OHAU CHANNEL DIVERSION WALL

An assessment of the koura and kakahi populations in the Okere Arm and Lake Rotoiti.

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EXECUTIVE SUMMARY

This report documents the first year of baseline monitoring for koura and kakahi in the Okere Arm and Lake Rotoiti. Monitoring was carried out on a 3 monthly basis from June 2005 to September 2006.

The tau koura (a traditional Maori method for harvesting koura in the Te Arawa and Taupo lakes) proved to be an effective means of monitoring koura with a total of 2349 koura captured in the Okere Arm during the 4 surveys. Catches ranged from 286 to 972 koura per tau per sampling with a wide size range of koura captured.

The kakahi monitoring methodology used in this study was developed by NIWA specifically for use by community groups. This method proved to be a safe, easily replicable, and cost-effective means of monitoring kakahi abundance. Kakahi were very abundant in the Okere Arm with the highest count of 803 per transect (or per $20m^2$) recorded at the 'Ditch' site. However, initial analysis of the sub-samples taken from Lake Rotoiti and the Okere Arm has revealed that many of these kakahi are in relatively poor condition.

It is recommended that baseline monitoring of koura and kakahi populations in the Okere Arm and Lake Rotoiti continue to establish a more comprehensive pre-diversion database for these species. The following amendments to the monitoring programme are proposed.

1. Establish a tau koura in the Western Basin as a control for future monitoring purposes. A tau koura at this site would be a more comparable reference site than the existing control site at Emery's Reef.

2. Replace fern bundles every 6 months. Fern bundles decomposed faster in the Okere Arm (6 months) compared to Emery's Reef (12 months). It is therefore recommended that fern bundles be replaced every 6 months in the Okere Arm.

3. Continue to collect kakahi samples to determine condition and develop size/age/biomass relationships. Kakahi samples will be analysed at the completion of the baseline monitoring programme in October 2007.

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Cover photo: Processing koura captured from the Okere Arm, 8 December 2005.

1 INTRODUCTION

Environment Bay of Plenty is proposing to construct a diversion wall to divert nutrient rich water from Lake Rotorua through the Ohau Channel and down the Kaituna River. This will separate Lake Rotoiti into two ecologically separate waterways, an eastern basin (no Lake Rotorua influence) and a very small western basin (Lake Rotorua influence).

Two of the main concerns to Ngati Pikiao are the potential impacts of the proposed diversion on koura (*Paranephrops planifrons*) and kakahi (*Hyridella menzeisi*). Koura, are the largest bottom-living crustacean in Lake Rotoiti with a maximum orbit-carapace length (OCL) of about 70mm (Devcich 1979). Koura support an important traditional fishery in Lake Rotoiti where significant quantities of koura are still harvested. The koura fisheries in Lake Rotorua and in the Ohau Channel are less well known.

In New Zealand, kakahi attain sizes over 100mm length, and reported maximum ages ranging from 13 to 33 years (Walker, Byrne, Hickey & Roper 2001). The primary food source for kakahi is material suspended in the water, and dense aggregations may modify algal composition and microbial activity. However, their propensity to accumulate pollutants may prejudice the health of consumers (Walker et al 2001). This may be one of the main reasons why kakahi are no longer exploited on a large scale in the Te Arawa lakes. Nevertheless, localised harvesting of kakahi still occurs in Lake Rotoiti and some of the Rotorua lakes.

Little research has been carried out on koura or kakahi in the Ohau Channel and Okere Arm of Lake Rotoiti. Therefore the purpose of this study was to carry out a baseline assessment of the koura and kakahi populations in the Okere Arm prior to the proposed diversion of Rotorua water.

2 OBJECTIVES

- Establish baseline monitoring programmes for koura and kakahi in the Okere Arm and Lake Rotoiti.
- Recommend future monitoring requirements.

Figure 1 Measuring a koura (freshwater crayfish) captured in the tau koura set at Emery's Reef, Lake Rotoiti.

Figure 2 A kakahi (freshwater mussel) from the Okere Arm, Lake Rotoiti.

Figure 3 Koura and kakahi monitoring sites, Lake Rotoiti, 2005 to 2006.

3 METHODS

3.1 Tau location and lay out

The koura population in the Okere Arm was sampled using the tau koura, a traditional Maori method of harvesting koura in the Te Arawa and Taupö lakes (Kusabs, Hickey, Parkyn & Quinn 2004). The tau was located in the Okere Arm at about NZMS 260 U15 038 482 (Figure 3). Fieldwork was carried out on a 3 monthly basis from 8 December 2005 to 12 September 2006 (Table 2).

A tau comprised of 10 whakaweku, dried rarauhe or bracken fern (*Pteridium esculentum*) bundles, each with c. 14 dried fronds per bundle, was attached to a bottom line (a 200m length of sinking anchor rope) and set in the Okere Arm. One end of the bottom line was attached discreetly to the base of a tree on the shoreline while the lake end was anchored to the lake bottom using a heavy weight (a car tyre filled with concrete). The tau was set in an area of the Okere Arm which was relatively free of large aquatic macrophytes in a water depth of approximately 4 to 7m.

The tau was left for 2 months to allow koura to colonise the fern and was retrieved every 3 months. Owing to rapid decomposition in warm water, our summer whakaweku (bracken fern bundles) were replaced on 3 March 2006 (Figure 4).

Figure 4 Replacing whakaweku (fern bundles) on the tau koura set in the Okere Arm, Lake Rotoiti.

3.2 Koura harvesting

Harvesting was achieved by lifting one end of the rope and successively raising each whakaweku while moving along the bottom line in a boat. A korapa (a large net designed especially for this purpose – see cover photo) was placed beneath the whakaweku before it was lifted out of the water. The whakaweku were then shaken to dislodge all koura from the fern into the korapa. The whakaweku was then returned to the water. The koura were then collected and sorted into labelled plastic boxes with lids above them to keep them shaded and calm before being measured and weighed. All koura were counted and the volume of the total koura catch measured.

3.3 Koura measurement

Subsamples of the population were measured, typically this comprised all koura captured on whakaweku 3, 5 and 7, or at least 100 individuals, to assess size class distribution. All koura in the subsamples were measured for OCL (orbit-carapace length to the nearest 1mm using callipers, Figure 1), and shell softness, sex and reproductive state (presence of eggs or young) recorded. After processing, all koura were returned live to the water in close proximity to the tau.

3.4 Common bully

Common bully or toi toi (*Gobiomorphus cotidianus*) were a significant by-catch from the Okere Arm tau. Common bully were counted and classified into three size classes, small (<30mm), medium (31-60mm) and large (>61mm) sizes. Once counted and their size estimated, common bully were returned immediately to the water.

3.5 Kakahi monitoring

Kakahi transects were located at each of 3 sites along the area between Ohau channel and the Rotoiti delta and at 3 reference sites in Lake Rotoiti that were outside the area of influence of the diversion (Figure 3). Grid references for the 6 sampling sites are shown in Table 1.

At each site 40m transects, 0.5 m wide, and perpendicular to the shore, were inspected out into the lake from standard points to a depth where the water was regularly wadeable. All mussels within 0.5m up current from a weighted survey line, observed with an underwater viewer, were counted with the counts summed for each 1 m interval. An 'L' shaped measuring device constructed of 25mm PVC pipe (1.2m high x 0.5m wide) was used to measure water depth (to the nearest 1cm) and to maintain the 0.5m distance from the survey line (Figure 5). Sediment type is an important determinant of mussel density (James 1985) and was visually assessed along the transect lines as mud, mud-sand, clean sand, gravely

sand, sandy gravel etc. These surveys were repeated three-monthly for the 1 year period before diversion.

Table 1 Sampling site, number, location, grid reference and direction of transect for 6 kakahi monitoring sites located in Okere Arm and Lake Rotoiti.

Sampling site	Location	Grid reference (NZ Geodatum)	Compass bearing
1. Boat Ramp	Okere Arm	E2802931 N 6346315	70°
2. Rest area	Okere Arm	E 2803075 N6346554	110°
3. Ditch	Okere Arm	E 2803237 N 6346621	90°
4. Okawa Bay	Lake Rotoiti	E 2802903 N 6345642	75°
5. Tumoana Point	Lake Rotoiti	E 2805639 N 6345842	350°
6. Ruato Bay	Lake Rotoiti	E 2811245 N 6343779	290°

Figure 5 Josette Moore and Joe Tahana using an underwater view and measuring device for the kakahi monitoring programme, Tumoana Bay, Lake Rotoiti.

4 RESULTS

4.1 Koura

Abundance and biovolume

A total of 2349 koura were captured in the 4 surveys. Koura were numerous throughout the year with mean CPUE ranging from 28.6 to 97.2 koura whakaweku^{-1}. The highest catch of koura (n=972) was recorded on 12 September 2006, but the greatest biovolume of 15 litres was recorded on the first sampling survey on 8 December 2005 (Table 2). Koura were most numerous in September and December and least numerous in February and June (Figure 6).

Table 2 Number, biovolume and mean OCL of koura captured in a tau koura (comprised of 10 whakaweku or fern bundles) set in the Okere Arm, December 2005 to September 2006.

Sampling date	Number of koura	Biovolume (lt)	Mean OCL (mm)	OCL range (mm)
8 December 2005	803	15	20.5	12 - 40
23 February 2006	286	9.2	21.6	9 - 36
8 June 2006	288	8	19.2	9 - 44
12 September 2006	972	12.3	15.0	9 - 29

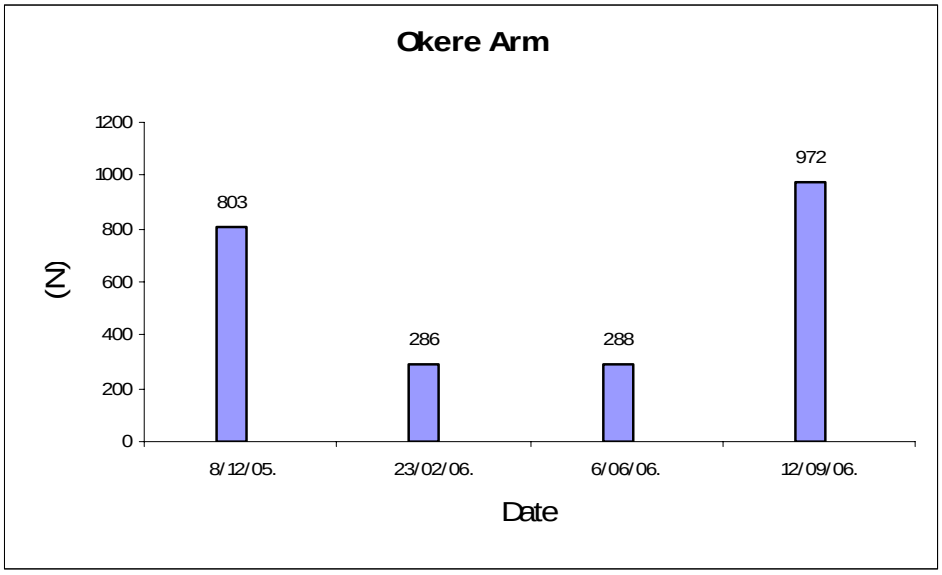

Figure 6 The number (N) of koura captured in the Okere tau koura (comprised of 10 whakaweku or fern bundles), Lake Rotoiti, December 2005 to September 2006.

Size range

The largest and smallest koura sampled in the 4 surveys had OCL lengths of 44 and 9mm, respectively. The highest mean OCL of koura sampled in the 4 surveys was 21.6mm which was recorded in the February 2006 sample (Table 2).

Sex ratio

The sex of 656 koura was determined during the survey. The percentage of females in the subsamples ranged from 43.8% to 54.7% (Table 3). The proportion of females with eggs or juveniles was highest in June comprising 11.4% of females sampled. The proportion of koura with soft shells was determined for June and September only. Soft shelled koura comprised 14.8% and 7.8% of samples collected in June and September, respectively (Table 3).

Table 3. Percent females, percentage of females with eggs/young and percentage of koura with soft shells, in subsamples taken from a tau koura (comprised of 10 fern bundles) set in the Okere Arm, December 2005 to September 2006. nr = not recorded.

Sampling date	Number of koura sexed	% of females in sample	% of females with eggs or young	% of sample with soft shells
8 December 2005	74	44.6	0	nr
23 February 2006	139	54.7	0	nr
8 June 2006	121	50.4	11.4	14.8
12 Sept 2006	322	43.8	3	7.8

Okere Arm - Length frequency distributions

Length frequency distributions of the 4 samples of koura captured from the Okere Arm are shown in Figure 7. These distributions show that the koura population was comprised mainly of small (OCL < 18mm) and medium (OCL 19-29mm) sized koura, with large, harvestable (OCL > 30mm) koura comprising only a minor proportion of the catch.

Small koura were most abundant in June and September and least abundant in February. In contrast, large koura were least abundant in September when no koura >30mm OCL were recorded in the subsamples (n=321).

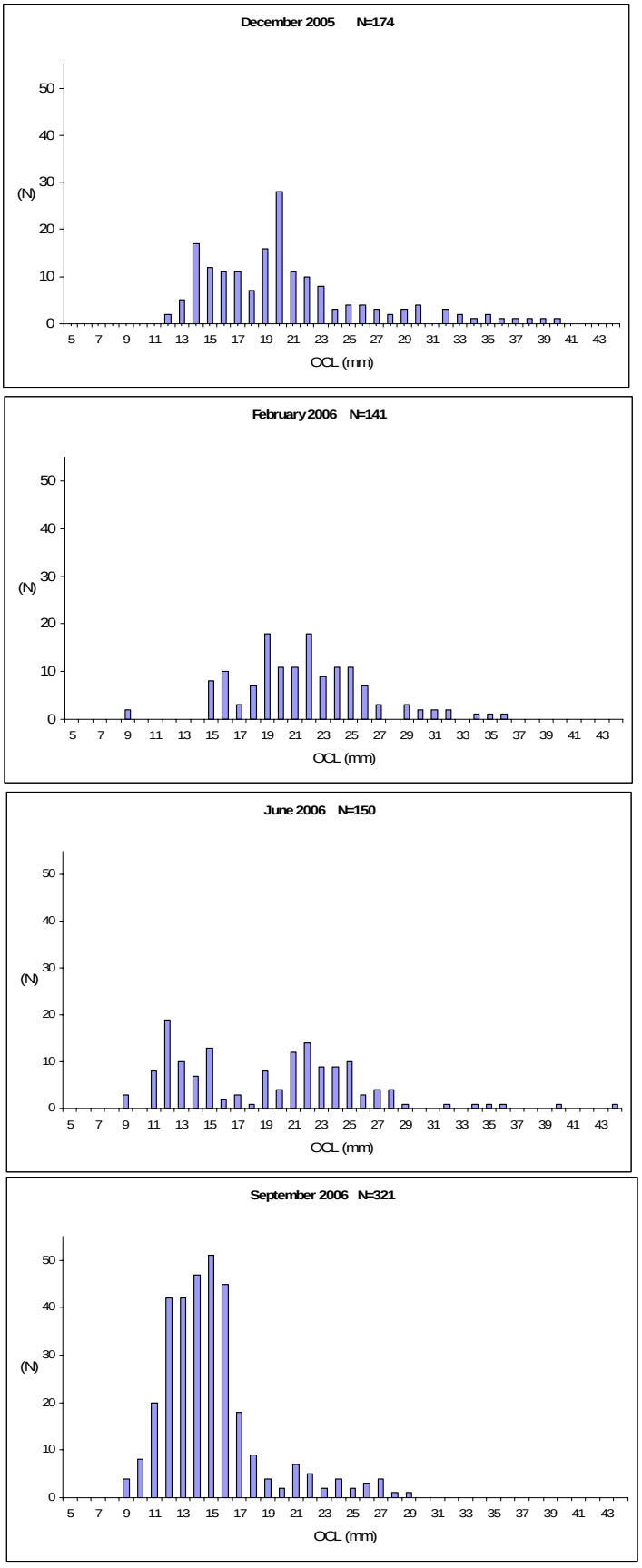

Figure 7 Length (OCL) frequency distributions of koura sampled from the Okere Arm tau koura from December 2005 to September 2006.

Okere Arm compared to Emery's Reef

The length frequency distributions of koura captured from the Okere Arm (23 February 2006) and Emery's Reef (2 March 2006) are shown in Figure 8. There were observable differences between the koura populations at these two sites during this late summer period. Most koura captured in the Okere Arm were of medium size (19-29 mm OCL) whereas at Emery's Reef the koura population was more evenly comprised of small, medium and large koura (Figure 8).

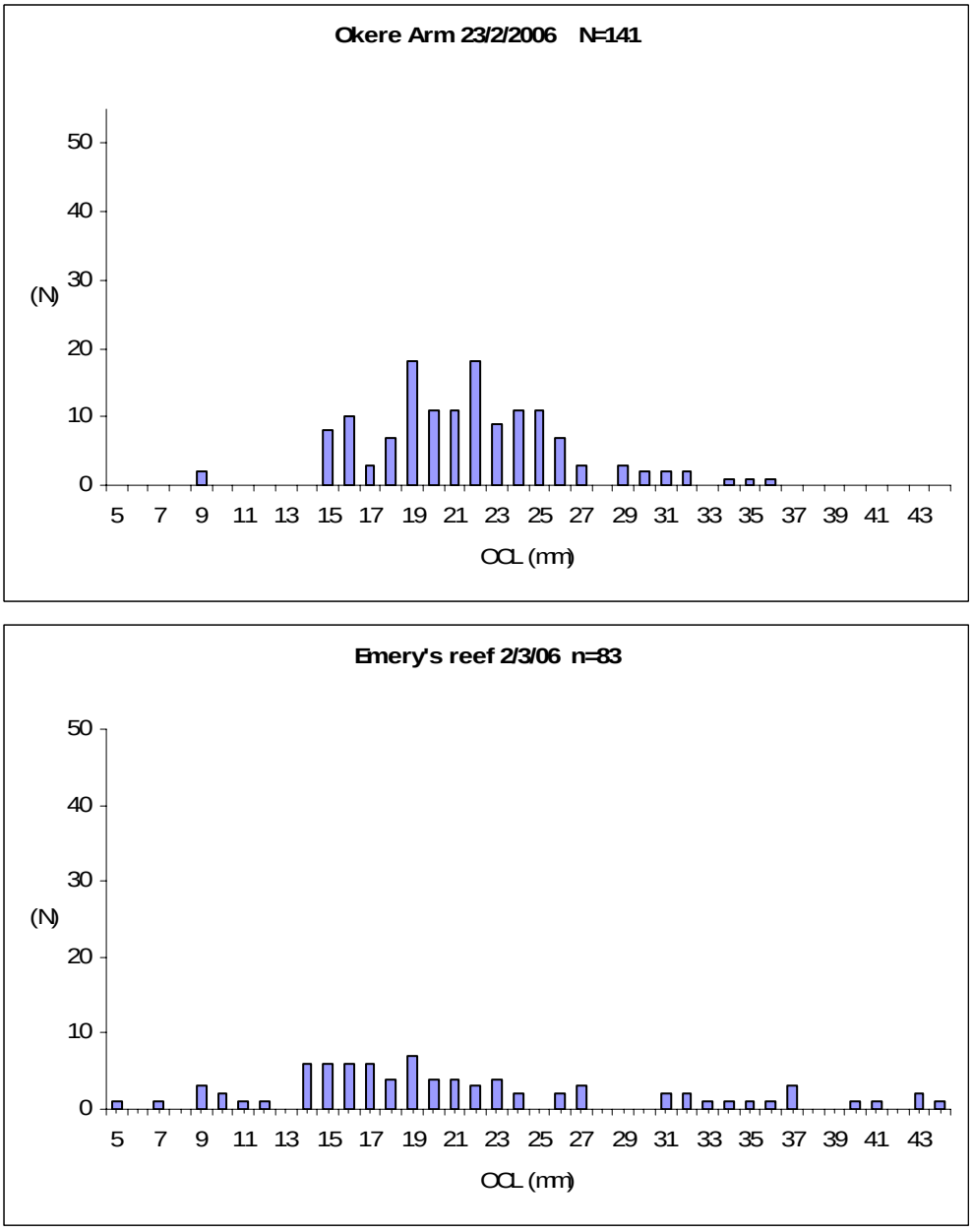

Figure 8 Length (OCL) frequency distributions of koura sampled in tau koura set at Emery's Store (23 February 2006) and the Okere Arm (2 March 2006), Lake Rotoiti.

4.2 Common bully (toi toi)

A total of 848 common bullies were captured in the Okere Arm over the sampling period. Common bullies were most abundant in June 2006 when 490 fish were recorded and lowest in February 2006 when only one fish was recorded (Figure 9). Most common bully were captured from the first 4 whakaweku (fern bundles) which were all located at the upstream section of the tau where water velocity was slowest. The common bully population in the Okere Arm was comprised mainly of small, juvenile fish.

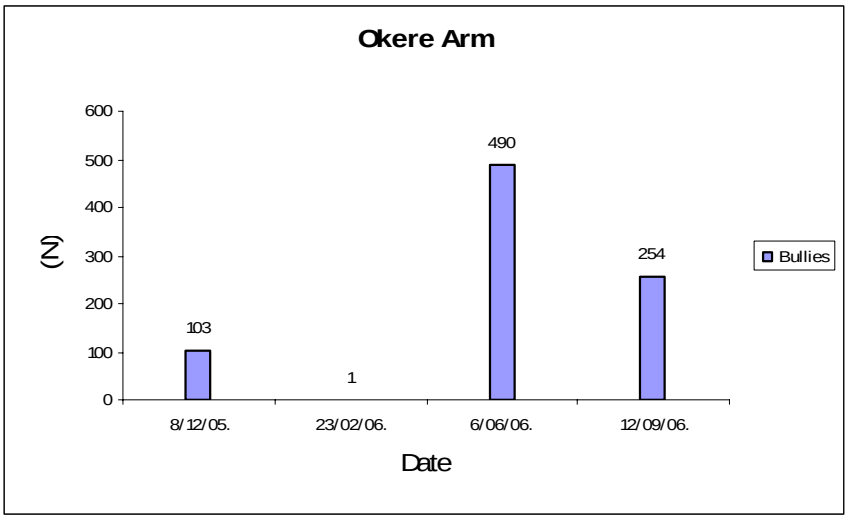

Figure 9 Numbers (N) of common bully captured in the Okere tau koura (with 10 whakaweku or fern bundles), Lake Rotoiti, December 2005 to September 2006

4.3 Kakahi

Field work was carried out from 17 June 2005 to 8 June 2006. At the time of the surveys, weather conditions and water clarity allowed good visual observations to be made of kakahi in Lake Rotoiti. A total of 4908 kakahi were counted in the 5 surveys (Table 4). Kakahi were more numerous in the Okere Arm than at the control sites (Table 4). The highest densities of kakahi were recorded at the 'Ditch' site (situated in the Okere Arm) and in the Okawa Bay site (a control site) (Figure 10).

Kakahi numbers varied markedly amongst sampling events, for example at the 'Ditch' site kakahi numbers ranged from 329 to 803 per transect (or per $20m^2$). The lowest numbers of kakahi were present at the 'Tumoana' site which had a mean count of 4 kakahi transect $^{-1}$ (Table 4).

Sub-samples of kakahi were collected in June 2005 to determine condition and develop size/age/biomass relationships. Initial analysis of these sub-samples has revealed that many of these kakahi are in relatively poor condition (C. Hickey, NIWA, pers. comm.). Sub-samples of kakahi will continue to be collected and will be analysed at the completion of the baseline monitoring programme in October 2007.

Table 4 Number of kakahi counted, totals, mean and standard errors for 0.5m wide x 40m long transects at the six sampling sites situated in Lake Rotoiti, June 2005 to June 2006. - = not included in monitoring programme until September 2005.

Date	Boat ramp Okere Arm	Rest area Okere Arm	Ditch Okere Arm	Okawa Bay Control	Tumoana Bay Control	Ruato Bay Control	Total
Jun-05	20	125	633	236	-	-	1014
Sep-05	33	57	686	269	0	19	1064
Dec-05	40	106	803	131	9	29	1118
Mar-06	28	28	471	240	4	42	813
Jun-06	28	119	329	413	3	7	899
Total	149	435	2922	1289	16	97	4908
Mean ± SE	29.8±3.3	87±19	584.4±83.2	257.8±45.3	4±1.9	24.3±7.4	

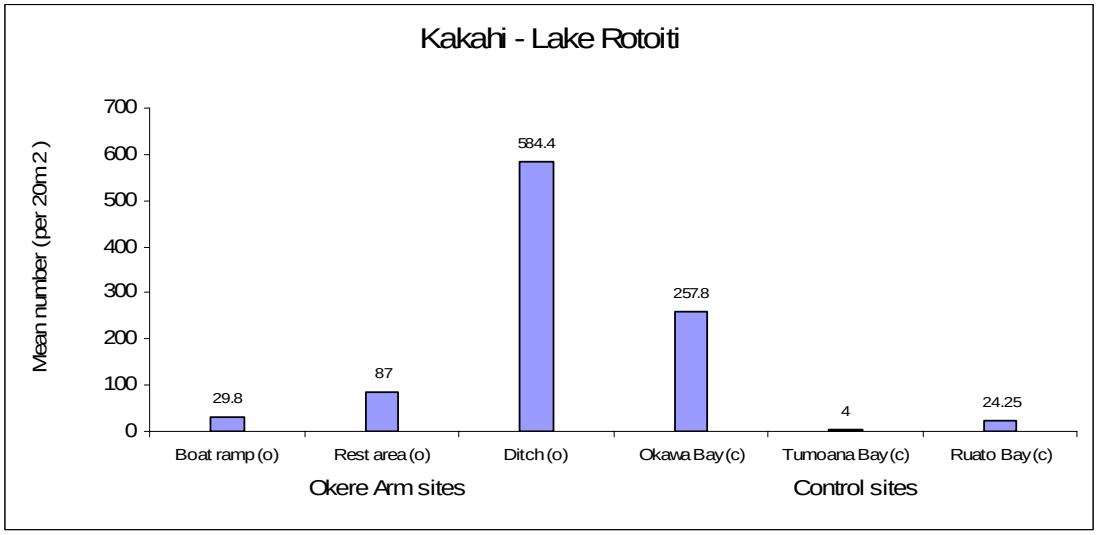

Figure 10 The mean number of kakahi recorded at 6 sites (0.5m x 40m transects) situated in Lake Rotoiti, June 2005 to June 2006.

5 DISCUSSION

Koura

The Te Arawa/Ngati Tuwharetoa tau method proved to be an effective and successful monitoring technique for collecting baseline information on koura and common bullies in the Okere Arm. A total of 2349 koura were captured in the Okere Arm during the 4 surveys, with catches ranging from 286 to 972 koura tau sampling^{-1}.

Koura in the Okere Arm ranged in size from 9mm to 44mm OCL. However, the Okere Arm had a far higher proportion of small sized koura and less large koura than Emery's Reef, in the Western Basin of Lake Rotoiti. Female koura are known to release juveniles at depths less than 10m particularly near areas of cover (Devcich 1979). The Okere Arm has these attributes, it is shallow (water depth less than 7m) and has abundant cover in the form of a heavily vegetated shoreline and extensive aquatic macrophyte beds. Although, the Okere Arm is not suitable for harvesting large koura it is an important nursery area for juvenile koura.

Kakahi

The kakahi monitoring methodology developed by NIWA specifically for community groups, proved to be a safe, easily replicable and cost-effective means of monitoring kakahi abundance. Kakahi numbers varied markedly between the monitoring sites. In general, kakahi were far more numerous in the Okere Arm sites than in the control sites. This is not surprising given that there is a constant flow of highly productive water through the Okere Arm. The lowest numbers of kakahi were present at the 'Tumoana' site which had a mean count of 4 kakahi transect^{-1}.

Kakahi numbers also varied markedly between sampling events, for example, densities at the 'Ditch' site in the Okere Arm ranged from 329 to 803 transect^{-1}. The reasons for this variability are unknown but may become more apparent over time.

Common Bully

Common bullies were a significant by-catch of the Okere Arm tau. Common bullies were most abundant in June and September but declined in December and were rare in February. The reasons for this seasonal decline are unclear but may be due to increasing water temperatures during the late spring and summer months.

6 RECOMMENDATIONS

The first year of baseline monitoring of koura and kakahi was completed successfully, with the tau koura proving to be an effective means of sampling koura and common bully in the Okere Arm and Lake Rotoiti. In addition, the kakahi monitoring methodology developed specifically for community groups by NIWA, proved to be a safe, easily replicable and cost-effective means of monitoring kakahi abundance.

It is recommended that baseline monitoring of koura and kakahi populations in the Okere Arm and Lake Rotoiti continue to establish a more comprehensive pre-diversion database for these species. The following changes to the monitoring programme are recommended.

1. Establish a tau koura in the Western Basin as a control for future monitoring purposes. Initially it was intended to use an existing tau at Emery's Reef as a control, however, this was not suitable as it was occasionally used to harvest koura and it is unclear, at this stage, how this affects monitoring performance. In addition, it was situated in the Eastern Basin of Lake Rotoiti which meant that monitoring was logistically more difficult and time consuming. A tau koura located nearby in the western basin would be a more comparable reference site than the Emery's Reef site.

2. Replace fern bundles every 6 months. Fern bundles decomposed faster in the Okere Arm (6 months) compared to Emery's Reef (12 months). It is therefore recommended that fern bundles be replaced every 6 months in the Okere Arm.

3. It is proposed that kakahi samples continue to be collected to develop size/age/biomass relationships. It is envisaged that these kakahi samples will be analysed at the completion of the baseline monitoring programme in October 2007.

7 ACKNOWLEDGMENTS

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