of the DOC farm. These floodgates are no longer operating and have been left in a state allowing fish passage. Culverts are found throughout the area, in particular under roadways and pathways. The areas of major concern to this study are listed below.

b. It is important to note that there are also modifications upstream from the survey area that could be of concern. Some of these are discussed in Section Five (Discussion) below.

c. **List of Modifications to Waterways and their impact on Freshwater fish: (See Appendix One for map of Sites listed below).**

Where Found	GPS Co-ordinates	Description of Modification	Impacts for freshwater species
Briclke Bridge **(site 1)**	E2734802 N6509874	Stream straightened and bridge built.	Faster flowing water than natural waterway. Road runoff.
"Leo's Ditch" confluence with Waikawau Stream **(site 2) and (site9)**	E27344737 N6509156	Ditch to drain wetland. Straight. Culvert under road. (30m further upstream under road= **Site 9**).	Faster flowing water than natural waterway. Road runoff. High water events, flood roadway (1-2 times per month. Good culvert for fish passage.
Waikanae Stream bridge **(site 4) to (Site 5)**	E2735450 N6508445	Stream dredged and straightened (about 60 years ago) and bridge built. Straightened from 1.5m upstream out to estuary mouth.	Faster flowing water than natural waterway. Road runoff. Good overhanging vegetation.
Culverts and drains around **site 4**	E2735450 N6508445	Paddocks ditched and drained about 60 years ago.	Stock nutrient runnoff from paddocks. Litle suitable spawning vegetation in paddocks. Culvert broken. Damage of ditch sides and waterways from cattle.
Waikanae Stream/ Waikawau estuary confluence **(site 5)**	E2735417 N6508652	Stream straightened about 60 years ago	Faster flowing water than natural waterway. Good overhanging vegetation. Culvert intact and good for fish passage.
Waikanae Valley Stream – lower reaches and middles reaches.		Stream straightened about 60 years ago	Faster flowing water than natural waterway. Vegetation removal in 2011, as yet no replanting. Banks of silt falling into stream. major flood could have considerable impact. Stock still on stream edges – even in some fenced areas.
Whitehouse driveway culvert **(site 6)**.	E2735414 N6508346	Small stream straightened and paddocks ditched and drained about 60 years ago.	Faster flowing water than natural waterway. Good overhanging vegetation in lower parts of stream/ditch. Roadway falling into stream/ditch.
Leo's Driveway ponding area. **(site7)**	E2734699 N6508970 to E2734659 N6508909	Stream straightened and ditches built.	Faster flowing water than natural waterways. One side well vegetated by mix of pampas, exotic weed species and native plants. Little overhead vegetation. Stream debris common.
Tidal pond in pastureland and fenced stream edge behind DOC Farm Park Woolshed. **(Site10**	E2734659 N6508909 to E2735589 N6508970	Floodgate, culvert, ditches. Paddocks in use and drained.	Stock nutrient runnoff from paddocks. Floodgate open and not in use. Culvert at good level for fish to travel from ditch to small tidal/vernal pond. No vegetation around pool. Stock in pond.
Floodgate and ditches in north saltmarsh. **(Site 19)**	E2735065 N6508806	Floodgate, ditches.	Floodgate not in use. Ditches and bunds of pampas, blackberry, ribbonwood, reeds, coastal ribbonwood. Nearby flood channel partly blocked by siltation from flooding and saltwater paspalum changes to estuary (Seagrass in flood channel under threat).

Table One

Disused culvert in drainage ditch near Site 4.

Whitehouse culvert Site 6.

Confluence Waikawau stream and Leo's ditch Site2.

Culver under road – Leo's ditch Site 9.

Leo's Driveway ponding area Site 7a.

North saltmarsh disused floodgate site 19.

2. Objectives:

- 1. To identify both freshwater fish species in the Waikawau Bay northern wetlands, streams, and ditches, and the two major confluence points.
- 2. Describe the ecology of the sites in which the species are found, and,
- 3. Describe any manmade or otherwise, obstructions to any waterways which might impede fish movements.

3. Methods:

3.1 The first surveys carried out between 6 November 2008 and 30 November 2008.

- Equipment used included:
  - 2 Fine mesh rectangular fish traps 2mm mesh 60mm aperture.
  - 1 coarse mesh "hinaki" trap 20mm mesh 80mm aperture.
  - 1 large whitebait scoop net 2mm mesh 600mm aperture.
  - 2 fine mesh scoop nets 1mm mesh 300mm aperture.
  - 2 plastic tubular bait catchers 30mm aperture.
- Bait used:
  - Marmite.
  - Cereal mixed with Blood and Bone.
  - Beef Mince.
- Several methods were employed including: scooping, trawling and trapping (described in more detail in Tables Two and Three below).
- Day and night searches were carried out.
  - Night searches were made with spotlights along ditches, riverbanks, and vegetation alongside riverbanks
  - Surveys were carried out during daylight hours and after dark and coincided with high water events.
  - Searches were made from the headwaters of the wetlands down to and including streams, ditches, estuarine/river confluences and any vernal pools (especially after very high water events such as king tides).
  - Habitat types investigated included; tidal streams, vernal pools, ditches and inundated paddocks; streams and ditches at both lower and mid reaches; margins of mangroves (but not in the mangroves themselves); standing water in the middle and back of the wetlands, and small water runs at the back of the wetlands.
- All survey areas were GPS'd to record where fish were located.
- General descriptions of the site were noted. These included: stream or ditch profile, vegetation types and cover, and descriptions of any other wildlife observed (in Tables below).

Scoop netting in Waikawau Estuary 17 November 2008

3.2 Further surveys were carried out in December 2008. In these minnow traps were installed

- One, being at the base of the valley, separated from the wetlands main survey area, to the north at the Gravelle's property.
- Two were on the ALU (wetland rat trap line) line in the south west of the wetlands proper.
- Two were in an upland swampy remnant surrounded by grassland known as Knox Farm.
- Two more were to be installed at the upland end of the wetlands proper, but these were abandoned due to paper wasp nests hazards.

3.4 Day Surveys: dates, equipment, methods and habitat. For Map of Sites – see Appendix One.

Date/conditions	Site Name	GPS	Equipment	Method	Time	notes
6 November 2008 SW winds. Wet underfoot (light rain previous night)	Briclke Bridge **(site 1)**	E2734802 N6509874	Fish trap with marmite	Placed under bridge	(one hour before high tide) 11.30 checked 13.45 then left overnight	Tidal modified stream confluence with Waikawau Stream. Banks 1.5m, depth 1.5-4m. Width 2m. Mod clear flow. Gravel and silt bottom. Flax, toetoe, pampas, reeds, exotic grasses, saltwater paspalum, saltmarsh ribbonwood, coastal tree daisy, reeds.
6 November 2008 As above	"Leo's Ditch" confluence with Waikawau Stream **(site 2)**	E2734737 N6509156	Fish trap with marmite	Placed in mainstream channel of Waikawau stream	11.45 checked 13.30 then left overnight	Water level close to banks (overflows at monthly high tides and rainfall). Width 2m. Mod flow, silt and gravel bottom. Reeds, exotic grasses, saltwater paspalum.
6 November 2008 As above	Waimanu Rd Bridge **(site3)**	E2734826 N6509129	1). 2 baitcatchers weighted and baited with bonemeal, poultry mash and sand 2) Hinaki trap with mince and marmite 3) Whitebait net.	1) Placed in stream 2m from stream edge and 1m from stream bottom 2) placed in centre stream – lowered to bottom 3) Three trawls: a) along stream edge and soft silt bottom b) along stream edge just below stream surface (600mm) c) Same as above. Biota placed in container, measured and counted	1) 12 noon checked 14.00 2) 12 noon - 14.00 3) 12 noon	Left banks 2m, (with bird roosts and perches), right bank at water level. Width 12m, depth 2-5m (tidal), medium flowing; clear. Silt bottom. Fish visible. Left side pampas, kanuka, manuka, reeds, flax. Right side, saltwater paspalum, reeds, exotic grasses.
11 November 2008 Slight NE wind. Warm.	Waikanae Stream bridge **(site 4)**	E2735450 N6508445	1) 2 baitcatchers weighted and baited with bonemeal, etc. 2) Hinaki with mince and marmite	1) Placed in stream 2m from stream edge and 1m from stream bottom 2) placed in centre stream – lowered to bottom	1) 9.00 checked 11.30am then left overnight 2) 9.00 checked 11.30am then left overnight	Banks 1-2m. 5m width, depth 2-5m (tidal), Pateke roost. Pohutakawa, manuka, saltmash ribbonwood, pampas, exotic grasses, reeds, saltwater paspalum.

11 November 2008 As above	Waikanae Stream/ Waikawau estuary confluence **(site 5)**	E2735417 N6508652	1) Fish trap (hinaki) baited with mince and marmite. 2) Whitebait scoop nets	1) Fish trap placed 1m from stream edge and 1m deep on stream bed 2) Trawls made along 10m stretch of streambank edge Biota placed in container, measured and counted	1) 9.45 Checked 11.45 then left overnight 2) 9.45	No banks. Width 3m. Clear med flow. Silt bottom. Reeds, saltwater paspalum, exotic grasses, pampas, saltmarsh ribbonwood, flax.
11 November 2008 As above	Whitehouse driveway culvert **(site 6)**.	E2735414 N6508346	1) Fish trap with mince and marmite 2) Whitebait scoop net.	1) Fish trap placed on rocky bed 5m from junction of culvert and stream. 2) Trawls made along open ditch for 10-15m. Biota placed in container, measured and counted	1) 10.30 Left overnight. 2) 10.30	Modified ditch. Steep sides, unstable silt bank 1-2m. Med clear flow, silt bottom. Pampas, exotic grasses, saltmarsh ribbonwood, flax, manuka.
11 November 2008 As above	Leo's Driveway ponding area. **(site7b – see below - Night searches)**	E2734709 N6508959	Whitebait scoop net	Trawls made along open ponded area Biota placed in container, measured and counted	11.30	Bank .5m, width 1.5m. (Drainage ditch). Water still and stagnant. Water semi cloudy, mud bottom. Shaded by manuka and kanuka.
14 November 2008 No wind. Partly cloudy Warm.	Around **site 4** and in any drainage ditches and near culvert pipes	E2735450 N6508445	Visual search.	Searches made by six people for inanga in ditches, stream, inundated rushes, grasses and on banks.	19.00 to coincide with high tide - Major monthly high tides. (3.4m) @ 19.00	Pastures and saltmarsh edges, scrubby stream banks Exotic grasses including saltwater paspalum. Saltmarsh ribbonwood, pampas, reeds, gorse flax.
14 November 2008 As above	Around site 3 and also on upstream bank of Waikawau stream. **Site 3**	E2734826 N6509129	Visual search	Searches made by six people for inanga in ditches, stream, inundated rushes, grasses and on banks.	19.00, to coincide with major monthly high tides. (3.4m) @ 19.00	Pasture lands with exotic grasses – mainly saltwater paspalum.
16 November 2008 No wind. Partly cloudy Warm.	**Site 4**	E2735450 N6508445	Whitebait scoop net and 2 finer mesh nets.	Trawls carried out by three people 1) Two trawls. Front paddock near bridge. 2) Five trawls in front paddock moving further inland.	8.30 start , to coincide with high tide at 10.30.	Pastures and saltmarsh edges, scrubby stream banks Exotic grasses including saltwater paspalum. Saltmarsh ribbonwood, pampas, reeds, gorse flax.
16 November 2008 No wind. Partly cloudy Warm.	Between sites 1 and 2	E2734802 N6509874 E27344737 N6509156	Whitebait scoop net and 2 finer mesh nets.	Five trawls carried out by three people	11.30	Saltmarsh ribbonwood, reeds, pampas, blackberry, flax.

17 November 2008 Slight SW wind. Cloudy, light rain	1) **Site 1** 2) Brickle Bridge and confluence of Waikawau Stream **(Site 8)** 3) **Site 2** 4) Leo's Ditch Culvert pipe at Waikawau Bay road. **(Site 9)** 5) Tidal pond in pastureland and fenced stream edge behind DOC Farm Park Woolshed. **(Site10)**	1) E2734802 N6509874 2) E2734839 N6508889 3) E27344737 N6509156 4) E2734700 N6508970 5) E2735589 N6508970	1) Whitebait scoop net and 2 finer mesh nets. 2) As above 3) As above 4) As above 5) As above.	1) Three trawls carried out by two people. 2) As above 3) Two trawls, as above. 4) Seven trawls, as above. 5) Four trawls. As above	High Tide 11.30 1) 9.50 3) 10.20 4) 11.15 5) 10.50	1) As above 2) Reeds, saltmarsh ribbonwood, pampas. 3) As above. 4) Reeds, pampas, toe toe, saltmarsh ribbonwood, coastal tree daisy, manuka. 5) Exotic grasses, saltwater paspalum, reeds, saltmarsh ribbonwood, pampas.

Table Two

3.4 Night Surveys: dates, equipment, methods, habitat.

Date	Site Name	GPS	Equipment	Method	Time started	notes
26 November 2008 Clear, dark, humid.	Leo X SMI Line/Brickle Stream **(Site11)**	E2734736 N6508915	Head lamps, spotlights and Whitebait trawl net	50m of stream trawled	20.15	Stream bank 1m. Compacted silt. Width 1.5m. Mod strength flow; incoming water from tide. Silty with light shingle bottom; flood and vegetative detritus. Surrounding and overhead vegetation: (dense) flax, manuka, kanuka blechnum, mistflower, reeds, saltwater paspalum.

26 November 2008 As above.	Leo's Driveway Ponding Area **(Site 7)** **7a)** ditch near road **7b)** 50m inland **7c)** 50m further inland from last site. **7d)** 50m further inland from last site. **7e)** 50m further inland from last site.	Ponding Length: 7a) E2734699 N6508970 7b)E2734706 N6508958 7c) E2734659 N6508909	Head lamps, spotlights and Whitebait net	Pond length trawled at intervals of approx 50m. 10–20 m length trawls.	7a) 20.45 7b) 21.05 7c) 21.25 7d) 21.40 7e) 21. 55	7a) Bank .25m, with 2.5m. Modified drainage ditch. Barrier to water flow. Water semi stagnant, green algal bloom, murky water quality. Mud bottom with detritus. No overhead vegetation. 7b) Bank .5m, width 1.5m (drainage ditch). Water still and stagnant. Water semi cloudy, mud bottom. Shaded by manuka and kanuka. 7c**)** Bank 1m, width 1.5m. Water in ditch clear and flowing freely – some detritus. Mud bottom. One side stream, recently bulldozed pampas and blackberry, other side reeds, mistflower, flax, manuka, kanuka. 7d) Same water and vegetative conditions as above. 7e) Same conditions as above, except small steep banks down to stream.
30 November 2008 Clear, calm, humid.	Pig Wallow Back of Wetlands on ALU rat line **(Site 12)**	E2734459 N6508456	Head lamps, spotlights and whitebait net.	7.5m pool size. Whole pond trawled with net.	20.00	7.5m long narrow runnel. Small flow of med run speed, disturbed by muddy, oily undercover. Soft bottom. Clear water. Banks moderately stable .5m high. Tree fern, cabbage trees, blechnum, manuka, kanuka, sedges,raupo, convolvulous.
30 November 2008 As above.	Back of wetland **(Site 13)**	E2734468 N6508444	Head lamps, spotlights and whitebait nets.	Trawl with net and hand search of vegetation. 20m length searched.	20.20	Shallow slow moving and standing water. Murky water, iron stained in colour, methane smell, anoxic, slimy algal bloom, oily. Rotting vegetation on bottom. Fibrous root matter. Coprosma, grasses, mistflower, raupo.

30 November 2008 As above.	Back of wetland **(Site 14)**	E2734231 N6508446	Headlamps, spotlights and whitebait net.	Trawl with net and hand search of vegetation. Search and trawls over 10m X.5m length.	20.40	Long shallow pool (depth 25-50mm). Slow trickle/flow. Murky water. Soft, muddy algal bottom. Fibrous root matter. Vegetative matter top of water. Man made walkway through pool also used by pigs. Raupo, sedges, blechnum.
30 November 2008 As above.	Intersection of ALU rat Line and Leo's Driveway. **(Site 15)**	E2734297 N6503681	Headlamps, spotlights and whitebait net.	Trawl with net and hand search of vegetation. 50m search. 15a) downstream 15b) midstream 15c) upperstream.	21.25 – 23.00	Modified stream (drain) Width 1.5m. Bottom mix small clay, shingle, sediments. Shallow, moderate flow. Sandbar in midstream, 200 – 1m wide. Deep pool upstream (1.5m). Banks shallow and stable (downstream) to steep (2m) and less stable (upstream). Upper reaches, large, kanuka fallen in stream from recent flood. Kanuka, coprosma, tobacco weed, flax, mistflower, pampas, blechnum, convovulous, blackberry.
30 November 2008 As above.	Briclke Bridge **(site 1)**	E2734802 N6509874	Headlamps, spotlights and whitebait net.	Trawl with net.	23.15	Tidal modified stream confluence with Waikawau Stream. Banks 1.5m, depth 1.5-4m. Width 2m. Mod clear flow. Gravel and silt bottom. Flax, toetoe, pampas, reeds, exotic grasses, saltwater paspalum, saltmarsh ribbonwood, coastal tree daisy, reeds.

Table Three

3.5 Minnow Trap Surveys:

Date/conditions	Site Name	GPS	Equipment	Method	Time	Notes:
14 December 2008	Gravelle's **(Site 16)**	E2735153 N6509876	Minnow trap, spade.	Trap hole was dug to place trap (2/3rds submerged) and allow water to collect. No bait is used for these traps.	24 hours	Thick grass sward, some scattered raupo. Spongy underfoot, with water seepage. Very fibrous root matter; water discoloured reddish brown with fine silt-mud underneath.
18 December 2008	ALU Line **(Site 12)**	E2734459 N6508449	As above.	As above.	24 hours	Small clear water pool 1.75m long x 500mm wide x 200mm deep, with small steady in flow. Surrounded on two sides with roots of Cabbage trees; blechnum ferns, mist flower.
18 December 2008	ALU Line **(Site 13)**	E2734465 N6508444	As above.	As above.	24 hours	Some 30m "upstream" at crossing. Tall dense wire rush, Raupo, mistflower. Very fibrous root mat under water. Water flow evident. Water reddish brown with very fine silts and black mud 200mm below water surface.
14 December 2008	Knox Farm **(Site 17)**	E2735455 N6509232	As above.	As above.	24 hours	Old drainage ditch, infilled with grasses (kikuyu, couch, and reeds. Some water flow evident but more a seepage. Water chocolate brown but cleared . Silts brown and very fine grains to 300mm below water surface after digging.

14 December 2008	Knox Farm **(Site 18)**	E2735509 N6509229	As above.	As above.	24 hours	Tall reeds and sedges. Cabbage tree 1m away. Clear water evident in depressions. Brown, fine silts clearing quickly. Some water flow.

TableFour

4. Results:

4.1. Day Surveys:

Date	Site Name	GPS	Equipment	Time notes	Results: Species	Results: description / Measurements
1) 6 November 2008 2) overnight 7 November	Briclke Bridge **(site 1)**	E2734802 N6509874	Fish trap with marmite	1) Checked 13.45 2) Then left over night.	1) 5 common bullies (*gobiomorphus cotidianus*). Several juvenile shrimp. 2) 3 common bullies. 5 assorted shrimp.	1) 1@70mm, 2@65mm, 1@55mm, 1@45mm. 2) 1@ 60mm, 1@ 40mm, 1@ 35mm.
1) 6 November 2008 2) overnight 7 November	"Leo's Ditch" confluence with Waikawau Stream **(site 2)**	E27344737 N6509156	Fish trap with marmite	1) Checked 13.30 2) Then left overnight.	1) 3 common bullies 2) nil.	1) 1@50mm, 1@90mm (dk brown), 1@70mm (mid brown).
6 November 2008	Waimanu Rd Bridge **(site3)**	E2734826 N6509129	1). 2 baitcachers weighted and baited with bonemeal, poultry mash and sand 2) Hinaki trap with mince and marmite 3) Whitebait net.	1) checked 14.00 2) 14.00 3) Three trawls: 3a) muddy bottom: 3b) open water near river bank. 3c) As above. Biota placed in container, measured and counted.	1) 1 common Bully 3 shrimp 2) 1 common bullies 3 Yellow eye mullet 2 herring 1 shrimp 3 snails. 3a) 3 elver (*Anguilla australis*). 3b) 1 inanga (*Galaxias maculates*). 3c) nil.	1) 1@75mm 2@ 30mm 1@ 20mm. 2) 1@65mm 1@ 150mm, 1@145mm 1@ 130mm. 1@90mm, 1@100mm. 3a) 1@40mm 1@30mm 1@ 50mm. 1@15mm.
11 November 2008	Waikanae Stream bridge **(site 4)**	E2735450 N6508445	1) Two bai catchers weighted and baited with bonemeal, etc. 2) Hinaki with mince and marmite. 2b) then left overnight	1a) checked 11.30am 1b) then left overnight. 2a) Retrieved 11.30.	1a) 3 red finned bullies (*gobiomorphus huttoni*). 1b) nil. 2a) 3 yellow eye mullet (*Aldrichetta forsteri*) 1 parore (*Girella tricuspidata*) 1 triplefin (*Forsterygion sp.*). 1 common bully 2b)2 yellow eye mullet 4 Bullies.	1a) 1@55mm, 1@ 75mm, 1@ 65mm. 2a) 1@165mm, 2@145mm 135mm 45mm 1@ 60mm. 2b) 1@150mm, 1@105 Escaped net.

11 November 2008	Waikanae Stream/ Waikawau estuary confluence **(site 5)**	E2735417 N6508652	1) Fish trap (hinaki) baited with mince and marmite. 2) Whitebait scoop nets	1) Checked 11.45. 2) Then left over night. Biota placed in container, measured and counted	1) 3 giant bullies (*Gobiomorphus gobiodes*) 4 shrimp. 2) 1 elver (*Anguilla australis*) 1 inanga Many tiny mud crabs, snails and inanga (50+).	1) 1@ 35mm, 1@45mm, 1@25mm. 1@ 40mm, 1@ 35mm, 1@ 30mm, 1@25mm. 2) 40mm. 40mm
11 November 2008	Whitehouse driveway culvert **(site 6)**.	E2735414 N6508346	1) Fish trap with mince and marmite 2) Whitebait scoop net.	1) Left overnight. 2) Trawls in open ditch. Biota placed in container, measured and counted	1) 2 common bullies 1 common bully 2 common bullies (*Gobiomorphus cotidianus*) Many shrimp 2) 8 inanga shrimp	1) Male 1@65mm, 1@ 60mm. Female @ 50mm. Juv 1@25mm, 1@40mm. 2) Average @ 30mm
11 November 2008	Leo's Driveway ponding area. **(site7b)**	E2734709 N6508959	Whitebait scoop net	Biota placed in container, measured and counted	1) many shrimp 1 water louse 1 red looper worm.	
14 November 2008	Around site 4 and in any drainage ditches and near culvert pipes	E2735450 N6508445	Visual search		Inanga and other migrating fish seen moving in and out of ditches into the grass.	
14 November 2008	Around site 3 and also on upstream bank of Waikawau stream.	E2734826 N6509129	Visual search		Eel Many inanga seen moving up through *paspalum vaginatum/distictum*.	850mm.
16 November 2008	Around **site 4**	E2735450 N6508445	Whitebait scoop net and 2 finer mesh nets.	9.00 to coincide with high tide, (3.5m) Trawls in two general areas. 1) 2 trawls front of paddock near bridge. 2) 5 trawls at 25m intervals in front - middle of paddock moving further inland from 2nd ditch. Biota placed in container, measured and counted	1) Many inanga, glass eels? and/or smelt seen moving in and out of inundated paddocks and ditches. 1a) Milky sum (milt?), spawn. 1b) Spawn? and many shrimp. 2a) Shrimps and small invertebrates (river edge). 2b) Shrimps (25m from above). 2c) crabs and invertebrates (2nd ditch) 2d) nil (25m from above). 2e) Shrimp (25m from above). 2f) 1 inanga (25m from above).	1a) Spawn - dark blue head and slender thread like body, in clear gel-like capsule. 1b) as above. 12mm.
16 November 2008	Between **sites 1 and 2**	E2734802 N6509874 E27344737 N6509156	Whitebait scoop net and 2 finer mesh nets.	11.30 5 trawls at 25m intervals – upstream of Brickle bridge.	1) 1 shortfinned eel (*Anguilla australis*). 2) 2 inanga spawn, shrimps. 3) 1 inanga spawn? 4) 10 inanga spawn? glass eels?, shrimps 5) 2 inanga? smelt, spawn?, many shrimp. School of yellow eye mullet seen.	1) 1m.

17 November 2008	1) Site 1	1) E2734802 N6509874	1) Whitebait scoop net and 2 finer mesh nets.	High tide 3.5 m 12.30	1) Trawls carried out by three people. 1a) 2 inanga spawn? 1b) 5 inanga spawn? 1 snail. 1c) 4 inanga, smelt spawn? 1 inanga, 1 shrimp.	
	2) Brickle Bridge and confluence of Waikawau Stream **(Site 8)**	2) E2734839 N6508889	2) As above. 2a) scoop along stream edge. 2b) as above 2c) bottom scoop.		2a) 6 inanga. 7 shrimp, 1 snail 2b) 10 inanga 4 inanga, smelt spawn? 2c) many shrimp.	2a) 10-20mm 2b) 35-40mm
	3) Site 2	3)E27344737 N6509156	3) Whitebait scoop nets		3a) Many inanga (100+) many shrimp. 3b) 5 inanga.	3b) 15-40mm
	4) Leo's Ditch Culvert pipe at Waikawau Bay road. **(Site 9)**	4) E2734700 N6508970	4a)Culvert 4b) culvert 4c) ditch right side of drive 4d)left side of driveway 4e) 50m inland from above.		4a) Shrimps 30+ inanga Snails. 4b) 2 common bullies 4c) 2 kinds water louse Water snails. 4d) many shrimp Water louse. 4e) mosquito larvae Water worm, water snails. Many shrimp	4b) 2 females @ 35mm
		4f) E2734659 N6508909	4f)50m inland from above 4g) same place as above		4f) 5 banded kokopu (juv). 4g) 1 inanga Shrimp, water snails.	4f) 3@ 30mm, 2@ 35-40. 4g) 1 @ 30mm
	5) Tidal/vernal pond in pastureland behind DOC Farm Park Woolshed. **(Site10)**	5) E2735589 N6508970	5a) Vernal pool 5b) as above 5c) culvert into pool 5d) As above		5a) 1 crab 3 snails. 5b) nil. 5c) nil. 5d) Shrimp larvae	

Table Five

4.2 Night Surveys:

Date	Site Name	GPS	Equipment	Time notes	Results: Species	Results: description / Measurements
26 November 2008	Leo X SMI Line/Brickle Stream **(Site11)**	E2734736 N6508915	Head lamps, spotlights and Whitebait trawl net	20.15	Many banded kokopu 1giant bully Shrimps Many inanga.	1@100mm

26 November 2008	Leo's Driveway Ponding Area **(Site 7)** **7a)** ditch near road **7b)** 50m inland **7c)** 50m further inland from last site	Ponding Length: 7a) E2734699 N6508970 7b) E2734706 N6508958 7c) E2734659 N6508909	Head lamps, spotlights and Whitebait net	7a) 20.45 7b) 21.05 7c) 21.25 7d) 21.40 7e) 21.55	7a) Many banded kokopu Many shrimp Many red fin bullies. Many freshwater invertebrates (similar mosquito). 7b) eel 7c) 3 banded kokopu 7d) longfin eel 11 banded kokopu Freshwater invertebrates – flying insects 7e) Inanga, 1 giant bully.	7a) 1@ 165mm, 1@ 150mm, 1@ 75mm, etc. 7b) 1@ 300mm 7c)2@ 75mm, 1@ 170mm. 7d) 1@400mm Between 125mm-200mm. 7e) 1@140mm.
30 November 2008	Pig Wallow Back of Wetlands on ALU rat line **(Site 12)**	E2734459 N6508456	Head lamps, spotlights and whitebait net	20.00	No fauna found.	
30 November 2008	Back of wetland **(Site 13)**	E2734468 N6508444	Head lamps, spotlights.	20.20	No fauna found.	
30 November 2008	Back of wetland **(Site 14)**	E2734231 N6508446	Headlamps, spotlights and whitebait net	20.40	Mosquito larvae? Flies/beetles on surface. Cadisfly/mayfly nymphs.	
30 November 2008	Intersection of ALU rat Line and Leo's Driveway. **(Site 15)**	E2734297 N6503681	Headlamps, spotlights and nets	20.45– 21.30	15a) Many shrimp Many banded kokopu Inanga Common bullies Water snails 15b) Many banded kokopu Common bullies Many juv. bullies Many shrimp Elver Eel Giant kokopu inanga 15c)1 koura Many juv kokopu	Some @150mm 50-100mm. 1@200mm 1@400-500mm.
30 November 2008	Briclke Bridge **(site 1)**	E2734802 N6509874	Headlamps, spotlights and whitebait net	21.45 - 21.55	Grey mullet Inanga Many giant/common bullies?	1@ 400mm.

TableSix

inanga found in pasture margins (Denton Paddocks) Waikanae Valley stream November 2008

4.3 Minnow Trap Results:

Date	Site Name	GPS	Time notes	Results: Species	Results: description / Measurements
December	**Site 16**	E2735153 N6509876	Trap left for 24 hours.	1 Short finned eel (*Anguilla australis*)-	300mm
December	**Site 12**	E2734459 N6508449	Trap left for 24 hours.	2 Banded Kokopu (*Galaxias fasciatus)* Freshwater invertebrates.	1@ 130mm, 1@ 140mm
December	**Site 13**	E2734465 N6508444	Trap left for 24 hours.	1 Short finned eel (*Anguilla australis*)	147mm
December	**Site 17**	E2735455 N6509232	Trap left for 24 hours.	Nil	
December	**Site 18**	E2735509 N6509229	Trap left for 24 hours.	1 Short finned eel (*Anguilla australis*)	120mm

Table six

Minnow trap and short fin eel (Knox Farm)

4.4 Other observations:

1) A black flounder was observed at Waimanu Road Bridge 24 April 2009. This is approximately 1kilometre from the Estuary mouth.
2) Smelt swimming in schools of about 30 - 40, and about 100-150mm in length, were observed on numerous occasions, at the Waikanae Valley Road Bridge during surveys in November 2008. Mullet were also seen often.
3) Large longfin and shortfin eels were seen in the mid reaches of the survey areas, and in the upper reaches of the lands around the survey areas, on numerous occasions.
4) A very large (live) banded kokopu (250+mm) was found in the grass near a pool at the north headland of Waikawau Bay in February 2009.
5) On 16 December 2008, at a 3.5m high tide (11.45am) The Denton paddocks around Site 4 were inundated with water. Many schools of yellow-eyed mullet were seen in the paddock. Fish were approximately 150 - 180mm in length. Some schools had as many as 100 fish. At the same time large schools of inanga and smelt were also seen in the paddocks.

Large banded kokopu found on north headland February 2009.

Black flounder in upper estuary April 2009.

Fish in flooded saltwater paspalum/mercer grass, 16 December 2008 (around site 4 – Denton Paddocks).

4.5 Summary of Fauna Results:

1) Surveys were for presence/ absence. No surveys were done for abundance. All freshwater and estuarine species that would normally be encountered in such environments and in this area, were found.
2) Estuarine/marine species found included parore, grey and yellow eye mullet, flounder, triplefin.
3) Lowland freshwater species encountered included: common bully, redfin bully, giant bully, long-finnned and shortfinned eels, banded kokopu, smelt, inanga.
4) Mid reach species encountered included: banded kokopu, redfin bully, short-finned and long-finned eels.
5) Eggs, larvae, and milt were found in pasturelands in late November. Species identification was not able to be made, however two options are probable.

i) Smelt, which are anadromous, spawn in the late Spring and early Summer and their preferred spawning grounds are lowland reaches.

ii) Although their main spawning time is in Autumn, inanga, also are known to spawn at his time (McDowell[12] notes that inanga will spawn from September – June).

6) Banded kokopu were found in a variety of environments, including: running pools and streams, but also in muddy seepages and grasses.
7) Redfin bully were commonly found, as were banded kokopu.

[12] McDowell, R.M. 1976. pp.30.

5. Discussion:

As pointed out in the Methodology, habitat types investigated included; tidal streams, vernal pools, ditches and inundated paddocks; streams and ditches at both lower and mid reaches; margins of mangroves (but not in the mangroves themselves); standing water in the middle and back of the wetlands, and small water runs at the back of the wetlands. Survey areas were all estuarine, tidal, lowland or mid reaches. No surveys were carried out in upper reaches.

Habitat types of native freshwater fish found in the Coromandel are as follows:

- "Inanga and other Galaxiid species spawning habitat – both estuarine and inland
- Giant bully habitats – estuarine and tidal lowland reaches
- Red-fin bully spawning habitat – lowland and mid reaches
- Adult banded and giant kokopu habitat – lowland, mid and upper reaches
- Adult and elver longfin eel habitat – lowland and mid reaches
- Adult koaro habitat – upper and mid reaches"[13]

Surveys for fish found <u>all</u> those species that were expected to have been found.

However, it needs to be pointed out that for our freshwater fish species and for some marine species as well, the estuary is vital to their lifecycle. Many of our fish species migrate from fresh to marine environments for part of their life time. There not only are good freshwater environments essential for the important for the integrity of our native freshwater fauna, but also a pristine estuary

"River estuaries are pathways – or bottlenecks – through which most New Zealand freshwater fishes must pass during their upstream and downstream migrations. Although the estuaries may play only a minor and temporary role in the lives of these fishes, they are an essential link in the life histories that must not be interfered with".[14]

Joy and McEwan note that two thirds of our native fish are on the threatened species list. This is because: "New Zealand indigenous fish are highly affiliated with native forest and we've chopped down 70% of our forests. Many of them are wetland specialist and we've drained more than 90% of our wetlands to create more and more pasture. A large number of them need to migrate between freshwater and the ocean and we've blocked these passageways with dams, culverts, and chemical pollution barriers. Perhaps most obvious of all, our native fish evolved in clean, cold water - historical landscapes that have been largely replaced with streams full of mud, municipal effluent, factory by products, nutrient run off and the agrichmicals and waste product associated with 5.3 million diary cows".

Furthermore, "it is little wonder that the many freshwater invaders from Europe and Asia such asl koi carp and perch are doing so well here – we have recreated the warm, nutrient rich soups they have evolved in. As well as being a symptom of the degraded conditions they thrive in, these invaders provide yet another nail in the coffin for native species".[15]

Interestingly, most freshwater species have little legal protection and are actually allowed to be exploited for economic gain – further enhancing their vulnerability and demise.[16]

Of the native species found in the surveys the following notes have been made:

5.1 <u>Inanga (*Galaxias maculates*)</u>

Ianga are vital for the health of the estuary and waterways. They are an important food source for various other estuarine fish species, such as; kahawai and flounder and freshwater fish such as eels. Inanga eggs are

[13] Environment Management Services Ltd. 2009, pp.35.
[14] McDowell, R.M. 1976. pp.29.
[15] Joy, Mike. and McEwan, Amber. 2009. pp.30.
[16] cit op. pp.31.

also eaten by elver, bullies, adult inanga and other freshwater fish species. In addition, inanga are a source of food for birds, such as; bittern, gulls, kingfisher, herons and shags.

"Inanga and smelt are primarily lowland river dwellers. Spawning habitat is varied in terms of vegetation uses, ranging from pristine flax to long rank pasture. Regardless of the vegetation used, access to this habitat on spring high tides is critical for successful spawning. The swampy tidal, stream margins and wetlands within the lower reaches are likely to provide important spawning habitat for all Galaxiid fish. These fish spawn in wetland vegetation (or more commonly now days, rank introduced grasses) on spring tides…. Thus river margin wetland is critical for their survival".[17]

From about August – November juvenile inanga "run" upstream from the sea around the time of the full and/or new moons, on the high tides. Inanga will stay upstream until maturity and leave from February – May, after staying there from 6 months – 3 years (adults can reach a size of 100mm – 170mm). They once again migrate on a high tide. This time downstream, into tall grasses, river banks, inundated pastures etc, where they spawn and then die. Eggs incubate on the river or stream edges and hatch at around 6 weeks, when they migrate into the sea and live for a little less than six months, before they "run" and return upstream about August - November.

Interestingly, spawn, milt and eggs were found in November in pastureland. McDowell, notes that while the major spawning time is during the Autumn, larvae of Galaxiid whitebait are also known to spawn from at least September through to June[18].

It is vital to protect spawning grounds if the health of other fauna of both the estuary and the streams is to be maintained. There are a number of concerns around the integrity of the spawning grounds, and the migration of both juveniles and adults in the Bay. These are centred on:

- a. Trampling of eggs by stock.
- b. Predation of eggs by rodents.
- c. Obstruction to migration through culvert construction without fish ladders, channelization, etc.
- d. Exotic plants in the streams[19] .
- e. Water abstraction.

a. There are unfenced areas in both the Waimanu Rd area and the Waikanae Valley Rd area where inanga spawn. Stock here, are likely to impact on inanga survival rates. Fencing of these areas or removal of stock during the spawning season, should positively impact on the inanga population.

b. Predation of native fauna by rats is well documented. This study assumes that they predate inanga eggs also. In addition, a study of mouse predation of inanga eggs in the three years from 2003-2005, Cindy Baker found the following:

"Over the three seasons, the main predator of inanga eggs was the common house mouse (*Mus musculus*). Mice were located at both camera sites during 2004 and 2005. Each season, mice were observed eating all eggs under surveillance …"[20]

Furthermore: "[t]his study shows inanga eggs are readily consumed by mice, and as inanga eggs are spawned amongst lowland terrestrial vegetation, where mice forage, a high density of mice within the vicinity of an inanga spawning ground could significantly impact on egg survival".[21]

This is of great concern as during the rodent and reptile monitors of late January through to April 2010[22] in the Waikawau catchment (a time of drought, when it is thought rodents migrated to the wetlands in significant

[17] ibid.
[18] McDowell, R.M. 1976. pp.30.
[19] Rook, H. 1996. pp.5.
[20] Baker, C. 2006 pp.145.
[21] cit op. pp.146.

numbers), rodents were at almost 85% in the saltmarsh and wetlands. They were particularly prominent in the areas of pampas, reed and grasses on the bunds and on stream banks[23].

While there is a considerable amount of trapping (mostly) and some toxin control for rodents, in and around the wetlands, more will be required if inanga spawning is to be enhanced and protected.

c. While this study did not look at <u>all</u> culverts and other obstructions to inanga migration, it is known that there is remedial work required in the catchments around this issue. For example, as mentioned above, there was extensive straightening of the Waikanae Valley stream, and channeling to form ditches, (about 60 years ago). In these areas there is increased water velocity at times of high rainfall. Inanga are not strong swimmers and prefer slower moving streams with breaks such as rocks, branches, established vegetation and meanders. Meanders are effective in restricting flow. Velocity, and gradients without breaks, and meanders, are an impediment to inanga migration upstream.

d. Of the exotic plant species that Rook[24] lists as threats to spawning sites, the following are found on the edges and banks of waterways in the survey area:

Silver poplar
Crack willow
Grey willow
Pussy willow
Weeping willow
Blackberry
Gorse
Pampas.

These plants smother out desirable grasses and destroy spawning habitat.

e. Water is taken from all catchments in the area. This is not seen as a major threat to inanga in most years. However, in drought years more water is being taken by local residents than normal, watering gardens, etc. This is potentially a major threat in such years. During the drought of 2010, when water levels dropped a weir built to accommodate the migration of fish in normal years, showed the culvert pipes at too high a level for fish to traverse (Karuna Ford)[25].

5.2 <u>Redfin bully: (*Gobiomorphus huttoni*)</u>:

Mike Joy and Amber McEwan[26] note that redfins were formally stalwarts of the mid reaches, but that they are now found only in catchments with little or no farming, such is their susceptibility to, stock runoff, farm chemicals and catchment changes. Redfin bullies prefer moderate flows with plenty of gravelly substrate, vegetative overhang, instream debris, boulders and rocks in which to “hide”. These fish can be found deep down in the tunnels formed by gravel and rock substrate. This “third dimension” allows many more fish to exist than if it were not available. However, this dimension is increasingly disappearing from our waterways - the spaces filling up with sediments from hill country erosion.[27]

They spawn in mostly in the spring underneath rocks in the low reaches. Redfins migrate downstream to spawn. Larvae then move out to sea for some months before migrating back to freshwaters of the low and mid reaches.

Fortunately, Redfin bullies are widespread and are still found in abundance in our area[28]. The need to maintain the health and restoration of their habitat is therefore vital if this is to continue. Most Waikawau Bay surveys were however, carried out in areas where stock runoff is negligible.

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[22] Monitors have been carried out every three months for the past three years.
[23] See Parr, K and Tood, W. Reptile Surveys 2009 – 2011. www meg.org.nz.
[24] Rook, H. 1996. pp.6.
[25] Observation by author.
[26] Joy, M and McEwan, A. 2009. pp.30.
[27] ibid.
[28] See for example, Kessells (2009) and Environmental Management Services (2009) pp. 36.

5.3 Giant Bullies (*Gobiomorphus gobiodes*):
Giant Bullies tend to inhabit waters with overhanging vegetation, in stream debris , logs and rocks with a gravely or rocky bottom. They are solitary or in pairs and are territorial. They spawn in spring and eggs which are deposited in a layer beneath a rocky or gravelly substrate. They take several weeks to hatch, and then the larvae go to sea, returning after several months. Giant bullies are not commonly recorded in the Coromandel[29]. But it is thought that this may be due to the difficulty in capture, rather than scarcity. The survey found numerous specimens in both estuarine and lowland reaches.

Recent works in removal of vegetation from the banks and streambed of the Waikanae Valley stream, in its lower reaches, is likely to have impacted on the habitat of this fish, causing silting the gravel based bed of the stream from the erosion of the banks, and removing instream debris and allowing the water to flow at an even faster rate (stream already straightened). This flushing may wash out the silts, but it may also be at too fast a rate for fish optimal habitat at times of high rainfall and/or breeding.

Giant bully (140mm).

Banded kokopu.

Leo's Ditch, Site15 , 26 November 2008.

5.4 Banded kokopu: (*Galaxias fasciatus*):
Although banded kokopu can be found at all reaches as they are good climbers, they are principally a fish of the lower reaches. They were often encountered in the surveys at both mid and low reaches and were often seen in the course of other survey work. They spawn in autumn and the larvae then go to sea. Migration back inland occurs at the same time as inanga. These fish can live to over nine years, before they spawn. They feed mainly on terrestrial Invertebrates and tend toward location/pool fidelity.

West, Jowett and Richardson found the abundance of banded kokopu in Coromandel to be the highest recorded anywhere in New Zealand[30]. Our surveys would seem to support these findings. While abundance was not surveyed, a number of observations can be made around this point.

a. Banded kokopu were found in a large number of environments:
    i) In pools, at both mid and lower reaches, and in pools with both gravel/shingle substrate and silt substrate.
    ii) In muddy seepages and grasses at the back of the wetlands (Site 18).
    iii) In grass beside a deep temporarily landlocked pool (not landlocked during floods – when surrounding damp area becomes a wetland and joins with tidal stream which often dries up)

b. In some locations (Sites 7, 11 and 15) there were so many banded kokopu that they could not be counted.

West, Jowett and Richardson also not that habitat quality and quantity probably influence abundance as does the availability of terrestrial prey. Streams and ditches surveyed around Leo's driveway (sites 2 and 7 and 9) noted abundant terrestrial and aquatic invertebrate life. At the time of the surveys one can assume relatively

[29] ibid.
[30] 2005. pp. 926.

good environment quality for banded kokopu. Since the 2008 surveys, several large floods and machine work alongside pools may have compromised their environments around sites 7 and 15, 2 and 5.

5.5 Long-finned eel (*Anguilla dieffenbachia*) and Short-finned eel (*Anguilla australis*)
The long-fin is listed by DOC as a *"Chronically threatened species in gradual decline".* Shortfins are also in decline, but due to their shorter lifecycle are not in such a critical condition (see discussion below).

Both species were found in both the lower and mid reaches of survey areas. The Environmental Management services Report 2009, found that both long-finned and short-finned eels were relatively abundant in the area. In general, short finned eels are smaller than long-finned eels. The "silverbellies" are the short-fins, while the "yellow bellies" are the long-fins. Dorsal fins on the long-fin extend further forward than the anal fin, while the dorsal fin of the short-fin does not extend further than the anal fin.

Long-finned eels migrate from the sea as glass eels in the late winter and spring. They change to elver about a week later and then move upstream to the mid and upper reaches where they may stay for many years before migrating back to sea in the Autumn to spawn in the sub tropical western Pacific. Eels only spawn once before they die. Long-fins males mature at about 23 - 25 years when they are around 1metre in length. Females mature much later at anywhere between 34 – 56 years (some not for 80+ years) and when they can be up to 2 metres in length. Short-fins mature much earlier at about 9 - 15 years for males and 30 - 40 years for females. Spawning migration of short-finned eels is earlier than the long-finned eels. This occurs in February when the male leaves and then the females in March. In April the long-fin males leave and then the females in May (or thereabouts).

While quota are now allocated for the commercial taking of eel, they are in serious decline and it is estimated that that they will continue to decline by five – 30% in the next decade. In many rivers large eels have now completely disappeared. There are three reasons for this.

a. Eels only breed once before they die. Most large eels are the females. For Longfins their longevity makes them extremely vulnerable to capture before they become sexually mature. While most eels taken are the larger females, allowing the smaller eels to mature and survive, it now seems that the majority of young eels turn into males. In one survey 95% of eels recorded were males[31].

b. Habitat removal and land use changes:
- Drainage and channelization of streams and wetlands.
- Effluent runoff and discharges into waterways.
- Restricted access to watercourses and/or upper and lower reaches
- Stock entering waterways.
- Water temperature rises due to removal of overhanging vegetation.

c. Recreational and commercial fishing and exploitation, including the removal of eels to make way for trout and salmon. While the later has not occurred in the Coromandel, it has had a major impact on the numbers of eels in many parts of New Zealand. However, what is of concern here is the attitude of many people toward eels. Some view them as a large biting menace, as unwelcome "taniwha", therefore wanting to rid the waterways and swimming areas of their presence.

5.6 Exotic Freshwater Fish species:
Of note was the absence of exotic fish species, such as koi carp, perch and gambusia. This is a significant positive finding. As many native freshwater fish populations in the Waikato have been significantly negatively impacted by these species

[31] Napp, B. 2004. pp. 21.

5. 7 Descriptions of obstructions/modifications and stream work (As in Objective Three):

Some assessment of possible and known obstructions to fish passage has been detailed in Introduction (1.5) of this Report. However a more detailed assessment is required as areas of the freshwater fish surveys were the only areas looked at in any depth. Local knowledge by the authors has contributed further to the assessments of this Report, but there are large areas where investigation is still required.

Recent work by Environment Waikato on the Waikanae Valley stream (August and September 2011) has cut down trees overhanging the lower reaches and has scooped large amounts of fallen debris out of the stream bed. This has been as a result of a bid to prevent any flooding bank up caused by fallen trees, which in turn has been exacerbated by the straightening of the stream and the congruent rush of waters during times of high rainfall. This area is known to be the home to eels, banded kokopu, giant kokopu, redfin bullies and is a major thoroughfare for inanga and other migrating species.

Planting of the banks and further fencing are required to ensure that such work does not result in further erosion of the banks during future high rainfall events. Also, stock need to be kept from the areas already fenced, and future fenced off areas. Stock should also be kept from the area around the "Karuna Pond", which is already fenced. Although this area has not been surveyed for freshwater fish, it is known to have a large number of both shortfin and longfin eels.

5.8 Saltwater paspalum has become established in the Waikawau estuary and surrounds. This plant pest is changing the hydrology of the estuary and the wet areas behind the estuary; smothering gravel beds, building up sediments and providing stable ground for other plant pests such as blackberry, gorse and pampas to become established. Flooding is now occurring more frequently behind the build up of sediments in the estuary. In addition, stream channels are becoming narrower as banks build up. Flood channels are being choked and recent surveys[32] have found that native flora and fauna in the estuary are all being negatively impacted by its presence. Estuarine and freshwater fish have yet to be surveyed in relation to this plant species but, recent surveys of other flora and fauna have found that native flora and fauna are all being negatively impacted by its presence. This plant pest has the potential to have a major negative impact on freshwater fish species.

6. Conclusions:

6.1 All Estuarine fish species that would be expected to be found in the estuary were in evidence: these included flounder, parore, mullet and triplefin.
6.2 All freshwater species that should have been present were found and were healthy.
6.3 No exotic freshwater species such as koi carp or gambusia were found.
6.4 All native freshwater species were found relatively easily and numerous specimens of each were encountered. It is assumed therefore that they are relatively abundant.
6.5 There are a number of threats to the integrity of freshwater fish habitat. A major threat is that of the build up of saltwater paspalum in the estuary. Others include;

- pest plant build up,
- lack of adequate fencing,
- nutrient runoff and
- animal pests predating eggs and adult fish.

7. Recommendations:

1. Survey for freshwater invertebrate species (food source for fish).
2. Further protect the migration and spawning routes and grounds of freshwater species: This to include;
   i Protection of spawning grounds from stock
   ii Further investigation of obstructions to migration routes

[32] Surveys of saltwater paspalum Waikawau Bay, 2008 – 2010. W. Todd and K. Parr. Provisional reports available on request.

iii Implement protection of spawning grounds from rodents. Increase rodent traps around spawning grounds and number of trap maintenance rounds during spawning seasons.

iv Continue removal of exotic weeds from edges of waterways.

v Education of local residents (both downstream and in the upper catchment areas), about the effect of taking water from streams during extreme dry weather events has on native fish populations

3. Follow-up freshwater fish surveys with further surveys in Spring and Autumn, 2012 and 2013.
4. Survey estuary fish species - especially in and around the seagrass bed and the mangroves.
5. Further work be carried out on the growth of saltwater paspalum on the environmental impacts to freshwater fish species.
6. Survey the “Karuna Pond” for fish and freshwater invertebrate species.
7. Construct a Water Management Plan for the catchment (some work has already been carried out on this project by Alice Lenny, for the Karuna Falls Catchment).

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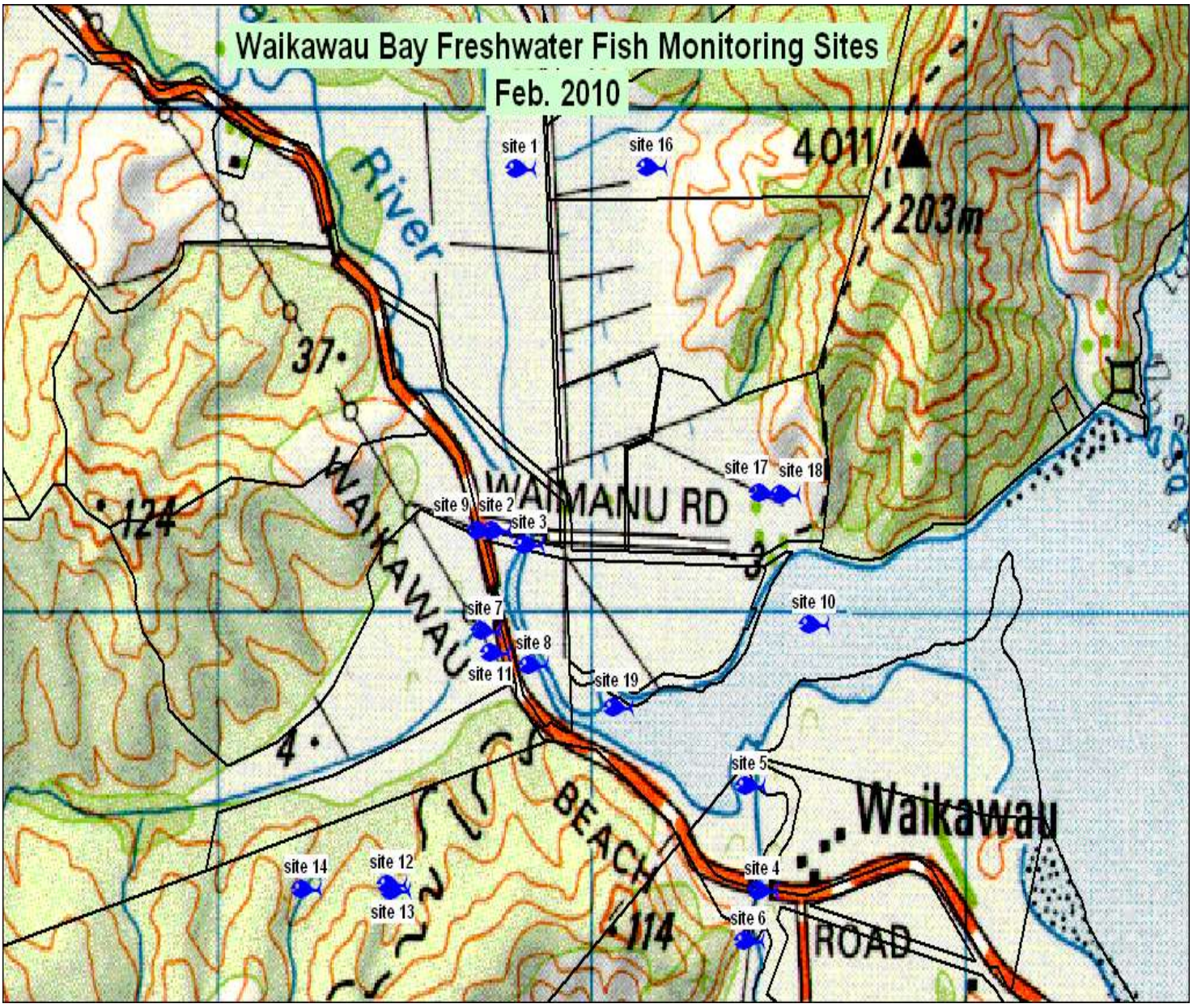
Appendix One



Appendix Two
Fish Species List:

Aldrichetta forsteri	Yelloweye mullet
Anguilla australis	Short finned eel
Anguilla dieffenbachii	Long finned eel
Galaxias fasciatus	Banded kokopu
Galaxias maculatus	Inanga
Girella tricuspidata	Parore
Grahamina sp	Triplefin
Gobiomorphus cotidianus	Common bully
Gobiomorphus huttoni	Redfinned bully
Gobiomorphus gobioides	Giant bully
Mugil cephalus	Grey mullet
Retropinnia retropinnia	Smelt
Rhombosolea retiaria	Black flounder

Appendix Three
Monitor Sites for Freshwater Fish Surveys
Waikawau Bay 2008 – 2009.

Site description	Site number	Easting	Northing
Brickle Bridge	site 1	2734802	6509874
Leo's ditch confluence with Waikawau Stream	site 2	2734737	6509156
Waimanu Rd Bridge	site 3	2734826	6509129
Waikanae Stream Bridge	site 4	2735450	6508445
Waikanae Stream / Waikawau Stream confluence	site 5	2735417	6508652
Whitehouse culvert	site 6	2735414	6508346
Leo's driveway ponding area	site 7	2734709	6508959
Brickle bridge/ waikawau stream confluence	site 8	2734839	6508889
Leo's ditch culvert (under road)	site 9	2734700	6509156
Vernal pool woolshed paddock	site 10	2735589	6508970
Leo SMI no.1 stream	site 11	2734736	6508915
Pig wallow back of wetlands. ALU rat line	site 12	2734459	6508456
Back of wetlands	site 13	2734468	6508444
Back of wetlands	site 14	2734231	6508446
Intersection ALU rat line Leo driveway ditch/stream	site 15	2734297	6503681
Gravelle's	site 16	2735153	6509876
Knox Farm	site 17	2735455	6509232
Knox Farm	site 18	2735509	6509229
North saltmarsh floodgate	site 19	2735065	6508806