



Whangamata Wastewater Scheme
Biological Sampling for Waikiekie Stream
Annual Resource Consent Compliance Report - June 2005



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1 Introduction

Environment Waikato (EW) resource consents granted to Thames Coromandel District Council (TCDC) allow for the spray effluent disposal of treated effluent from Whangamata township. Variation of the original consent conditions altered the consent condition to reflect previous monitoring which had been carried out in the Waikiekie Stream in 1999 and 2000 as described in the June 2000 report, "*Whangamata Sewerage Biota Study*" (Kessels, 2000) as well as specifying continued biological monitoring requirements as detailed in Section 2 of this report. Accordingly, Condition 17 of Consent No. 940707 states:

"The consent holder shall undertake a biological sampling programme of the Waikiekie Stream. Sampling locations shall be at least, three of the four existing survey sites as detailed in the report "Whangamata Sewerage Biota Study" (Kessels & Associates, June 2000), one upstream and two downstream of the influence of the irrigation scheme. Sampling frequency shall be in Late December and then again in Late March.

Stream biological monitoring shall include as a minimum algal and macrophyte growth and macro invertebrate assessment and shall be in general accordance with the methods detailed in 'Thames Coromandel District Council, Whangamata Wasterwater Scheme, Application to Change Resource Consent Conditions (Revised to include supplementary information)', dated 30 April 2001, by Montgomery Watson. The design of the sampling shall be forwarded to the Waikato Regional Council for written approval prior to the first sampling being undertaken."

This report presents and discusses the results of the biological monitoring programme of the Waikiekie Stream carried out on 15 February 2002, 27 March 2002, 16 December 2002, 24 March 2003, 9 April 2003 (electric fishing only), 26 May 2004, 20 December 2004 and 24 March 2005.

Figure 1. Location of Sampling Sites



2 Methodology

2.1 Survey Sites

Site selection was based on the five sites selected by Penny (1988) and Kessels (1999). In order to allow comparison with the sites used by Penny (1988 & 1991) and Kessels (1999 & 2000) the same site numbers have been used. The locations of the sites are shown in Figure 1. Grid references are approximately:

- Site 1a:NZMS 260 T12 615 398
- Site 1b:NZMS 260 T12 610398 (not surveyed 2002 - 2005
- Site 2: NZMS 260 T12 623 398 (not surveyed 2002 - 2005)
- Site 4: NZMS 260 T12 624 400
- Site 6: NZMS 260 T12 634 403

Sites 1, 4 and 6 were sampled for algal and macrophyte growths and aquatic macroinvertebrates, while Sites 1 and 6 were surveyed for fish. In the 2004 and 2005 surveys EW stream assessment forms were also filled in for each of the three sites (Kelly, 2003).

2.2 In-stream Vegetation

Surveys conducted from March 2002 onwards were based on survey methods described below. Specifically, three transects were taken at Sites 1, 4 and 6 at 10-metre intervals. At each transect 3 samples were taken evenly spaced across the transect using a 6.5cm diameter viewing bowl. Within each bowl, periphyton abundance, distribution and type was visually assessed on the substrate using the following criteria:

- Thin Mat or film (less than 0.5mm thick) - Green, light brown or black/dark brown.
- Medium mat (0.5 to 3mm thick) - Green , light brown or black/dark brown.
- Thick mat (more than 3mm thick) - Green , light brown or black/dark brown.
- Short filaments (less than about 2cm long) - Green, brown/reddish.
- Long filaments (more than about 2 cm long) -Green, brown/reddish.

The percentage cover of each periphyton type at each transect was estimated and then averaged for each site for each sampling episode.

2.3 Aquatic Macroinvertebrate Composition

Macroinvertebrate assessment was undertaken at 3 of the existing sites (one upstream and 2 downstream) using a 0.25mm standard Surber sampler ($0.1m^2$). Four replicates were taken per site – from the riffle environment in random placement, moving upstream. Samples were chilled and preserved in diluted isopropyl alcohol and taken to the laboratory for analysis by a taxonomist (Dr. S. Moore of Landcare Research Ltd., Auckland). Macroinvertebrate analysis was undertaken using "*Protocol P2 200 Individual Fixed Count with Scan for Rare Taxa*' as described in Stark *et al* (2001).

Macroinvertebrate Analysis was assessed using the following metrics as well as identification and abundance of taxa:

a) Macroinvertebrate Community Index (MCI);

b) Quantitative Macroinvertebrate Community Index; and

c) Ephemeroptera, Plecoptera, Trichoptera (EPT Taxa criteria).

MCI is used to describe the general health of a stream based on abundance, taxonomic richness and pollution/habitat tolerance of the animals within the sample. The MCI values can theoretically range from 20 to 200. However, streams generally do not have an MCI of over 150 (Stark, 1985). Streams with an MCI above 120 are believed to be of pristine condition with very good water/habitat quality. Only streams that are very polluted or have poor habitat will have scores of less than 95 (refer to Table 1).

The EPT criteria provide a guide to the ecological health of the stream, as these "EPT" insects (stonefly, caddisfly and mayfly larvae) are very sensitive to pollution, particularly nutrients/sediments and habitat modification. Generally, for a stream of average water/habitat quality, the EPT Taxa numbers would range from 3 to 9. For a stream of "pristine" quality this number can be very high – above 20 EPT species. Streams with a score below 3 are either of poor water quality or poor substrate habitat.

Table 1 MCI/QMCI Habitat Score Assessment Chart (after Boothroyd & Stark, 2000)

Macroinvertebrate Community Index Score	Quantitative MCI Index Score	Habitat Quality
>120	> 6.00	Clean water
100 – 119	5.00-5.99	Doubtful quality or possible mild pollution
80-99	4.00-4.99	Probable moderate pollution
<80	< 4.00	Probable severe pollution

2.4 Fish

Estimation and analysis of fish population parameters was conducted using the electric-fishing methods as detailed in Allibone (2000).

The electric fishing surveys were supplemented with spotlight sampling over one night – usually the night following the electric-fishing survey.

All electric-fishing survey was undertaken using a certified NIWA "Kainga" model back pack Electro-fishing machine. The presence/absence of particular fish species was assessed by fishing a 50-metre reach up to three times at Sites 1 and 6. Run/riffle, pool and backwater habitat was found in each reach to ensure that all potential fish habitats were surveyed.

Spot light survey was carried out at four sites - Site 1 upstream, Sites 4 (new culvert) & 6 (old culvert) downstream as well as in the vicinity of the State High 25 bridge over the Waikiekie Stream, approximately 1km downstream of Site 6.

3 Results & Discussion

3.1 Stream Morphology

The substrate of Waikiekie Stream changes from one characterised by cobbles and silts at the upstream site to one dominated by cobbles, gravels and silts at the downstream sites (Table 2). Stream width, wetted width, depth profiles and mean water velocity also reflect changes as the topography flattens and water volumes increase (Table 2). Water depths and mean water columns were typical for streams found in the Coromandel Peninsula (Kessels, 1995; Kessels, 1999a, Kessels, 2000).

Stream bank vegetation, shading and stability at each site are shown in Table 3. The catchment vegetation is dominated by pine forest with secondary indigenous vegetation and common exotic weeds growing along the stream margins and exposed sites. At the time of the Dec '04 and March '05 surveys, there had been no significant rainfall event at least 2 weeks prior.

Vegetation on the stream banks delineates the terrestrial aquatic interface and to a great extent controls erosive activities such as undercutting of the banks. Riparian vegetative canopy cover was highest at Site 1 (70%) than at Site 4 and Site 6 (40%). This cover affects the amount of sunlight reaching the water, which in turn affects the growth of the aquatic plants. The canopy cover also provides detritus matter which becomes a food source for many organisms in the stream.

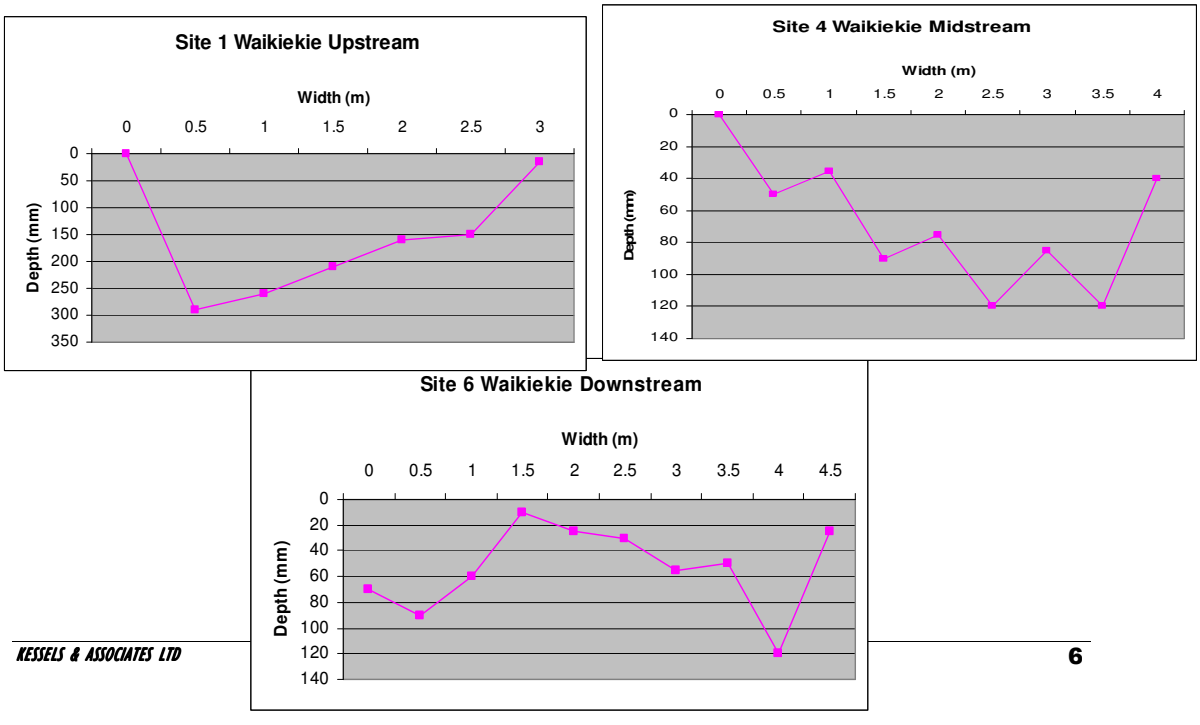
Table 2 Substrate Evaluation (from surface aspect) of survey sites in Waikiekie Stream -24 March 2005 (mean estimate from visual observations)

Substrate type	Diameter	Percentage composition		
		Site 1	Site 4	Site 6
Bedrock				
Boulder	> 256mm	5	5	10
Cobble	64-256mm	70	55	40
Gravel	2-64mm	5	15	15
Sand	0.06-2mm	5	5	5
Silt	0.004-0.06mm	15	20	25
Clay	<0.004mm	0	o	5

Table 3 Stream bank vegetation, shading and bed stability at 3 sites in Waikiekie Stream (mean estimate from visual observations)

Sample Site	Stream bank vegetation (m)	% shading	Stability
1	*Hebe salicifolia*, mahoe, mingimingi, manuka, rewarewa, puriri, tawa, hinau, *Coprosma robusta, C. grandifolia*, *Blechnum discolor*, nikau, *Dicksonia squarrosa, Lotus major*, red matipo, kawakawa, *Carex secta,* hangehange.	70	Good except for incised clay bank
4	*Pinus patula,* grey willow, *C. robusta*, pampas, manuka, *Hebe salicifolia*, mahoe, ponga, hangehange, pasture grasses	40	Good, although some movement below ford
6	Bracken fern, grey willow, pampas, *Dicksonia squarrosa,* manuka, *Coprosma robusta, Hebe salicifolia, P. radiata,* pasture grasses.	40	Good, although some bank erosion downstream of ford

Figure 2 Physical Characteristics of survey sites in Waikiekie Stream (mean estimate from visual)



3.2 Water Quality

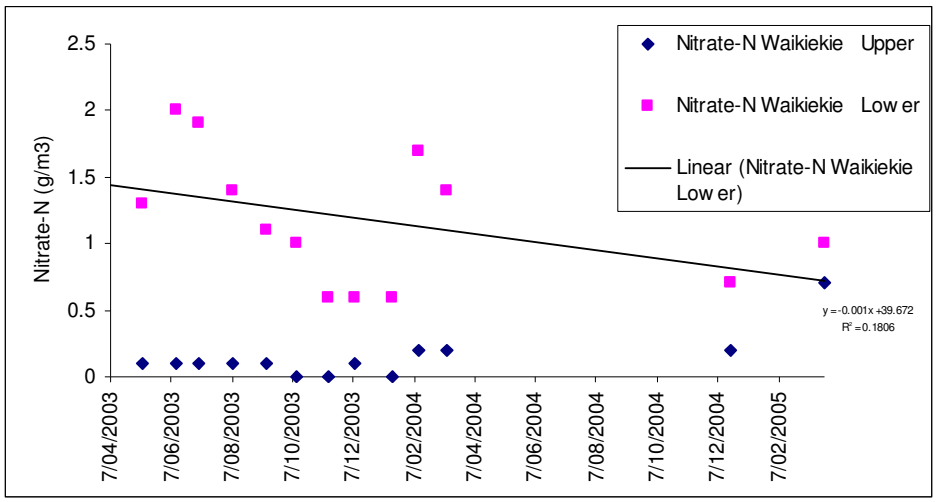
Water quality sampling is not a requirement of the biological monitoring consent conditions. However, given that water quality can have a significant influence on in-stream biota, basic water quality parameters were sampled for in the Dec.'04 and March '05 surveys (pH, suspended solids, Total Ammoniacal-N, and N as TKN, TON and Nitrate-N). These results were compared with the in-stream water quality sampling undertaken for other consent conditions in relation to the irrigation area.

Review of the water quality parameters suggests that dissolved nitrogen concentrations are consistently higher downstream of the spray irrigation area than upstream, as shown by Figure 3. Nonetheless, the linear regression line shows that there is an improving trend for the N concentrations over time. Dissolved inorganic nitrogen can cause excessive algal growths. Excessive nitrogen can also adversely affect macroinvertebrate diversity and composition. In relation to this ammonia concentrations were also higher in the downstream site (Site 6 – 0.15 g/m^3) as opposed to the upstream site (Site 1 – g/m^3). Ammonia is toxic to both invertebrates and fish at elevated concentrations.

Interestingly, suspended sediment concentrations in the March survey were noticeably higher in the upstream samples (Site 1 – 30 g/m^3) as opposed to the downstream concentration (Site 6 – 18 g/m^3).

All other water quality parameters showed no notable trends and were within normal ranges for this type of stream.

Figure 3 Nitrate-N (g/m^3) concentrations within Waikiekie Stream



3.3 Aquatic Vegetation

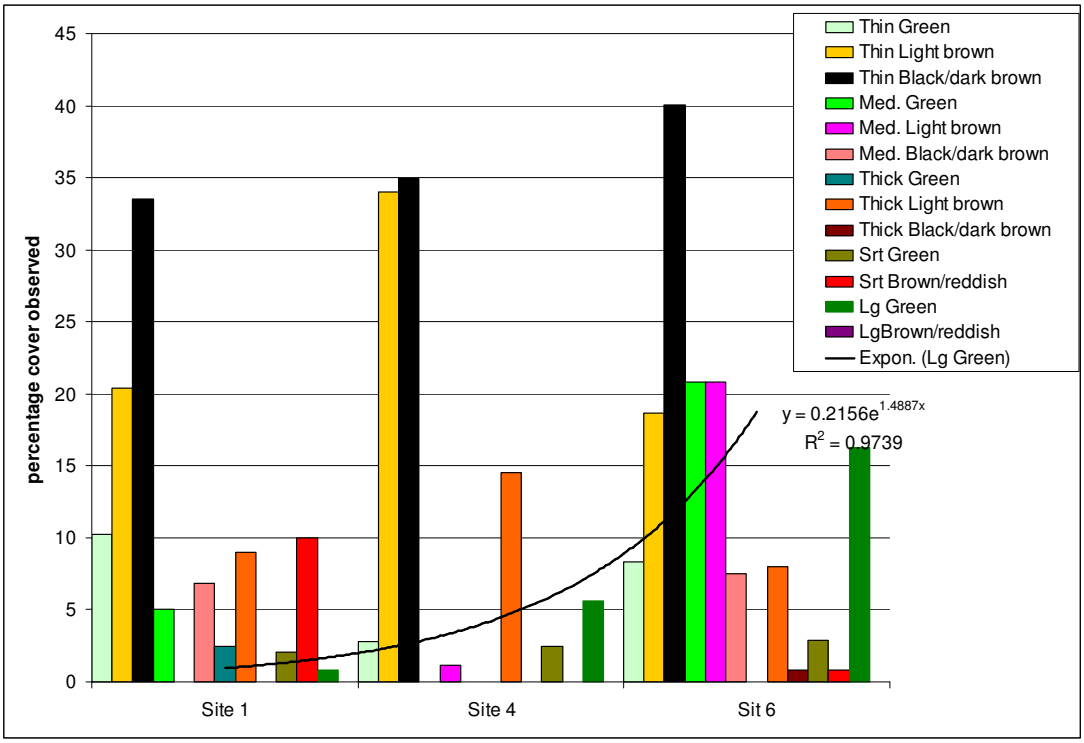
"New Zealand Periphyton Guideline" (Biggs, 2000) recommend that a seasonal maximum cover within stream or river beds by periphyton as filamentous growths or mats (> ca. 3mm thick) should not exceed 30% for a stony-bottomed stream. While this limit was breached in the March 1999 and to a lesser extent the December 2002 surveys, periphyton and macrophyte percentage cover in all other survey episodes was well under the guideline limit for all the sites surveyed.

Aquatic vegetation contributes to nutrient and energy flow of the stream by providing food for many aquatic insect species (herbivores/ omnivores) and a "niche" habitat for others. Additionally, they provide a source of oxygen for the water. However, excessive growth can consume too much oxygen and smother habitat.

Seasonal variability in water temperature and sunlight penetration, combined with inputs of nutrients is likely to be the key drivers of aquatic plant cover in the lower Waikiekie Stream.

In-stream temperatures and sunlight penetration are determined by overhead vegetation cover, and in this case the dense overhead canopy at Site 1 will be reducing excessive growth to some extent, while at Site 4 and 6, where overhead cover is less dense, water temperatures and sunlight penetration will be greater. Summer low flows often cause a marked increase in periphyton growth where overhead cover is not complete, regardless of nutrient status. Nonetheless, elevated nitrogen loadings may be having a potential effect on percentage composition when water flows are low and temperatures are high, as shown by the noticeable increase in long green filamentous algae growths (probably *Stigeoclonium tenue* and *Spirogyra sp.*) - shown by the sharply inclining regression line in Figure 5. Despite this increase, overall average cover for long green filamentous algae is 16.3%, which is half of recommended maximum growth cover (refer to detailed tabulation of results in Appendix I).

Figure 4 Average Periphyton Type & Composition Cover in Waikiekie Stream (averages for 2002-2005 surveys)



3.4 Macroinvertebrates

Appendix II lists the taxonomy analysis sheets for the Dec. 2004 and March 2005 aquatic macroinvertebrate samples.

Figure 6 shows averages of the key indices for the macroinvertebrate samples from 1999 until March 2005. Site 1 MCI and QMCI scores are reflective of good quality habitat characteristic of plantation forestry clad catchments, albeit slightly lower than typical bush clad Coromandel streams. The Site 4 MCI results appear to be recovering well from the disturbance caused in 2000 when the new culverts were installed here. Bed disturbances can be important in dictating species composition and richness (Scrimgeour & Winterbourn 1989; Death 1996; Townsend *et al*. 1997c). This recovery is shown by the inclining regression line over time (Figure 6). Site 6 is generally scoring significantly lower than either Site 1 or Site 4 on almost every sampling occasion. While habitat composition, in terms of a more boulder-dominated substrate and less overhead cover is likely to be an influence, the elevated nitrogen concentrations may be causing lower macroinvertebrate abundance and diversity at this site. The December 2004 and March 2005 results show a significant drop in MCI and QMCI indices over all three sites, however the linear regression line shows no significant trend

as a result of this for Sites 4 and 6 for both MCI and QMCI. When the data sets for these two last surveys are examined more closely, the QMCI scores for both Sites 1 and 6 are indicative of 'severe' pollution. Recent logging during sampling has most probably caused the elevated suspended sediment concentrations noted. The elevated levels of suspended sediment concentrations and accumulated fine sediments as a result of road and harvesting operations can reduce in-stream fauna diversity and abundance (Harding *et al*, 2000; Fahey *et al*, 2004). Given that the control site (Site 1) shows an even more significant drop from previous years this is considered to be the most likely explanation for the resultant low MCI and QMCI values. It is noted, however, that elevated in-stream ammonia and nitrate concentrations are found at Site 6 and these elevating concentrations may also be contributing to indirect and direct impacts on benthic fauna.

Taxa number and EPT taxa numbers suggest diverse insect populations with most families well represented at Sites 1 and 4, while Site 6 generally shows lower overall taxa and EPT scores (Figure 7). In particular, the larvae of mayflies and caddis flies are present throughout the length of stream surveyed. There appears to be a clear trend in distribution down the sites - where Site 1 contained higher numbers of the very pollution sensitive mayfly larvae - *Oniscigaster distans, Deleatidium* sp. and *Coloburiscus* sp., the other site samples generally contained lower numbers of these species. In particular, the larva of *Orthopsyche* sp. was commonly captured at the upstream site, where it was usually in lesser numbers or absent in the Site 4 and 6 samples. Stonefly larvae, while present in most samples, only occurred in low numbers and species diversity and showed no clear trends in distribution between the three sites, probably reflecting seasonal breeding patterns more than anything else. Figure 8 (raw abundance bar charts) shows a slight pattern indicating that the pollution-sensitive taxa are less prevalent in the two downstream sites, with the more pollution tolerant two-winged flies (Diptera), freshwater snails (*Potamopyrgus antipodarum*) and aquatic worms (Oligochaeta) becoming noticeably more prevalent at Site 4 and Site 6, although this is not a consistent trend and the Dec. 2004 and March 2005 tend to show Site 1 and Site 6 being of lower taxa diversity than Site 4.

As for the MCI and QMCI scores there is a noticeable drop of in taxa diversity over all sites for the March 2005 results, which can again most likely be attributed to the effects of logging within the catchment.

Figure 5 Time Series of MCI Scores for Waikiekie Stream 1999-2005

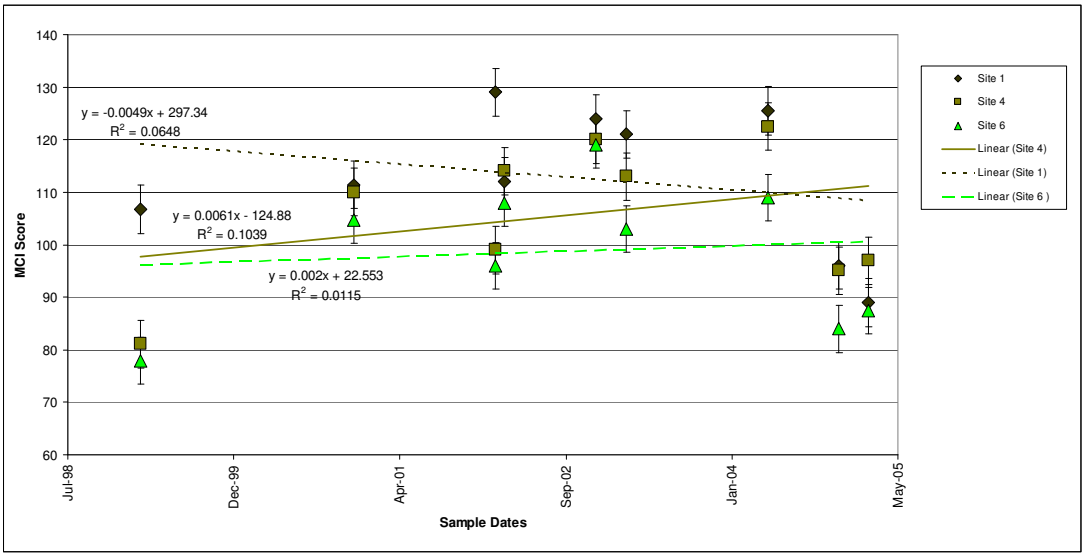


Figure 6 Time Series of QMCI Scores for Waikiekie Stream 1999-2005

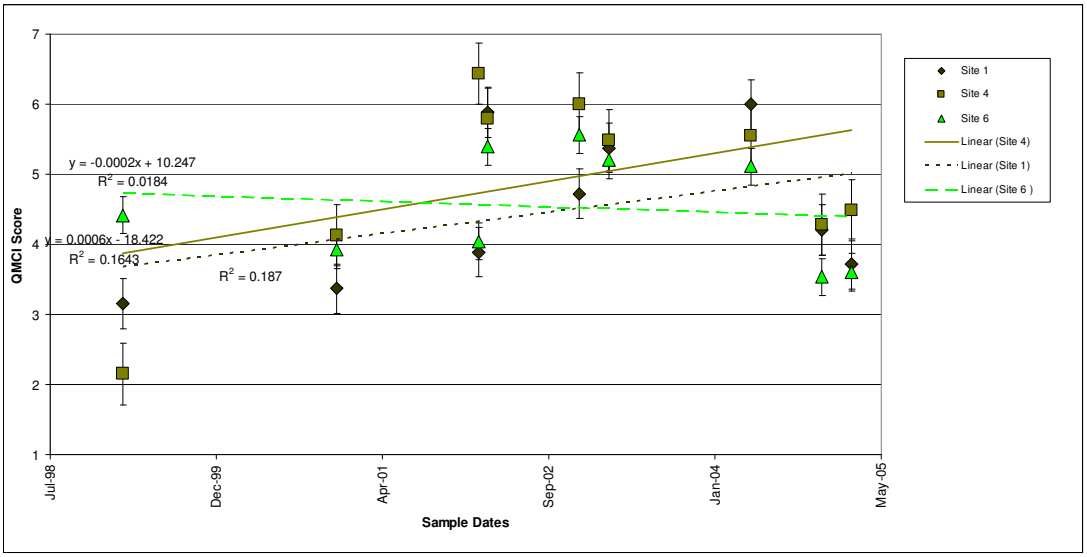
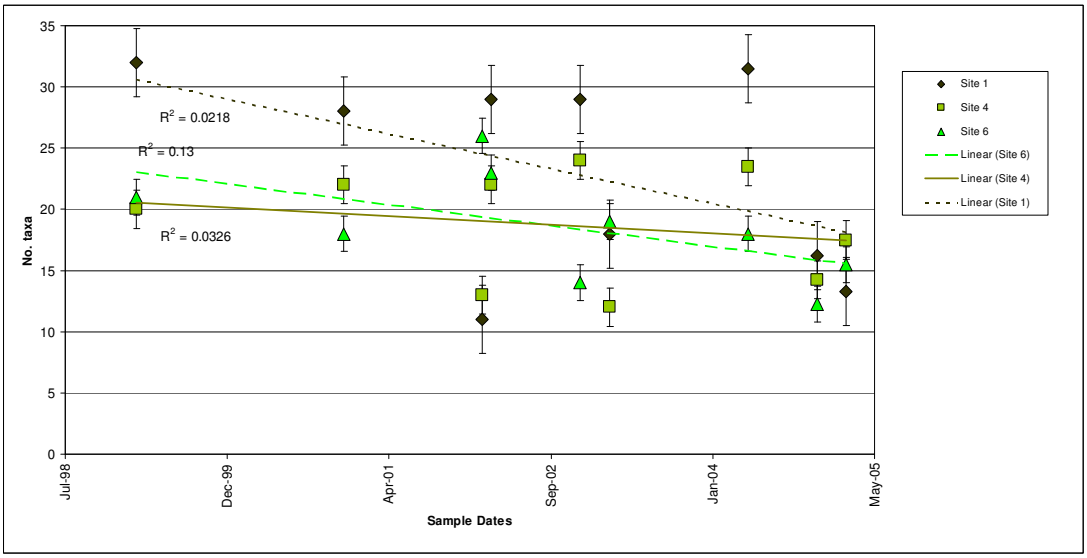


Figure 7 Time Series of Taxa and EPT Taxa Scores for the Waikiekie Stream – 1999-2005



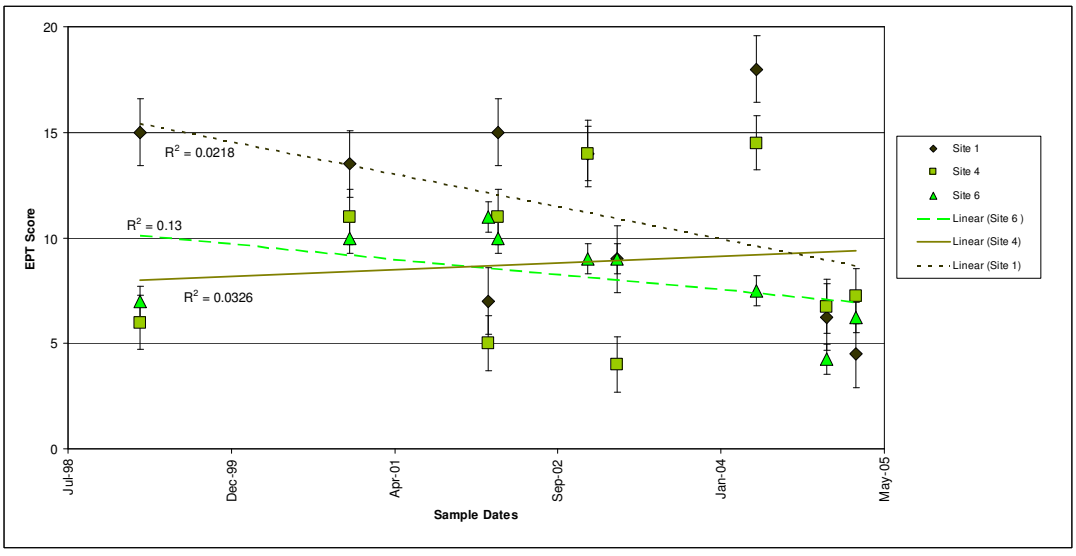
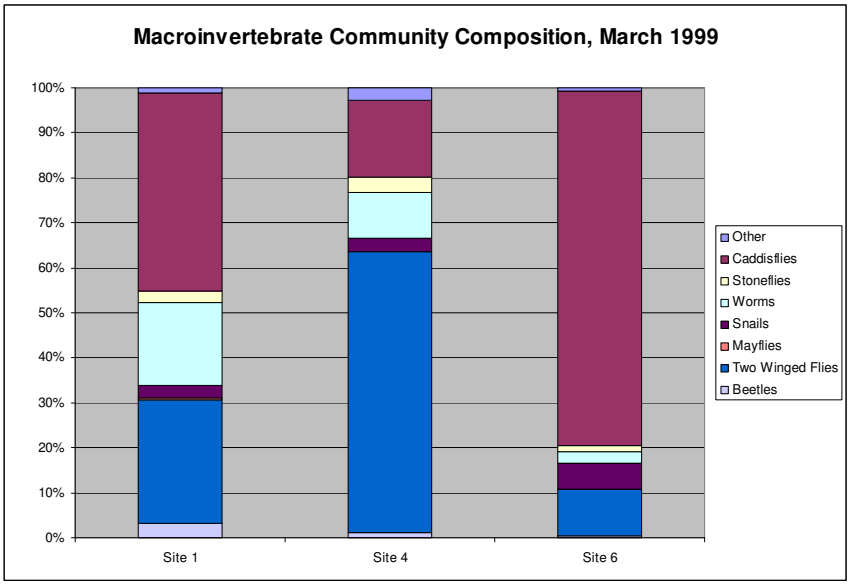
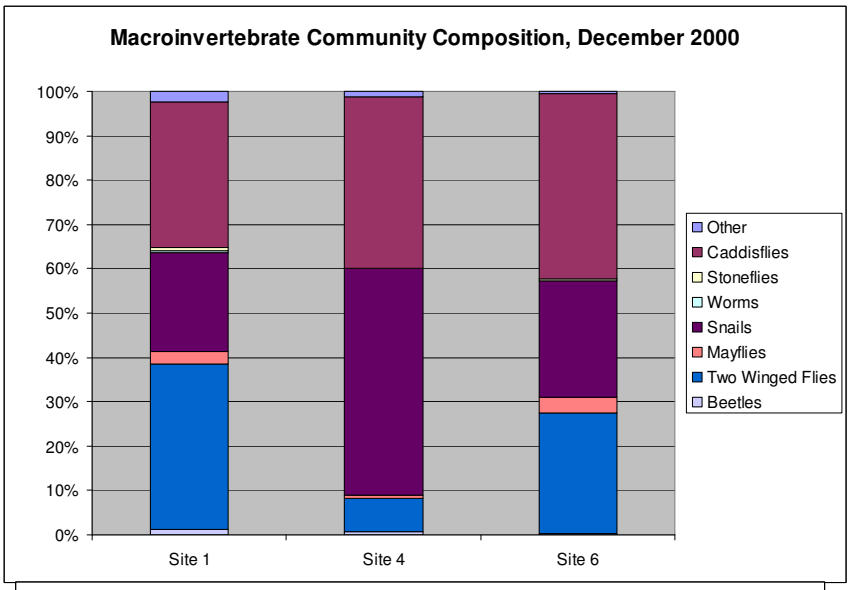
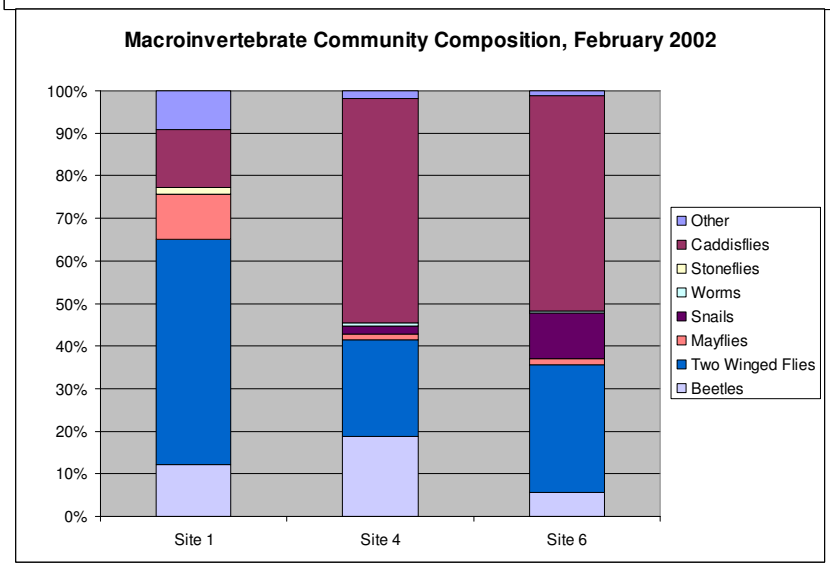
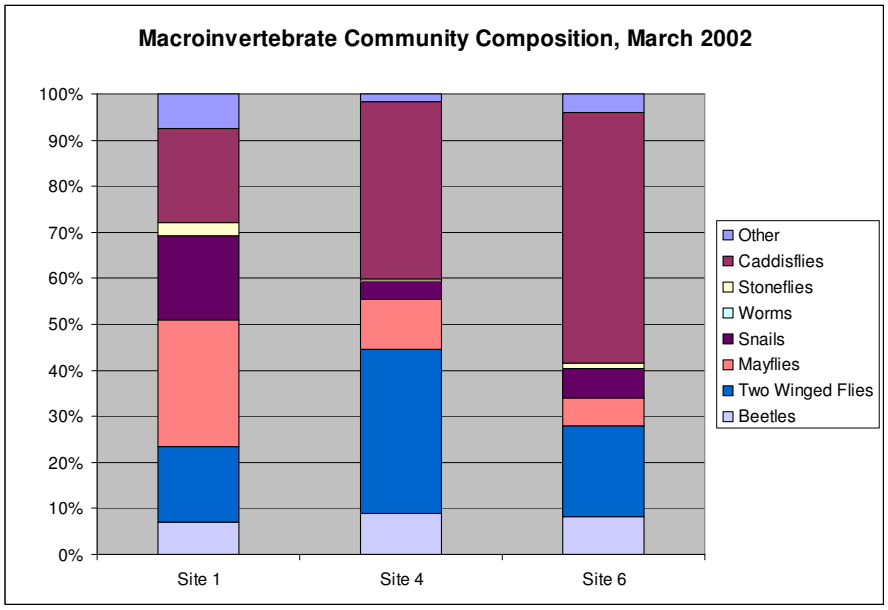


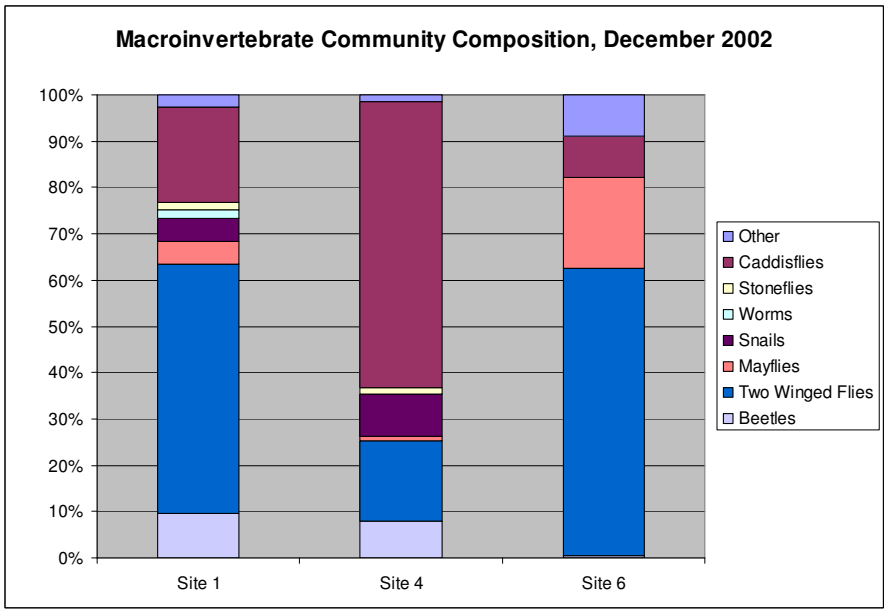
Figure 8 Taxa Community Composition Raw Abundance Bar Charts for the Waikiekie Stream – 1999-2005

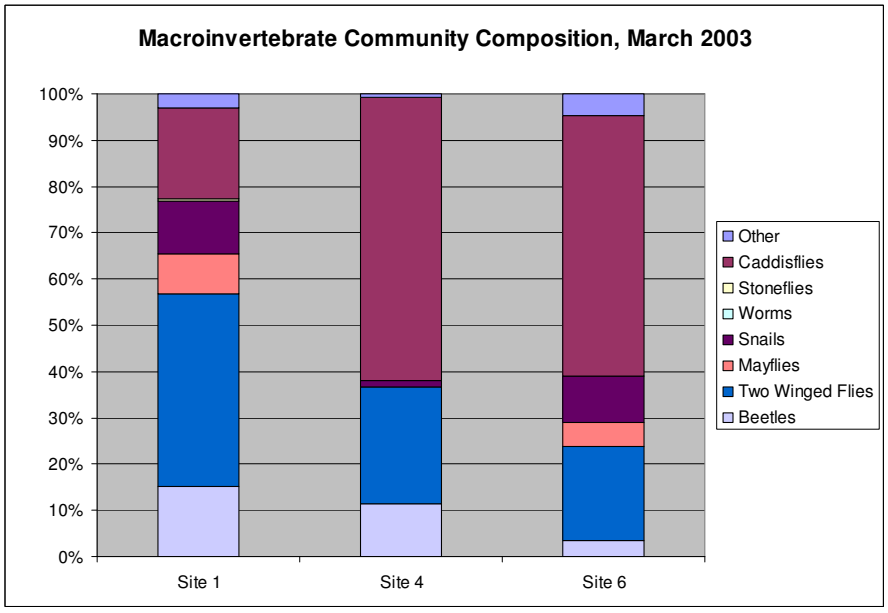


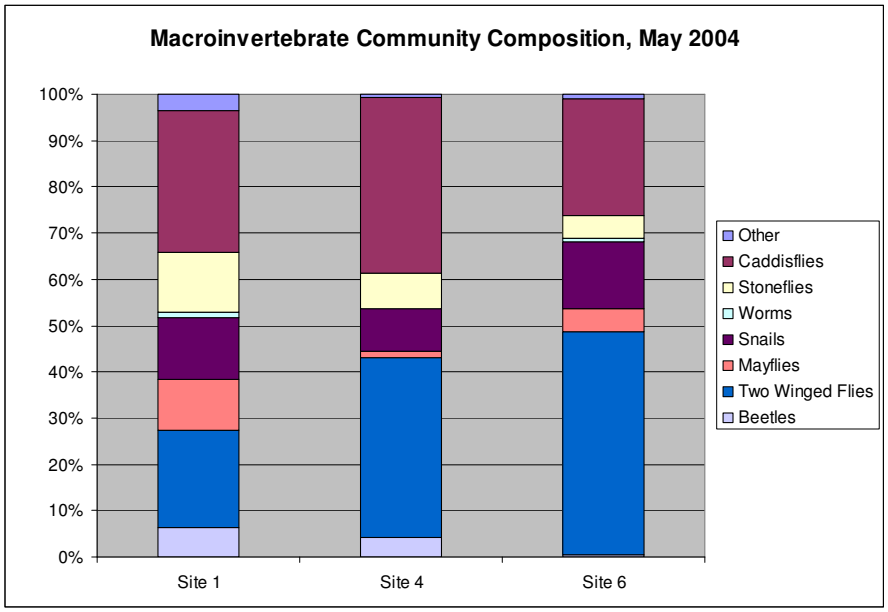


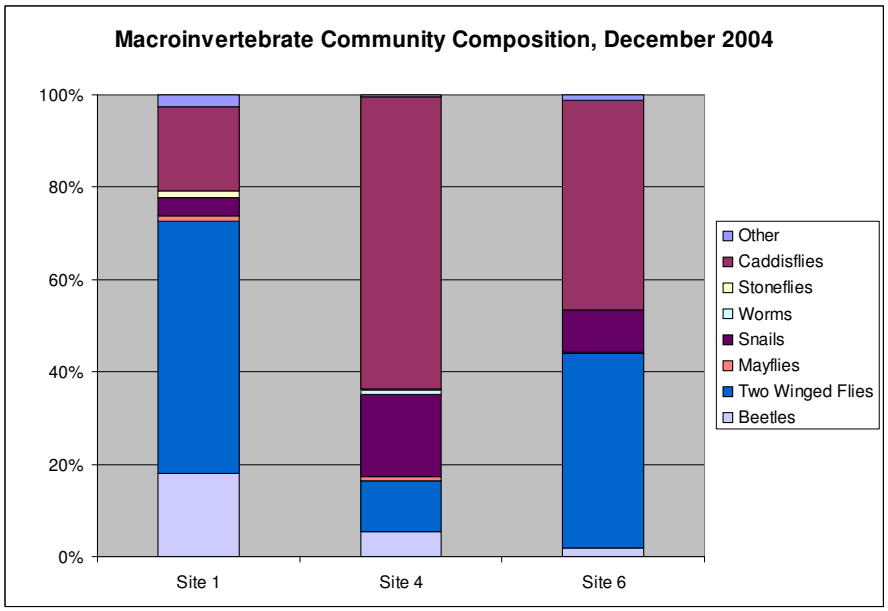


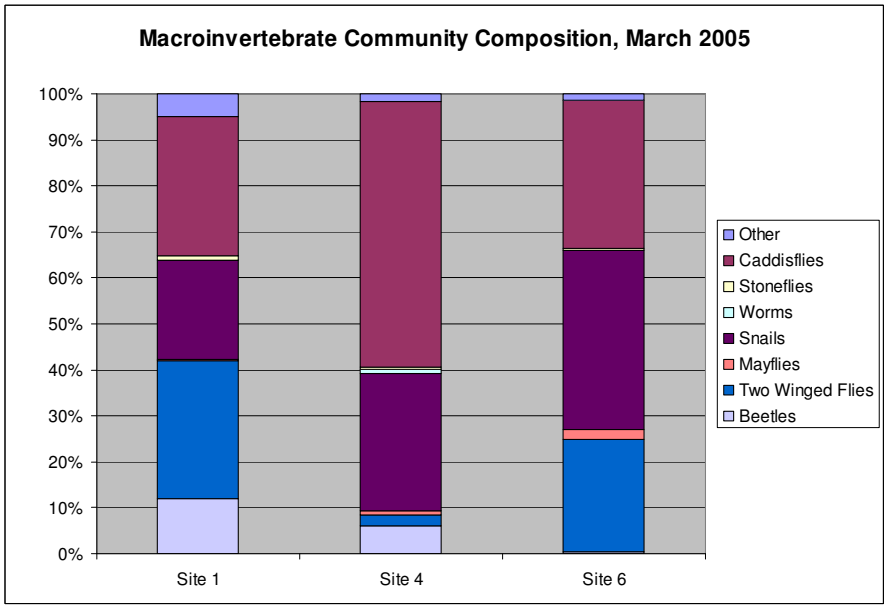

Macroinvertebrate Community Composition, March 2002
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Site 1
Site 4
Site 6
Other
Caddisflies
Stoneflies
Worms
Snails
Mayflies
Two Winged Flies
Beetles


Macroinvertebrate Community Composition, December 2002
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Site 1
Site 4
Site 6
Other
Caddisflies
Stoneflies
Worms
Snails
Mayflies
Two Winged Flies
Beetles


Macroinvertebrate Community Composition, March 2003
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Site 1
Site 4
Site 6
Other
Caddisflies
Stoneflies
Worms
Snails
Mayflies
Two Winged Flies
Beetles

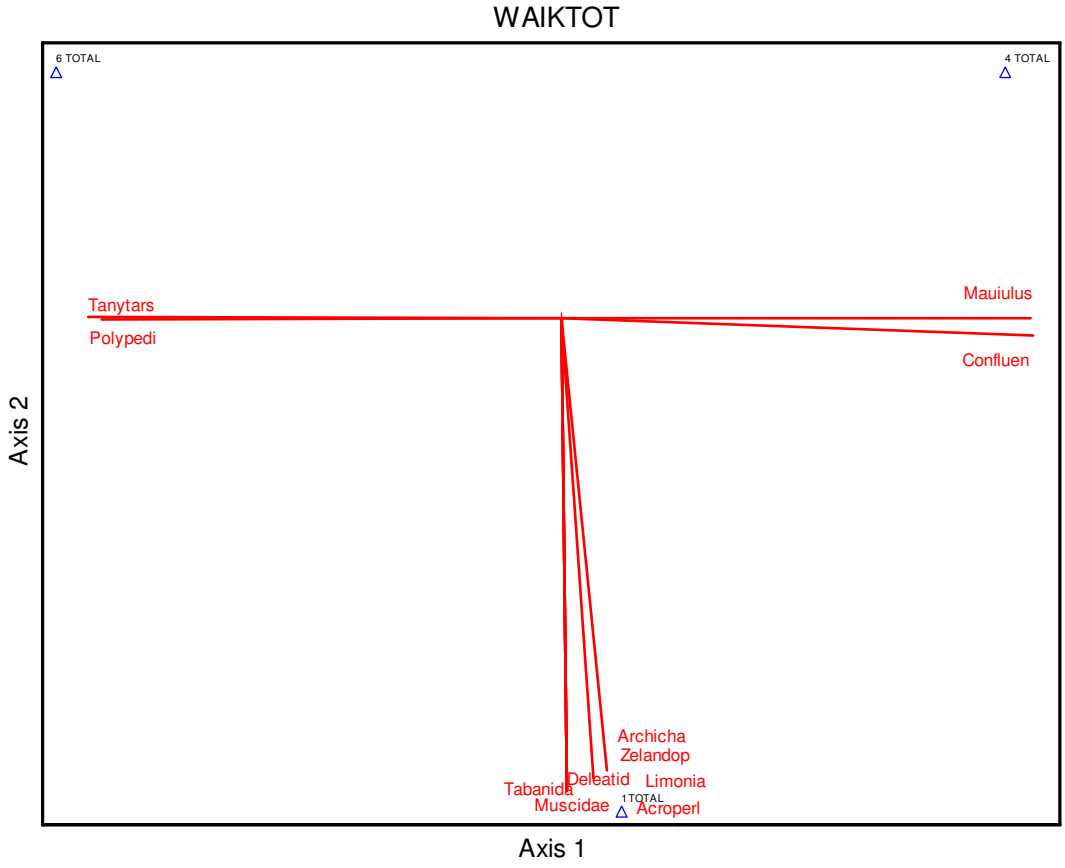

Macroinvertebrate Community Composition, May 2004
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Site 1
Site 4
Site 6
Other
Caddisflies
Stoneflies
Worms
Snails
Mayflies
Two Winged Flies
Beetles


Macroinvertebrate Community Composition, December 2004
100%
80%
60%
40%
20%
0%
Site 1
Site 4
Site 6
Other
Caddisflies
Stoneflies
Worms
Snails
Mayflies
Two Winged Flies
Beetles


Macroinvertebrate Community Composition, March 2005
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Site 1
Site 4
Site 6
Other
Caddisflies
Stoneflies
Worms
Snails
Mayflies
Two Winged Flies
Beetles

As no clear patterns emerged from the raw abundance bar charts, non-metric multidimensional scaling (MDS) was also undertaken (for the December 2004 data only due to time constraints), to explore differential taxa preferences between each of the sites. Figure 9 shows that with a R^2 cut-off of 0.95, key indicator taxa showed preferences between Site 1, 4 and 6 when the samples were totalled for each site. The MDS analysis shows that pollution/habitat tolerant taxa (Diptera) showed a preference to occur at Site 6, while more sensitive taxa (e.g. sensitive mayfly and caddis fly larvae) show a clear trend towards Site 1. At Site 4, both taxa found are representative of mayfly and caddis fly larvae which have MCI taxon scores of 5 (out of 10), which suggests that at this site preference for species of moderate pollution/habitat sensitivity occurs. Separation of samples within sites showed significant variation and thus no clear trends.

Figure 9 Non-metric multidimensional scaling for macroinvertebrate totals of samples at Sites 1, 4 and 6 for December 2004 within the Waikiekie Stream



3.5 Fish

The fish fauna within the Waikiekie Stream is characteristic of a typical Coromandel waterway within a pine/indigenous forest dominated catchment, near a large harbour (Speirs, 2001; Kessels, *pers obs*).

The most pollution-sensitive fish are the two Galaxiid species - banded kokopu and inanga. Banded kokopu have been consistently found both upstream and downstream of the spray irrigation area, apart from the Dec. 2004 survey. Inanga are not found above the spray irrigation area, but this is almost certainly because the habitat is unsuitable for this fish upstream of Site 4 rather than any possible effects associated with the WWTP.

The downstream site consistently yielded reasonable catches of common bully as well as ripe female and coloured male red-finned bully which is to be expected in a stream such as this.

Eels are not particularly common in the Waikiekie, although elvers suggest recruitment is occurring. The absence of short-fin eel is probably a reflection of the boulder habitat rather than other factors.

The downstream site (6) also often had schools of smelt present.

The spotlighting surveys have yielded two interesting species, both downstream of the spray irrigation area – lamprey and giant bully. Little is known about either of these rarely observed and cryptic species and their presence in the Waikiekie is possibly an indicator that habitat suits these species, being of sandy substrate at the SH25 bridge.

Figures 10 and 11 summarise catches made during the electric-fishing and spot-light surveys.

Both sites were also always characterised by an abundant population of freshwater shrimp (*Paratya curvirostris*) and the occasional freshwater crayfish (*Parenephrops planifrons),* suggesting that recruitment of these invertebrates is occurring and habitat is suitable.

Figure 10 E-Fishing Results

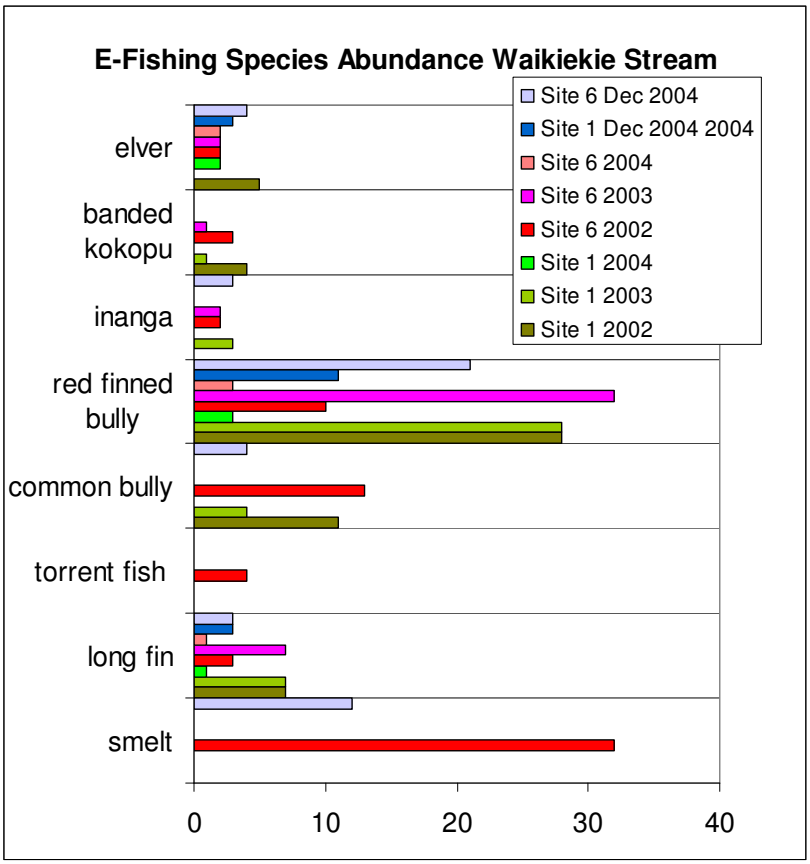
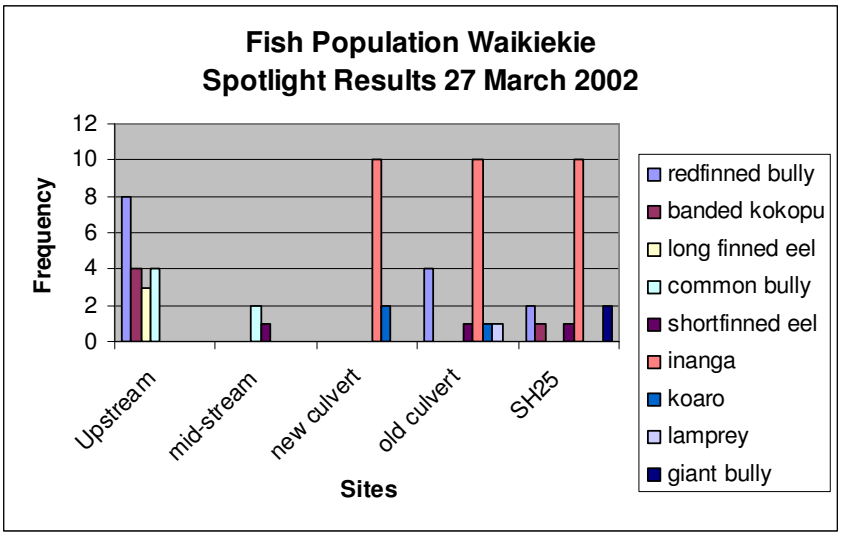
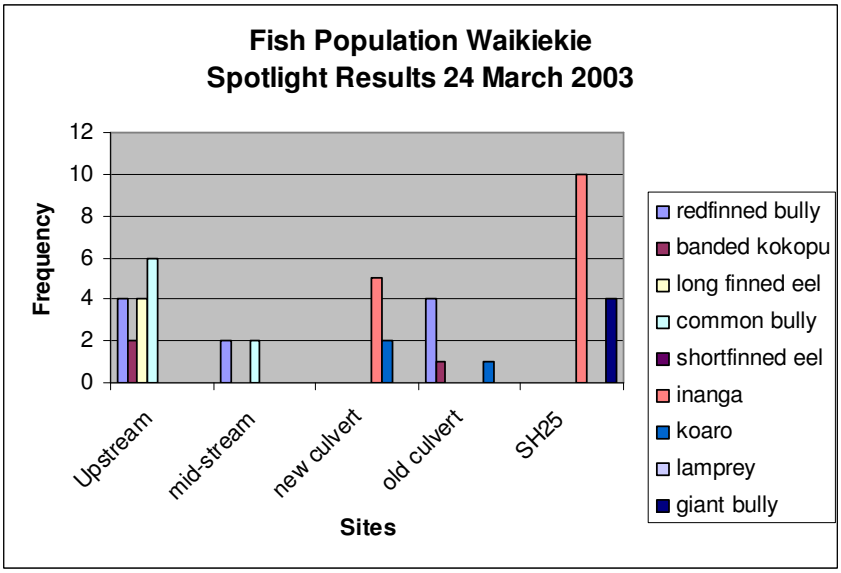
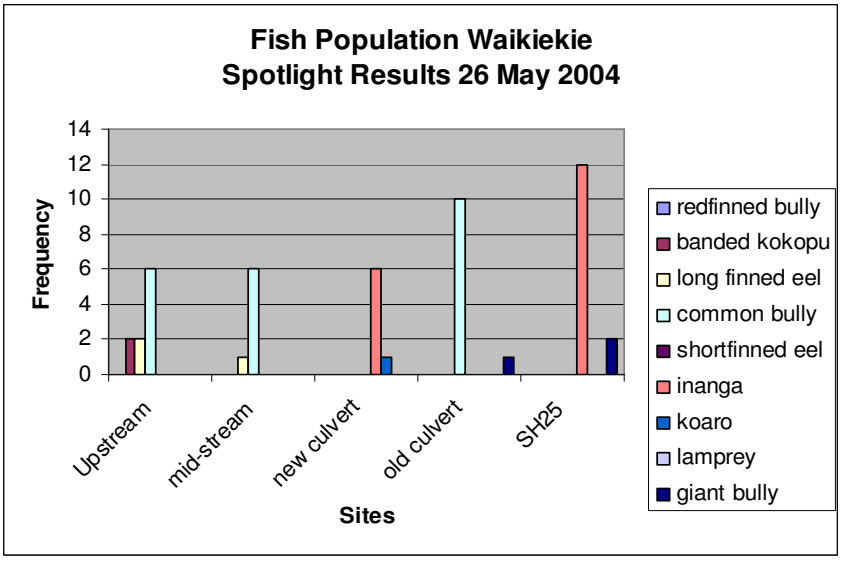
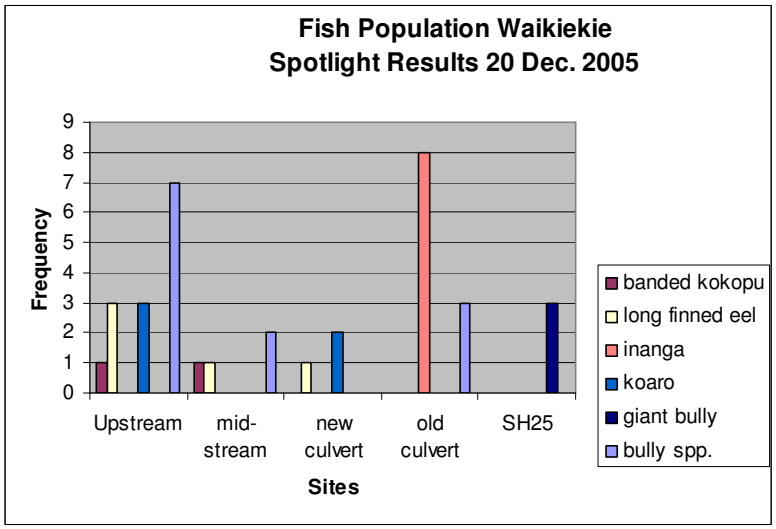


Figure 11 Fish Spot Lighting Results









4 Conclusions and Recommendations

4.1 Survey Conclusions

The following conclusions can be made based on the survey results:

- Periphyton growth within the Waikiekie Stream downstream of the spray irrigation area appears to be noticeably greater than at the upstream site. In particular, long green filamentous algae are averaging about 16.3% substrate cover at Site 6 as opposed to below 3% cover at Site 1 (control site). This species can be indicative of excessive nutrient loadings. However, the average cover is still less than the recommended maximum cover of 30% for stony-bottomed streams and less than recorded the previous year. This may partly be as a consequence of the decreasing nitrogen concentrations recorded (refer to Figure 3), which in turn is likely to be as a result of the implementation of an increase in the size of the spray irrigation fields.
- While MCI, QMCI and EPT scores have shown a gradual improvement in quality since 1999 for Sites 4 and for Site 6 up until December 2004, the Dec. '04 and March '05 showed a noticeable decline at these two sites as well as at Site 1. The indices are indicative of severe pollution and/or habitat modification. Given that Site 1 (the control site) showed an even more dramatic decline that the two downstream sites, the drop in in-stream invertebrate diversity may be explained by the adverse ecological effects of elevated suspended sediment concentrations at all threes sites during pine harvesting. Once harvesting has finished, in-stream biota diversity is expected to recover to pre-harvesting levels within a season or two.
- The results suggest a stream with a diverse fish fauna, typical of that found in most Coromandel Streams within a forested catchment. There appears to be no noticeable differences between the upstream and downstream sites in terms of diversity or abundance of fish species that could be attributed to any potential effects of the spray irrigation. The lack of banded kokopu observation in Dec. 2004 survey may be of some concern however – this species does not appear to tolerate prolonged periods of elevated suspended silt concentrations. It is expected that once pine harvesting is completed banded kokopu will move back into this reach of the Waikiekie. More intensive efforts to survey for this species in the December 2005 is recommended.

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Appendix I

Periphyton Data

		Thin mat			Med mat.			Thick mat			Short Filaments		Long Filaments	
		Green	Light brown	Black/dark brown	Green	Light bro	Black/dark brown	Green	Light bro	Black/dark brown	Green	Brown/reddish	Green	Brown/reddish
Site 1 27 March 2002		11.67	43.57	43.5	5	0	20	10	10	0	0	0	0	0
Site 1 16 Dec 2002		10	13.7	18	5	0	0	0	0	0	0	0	0	0
Site 1 24 March 2003		0	0	40	5	0	0	0	22.5	0	5	60	5	0
Site 1 26 May 2004		24.6	50.5	45.6	5	0	10.5	0	15.6	0	0	0	0	0
Site 1 20 Dec 2004		10	14.5	15.5	5	0	0	0	0	0	0	0	0	0
Site 1 24 march 2005		5	0	38.7	5	0	10.65	5	5.75	0	7.5	0	0	0
Site 1 AV.		**10.21**	**20.38**	**33.55**	**5.00**	**0.00**	**6.86**	**2.50**	**8.98**	**0.00**	**2.08**	**10.00**	**0.83**	**0.00**
Site 4 27 March 2002		7	28.83	40	0	0	0	0	37	0	0	0	5	0
Site 4 16 Dec 2002		5	11.7	27.3	0	0	0	0	0	0	0	0	6.25	0
Site 4 24 March 2003		0	47.5	28.75	0	6.7	0	0	20	0	10	0	0	0
Site 4 26 May 2004		0	52.7	36.2	0	0	0	0	15	0	5	0	15.6	0
Site 4 20 Dec 2004		0	10.2	34.5	0	0	0	0	0	0	0	0	4.3	0
Site 4 24 March 2005		5	53.5	43	0	0	0	0	15	0	0	0	2.5	0
Site 4 AV.		**2.83**	**34.07**	**34.96**	**0.00**	**1.12**	**0.00**	**0.00**	**14.50**	**0.00**	**2.50**	**0.00**	**5.61**	**0.00**
Site 6 27 March 2002		6.7	25	56.7	70	0	30	0	0	0	0	0	6.25	0
Site 6 16 Dec 2002		21.25	10.7	39.1	5	0	0	0	0	0	0	5	5.7	0
Site 6 24 March 2003		0	19	30	0	0	0	0	32.9	5	7.5	0	26.09	0
Site 6 26 May 2004		5.4	20	30	0	0	0	0	0	0	5	0	30.06	0
Site 6 20 Dec 2004			8.6	28.6	0	0	0	0	0	0	0	0	3.2	0
Site 6 24 March 2005			28.8	55.9	50	0	15.3	0	15	0	5	0	26.5	0
Site 6 AV.		**8.34**	**18.68**	**40.05**	**20.83**	**0.00**	**7.55**	**0.00**	**7.98**	**0.83**	**2.92**	**0.83**	**16.30**	**0.00**

Appendix II

Macroinvertebrate Data

Dec 2004 & March 2005

20 Dec. 2004 Survey

Site 1A

Number of Taxa	18
Total abundance	109
EPT Value	6
% EPT (taxa number)	33.3%
%EPT (numbers of individuals)	13.8%
Sum of recorded taxa scores	81
MCI Value	90.0
Sum of abundance loaded scores	472
QMCI Value	4.33

Site 1B

Number of Taxa	15
Total abundance	108
EPT Value	5
% EPT (taxa number)	33.3%
%EPT (numbers of individuals)	19.4%
Sum of recorded taxa scores	71
MCI Value	94.7
Sum of abundance loaded scores	471
QMCI Value	4.36

Site 1C

Number of Taxa	15
Total abundance	144
EPT Value	6
% EPT (taxa number)	40.0%
%EPT (numbers of individuals)	15.3%
Sum of recorded taxa scores	80
MCI Value	106.7
Sum of abundance loaded scores	696
QMCI Value	4.83

Site1D

Number of Taxa	17
Total abundance	178
EPT Value	8
% EPT (taxa number)	47.1%
%EPT (numbers of individuals)	30.9%
Sum of recorded taxa scores	79
MCI Value	92.9
Sum of abundance loaded scores	590
QMCI Value	3.31

Site 4A

Number of Taxa	16
Total abundance	102
EPT Value	8
% EPT (taxa number)	50.0%
%EPT (numbers of individuals)	68.6%
Sum of recorded taxa scores	73
MCI Value	91.3
Sum of abundance loaded scores	431
QMCI Value	4.23

Site 4B

Number of Taxa	13
Total abundance	102
EPT Value	5
% EPT (taxa number)	38.5%
%EPT (numbers of individuals)	48.0%
Sum of recorded taxa scores	52
MCI Value	80.0
Sum of abundance loaded scores	431
QMCI Value	4.23

Site 4C

Number of Taxa	13
Total abundance	230
EPT Value	6
% EPT (taxa number)	46.2%
%EPT (numbers of individuals)	57.4%
Sum of recorded taxa scores	71
MCI Value	109.2
Sum of abundance loaded scores	1039
QMCI Value	4.52

Site 4D

Number of Taxa	15
Total abundance	204
EPT Value	8
% EPT (taxa number)	53.3%
%EPT (numbers of individuals)	78.9%
Sum of recorded taxa scores	75
MCI Value	100.0
Sum of abundance loaded scores	844
QMCI Value	4.14

Site 6A

Number of Taxa	11
Total abundance	138
EPT Value	5
% EPT (taxa number)	45.5%
%EPT (numbers of individuals)	64.5%
Sum of recorded taxa scores	55
MCI Value	100.0
Sum of abundance loaded scores	609
QMCI Value	4.41

Site 6B

Number of Taxa	11
Total abundance	123
EPT Value	4
% EPT (taxa number)	36.4%
%EPT (numbers of individuals)	56.9%
Sum of recorded taxa scores	44
MCI Value	80.0
Sum of abundance loaded scores	452
QMCI Value	3.67

Site 6C

Number of Taxa	14
Total abundance	133
EPT Value	4
% EPT (taxa number)	28.6%
%EPT (numbers of individuals)	25.6%
Sum of recorded taxa scores	51
MCI Value	72.9
Sum of abundance loaded scores	383
QMCI Value	2.88

Site 6D

Number of Taxa	13
Total abundance	142
EPT Value	4
% EPT (taxa number)	30.8%
%EPT (numbers of individuals)	36.6%
Sum of recorded taxa scores	54
MCI Value	83.1
Sum of abundance loaded scores	451
QMCI Value	3.18

24 March 2005 survey

Site 1A

Number of Taxa	11
Total abundance	67
EPT Value	3
% EPT (taxa number)	27.3%
%EPT (numbers of individuals)	11.9%
Sum of recorded taxa scores	46
MCI Value	83.6
Sum of abundance loaded scores	257
QMCI Value	3.84

Site 1B

Number of Taxa	11
Total abundance	58
EPT Value	3
% EPT (taxa number)	27.3%
%EPT (numbers of individuals)	22.4%
Sum of recorded taxa scores	46
MCI Value	83.6
Sum of abundance loaded scores	251
QMCI Value	4.33

Site 1C

Number of Taxa	18
Total abundance	224
EPT Value	6
% EPT (taxa number)	33.3%
%EPT (numbers of individuals)	46.4%
Sum of recorded taxa scores	88
MCI Value	97.8
Sum of abundance loaded scores	714
QMCI Value	3.19

Site 1D

Number of Taxa	11
Total abundance	58
EPT Value	3
% EPT (taxa number)	27.3%
%EPT (numbers of individuals)	22.4%
Sum of recorded taxa scores	46
MCI Value	83.6
Sum of abundance loaded scores	251
QMCI Value	4.33

Site4A

Number of Taxa	16
Total abundance	96
EPT Value	6
% EPT (taxa number)	37.5%
%EPT (numbers of individuals)	51.0%
Sum of recorded taxa scores	69
MCI Value	86.3
Sum of abundance loaded scores	408
QMCI Value	4.25

Site 4B

Number of Taxa	22
Total abundance	474
EPT Value	8
% EPT (taxa number)	36.4%
%EPT (numbers of individuals)	72.2%
Sum of recorded taxa scores	102
MCI Value	92.7
Sum of abundance loaded scores	2157
QMCI Value	4.55

Site4C

Number of Taxa	16
Total abundance	67
EPT Value	6
% EPT (taxa number)	37.5%
%EPT (numbers of individuals)	56.7%
Sum of recorded taxa scores	85
MCI Value	106.3
Sum of abundance loaded scores	310
QMCI Value	4.63

Site4D

Number of Taxa	16
Total abundance	702
EPT Value	9
% EPT (taxa number)	56.3%
%EPT (numbers of individuals)	51.0%
Sum of recorded taxa scores	82
MCI Value	102.5
Sum of abundance loaded scores	3174
QMCI Value	4.52

Site 6A

Number of Taxa	17
Total abundance	196
EPT Value	6
% EPT (taxa number)	35.3%
%EPT (numbers of individuals)	17.9%
Sum of recorded taxa scores	76
MCI Value	89.4
Sum of abundance loaded scores	607
QMCI Value	3.10
Two bullies present	

Site 6B

Number of Taxa	19
Total abundance	182
EPT Value	9
% EPT (taxa number)	47.4%
%EPT (numbers of individuals)	40.7%
Sum of recorded taxa scores	94
MCI Value	98.9
Sum of abundance loaded scores	767
QMCI Value	4.21

Site 6C

Number of Taxa	13
Total abundance	178
EPT Value	6
% EPT (taxa number)	46.2%
%EPT (numbers of individuals)	34.8%
Sum of recorded taxa scores	56
MCI Value	86.2
Sum of abundance loaded scores	710
QMCI Value	3.99

Site 6D

Number of Taxa	13
Total abundance	126
EPT Value	4
% EPT (taxa number)	30.8%
%EPT (numbers of individuals)	51.6%
Sum of recorded taxa scores	49
MCI Value	75.4
Sum of abundance loaded scores	390
QMCI Value	3.10
Bully present	

Appendix III
Summary of E-Fishing Data

Site 6 2002		
N	Average Fork Length	
32	73.4	smelt
3	168.7	long fin
4	86.5	torrent fish
13	43.7	common bully
10	54.0	red finned bully
2	56.5	inanga
3	61.3	banded kokopu
2	77.5	elver
69		

Site 1 2002		
N	Average Fork Length	
0	0.0	smelt
7	204.3	long fin
0	0.0	torrent fish
11	43.2	common bully
28	56.2	red finned bully
0	0.0	inanga
4	58.3	banded kokopu
5	103.0	elver
55		

Site 6 2003		
N	Average Fork Length	
0	0.0	smelt
7	200.7	long fin
0	0.0	torrent fish
0	0.0	common bully
32	51.3	red finned bully
2	69.5	inanga
1	93.0	banded kokopu
2	77.5	elver
44		

Site 1 2003		
N	Average Fork Length	
0	0	smelt
7	210	long fin
0	0	torrent fish
4	37.5	common bully
28	57.10714	red finned bully
3	84	inanga
1	103	banded kokopu
0	0	evler
43		

Site 1 May 2004		
N	Average Fork Length	
0	0.0	smelt
1	550.0	long fin
0	0.0	torrent fish
0	0.0	common bully
3	50.3	red finned bully
0	0.0	inanga
0	0.0	banded kokopu
2	172.5	elver
6		

Site 6 May 2004		
N	Average Fork Length	
0	0	smelt
0	0	long fin
1	113	torrent fish
4	37	common bully
7	0	red finned bully
0	0	inanga
2	67.5	banded kokopu
1	79	elver

Site 1 Dec 2004 2004		
N	Average Fork Length	
0	0.0	smelt
3	401.7	long fin
0	0.0	torrent fish
0	0.0	common bully
11	58.2	red finned bully
0	0.0	inanga
0	0.0	banded kokopu
3	133.3	elver
17		

Site 6 Dec 2004		
N	Average Fork Length	
12	73.2	smelt
3	255.0	long fin
0	0.0	torrent fish
4	37.0	common bully
21	56.5	red finned bully
3	93.3	inanga
0	0.0	banded kokopu
4	96.3	elver