An Investigation of Freshwater Prawns as Indicators of Stream Health

Report on a study trip to Rarotonga Oct 2000

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Summary

Background

In Oct 2000 the author was invited to join a group interested in stream restoration on the island of Rarotonga. The project was developed by the author and Northland Polytechnic Environmental Management student Carina Langsford. Rarotongan based individuals and organizations that have supported the project are: Gerald McCormack, Manager of the Natural Heritage project, Io Tuakeu-Lindsay, Manager of Environmental Services Department, Tu Tangata, Education manager, Environmental Services Department, Tania Compliance Manager, Environmental Services Department, Ian Karika-Wilmott, Environmental Council & Manager of Takitimu Conservation Area – Rarotongan Fly Catcher, *Pomarea dimidiata,* recovery project. The proposed aims of the project are:

1. To initiate a restoration project for the Takuvaine stream which runs through the main township of Avarua.
2. To provide an opportunity to involve the community in the protection and care of a stream
3. To develop a stream monitoring method for Rarotonga that could help them to assess stream health in relation to development, point source discharge and water extraction/minimum flow issues.

There is a long history of management and use of the freshwater systems of Rarotonga. (Insert description here. Size hydrology) Most significant of the traditional uses of the freshwater resources was the channeling and bed raising activities of Taro growing in the wetland areas that typically lie between the coastal fore dune systems and the bottom slopes of the mountains. The traditional Taro growing practices apparently worked well with natural stream and wetland processes. The preparation of the raised Taro beds appears to fulfill the function of cycling the silt, organic matter and nutrients through a cropping cycle. Traditionally because the wetland areas were seen as highly productive areas it is unlikely that they were drained for other uses or channelised. Many of these traditional taro systems are still in use today, while others have been in filled for housing development. The channelisation and infilling of the wetland areas effectively reduces the stream systems ability to absorb peak flow volumes and incorporate the silt and gravels which are regularly transported down from the sloped areas of the catchment.

As pressure for resort development and residential housing has increased over the last several decades, most development has been focussed on the fore dune areas. There has also been significant drainage and infilling of the wetland areas to create more land. This process is most noticeable in the Avarua area that is in the catchment of proposed restoration stream the Takuvaine. In the Avarua area there has been

considerable channelisation work, removal of large rocks and pool structures for the purpose of flood control and protection of the developed land.

Point discharges are a growing concern for the Takuvaine stream as development within the of the catchment progresses. Generally septic tank systems are used for sewage treatment. Some of these systems are very close to the stream and some are catering for large dormitories subject occasionally to heavy use. A small commercial laundry with a direct outflow to the stream was observed and in some areas significant quantities of rubbish and organic wastes had been disposed of in the streambed.

Water extraction has a significant impact on the hydrology of several of the streams on Rarotonga, including the Takuvaine. Water extraction is in the form of a small weir located in the upper third of the catchment with a pipe system providing gravity pressured supply to the houses and resorts of the coastal area. These stream sources of good quality water are obviously very important to Rarotonga as other sources of water such as rainwater tanks or bores appear not to be used. In recent years stream extraction volumes have increased along with development. In the Takuvaine catchment during dry periods the water system can take virtually the entire stream flow for a period of weeks or even months. The system is managed from a water supply perspective with no minimum flow requirement.

The freshwater species present in Rarotonga have been recorded in the database of the Cook Islands Natural Heritage Project. Gerald McCormick manager of the Natural Heritage Project has supplied the species list below.

LIST of SPECIES HERE

Method

Pilot surveys were conducted in three streams to examine fish and invertebrate distribution. The aim was to look for differences between fish and invertebrate communities of the upstream steep forested areas and the lower reaches. Upstream sites were all draining steep forested areas and appeared to have high water quality. The lower stream reaches surveyed varied in the level of impacts and degree of agricultural or residential development. The study streams' locations are described in Figure 1&2 and Table 1.

Figure 1 Location map of the Cook Islands

Figure 2 Streams of Rarotonga

Table 1 Stream description and study areas

Stream Name	Stream Length	Relative impairment of lower reach	Relative impact of water extraction on flow volumes
Takuvaine stream Runs through Port township of Avarua	5.4 km	High	High
Turoa stream Catchment of the Takitimu Conservation Area	1.7 km	Low	Moderate to high
Avana stream Rarotonga's largest stream Primarily good forest cover	8.3 km	Low	Low to moderate

Invertebrate sampling was done with a 600mm width by 500mm deep 150 micron mesh hand net. For each site holding the net in the stream and disturbing the substrate with feet and hands upstream of the net for approximately 30 seconds sampled three riffle areas. In addition the edges of approximately 10 meters of pool edge were swept with the net to look for invertebrate species specializing in pool or pool edge habitats. Sorting and identification of the samples was done in a white tray with a hand lens. Macro-invertebrate samples were taken and examined at:

- the water intake of the Takuvaine stream, (upper catchment)
- the middle reach area of the Avana stream, (500 m down stream from the water intake)
- the lower reach of the Takuvaine stream, (2 sites 100m and 800m upstream from the sea)

General fish surveys were done by walking the streams with a hand net in the daytime and spot lighting along the streams at night.

A semi-quantitative survey method was attempted for the two prawn species: the bracelet prawn *Macrobrachium lar,* and the thick-clawed prawn, *Macrobrachium latimus.* Since these species are predominantly nocturnal, walking along the streamside with a spotlight was the preferred method for observing and counting the prawns. At each site all individuals were counted in a series of pools. The size of the pool was estimated and recorded. The average prawn size and a rough estimate of the species composition were recorded where possible. The presence or absence of large individuals and very small prawns was also noted. At each site a series of pools were counted. An effort was made to count the pools of at least 100m of stream length at each site. The following sites were selected on the three study streams:

- Takuvaine stream lower reach, (from the first bridge 150m down stream)
- Takuvaine stream upper reach, (50m up and 50m down from the water extraction weir)
- Turoa stream upper reach, (a 200m section approximately 500m upstream from the end of the road into Takitimu Conservation area)

- Turoa stream lower reach, (a 200 m section from the estuary upstream)
- Avana stream, (a 100 m section of stream upstream from the water extraction weir)

Figure 3

Results

After the first look at the three streams it was decided to focus on the prawns as a potential monitoring species. The prawns were present in all areas of the stream from the salt/freshwater-mixing zone to the top of the catchments. In the unimpaired stream areas the productivity of prawns was very high, (highest count 10.5 prawns/m^2 pool area). The high productivity and even distribution observed suggests that the prawn species make up a significant part of the stream biomass. Prawns also are important as food specie for the local people and are well known and valued by the local people.

Fish Survey

Low numbers of the eel believed to be pacific long-finned eel, *Anguilla megastoma* were found in the upper catchment areas of the three streams. Of the total of approximately 600m of upper catchment streams spotlighted three eels were spotted ranging in size from 300mm to 800mm in length. The other fish species were not found in the upper catchments. In these areas the slopes were often quite steep, occasionally producing small waterfalls possibly limiting fish distribution. It is quite possible that this limited set of spotlight surveys could have missed the presence of some of the fish species in upper catchment areas. Observations of the fish species and distribution in the lower reaches of the three streams showed little difference between the three streams. The two guppy species and several of the goby species appeared in areas with the worst water quality. In these areas filamentous algae growth was rampant forming dense mats in some areas suggesting high nutrients loads and a eutrophic state. ***(Insert here reference Niwa's Periphyton Guide and rating of algal cover)*** The guppy species are well known for their tolerance of poor water quality and were present in high numbers in these impaired areas. These observations suggest that the fish species present may not be useful as indicator species of the changes in stream health. It would be desirable to test this idea with a more rigorous survey of fish distribution and habitat preferences. No attempt to quantify the observations above was made due to time constraints and the decision to concentrate on survey of the prawn species.

Invertebrates

The same group of five species in low numbers was found in the macro-invertebrate sampling of the three study streams. This uniform result was found despite the differences in the sampling sites and water quality. The sites varied from lower catchment impaired to upper catchment unimpaired streams. The aquatic invertebrates found were:

- Larvae of two black fly species
- Two snail species
- One dragonfly larvae

The limited number of invertebrate species observed is consistent with results of other observers, (McCormack pers. Com). The very low numbers of number of macro-invertebrate species and the lack of difference in species composition between impaired and unimpaired sites suggests that macro-invertebrates would not be a useful for monitoring stream health.

Freshwater Prawns

As expected from the initial survey of the three streams counts of the two large prawn species, the bracelet prawn *Macrobrachium lar,* and the thick clawed prawn, *Macrobrachium latimus* showed differences between lower and upper reaches and between impaired and unimpaired areas. The results of these counts are given below in Table 2 and Figure 4.

Figure 4 Comparison of Prawn Densities in Takuvaine, Turoa and Avana streams

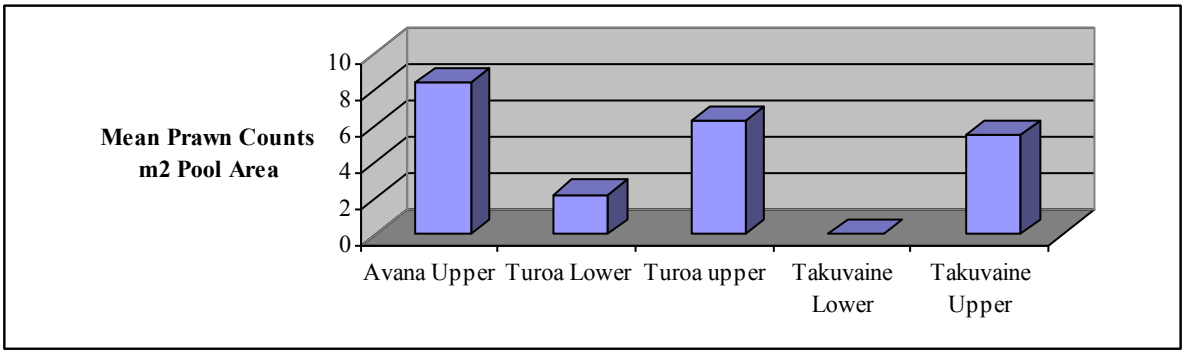

Table 2 Prawn Survey Results
(Insert standard deviation & range for prawn counts)

Stream Section Surveyed	**Mean Counts of Prawns/$m^{2\ of}$ Pool Area**	**M^2 of Pool Surveyed**	**Total Number of Prawns Counted**	**Size Classes Present (body length)**
Avana Upper	8.4	21	176	med & large 40-150mm
Turoa Lower	2.2	63	137	Small & med 20-80mm
Turoa Upper	6.3	20	126	med & large 80-150mm one pool had small prawns 15-30mm

Takuvaine Lower	.04	260	10	med 40-60mm
Takuvaine Upper	5.5	27	139	med & large 40-120mm

The size classes in Table 2 are estimates from the visual counts only and therefore can only be used as indications of the size distributions. In each of the stream sites at least twice or three times as much distance of stream was surveyed with spotlight as was counted for prawns. The author is confident from those observations that the results in Table 2 are indicative of the total stream area spotlighted.

The results of the prawn survey could match what would be expected from the combined impacts of pollution and loss of stream habitat in the Takuvaine. Another factor influencing the low counts in the lower Takuvaine could be fishing pressure. The lower Turoa was chosen as a control to examine this effect. The lower Turoa appears to be unimpaired in terms of pollution and habitat modification, but is easily accessible in the lower reach and commonly fished (Ian Karika-Wilmot pers.com.) Prawn fishing was observed by two local people in the lower Turoa on one of the nights spotlighting was done. Despite the obvious fishing pressure on the lower reach of the Turoa stream prawns were still counted at 2./2$m^{2.}$ In comparison prawn counts for the lower Takuvaine stream were .04/m^2. Consistent with the differences in counts was the size of prawns seen in the lower Turoa stream which was only small to medium sizes. This supports the idea that fishing pressure results in decreasing the size classes of the prawns as the large individuals are taken, but fishing alone does not necessarily eliminate the prawns from a segment of the stream.

Discussion

From this pilot study it appears that freshwater prawns could be useful in stream health monitoring. The freshwater prawns are distributed in all parts of the catchment and from this initial survey appear to vary in density and productivity in relation to the degree of stream impacts. The local people showed considerable interest in the use of the prawn species as a traditional food. If prawn productivity were profiled as a measure of stream health or success of good stream management the local population could better understand and support positive stream protection/restoration initiatives. Another aspect is that the prawns are possibly good indicators of streamside forest heath. It was observed in the study that large amounts of forest material were moving through the upper stream reaches and terrestrial insects were seen in the invertebrate samples. This forest 'litter' presumably is the major food source for the prawns. The ecological connection here is significant. Protection or restoration of streamside forest cover is well established as an essential factor for maintaining high water quality. ***(reference Doc/Niwa Riparian Management Manual)*** To put this in another way prawn productivity in a stream could be seen as a measure of forest health of the stream system. Focus on the connection of stream health to the forest quality could be a useful way to guide management approaches.

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Refinement of the prawn survey method

Use of other methods

Eel Conservation

The low eel numbers in these areas that appear to be ideal eel habitat, suggest that they have been heavily fished in these three catchments. If this level of impact on the eel populations is typical of the upper catchment streams of the entire island, there should be concern that production of breeding age eels could decrease to the extent that eel recruitment to the island could fail. More survey work would be required to test this question. The wetland and Taro areas presumably hold significant adult eel populations. Although these areas would be subjected to harvesting.

Liaison with interested parties in Rarotonga

Insert paragraph here on public meeting who attended and outcomes

Interest in conservation of the natural resources on Rarotonga is becoming a major issue. The indigenous people are motivated to preserve or restore their natural heritage now that they have seen how quickly these values can be lost. There is also a growing appreciation of the potential of the tourist market. Many tourists leave behind the impression that one of the main attractions of Rarotonga is its natural beauty, lagoons and culture. During the stream study it was noticeable how many tourists stopped while crossing the bridge over the Takuvaine stream to examine the stream. It's worth noting that for many overseas people, streams hold a great deal of fascination and interest. Sadly this stream section at the bottom of the Takuvaine has lost much of the values of Rarotongan beautiful mountain streams.

Acknowledgements

Funding assistance for the project was provided by the Faculty of Health and Science, Northland Polytechnic.
Carina
Cook Island people

References