Monitoring the Diversity and Abundance of Freshwater Fish and Macroinvertebrates in the Boyd and Quarry Streams

Draft report

Prepared by Jordan Lasenby
Environmental Reporting
Research project
October 2006
Diploma in Environmental Management (year 2)
Bay of Plenty Polytechnic

Contact Details

Jordan Lasenby
13 James Cook Dr
Welcome Bay
Tauranga
Phone: 021 178 8133
Bay of Plenty Polytechnic
Diploma in Environmental Management (Year Two)

Andrew Jenks
140 Wharawhara Rd
Katikati
Phone: (07) 549 0722
Wild About New Zealand
Programme Co-ordinator

Bay of Plenty Polytechnic
70 Windermere Dr
Windermere
Phone (07) 544 0920

Cover Picture: Left: Quarry stream
Right: Boyd Stream

Summary

Native freshwater fish populations were surveyed in the Boyd and Quarry streams prior to the commencement of extensive stream restoration activities to determine baseline values for diversity and relative abundance. Water quality and macroinvertebrate samples were collected at the same time to provide a snapshot of catchment health.

The Quarry and Boyd streams varied between 2 – 4 metre wide and have a gently sloping gradient. Fish were sampled from comparable reaches within each catchment: open pasture with low banks, open pasture with steep-sided/eroding unprotected banks and two unprotected bush covered reaches. Samples were collected from riffles, runs and pools within each of the three sample reaches per tributary.

Three fish sampling methods were used in accordance with accepted protocols: hand netting, spotlighting and fixed G minnow nets. Each survey methods was carried out on separate sampling occasions between 12 to 29 September 2006, concurrently with macroinvertebrate sampling.

Findings of significance were:

1. Fish diversity was similar in both catchments, but numbers were generally greater in the Boyd stream.
2. Pollution tolerant macroinvertebrates dominate in the Quarry stream
3. Banded kokopu and stonefly larvae were not found in either stream. Degraded habitat and/or poor water quality may be the cause(s).

Conclusions:
The Quarry stream is significantly degraded by ongoing sediment pollution, exacerbated by poor riparian habitat. Boyd stream aquatic

diversity is limited by poor riparian habitat but instream habitat is of high quality.

Recommendations:

The proposed riparian restoration project covering all monitoring sites used for this report will provide long-term benefits for aquatic life in both streams but will need to be accompanied by substantial improvements in water quality in the Quarry stream to take full advantage of this investment. Water quality may be a factor affecting aquatic communities in both catchments and a long-term monitoring programme should be initiated.

Acknowledgement

Thanks to Stephen Moore for use of fish species photographs, Brian and Bev Gordon for land access, Paul Woodward for information and equipment and finally Andrew Jenks for lending his time, expertise and background information on the Uretara stream catchment.

Table of Contents

Table of Plates

Table of Figures

1.0 Background

New Zealand has over 35 native fish species, relatively low for a country the size of New Zealand (Doc, 2006). It is believed that many of these species arrived through the oceans, which could account for the fact that 60% of the native species are diadromous (Dene A. and Woodard P., 2002). The remaining 40% may have been present before Gondwanaland separated from Pangea.

The five common whitebait species are found in many different habitats from swamps to rocky streams. Their presence and abundance in streams is often related to the amount of overhead cover from streamside vegetation (J Richardson 2003). Distribution is also related to location within a catchment: Inanga (*Galaxias maculates)* have poor climbing ability and are found in the lower catchments while banded kokopu (*Galaxias fasciatus)* may extend into upper catchment tributaries.

Native fish populations have been in steady decline over many years throughout New Zealand, as evidenced by the significant decline in whitebait catch. Loss of in-stream and riparian habitat through farming and development has reduced areas suitable for colonisation and spawning and depleted food sources. Migration barriers and high sediment loads have also taken their toll, reducing recolonisation of catchments. Water quality of streams in the Western Bay of Plenty is highly variable and often related to changing land use.

Nearly all of New Zealand's fresh water fish species are nocturnal and elusive, making it difficult to reliably estimate population size and diversity. Three sampling methods have been used in this survey in an attempt to overcome some of the problems associated with the use of a single technique.

Objectives of the investigation:

1) Survey native fish species in Boyd and Quarry streams to establish baseline data. Ongoing monitoring is planned to determine changes related to stream restoration within the study area. (The life support capacity of each stream is clearly very different making it imperative to set baselines for both catchments).
2) Collect and identify macroinvertebrate species in the Boyd and Quarry streams as a measurement of catchment health.
3) Monitor water quality of both catchments to determine variability of key water quality parameters: water clarity/suspended sediment, dissolved oxygen, water temperature and flow. (Water quality may change over time and will need to be factored into variations in community structure attributed to habitat improvement).
4) Compare macro invertebrate and native fish distribution in bush v pasture settings in both catchments to determine factors influencing presence and abundance. (This will be referenced to 3 above).
5) Undertake native fish surveys at all sampling sites using three proven fish survey protocols (spotlighting, fixed G minnow nets and hand netting). The three methods will be evaluated for suitability for ongoing trend monitoring.

2.0 Site Location / Description

The two streams are located 2 km west of Katikati. Farming, horticulture, and lifestyle blocks are predominant upstream land uses in both catchments, but the Katikati Quarry drains only to Quarry stream. A settlement pond for a septic tank cleaning business is located just above the top monitoring site in the Boyd stream.

The two streams are quite comparable in size, shape, substrate size, flow velocity, riparian habitat quality and gradient. Both streams start in the Kaimai and flow down through Katikati and into the Tauranga harbour, and therefore have the potential to contain similar populations and distribution of aquatic life.

Plate 1: Location of Boyd and Quarry stream survey sites

2.1 Individual Site Description

Site 1: Quarry Stream

A series of riffles and shallow runs lead into a pool about 1.5 metres deep. The substrate is largely embedded, caused by years of extremely high sediment deposition, originating from Katikati Quarry. This site is dominated by a steep eroding bank.

Quarry Stream Site 1

Site 2: Quarry Stream

This area starts at a pool with an undercut bank and overhanging vegetation on one sire, and open pasture opposite. The remaining reach is a mix of run and riffle with pebbles to 20 cm.

Quarry Stream Site 2

Site 3: Quarry Stream

This site starts at a pool with a slight undercut bank. The banks are covered in moderately shading native vegetation (shrubs and small trees). The mid-section is mostly riffle with large pebbles up to 35 cm. A shallow pool marks the end of this reach.

Quarry Stream Site 3

Note: All streambed substrate at sites 1-3 were embedded to 60% by coarse to medium-sized sand, leaving little space for fish refuge or macroinvertebrate colonisation.

Site 4: Boyd Stream

The entire site is surrounded by light bush cover comparable to site 3. Site 4 starts at a shallow pool but is predominantly riffle with pebbles up to 20 cm.

Boyd Stream Site 4

Site 5: Boyd Stream

This area is very similar to site 1, starting at a pool but mostly riffle with with pebbles up to 40cm. The northern bank is nearly vertical, and actively eroding. The opposite bank is a low grass covered floodplain.

Boyd Stream Site 5

Site 6: Boyd Stream

This area starts with a pool and a large undercut before entering a riffle/run where the water speeds up in a depth of about 10- 20cm, before rounding a sharp bend and entering a pool about 1.5 metres deep.

Boyd Stream Site 6

3.0 Methodology

3.1 Fish Survey Methods

Three techniques were used for surveying fish in Boyd and Quarry streams: hand netting, fixed G minnow nets and spot lighting. The protocols for each technique are outlined below. Electric fishing was not used because of difficulties replicating this process at regular intervals. Fish mortality caused by this method is also of concern.

3.1.1 Hand Netting

Hand netting is a fairly simple method which can be used in both riffles and in pools with slight variations. In pools the net is moved upstream working around undercut banks and through disturbed substrate. and down the deeper part of water, shifting the rocks and under undercut ledges. Trying to scare out any fish that may be hiding, any fish that may come out will hopefully go into the net. This works best where one person is down stream and one person up stream, scaring the fish into one net.

The other hand netting method is fairly similar; in faster moving current it is best where one person holds the net at the bottom of the riffle and the other person moves rocks above the net. Any fish that may be hiding will be swept into the net when disturbed.

3.1.2 G-minnow Traps

This piece of equipment is a mesh covered tapered cylinder, with an inverted cone at each end. Fish are able to swim on, but not out. The lure is a combination of bread and marmite in a plastic container with holes in it. This was left to soak before it was placed in the stream. The G-minnow net is left over night and retrieved early the next morning. Each site was surveyed in the pool section, as the fish will be more likely to enter the trap in a pool than a riffle. The traps were set just off the bottom and in different places to the bank.

3.1.3 Spot Lighting

The third method is spot lighting at night. Most fish species are nocturnal feeders and leave their day time cover to locate food at night, making it relatively easy to identify a range of species. This method was used in the same sites as the other two methods.

3.2 Macroinvertebrate Sampling Method

Areas of $2m^2$ are sampled within the most productive habitat available, in this case riffles. The net is placed at the downstream end of the sample area then rocks are successively lifted and undersides brushed to remove any macroinvertebrates so that they float into the net. Cleaned rocks are placed to one side then the exposed bed is disturbed to collect remaining macroinvertebrates. Collected macroinvertebrates are sorted into different orders and/or genera in accordance with the Wai Care Invertebrate Monitoring Protocol (WIMP) and assigned sensitivity scores based on the Macroinvertebrate Community Index (Stark 1985). Pollution sensitivity ratings for the groupings provide an index of catchment health.

4.0 Results

4.1 Fish Surveys

This graph shows the species present at sites 1 and 5 (steep eroding stream banks). The numbers of fish present in both streams are fairly similar; however there are a few more of nearly every species in Boyd stream and Torrent fish (*Cheimarrichthys fosteri)* were found only in the Boyd stream. Mature inanga were found in the Quarry Stream in a pool significantly larger than any in the Boyd stream.

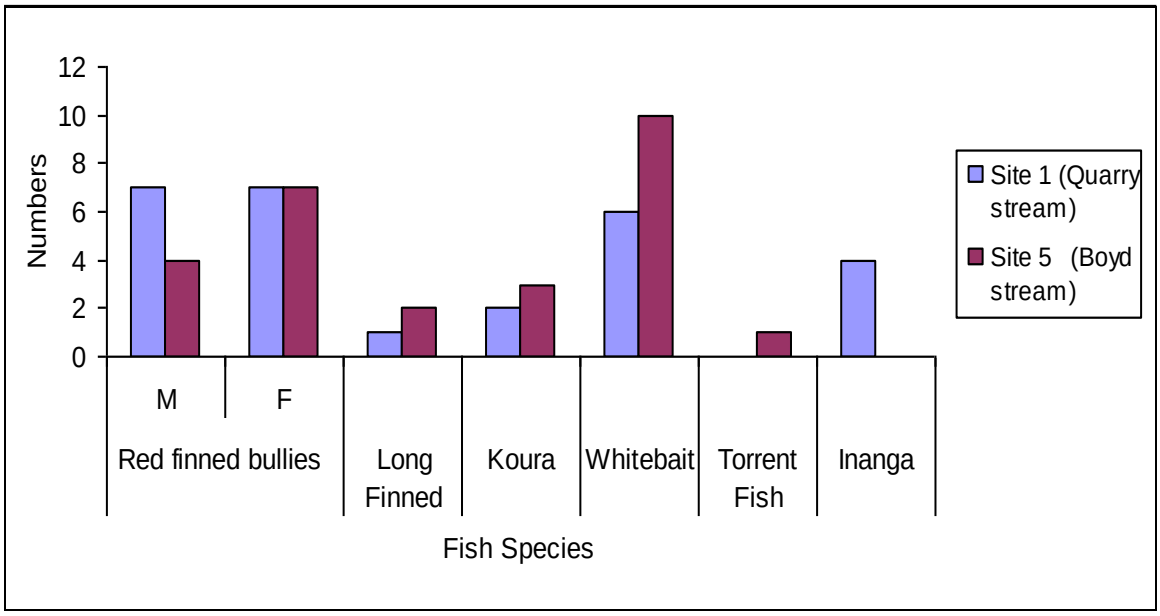

Figure 1: Species distribution site 1 and 5.

This graph shows the species collected at sites 2 and 6. The numbers of fish and species range are fairly similar; however there are a few more of nearly every species in Boyd stream. Torrent fish were again absent from the Quarry stream and whitebait were only present in Boyd stream. Koaro were found only in the Quarry stream.

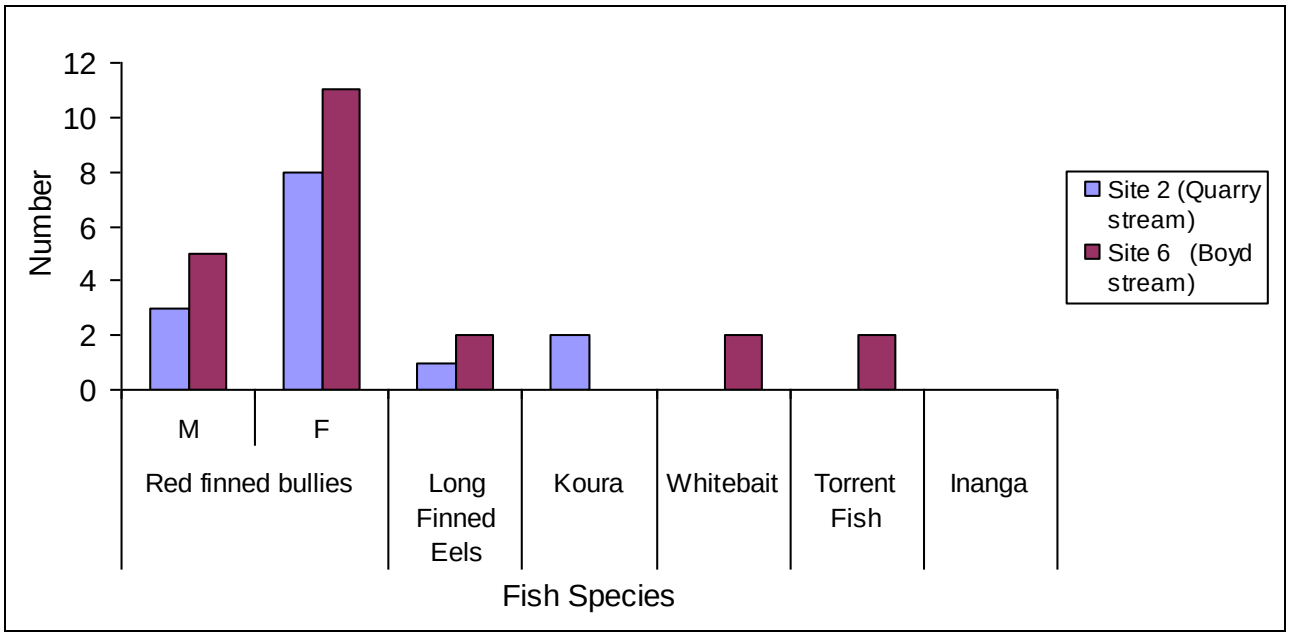

Figure 2: Species distribution site 2 and 6.

The fish collected at sites 3 and 4 (bush fringed) are similar in range but the numbers of each are lower in the Quarry stream. Koura and Torrent fish were only found in the Boyd stream.

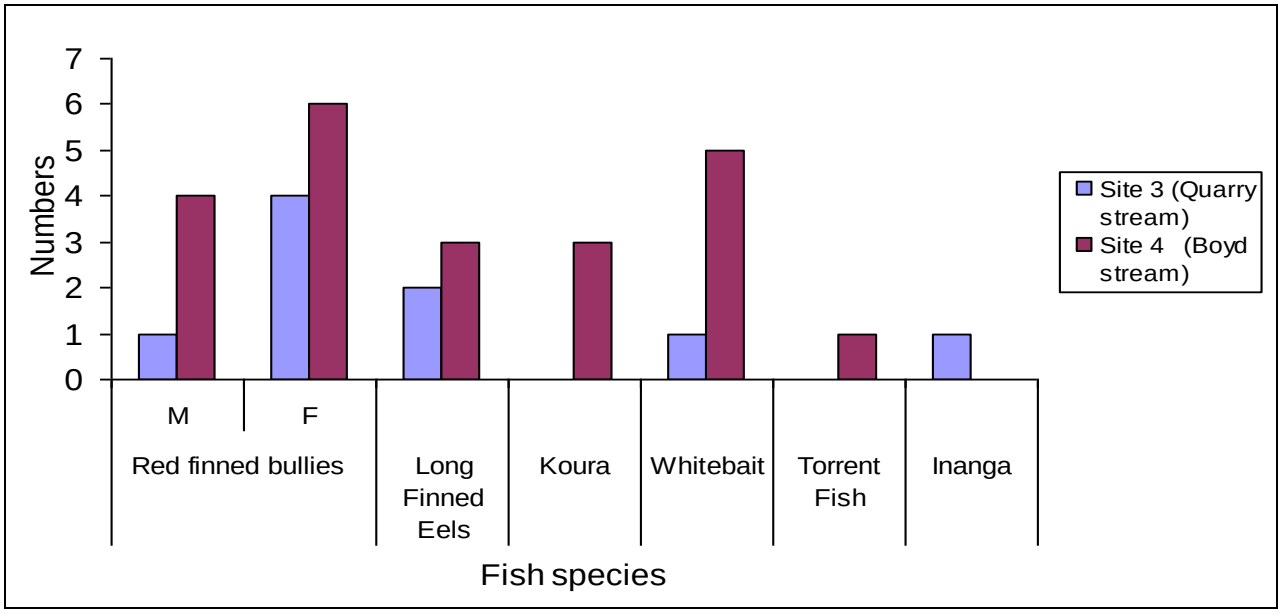

Figure 3: Species distribution site 3 and 4.

This graph shows the length of red finned bullies (*Gobiomorphus huttoni)* sampled in each stream. This species is relatively abundant in both streams and the populations have similar size/age distribution.

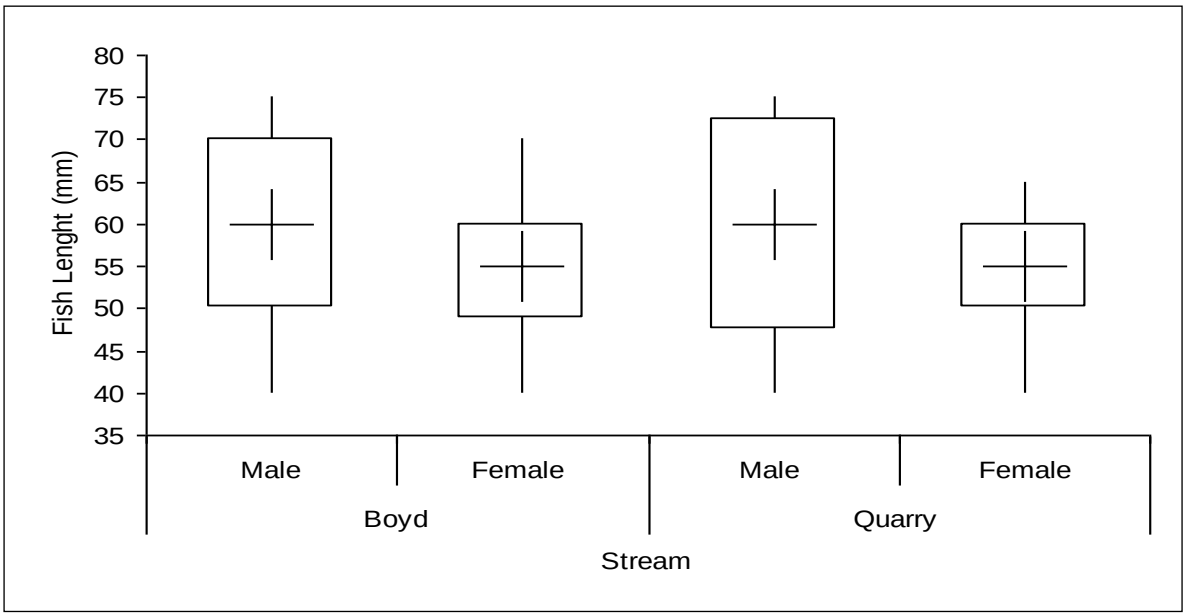

Figure 4: Length of red finned bullies in streams Boyd and Quarry

This graph shows the amount of juvenile red finned bullies (under 40cm) caught at each site. Nearly twice as many juvenile red finned bullies were caught at each site in the Boyd stream than in Quarry stream.

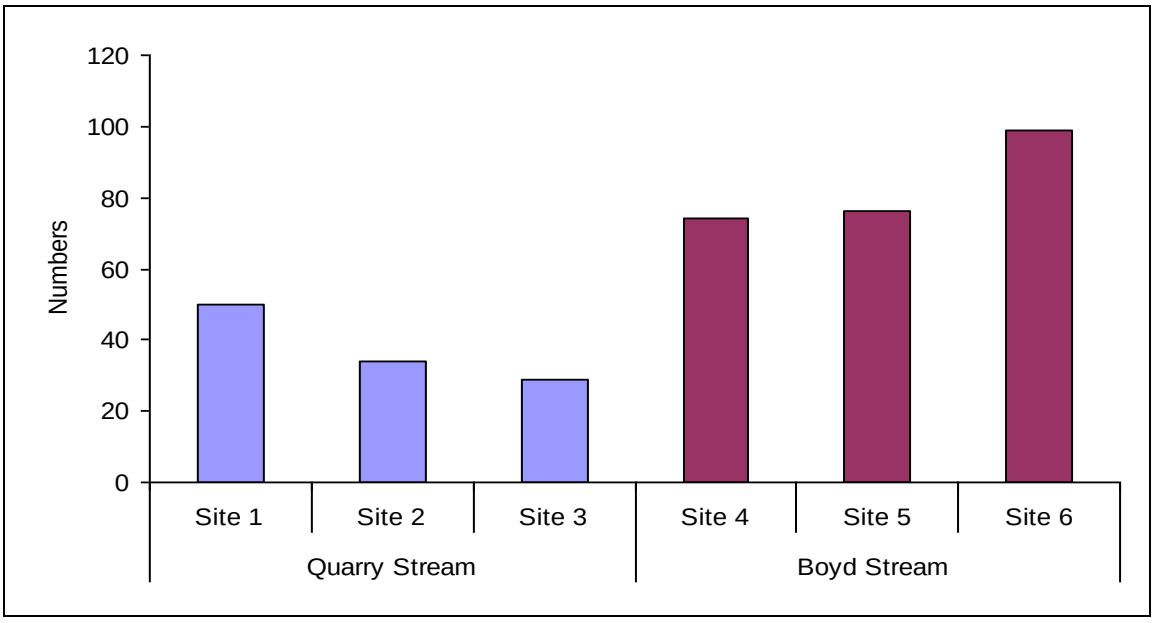

Figure 5: Number of juvenile red finned bullies caught at each site

4.2 Macro Invertebrates

Both streams have a similar range of aquatic insect species but a few species tend to dominate in the Quarry stream, particularly the free swimming caddis (*Aoteapsyche*) and stony cased caddis (*Pycnocentrodes*). Mayfly are uncommon in the Quarry stream (although a few specimens of both *Deleatidium* and *Colobursiscus* were found) and smooth cased caddis (*Olinga*) were found only in the Boyd stream.

Macroinvertebrates (insects species)	Site 1 Absent / Present	Site 2 Absent / Present	Site 3 Absent / Present	Site 4 Absent / Present	Site 5 Absent / Present	Site 6 Absent / Present	Sensitivity score (MCI)
Mayfly Nymph	Present	Absent	Present	Present	Present	Present	7-9
Damselfly larvae	Present	Present	Absent	Present	Present	Present	4
Dobsonfly larvae	Present	Present	Present	Present	Present	Present	7
Dragonfly Larvae	Absent	Absent	Present	Present	Absent	Absent	5
Stick caddis larvae	Present	Present	Absent	Present	Present	Present	5
Free swimming caddis larvae	Present	Present	Present	Present	Present	Present	4
Stony cased caddis larvae	Present	Present	Present	Present	Present	Present	5
Smooth cased caddis larvae	Absent	Absent	Absent	Present	Present	Present	9

Table 1: Macroinvertebrate species found in Quarry and Boyd streams.

5.0 Discussion

The Quarry and Boyd streams are very similar in most physical characteristics, including habitat and predominant land use (on a % basis). However there are large differences between the two in terms of water clarity/suspended sediment and substrate embeddedness – mostly attributable to historic and ongoing sediment pollution from Katikati Quarry. The Quarry is in the process of applying for a Resource Consent and it is expected that the current high levels of suspended sediment will be reduced, which of course must be factored into ongoing monitoring and evaluation.

The fish and macroinvertebrate populations were relatively similar in both catchments with shared species representing the more pollution tolerant range of invertebrates and fish. Greater numbers and diversity of fish and macroinvertebrate species were present in the Boyd stream, although pollution sensitive stonefly sp were not found and banded kokopu appear to be absent. The absence of torrent fish in the Quarry stream may be due to lack of habitat, caused by high % embeddedness of substrate and/or lack of adequate food sources.

Spotlighting proved to be an effective method for locating and estimating eels populations in the Boyd stream but high sediment loads in the Quarry stream made it impossible to see anything in the water on two of the three survey nights (despite good weather conditions/low rainfall). The results are presented are presented above graphed but are shown in the appendices as in Quarry stream it was. Two different types of G minnow nets were used, the standard metal mesh covered net (pictured page 6) caught nothing while one fabricated from "whitebait" net cloth trapped red finned bullies and whitebait. This data has not been graphed.

The three fish survey methods provided quite different results reflecting the strengths/limitations of each technique. For example, hand netting was excellent at catching smaller fish between 20 and 200mm as well as

benthic fish but larger fish, particularly eels, were often able to move out of the net before it could be brought up. Spot lighting proved to be the best way to identify larger fish, but counts on smaller fish like red finned bullies became impossible as they move very quickly. G minnow catch is limited by the small aperture size, allowing only smaller fish to enter.

Water clarity is an indirect method for estimating suspended sediment, and when taken in tandem with measurements of flow velocity are very useful for understanding probable sediment sources. Readings taken last year and during this study consistently show that sediment loads are much greater in the Quarry stream, even after little or no rain. It was also noted that sediment loads took a long time to drop back to moderate levels (70cm+ visibility), sometimes many days, after light to moderate rainfall (2-10mm over 24 hours). High sediment loads affect many aspects of stream ecology and can reduce upstream fish migration. Banded kokopu colonisation is almost certainly affected by this factor.

6.0 Conclusion

Four of the five different freshwater fish species found in the Boyd and Quarry stream sites are relatively common in New Zealand streams. The apparent absence of banded kokopu, the small numbers of mature inanga and relatively low population sizes of the 'common' species is surprising in the Boyd stream. The open habitat/lack of cover is certainly a factor that affects kokopu abundance but they were not located in the 'bush' sites either. The lack of abundance of macroinvertebrates (food source) may be a factor and it was also noted that the retention of large and small woody debris was poor. This latter factor may also account for the low numbers of small koura, which are normally in abundance in this type of catchment Other water quality factors will be investigated to determine other possible causes (such as contamination from the upstream commercial septic tank settlement pond).

High sediment loads, substrate embeddedness and lack of riparian habitat are factors that impinge significantly on the life support capacity of the Quarry stream. Singly any of these factors may have less effect on aquatic life, but cumulatively they have made it difficult for all but the hardiest common species to survive. It was also noted that the top surfaces of substrate (pebbles-large cobbles) were covered in fine sediment held within an algal matrix. The water also became very dirty when agitated, making it impossible to see the bottom in even the shallowest riffle.

The results from the fish surveys demonstrated that hand netting was the most effective method for collecting the widest range of fish species, and can be effectively supplemented by spotlighting.

7.0 References

Allan J.(1995) *Stream Ecology Structure and Function of Running Waters*, Chapman and Hall.

Auckland Regional Council, (2006) Freshwater Fish Monitoring Protocols, retrieved on 11th September 2006 from www.arc.govt.nz

Deely J. (1996) *Water Clarity of the Bay of Plenty Rivers,* Environment Bay of Plenty, Whakatane, New Zealand

Dene A. (2004) *Little Muddy Creek Survey*; Journal of the Native Freshwater Fish, *9*(3)

Dene A.; Woodard P. (2002) *Threatened Species*; Journal of the Native Freshwater Fish, *8*(2)

Department of Conservation [DoC] (2006) *Freshwater Fisheries*, Retrieved on the 12, August 2006 from http://www.doc.govt.nz/Conservation/001~Plants-and-Animals/001~Native-Animals/Native-Fish.asp

Moore S. (1997) Photographic Guide to Freshwater Invertebrates of New Zealand, Otago Regional Council.

New Zealand's fresh water fish society (2006), *Habitat destruction*, Retrieved on the 20, September 2006 from www.nzfreshwater.org/

NIWA (2006) *Freshwater fish database*, Retrieved on the 12, August 2006 from www.niwascience.co.nz/rc/freshwater/

Rowe D; Smith J; Williams E *Lethal Turbidities and Native Fish* NIWA, Water and Atmosphere 12/2 (2004)

8.0 Appendices

8.1 Appendix 1: Hand netting Results

Day 1								
Site	Red finned bullies			Long Finned Eels	Inanga	Torrent Fish	Whitebait	Koura
	M	F	J					
Quarry 1	3	3	25	1	1	0	0	1
Quarry 2	2	4	15	1	0	0	0	1
Quarry 3	0	2	11	1	0	0	0	1
Boyd 4	1	2	32	1	0	0	0	0
Boyd 5	0	0	30	0	0	0	0	0
Boyd 6	3	6	50	2	0	1	0	2

Day 2								
Site	Red finned bullies			Long Finned Eels	Inanga	Torrent Fish	Whitebait	Koura
	M	F	J					
Quarry 1	1	2	8	0	2	0	3	1
Quarry 2	0	1	12	0	0	0	0	1
Quarry 3	0	1	7	1	0	0	0	1
Boyd 4	1	2	24	0	0	1	1	0
Boyd 5	1	3	18	0	0	0	4	0
Boyd 6	1	3	30	0	0	0	0	1

Day 3								
Site	Red finned bullies			Long Finned Eels	Inanga	Torrent Fish	Whitebait	Koura
	M	F	J					
Quarry 1	3	2	17	0	1	0	3	0
Quarry 2	1	3	7	0	0	0	0	1
Quarry 3	1	1	11	0	0	0	0	0
Boyd 4	2	2	18	1	0	1	1	0
Boyd 5	3	4	28	2	1	1	6	0
Boyd 6	1	2	19	0	0	0	5	0

TOTAL								
Site	Red finned bullies			Long Finned Eels	Inanga	Torrent Fish	Whitebait	Koura
	M	F	J					
Quarry 1	7	7	50	1	4	0	6	2
Quarry 2	3	8	34	1	0	0	0	3
Quarry 3	1	4	29	2	0	0	0	2
Boyd 4	4	6	74	3	0	2	2	0
Boyd 5	4	7	76	2	1	1	10	0
Boyd 6	5	11	99	2	0	1	5	3

8.2 Appendix 2: Spot lighting

Day 1								
	Red finned bullies			Eel spp	Inanga	Torrent Fish	Whitebait	Koura
	M	F	J					
Quarry 1	0	1	Abundant	1	0	0	0	0
Quarry 2	0	1	Abundant	1	0	0	0	2
Quarry 3	0	2	Abundant	1	2	0	0	0
Boyd 4	1	0	Abundant	1	0	0	0	0
Boyd 5	0	1	Abundant	1	1	0	Present	0
Boyd 6	1	2	Abundant	0	0	0	Present	1

Day 2								
	Red finned bullies			Eel spp	Inanga	Torrent Fish	Whitebait	Koura
	M	F	J					
Quarry 1								
Quarry 2								
Quarry 3								
Boyd 4	0	2	Abundant	0	0	0	Present	0
Boyd 5	2	1	Abundant	1	1	0	0	1
Boyd 6	1	3	Abundant	2	0	0	0	1

Day 3								
	Red finned bullies			Unidentified Eel	Inanga	Torrent Fish	Whitebait	Koura
	M	F	J					
Quarry 1								
Quarry 2								
Quarry 3								
Boyd 4	2	1	Abundant	1	0	0	Present	1
Boyd 5	1	2	Abundant	1	1	0	Present	0
Boyd 6	1	2	Abundant	3	0	0	Present	0

TOTAL								
	Red finned bullies			Unidentified Eel	Inanga	Torrent Fish	Whitebait	Koura
	M	F	J					
Quarry 1	1	3	0	2	2	0	0	1
Quarry 2	1	3	0	2	0	0	0	4
Quarry 3	1	3	0	2	2	0	0	1
Boyd 4	3	3	Abundant	2	0	0	0	1
Boyd 5	3	4	Abundant	3	3	0	0	1
Boyd 6	3	7	Abundant	5	0	0	0	2

8.3 Appendix 3: G minnow nets

Day 1								
	Red finned bullies			Unidentified Eel	Inanga	Torrent Fish	Whitebait	Koura
	M	F	J					
Quarry 1	2	3	Abundant	0	0	0	4	0
Quarry 2	0	1	Abundant	0	0	0	0	0
Quarry 3	2	0	Abundant	0	0	0	0	0
Boyd 4	0	2	Abundant	0	0	0	0	0
Boyd 5	0	1	Abundant	0	0	0	13	0
Boyd 6	1	3	Abundant	0	1	0	0	0

Day 2								
	Red finned bullies			Unidentified Eel	Inanga	Torrent Fish	Whitebait	Koura
	M	F	J					
Quarry 1	1	1	Abundant	0	1	0	3	0
Quarry 2	0	0	Abundant	0	0	0	0	0
Quarry 3	1	0	Abundant	0	0	0	2	0
Boyd 4	0	2	Abundant	0	0	0	0	0
Boyd 5	0	1	Abundant	0	0	0	2	0
Boyd 6	0	2	Abundant	0	0	0	0	0

Day 3								
	Red finned bullies			Unidentified Eel	Inanga	Torrent Fish	Whitebait	Koura
	M	F	J					
Quarry 1	2	3	Abundant	0	0	0	0	0
Quarry 2	1	1	Abundant	0	0	0	0	0
Quarry 3	0	1	Abundant	0	0	0	0	0
Boyd 4	1	2	Abundant	0	0	0	6	0
Boyd 5	1	0	Abundant	0	0	0	2	0
Boyd 6	1	1	Abundant	0	0	0	6	0

Total								
	Red finned bullies			Unidentified Eel	Inanga	Torrent Fish	Whitebait	Koura
	M	F	J					
Quarry 1	5	7	Abundant	0	1	0	7	0
Quarry 2	1	2	Abundant	0	0	0	0	0
Quarry 3	3	1	Abundant	0	0	0	2	0
Boyd 4	1	6	Abundant	0	0	0	6	0
Boyd 5	1	2	Abundant	0	0	0	17	0
Boyd 6	2	6	Abundant	0	1	0	6	0

8.4 Appendix 4: Water quality results

	Quarry	Boyd
Average water flow (Velocity)	74.63 (sec)	36.43 (sec)
Average water clarity*	70cm	158cm
Total volume of Water (m^3s)	0.10	0.35

*Based on twenty paired samples 2006 - 2007