Size and Abundance of Freshwater Kōura, *Paranephrops planifrons* in Varying Water Quality Catchments in the Western Bay of Plenty.

Marine Reporting, Diploma in Marine Studies.

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Abstract

As Kōura are a heritage species in New Zealand and are fundamental to the sustainability of the freshwater ecosystem, this study aimed to investigate the influence of water quality on the size and abundance of Kōura. The Kōura were sampled in 3 sub catchment streams in the Western Bay of Plenty as the abundance and size of Kōura in these sites was unknown. This study also investigated whether there is a difference in the effectiveness of using either Bracken Fern or Manuka which are two different traditional Māori methods for trapping Kōura. It was predicted that there would be a positive relationship between the size and abundance of Kōura and the water quality. Specifically, this study aimed to answer the following questions: (1) does poor water quality reduce the abundance and size of Kōura in 3 Western Bay of Plenty streams? (2) do outside environmental factors such as farming run off or riparian vegetation near the streams have an impact on the water quality of 3 Western Bay of Plenty streams? (3) is there any difference in the effectiveness of using bracken fern to catch Kōura compared to the use of the Manuka tree branches? It was found that there was no statistically significant difference between the average size and abundance of Kōura in relation to water quality or environmental influences across the 3 streams. It was also found that Bracken Fern was more effective at trapping Kōura, so future studies in this field could look at using this method to increase the chances of collecting a larger sample. A large limitation to the study was limited time, which restricted the sample size. It is recommended that future studies consider increasing the time spent collecting samples and to help with this it is also recommended that the number of survey sites is increased.

Contents

1.0 Introduction

There are two species of freshwater crayfish, also known as Kōura, that are found in New Zealand. The *Paranephrops planifrons* is found in both the North Island and parts of the South Island, while the *P. zealandicus* is purely found at the southern end of the South Island (Kusabs, 2015). These two species are endemic to New Zealand and are fundamental to the sustainability of freshwater ecosystems, as well as being a common food source for both fish and humans. Māori traditionally used Kōura as an important food source especially in the North Island where there were large populations. Today in New Zealand, Kōura are considered a *taonga* (treasure) and a heritage species (Kusabs, 2009). In places where Kōura are abundant, there is shown to be influential biota in the aquatic system. Kōura have a wide variety of ecological functions, including being predatory and detritivore feeders and shredders. This has effects on the other fauna within that ecosystem (Parkyn, et al. 2001).

It is documented that Kōura abundance correlates to healthy streams all over the country and form a pivotal part of the ecosystems when compared to dirty and unhealthy streams ((Jowett, Parkyn & Richardson, 2007). Evidence of decline of Kōura were brought on by European settlement in New Zealand. Environmental factors that contribute to the decline of Kōura include the introduction of exotic fish and plant species (Barnes and Hicks 2003). Also, the rise of eutrophication levels from nutrient enrichment, can result in a decrease in dissolved oxygen at the bottoms of lakes which negatively impacts Kōura survival (Kusabs et al, 2015). This study's focus will be on the North Island species (*P. planifrons*) within stream ecosystems located in the Western Bay of Plenty as indicated below in

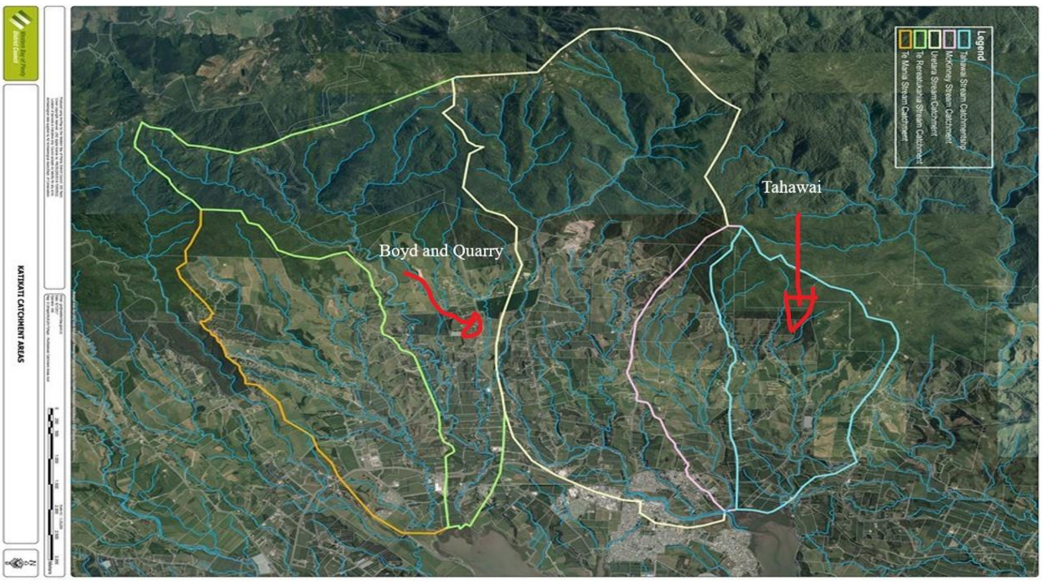

Figure 1-1.

Figure 1-1 Location of study, streams A, B, C, source: (Bay of Plenty District Council)

1.1. Study Aims and Objectives

The purpose of this study is to investigate the Kōura (*P planifrons*) abundance in an area that has never been researched before to see if the Kōura live functionally in that habitat. It is important to undertake this study, because if it is found that there is a low abundance of Kōura in the research sites, then we can find ways in future research to fix this problem, such as the addition of structures and objects or increasing the water quality by adding riparian technology to the stream.

For example, a European species of freshwater crayfish *(Astacus astacus)*, was shown to have low abundance in a lake with a soft bottom. They simply added 1000 tons of natural stones to the habitat. They monitored that area and the control site over 13 years and found the crayfish increased in abundance significantly to the point they could potentially harvest the crayfish from that area (Johnson & Taugbol, 2008). Potentially, simple methods such as changing the substrate could be transferred to New Zealand Kōura populations.

There has never been a full-length study done of Kōura in the study site streams. It is of interest to find the relationship between nutrient enrichment from surrounding farms and their effect on the calcium levels and other water quality parameters vital to Kōura growth.

A study has been done on calcium effects of the South Island species (*P. zealandicus*), which showed that an increase in calcium can affect the variability in growth rates. Specifically, the growth rates decreased with increased water calcium concentrations (Hammond, Hollows, Townsend & Lokman, 2006).

It is also of interest to find the gap between predator and prey interactions with Kōura within the streams and whether there is an effect on Kōura abundance. For example, an increase in eel populations may influence the Kōura abundance. A study in America showed the interaction between different sized freshwater crayfish (*Orconecte propinyuus*) and whether the predator, a small mouth bass (*Micropterus dolomieui*), would choose to eat crayfish by size from juveniles to adults by selective predation. It was found that the smaller sized crayfish were the easiest target for the fish, and the bigger crayfish were more likely to be able to protect themselves from predation due to well-developed morphological and physiological attributes (Stein,1977). This could suggest that in New Zealand waters where I will be researching, if the presence of eels is high, it is likely the abundance of small Kōura will be low and larger Kōura abundance high.

This research aims to fill a gap in the literature for the New Zealand public who may be passionate about protecting Kōura and want to know why there are less of them and what we can do to fix this problem. The aim is to compare the size and abundance of freshwater Kōura in a good quality vs a poor-quality river catchment, as well as to establish if the different water quality has any correlation between the size and abundance of the Kōura.

If high Kōura abundance within all the sites surveyed is found, this would indicate that the ecosystem is healthy. If, however low numbers are found, it will indicate that we need to make a difference and improve the quality of our freshwater streams in New Zealand.

- Hypotheses - There is a difference in size and abundance of Kōura due to water quality.
- Null Hypotheses - There is no difference in size and abundance of Kōura due to water quality.

1.1.1. Research Questions

The purpose of this report is to answer the following research questions regarding Kōura in 3 Western Bay of Plenty streams:

(1) Does poor water quality reduce the abundance and size of Kōura in 3 Western Bay of Plenty streams?
(2) Do outside environmental factors such as farming run off or riparian vegetation near the streams have an impact on the water quality of 3 Western Bay of Plenty streams?

(3) Is there any difference in the effectiveness of using bracken fern to traditionally catch Kōura compared to the use of the Manuka tree branches?

1.2. Literature Review

Between 1996 and 1998 a study by (Parkyn, Collier & Hicks, 2002). found that Kōura densities were usually higher at native forest streams due to high recruitment over summer.

At peak densities during summer months, it was found that in the native forest there were 9 Kōura per square meter, compared to 6 Kōura per square meter within pasture streams. Resulting in peak biomass in summer being much greater in pasture streams (Parkyn, Collier & Hicks, 2002).

Parkyn, Collier and Hicks (2002) looked at the feeding ecology of Kōura in native forest as well as pastoral land by investigating Kōura stomach content. Their goal was aimed to (1) identify the energy sources of crayfish, (2) determine whether these were affected by ontogeny or land use change, and (3) assess the functional and trophic roles of crayfish in New Zealand hill country streams. The outcome showed that the stomach content of Kōura was more than 60% leaf detritus in a native forest compared to the pastoral land streams, where 40% of stomach content was invertebrates and 30% was leaf detritus. Their main conclusion from this study was that Kōura have double roles as predators as well as processers of organic matter as they contain the role of trophic predator but also function as omnivores. The investigation of the gut content in conjunction with isotope analyses showed that the functional and trophic roles of *P. planifrons* differed.

The restoration of streams is an important part of New Zealand's clean green image, and the associated interaction of stream life and the surrounding habitat is usually complex and not understood well (Collier, Parkyn & Rabeni, 1997). A study by Parkyn, Meleason and Davies-Colley (2009), created three different wooden structures within a forest stream. Their key findings were that wood managed to increase stream complexity by retaining streambed substrate and providing microhabitat for Kōura with stable cover. Therefore, large wood debris such as logs and branches in streams are beneficial for Kōura.

2.0 Methods

The following sites have been selected for this study:

In total there are 9 areas (3 streams with 3 sites in each stream). This is the Boyd, Quarry, and Tahawai stream/river sub-catchments. These 3 streams are part of the larger Uretara river of Katikati.

The Boyd sub-catchment was selected as it is close to a natural New Zealand freshwater stream, the Quarry stream was selected as it has a low water quality which may be influenced from the surrounding pasture use, and the Tahawai stream was selected as it has had riparian vegetation planted in recent years. These sites were selected based on their differences in water quality and surrounding environmental input so that comparisons can be made on their impact on Kōura abundance and size.

Two types of traditional Māori capturing systems were used at each of the 9 sites. These consisted of 9 bunches of bracken fern or Manuka bundled and tied together using string. They were then weighted down at different sites; one fern and one Manuka trap were placed at each of the 9 sites, with a total of 18 traps set. Once placed they were left for 5 - 6 weeks before they were checked.

Size and abundance of Kōura were recorded from each trap. Size was measured from the total length of its carapace including its tail as shown in Figure 2-1.

After the information had been recorded the Kōura were released back into the respective streams near the area where the traps were placed.

Once all the data was collected from the surveys and collated, it was sorted and analysed. This indicated if there was any correlation between the data collected and whether the hypothesis and the null hypothesis were correct. Statistical testing such as an ANOVA (analysis of variance) was undertaken to establish if there were statistical differences between sites.

Figure 2-1- Freshwater Kōura from the Boyd Stream

3.0 Results

This section summarises the results for the water quality across the 3 survey areas, the size and abundance of Kōura that were found in each of the streams, and the difference between the two methods used to trap the Kōura.

3.1 Water quality

Table 1 summaries the raw data of the water quality tests done at the 9 survey areas within the 3 stream sites. The 3 areas tested in the Quarry stream all had similar results for the various measures of water quality as seen in Table 1. The 3 areas in the Boyd stream were also found to have the similar measures of water quality, as were the measures across the three areas tested in the Tahawai stream.

Table 1. Water quality tests of all 9 sites within the 3 stream catchments

Sites	Temp °C	Salinity	DO (%)	O_2 ppm	NH_4	NO_2	NO_3	pH	Ca
Quarry 1	15	0	102	8.3	0.25	0	5	7.2	40mg/L
Quarry 2	15	0	101	8.3	0.25	0.25	5	6.4	40mg/L
Quarry 3	15.5	0	107	8.1	0.25	0	5	6.4	40mg/L
Boyd 1	14.1	0	100	8.3	0.5	0	0	6.6	20mg/L
Boyd 2	14	0	99	8.3	0.5	0	0	6.8	20mg/L
Boyd 3	14.1	0	99	8.2	0.5	0	0	6.6	20mg/L
Tahawai 1	16	0	100	8	0.25	0	5	6	40mg/L
Tahawai 2	16.3	0	99	7.9	0.25	0	5	6	40mg/L
Tahawai 3	16.2	0	100	7.9	0.25	0	5	6	40mg/L

Table 2 shows the average water quality results across the 3 river catchments. Overall, the Boyd stream was found to have the best water quality, and the Quarry and Tahawai streams were found to have a similar water quality.

Table 2. Average water quality results from the 3 river catchments

Sites	Temp °C	Salinity	DO (%)	O2 ppm	NH4	NO2	NO3	pH	Ca
Quarry	15.2	0	103.3	8.2	0.25	0.08	5	6.7	40mg/L
Boyd	14.1	0	99.3	8.3	0.5	0	0	6.7	20mg/L
Tahawai	16.2	0	99.7	7.9	0.25	0	5	6	40mg/L

3.2 Kōura Size and Abundance

Figure 3-1 shows that 5 Kōura were found across the 3 sites along the Boyd stream.

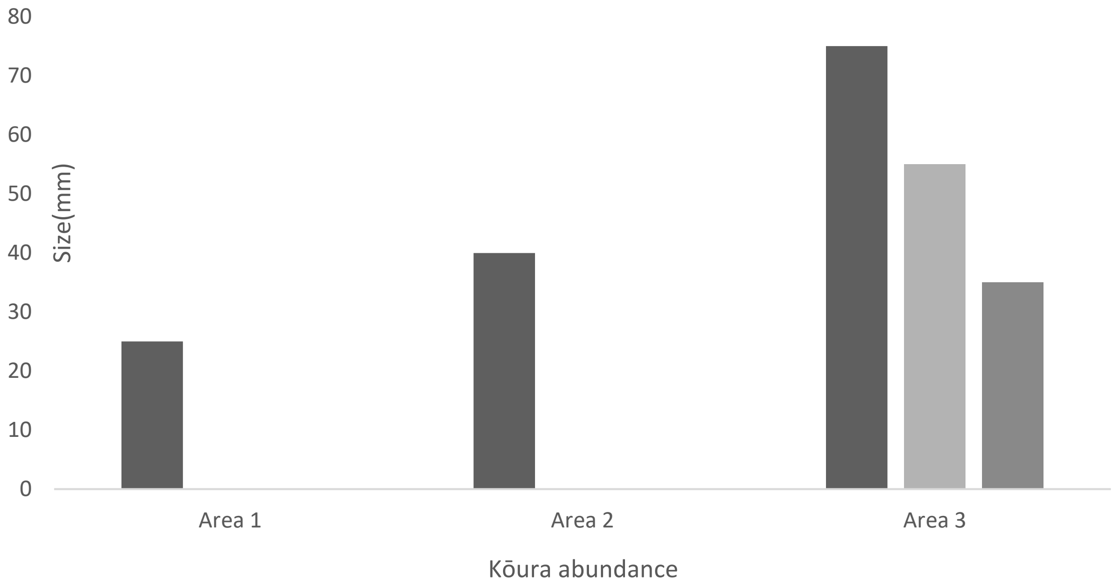

Figure 3-1- Bar graph showing the abundance and Kōura size(mm) at the Boyd stream

Figure 3-2 shows that 2 Kōura were found across the 3 sites along the Quarry stream.

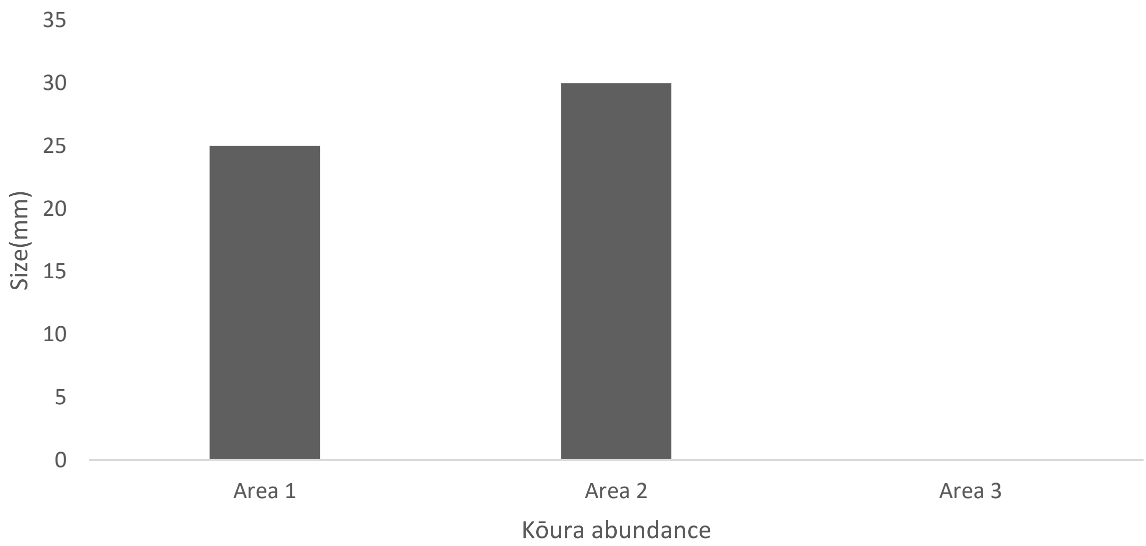

Figure 3-2- Bar graph showing the abundance and Kōura size(mm) at the Quarry stream

Figure 3-3 shows that 1 Kōura was found across the 3 sites along the Tahawai stream.

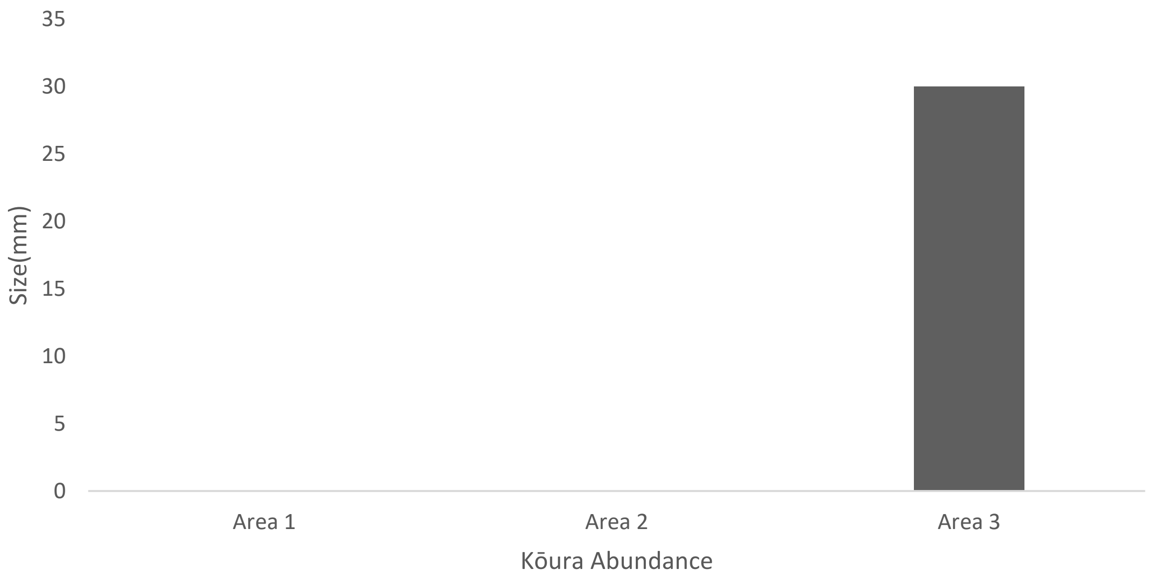

Figure 3-3- Bar graph showing the abundance and Kōura size(mm) at the Tahawai stream

Figure 3-4 shows the average size of the Kōura found in each of the 3 streams. The Boyd stream was found to have the largest Kōura with an average size of 46mm, followed by the Tahawai stream with an average size of 30mm, and then the 1 Kōura found in the Quarry was 27.5mm.

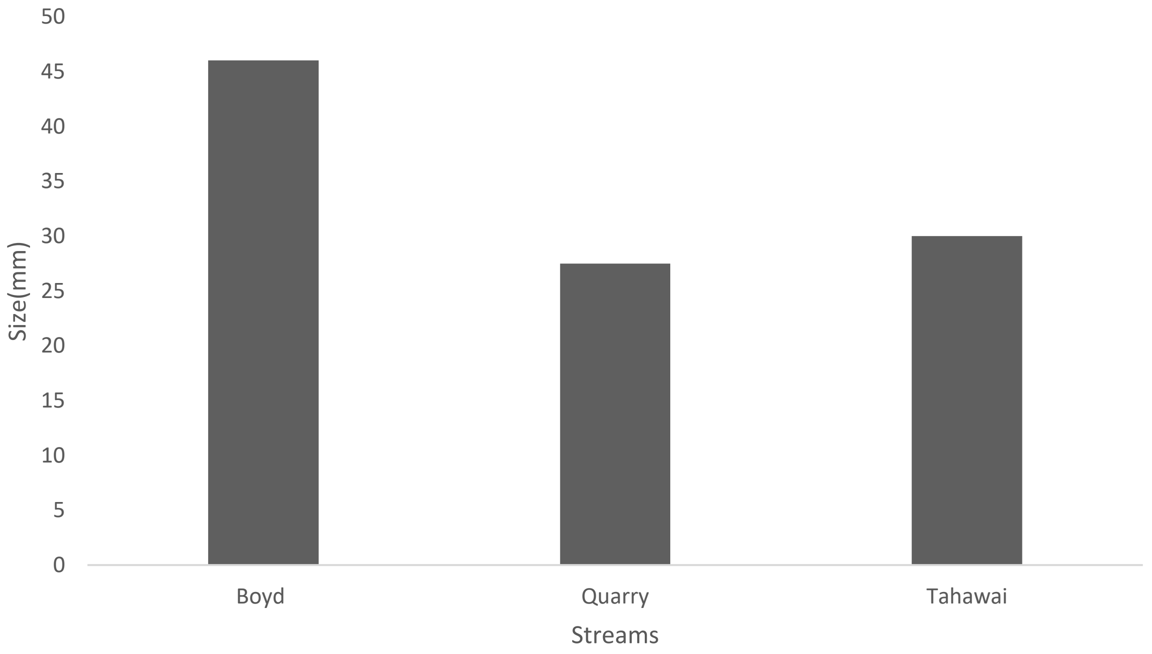

Figure 3-4- Bar graph showing the Average size of Kōura at the 3 survey streams

Figure 3-5 shows the total abundance of Kōura in each of the 3 streams studied. The most Kōura were trapped in were located in the Boyd stream with 5 The most Kōura were trapped in being trapped, followed by Quarry which trapped 2, and then the Tahawai which trapped 1.

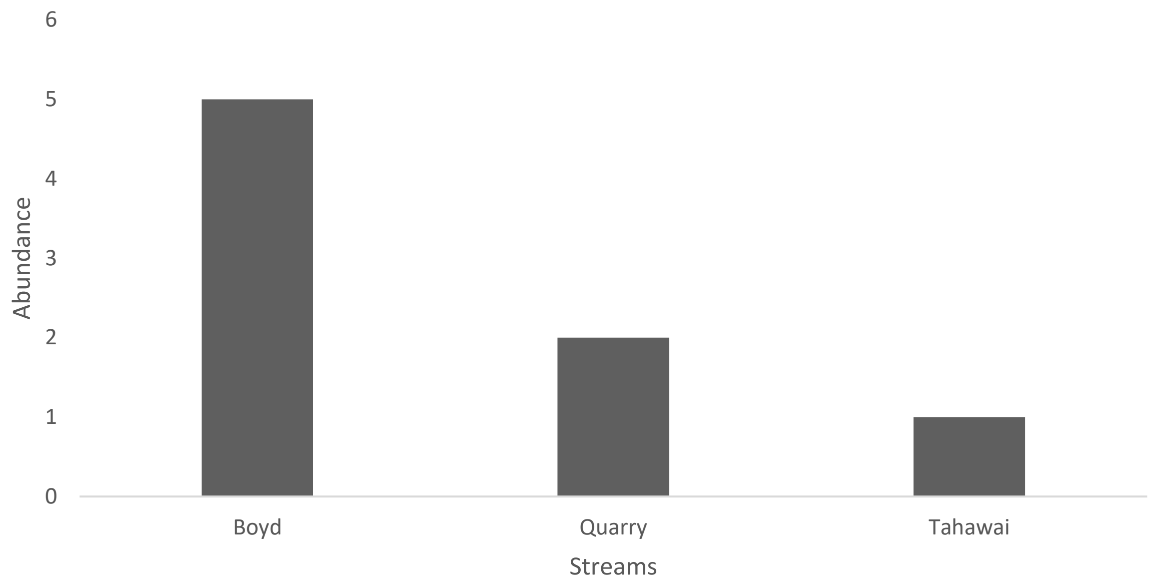

Figure 3-5- Bar graph showing the total abundance of Kōura at the 3 streams

3.3 Bracken Fern Vs. Manuka

Figure 3-6 shows the difference in the numbers of Kōura captured using the two methods. The Bracken Fern trapped 7 Kōura, while the Manuka trapped 1 Kōura.

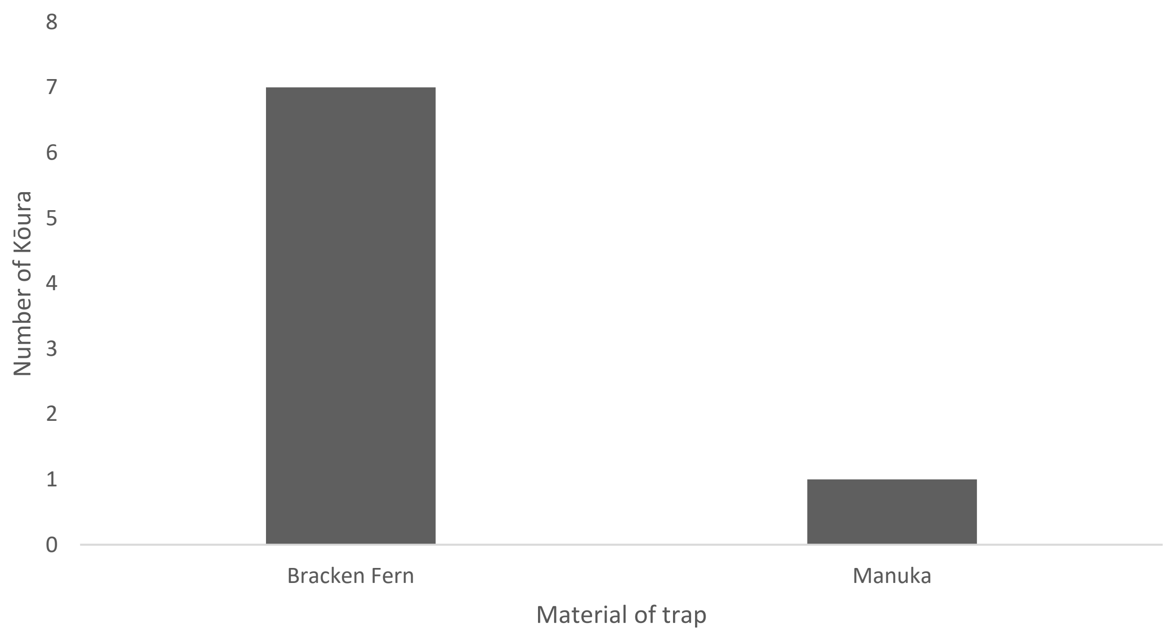

Figure 3-6- Bar graph showing the comparison of Fern Vs. Manuka to trap Kōura

Figure 3-7- Manuka trap in the Boyd stream

4.0 Discussion

A total of 9 sites where the traps were placed were tested for different water quality parameters. The first stream was the Quarry catchment which is known as the poor-quality water catchment with surrounding pasture used for stock and has a lack of riparian vegetation with it. The quarry had poor clarity as well as lots of suspended sediment, this is due to the sediment pollution from the nearby Katikati Quarry. The Boyd stream is the healthy natural waterway system with a larger water catchment with bigger pooling areas than the other 2 streams. And the Tahawai is on surrounding farmland with riparian vegetation around the stream that has been planted in recent years.

As expected the 3 streams showed different results in water quality, however shown in Table 1 the differences between the 3 streams were minimal, the average temperature was highest in the Tahawai and the Boyd had the lowest average temperature. The Quarry had the highest dissolved O^2 while the other 2 were similar. Ammonia, Nitrite and Nitrate tests were taken at each site. Ammonia was present in all 3 streams, Nitrites and Nitrate were present in only the Quarry and Tahawai stream, which could be due to surrounding farmland where fertilisers or runoff could influence the streams quality. If the Nitrate levels were to high/toxic in the stream the Kōura can be sensitive to the contaminants (Hickey, 2013). The pH of all 3 streams was similar and at a healthy level.

The Calcium levels at all 3 streams were at similar levels. The lowest was the Boyd stream at 20mg/L while the Quarry and the Tahawai were the same at 40mg/L. For Kōura to have good survival rates calcium is vital to be present in the water, higher the concentration of Calcium higher the chance of survival of Kōura (Hammond et. al. 2006). Calcium is important in the growth and strengthening of the Kōura exoskeleton. Often the Kōura will eat the old skeleton to gain extra calcium quicker as if their shell is soft and takes time to harden they are susceptible to predators (Ministry of Primary Industries, 2016).

Figure 3-1 shows the size and abundance within the Boyd streams 3 different survey areas, this stream had the highest abundance and average size out of all the 3 streams there were a total of 5 Kōura found here, this was a good sign as this stream is supposed to be the clean and healthy stream out of the 3 streams. Figure 3-2 shows the size and abundance of Kōura in the Quarry stream at the 3 areas within the three survey areas of that stream, there was 2 Kōura found here in total, this was good to see that there were 2 found, it was sceptical that there would be any found here at all due to the poor quality of the water and the sediment downflow from the nearby quarry. Figure 3-3 shows the size and abundance of Kōura in the Tahawai stream within the 3 survey areas of that stream, there was only 1 Kōura found here, again a good result as not sure if there would be any found here at all, this stream has riparian vegetation around the banks and pasture used nearby for farming, however the riparian vegetation had only been placed in recent years and that could have an effect on the water quality of the stream. This stream was also affected by heavy rain during the winter months and a lot of debris was washed down which could have affected pre-existing Kōura populations.

Figure 3-4 shows the average size of all the Kōura found within the streams, the average size was 45mm at the Boyd, 27.5mm at the Quarry and 30mm at the Tahawai. Again, the Boyd showed the best results with the largest average size. Then Figure 6 shows the Total abundance of Kōura at all the streams, as stated above the Boyd had the highest abundance of Kōura with five, then Quarry with two and Tahawai with one Kōura.

Although both the Quarry and Tahawai stream were subjected to turbid waters from suspended sediment and the abundance of Kōura was low in both streams. The turbidity may not have had an effect directly to the population size of Kōura. As a study done by Suren, Martin and Smith, (2005) tested the effected-on stream invertebrates including Kōura. The results showed that

Paranephrops had 100% survival after 24 hours in the highly turbid water. So, it shows Kōura are capable of survival in high turbid waters with large amounts of suspended sediment.

Riparian vegetation is a key attribute to the all 3 streams in the survey, the Boyd stream has the oldest and most riparian vegetation which could be a factor to the higher abundance and average size of Kōura found in this stream, the Quarry has a smaller amount of riparian vegetation that may have a small effect on the water quality but none to the extent of the Boyd. As explained the Tahawai has only had riparian vegetation paced in recent years so it is poorly developed and may have little effect on the water quality of that stream. It is important for streams to have Riparian vegetation as it can directly or indirectly affect many important structural and functional processes in stream ecosystems (Johnson and Almlöf, 2018)

On a positive note when lifting the traps at all 3 of the streams most of the traps had other vertebrates and invertebrates found within them, for example within the Boyd and the Quarry a total of three Freshwater shrimp (*Paratya curvirostris)*, a range of fish and macro invertebrates as well found. In 1 singular trap in the Tahawai had a juvenile eel living in it as well. Several Caddis and Mayfly invertebrates were found in the traps in the streams that were surveyed. This amount of different species coherently living together in a trap is a great indication to a healthy freshwater food chain and a good indication that the river is healthy.

Figure 3-8- vertebrate found in a trap in the Boyd stream (scientific name unknown)

As stated in the methods there were two types of plant used to create the Tau Kōura (trap), it was recommended by past research papers to use Bracken Fern to catch the Kōura and recommended in person to use Manuka bundles to catch the Kōura. So both were put to the test to see if there was a better option. In the surveys done at the 3 streams, when each trap was pulled up it was clear that the Fern would work better as to the human eye there was a lot more detritus that had accumulated in the fern traps compared to the amount of detritus that had accumulated in the manuka traps. The results show the that the fern clearly had the greater amount of Kōura caught in those traps through the 3 sites that were surveyed. A study by Kusabs (2018) explored a variety of ways to capture Kōura in streams such as minnow traps, fyke nets and electrofishing compared to the traditional Tau Kōura and results showed that the fern traps provided the better option for collecting Kōura.

If this project was to be done again there would be a few things that would change to benefit the outcome of the survey. Firstly, time is a big factor, if more time was available then the traps could have been placed for longer and a larger amount could have been placed which would have hopefully seen the results change and a larger amount of Kōura would have been caught. Better methods of tying the traps to the weighted bag for easy removal from the stream, as it was hard to take the traps out of the water without trying to lose any animals within the traps with the weights on. Potentially to have surveyed more sites as the more streams surveyed would help the bigger picture of the Kōura population within the Western Bay of Plenty.

Overall the abundance and average size of Kōura in the Boyd stream was greater than the Quarry and the Tahawai streams, however there was no statistically significant difference between the streams (P=0.44) and therefore we accept the null hypothesis that there is no difference in size and abundance of Kōura due to water quality (as shown in Appendix 1). This is a good result none the less as it shows that Kōura can live within the 3 different catchments regardless of outside environmental effects on the streams water quality.

5.0 Conclusion

This research report has studied the effects of water quality on the size and abundance of Kōura, as well investigating the effectiveness of different methods to trap Kōura. It was found that there was no statistically significant difference between the average size and abundance of Kōura due to water quality across the three streams. It was also found that the Bracken Fern was the most effect method for trapping Kōura which is beneficial to know for future studies. Despite the results not being what was expected, it has shown that Kōura can survive in differing levels of water quality which is a promising result as Kōura are a heritage species in New Zealand and are fundamental to the sustainability of the freshwater ecosystem. It is recommended that future studies in this field consider increasing the time to collect more samples and increasing the range of survey sites.

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7.0 Appendix 1

SUMMARY

Groups	Count	Sum	Average	Variance
Boyd	5	230	46	380
Quarry	2	55	27.5	12.5
Tahawai	1	30	30	#DIV/0!

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	589.38	2	294.69	0.96	0.44	5.79
Within Groups	1532.5	5	306.5			
Total	2121.88	7				