Boat electrofishing survey of five Waitakere City ponds

CBER Contract Report 64

Client report prepared for
Boffa Miskell Ltd

by

Brendan J. Hicks
Jeroen Brijs
Dudley G. Bell
Warrick Powrie

Centre for Biodiversity and Ecology Research
Department of Biological Sciences
School of Science and Engineering
The University of Waikato
Private Bag 3105
Hamilton, New Zealand

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Email: b.hicks@waikato.ac.nz

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CBER University of Waikato
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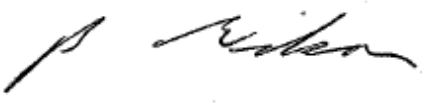
Reviewed by:



Ben Wilson
Auckland/Waikato Fish and Game

Approved for release by:

Nick Ling
University of Waikato

Executive summary

We conducted a fish survey of five ponds (Lake Panorama, Paremuka Ponds 1 and 2, Danica Esplanade and Longbush Pond) in the Waitakere District by single-pass boat electrofishing on 18 and 19 of July 2007. We caught 337 fish comprising four introduced and two native fish species in 2.89 km of fished distance from all 5 ponds. Assuming that each of the two bow-mounted anodes caught fish within a 1 m radius, the width fished was 4 m, and the total area fished was 11,537 m^2 or 1.154 ha. The water temperature for the 5 different ponds ranged between 10.8ºC and 14.9ºC.

In Lake Panorama, shortfinned eels (*Anguilla australis*) were the most numerous species caught (130 fish ha^{-1}), followed by perch (*Perca fluviatilis*) (100 fish ha^{-1}) and tench (*Tinca tinca*) (40 fish ha^{-1}).

In Paremuka Pond 1, koi carp (*Cyprinus carpio*) were the most numerous species caught (120 fish ha^{-1}), followed by shortfinned eels (50 fish ha^{-1}).

In Paremuka Pond 2, koi carp were again the most numerous species caught (340 fish ha^{-1}), followed by tench (250 fish ha^{-1}) and shortfinned eels (70 fish ha^{-1}).

In Danica Esplanade and Longbush Pond, shortfinned eels were the most numerous species caught (140 and 550 fish ha^{-1} respectively), followed by mosquitofish (*Gambusia affinis*). There was more macrophyte cover around the edges of Danica Esplanade compared to Longbush Pond and this decreased the catch rate as a large number of eels in Danica Esplanade were sighted but were unable to be captured.

Koi carp were only caught in the Paremuka ponds. The majority of koi carp were caught on the edges of the lake in macrophytes and rushes. Koi carp biomasses were highest in Paremuka Pond 2 at 261 kg ha^{-1} compared to 106 kg ha^{-1} in Paremuka Pond 1. Biomass is a more accurate reflection of the potential ecological impact of koi carp than their density. Previous results suggest that 21-73% of the total population is caught on the first removal, depending on water visibility. As we fished the area at each site only once, the estimates in this survey represent a minimum abundance, and true population sizes are likely to be 1.4-4.8 times greater. The density of eels in both the Paremuka ponds is also likely to be higher as a large proportion of eels were able to escape into the macrophytes before they could be captured in the nets. Mosquitofish were also observed to be living in both the Paremuka ponds. Of ecological concern for the Paremuka ponds is the dominance of the fish biomass by introduced koi carp, which have a deleterious impact on aquatic habitats. Another concern for these ponds is the presence of small koi carp (<200 mm), which suggests that natural spawning is most likely occurring, although recent releases of carp into the ponds is another possibility.

The fate of the introduced fish varied depending on what species they were. Perch and tench were released back into the ponds after capture as they are classified as sports fish. Koi carp and mosquitofish are classified as unwanted organisms and were humanely destroyed with an anaesthetic overdose (benzocaine), and retained for further analysis.

1. Introduction

Boffa Miskell Ltd contracted the Centre for Biodiversity and Ecology Research (CBER) to survey 5 ponds in the Waitakere City (Lake Panorama, Paremuka Ponds 1 and 2, Danica Esplanade, and Longbush pond; Fig. 1) for introduced fish species by boat electrofishing. The fishing effort was apportioned approximately equally between each of the sites as we did a complete circuit around the edge of each pond as well as a pass through the centre. We attempted to fish most of the habitats found such as the littoral areas and macrophyte beds for introduced species. Where eels were seen their presence was noted, but no attempt was made to estimate their biomass due to the difficulties of weighing live eels at the sites. No attempt was made to measure the abundance of mosquitofish as boat electrofishing is not effective at quantitatively sampling this species.

2. Methods

We used a 4.5-m long, aluminium-hulled, electrofishing boat (Fig. 2) with a 5-kilowatt gas-powered pulsator (GPP, model 5.0, Smith-Root Inc, Vancouver, Washington, USA) powered by a 6-kilowatt custom-wound generator. Two anode poles, each with an array of six electrode droppers, create the fishing field at the bow, with the boat hull acting as the cathode.

We fished 5 ponds in the Waitakere district on 18 and 19 July 2007 (Table 1; Fig. 1). At each pond the entire shoreline and a single pass through the middle of the pond was fished with the electrofishing boat. Electrical conductivity was measured with a YSI 3200 conductivity meter and horizontal water visibility was measured using a black disc (Table 2; Fig. 3). Specific conductivity, i.e., standardised to 25^{o}C, ranged from 132.8 to 191.0 μS cm^{-1} (Table 2), so all sites were fished with the GPP set to low range (50-500 V direct current) and a frequency of 60 pulses per second. We adjusted the percent of range setting of the GPP to between 50 and 70% to give an applied current of 3-4 A root mean square. We assumed from past experience that an effective fishing field was developed to a depth of 2-3 m, and about 2 m either side of the centre line of the boat. We thus assumed that the boat fished a transect about 4 m wide, which was generally consistent with the behavioural reactions of fish at the water surface. This assumption was used to calculate area fished from the linear distance measured with the boat's global positioning system.

3. Results

Specific conductivities were moderate in Panorama Lake, Paremuka Ponds 1 and 2 and Danica Esplanade (about 140 μS cm^{-1}), but were greater in Longbush pond (up to 191 μS cm^{-1}) (Table 2). Water temperatures ranged from 10.8 to 14.9^{o}C (Table 2); the highest temperatures were measured at the Paremuka ponds, at 1335-1600 h New Zealand Standard Time on 18 July 2007. Water fished at Panorama Lake and Paremuka Ponds 1 and 2 was approximately 2.4 m maximum depth, whereas the water fished at Danica Esplanade and Longbush pond was shallower at approximately 0.1 -1.5 m deep (Table 2). The littoral zones were well vegetated as the Waitakere District council has done

extensive planting of native plants such as manuka (*Leptospermum scoparium*), flax (*Phormium tenax*), cabbage tree (*Cordyline australis*) and a diversity of grasses and rushes (Fig. 4). Throughout the five ponds a range of submerged macrophytes were observed such as curly-leaved pondweed (*Potamogeton crispus*), hornwort (*Ceratophyllum demersum*), parrot's feather (*Myriophyllum aquaticum*) and water lily (Nymphaeaceae).

Table 1: Locations of the 5 ponds fished on 18-19 July 2007 in the Waitakere District .

		NZ map grid coordinates	
Site code	Location	Easting	Northing
Panorama Lake	Centre of pond	2653320	6478520
Paremuka Pond 1	Centre of pond	2654118	6480061
Paremuka Pond 2	Centre of pond	2653970	6480086
Danica Esplanade	Centre of pond	2658008	6482504
Longbush Pond	Centre of pond	2658282	6483000

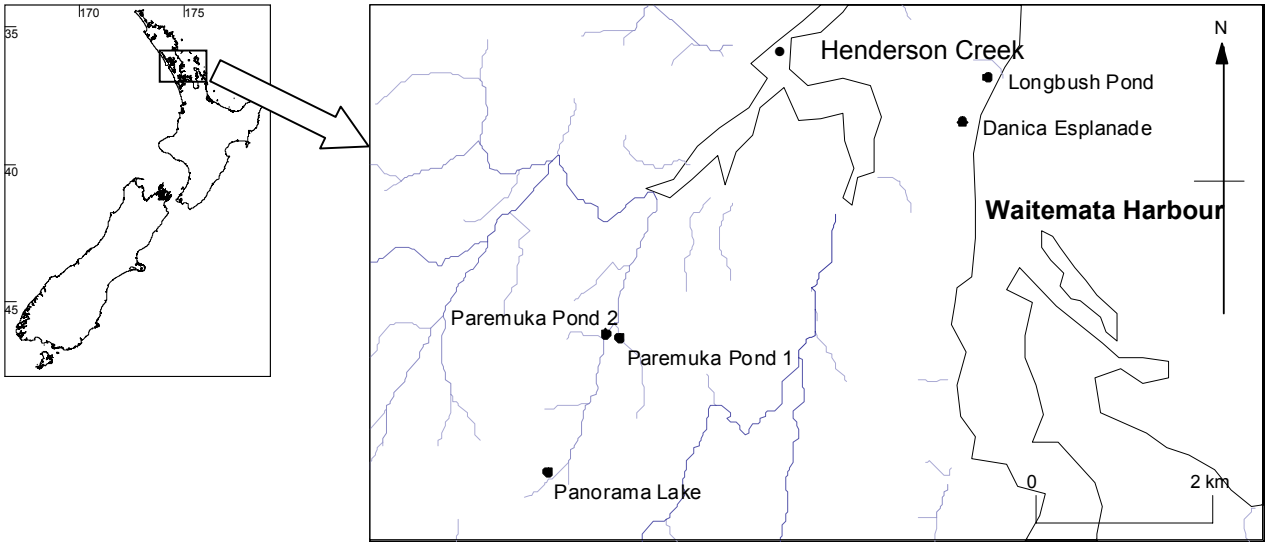


Figure 1: Sites fished in Waitakere City between 18 and 19 July 2007. Site codes correspond to the NZ map grid coordinates in Table 1.

Figure 2: The electrofishing boat in action on Longbush Pond, Te Atatu, Waitakere City. Photo: Warrick Powrie.

Figure 3: Dudley Bell measuring conductivity (on left) and Dudley Bell and Warrick Powrie measuring black disc water visibility (on right). Photo: Eddie Sides.

Figure 4: Native plants fringing the lake edge at Longbush Pond, Te Atatu, Waitakere City. Photo: Warrick Powrie.

We caught 337 fish comprising four introduced and two native species in the 5 lakes in a total of 2.89 km of fished length between 18 and 19 July 2007 (Table 3). Shortfinned eels were caught in all of the lakes and were the most numerous species (densities ranging from 50 – 550 fish ha^{-1}). The length of the shortfinned eels (e.g., Fig. 5) in the five lakes ranged from 70 to 535 mm with the majority of them being between 300 to 400 mm. Only two common bullies were caught and both of them were found in Longbush Pond. Perch were only found in Lake Panorama and ranged in size from 118 to 209 mm. Tench were also found in Lake Panorama as well as Paremuka Pond 2 where there was quite a high abundance of tench present (Tables 3 and 4). In Paremuka Pond 2 the tench seemed to be smaller in size than those found in Lake Panorama (Table 5). Mosquitofish were observed in all of the ponds with the exception of Lake Panorama but no attempt was made to quantify their abundance. They were observed to be very abundant in Danica Esplanade and Longbush Pond.

Table 3 shows that koi carp were only found in the Paremuka ponds. Koi carp densities of 120 fish ha^{-1} and 340 ha^{-1} were present in Ponds 1 and 2 respectively (Table 4). The majority of carp were caught on the edge of the ponds among submerged macrophytes and flax bushes. The mean weight of koi carp in Paremuka Pond 1 was 919 g compared to 825 g in Paremuka Pond 2 (Table 5). Koi carp dominated the introduced

fish biomass. Biomasses of 106 and 261 kg ha^{-1} for koi carp were found in Paremuka Ponds 1 and 2 respectively (Table 6). These biomasses (especially Paremuka Pond 2) are comparable to the average biomass values of koi carp (148 to 308 kg ha^{-1}) found in the main channel of the Waikato River between Hamilton City and Rangiriri (Hicks et al. 2005).

Table 2: Physical conditions of 5 ponds in Waitakere City on 18 and 19 July 2007.

Site	Date	Macrophytes	Bank and substrate	Specific conductivity (µS/cm)	Water temperature (ºC)	Distance fished (m)	Fishing time (mins)	Maximum water depth (m)	Horizontal water visibility (m)
Panorama Lake	18-Jul	Water lily (Nymphaeaceae)	Native plants, mud	143.9	11.2	561	75	0.1-2.4	0.36
Paremuka Pond 1	18-Jul	Parrot's feather, rushes	Native plants, mud	132.8	14.9	820	57	0.1-2.4	0.3
Paremuka Pond 2	18-Jul	Hornwort, rushes	Native plants, mud	135.5	14.5	237	33	0.1-2.1	0.3
Danica Esplanade	19-Jul	*Potamogeton crispus*	Native plants, mud	146.1	10.8	740	37	0.1-1.0	0.9
Longbush Pond	19-Jul	*Potamogeton crispus*	Native plants, mud	191.0	13.0	527	27	0.1-1.5	0.93

Table 3: Number of fish captured by the electrofishing boat in 5 ponds in Waitakere City on 18 and 19 July 2007.

	Number of fish per site					
Site	Tench	Perch	Shortfin eel	Koi carp	Common bully	Sum
Panorama Lake	**10**	**23**	**30**	0	0	**63**
Paremuka Pond 1	0	0	**18**	**38**	0	**56**
Paremuka Pond 2	**24**	0	**7**	**30**	0	**61**
Danica Esplanade	0	0	**40**	0	0	**40**
Longbush Pond	0	0	**115**	0	**2**	**117**

Table 4. Density of fish caught in 5 ponds in Waitakere City on 18 and 19 July 2007. Bold values are non-zero.

	Density of fish per site (number ha^{-1})				
Site	Tench	Perch	Shortfin eel	Koi carp	Sum
Panorama Lake	**50**	**100**	**130**	0	**280**
Paremuka Pond 1	0	0	**50**	**120**	**170**
Paremuka Pond 2	**250**	0	**70**	**340**	**660**
Danica Esplanade	0	0	**140**	0	**140**
Longbush Pond	0	0	**550**	0	**550**

Table 5. Mean weight (in bold) and range (in brackets) of fish caught in 5 ponds in Waitakere City on 18 and 19 July 2007. – = species not present.

	Mean fish weight at each site (g)		
Site	Tench	Perch	Koi carp
Panorama Lake	**386** (4 - 855)	**51** (24 - 131)	-
Paremuka Pond 1	-	-	**919** (35 - 2938)
Paremuka Pond 2	**182** (3 - 505)	-	**825** (105 - 2630)
Danica Esplanade	-	-	-
Longbush Pond	-	-	-

Table 6. Biomass per unit area of introduced fish species caught in the 5 ponds in Waitakere City on 18 and 19 July 2007. Numbers in bold are non-zero.

	Fish biomass (kg ha^{-1})			
Site	Tench	Perch	Koi carp	Sum
Panorama Lake	**17**	**5**	0	**22**
Paremuka Pond 1	0	0	**106**	**106**
Paremuka Pond 2	**46**	0	**261**	**307**
Danica Esplanade	0	0	0	0
Longbush Pond	0	0	0	0
Mean	**13**	**1**	**73**	**87**

Figure 5: Shortfinned eels (90 – 420 mm total body length) caught at Longbush Pond, Te Atatu, Waitakere City. Photo: Jeroen Brijs.

Koi carp were generally larger in Paremuka Pond 1 (modal length of 360-380 mm) compared to Paremuka Pond 2 (modal length of 300-320). The length frequency distribution showed that there were two or three size classes of koi carp in both the Paremuka ponds (Fig. 6). Small koi carp (<200 mm) were observed in both ponds suggesting that koi carp are rearing in the ponds. Koi carp caught in the Paremuka ponds were dominated by 3 year old fish with relatively few fish in excess of 5 years (Fig. 7).

When the koi carp were sexed, it was found that there were 37 mature males, 27 mature females and 4 indeterminate fish which were unable to be successfully sexed. In Paremuka Pond 1 the sex ratio of males to females was 1:1 whereas in Paremuka Pond 2 the sex ratio was 2:1. According to the definitions of Fouché et al. (1985), most of the mature females were at reproductive stage III (early developing – ovary is opaque and reddish with blood vessels and eggs are visible to the eye) and stage IV (developing late - ovary is reddish and opaque with eggs clearly discernable) indicating reproductive preparedness for spawning in spring (September/October).

The condition of the fish was measured using a method termed the regression-line-percentile technique which calculates the relative weight index or Wr (Murphy et al., 1990). The Wr index is calculated using the formula:

$$Wr = \frac{W}{Ws} \times 100$$

where W is wet weight in grams and Ws is a length-specific standard weight predicted by a weight-length regression of the specific species. The form of the Ws equation is

$$\text{Log}_{10}(Ws) = a + b \cdot \text{Log}_{10}(L)$$

where a is the intercept value and b is the slope of the $\log_{10}$(weight) against $\log_{10}$(length) regression and L is the maximum fork length of the fish (Anderson and Neumann, 1996). A basic concept of Wr is that it should describe the inherent condition of a fish compared to that of an average fish. When Wr values are well below 100 for an individual or group, problems may exist in food or feeding conditions; when Wr values are well above 100, there has been a surplus of food or gonadal development is occuring. Typically, Wr values for individuals vary between 80 and 120 and the koi caught from the Paremuka ponds fall exactly within this range. The mean Wr of the koi carp in both the Paremuka ponds was 100 (± 1.0 s.e), meaning that the inherent condition of the carp caught in the ponds on 18 and 19 July 2007 was comparable to the condition of an average koi carp. These values are slightly lower than the condition values for koi carp caught at the same time of the year in the Waikato River, which averaged 106 (± 2.6 s.e) (Tempero 2004).

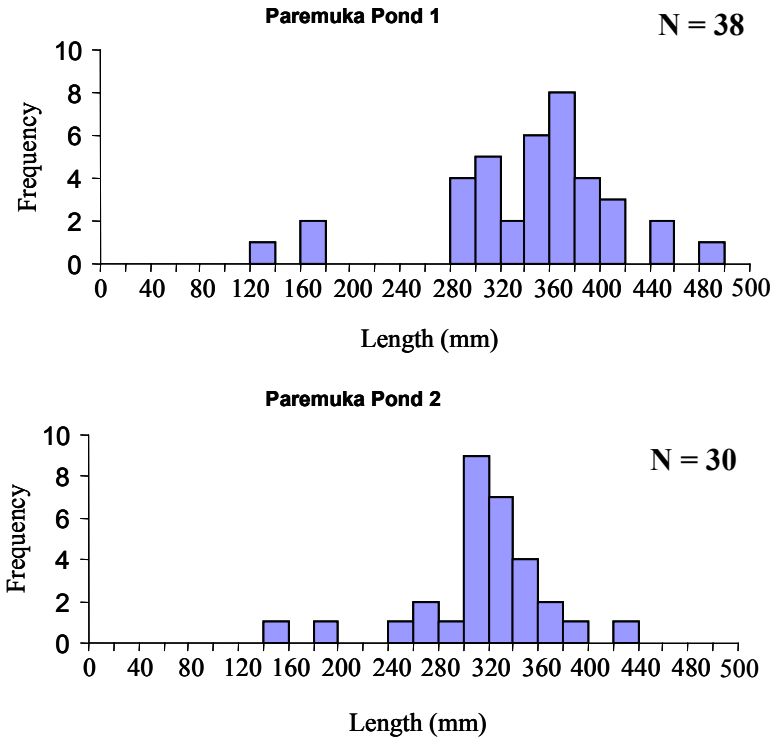


Figure 6: Length frequency of koi carp caught by boat electrofishing in the Paremuka ponds in Waitakere City between 18 and 19 July 2007.

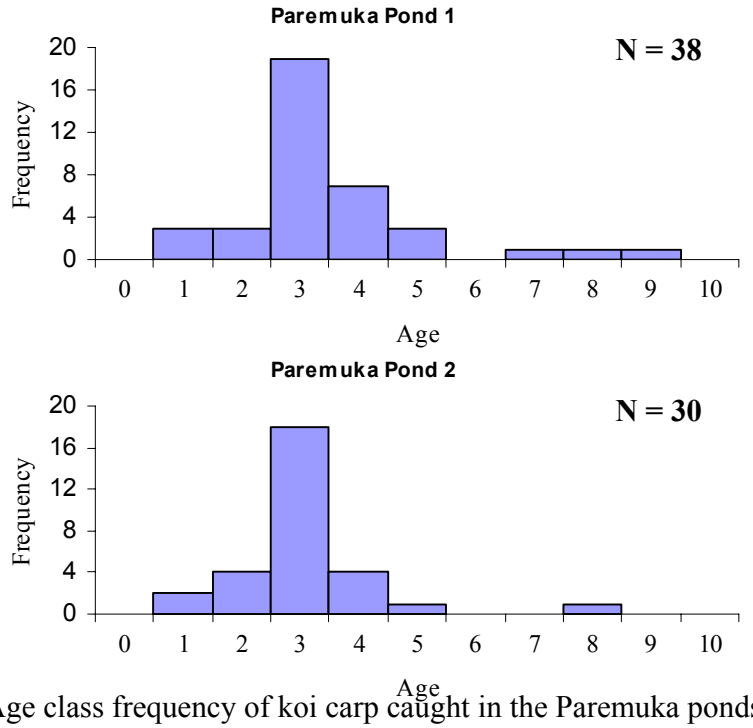


Figure 7: Age class frequency of koi carp caught in the Paremuka ponds in Waitakere City between 18 and 19 July 2007.

4. Discussion and conclusions

A variety of native fish (common bully and shortfinned eels) and illegally released introduced fish (koi carp, perch, tench, and mosquitofish) were caught by boat electrofishing in the 5 ponds located in Waitakere City. These fish had a large size range (from a 55-mm common bully to a 480 mm koi carp weighing 2.9 kg).

Biomass is a more accurate reflection of the potential ecological impact of koi carp than their density and koi carp dominated the biomass at sites where they occurred. The mean biomass of koi carp for Paremuka Ponds 1 and 2 was 106 and 261 kg ha^{-1} respectively, but previous results suggest that only 21-73% of the total population estimate is caught on the first removal, depending on water visibility (Hicks, unpubl. data). As we fished over the area at each site only once, the estimates in this survey represent a minimum abundance, and true population sizes would be 1.4-4.8 times greater. Biomass of eels was not estimated as the survey was focused on the density and biomass of introduced species in the 5 ponds located in Waitakere City.

The two size classes of the koi carp in this study corresponded to 1-year-olds (100-200 mm FL) and older fish (269-480mm FL) (Tempero et al. 2006). The presence of the young koi carp in the Paremuka ponds suggests that limited recruitment is occurring.

Previous fishing with the electrofishing boat in the North Island, in similar conductivities and habitats and with similar machine settings, has caught a full size range of eels, smelt, bullies, grey mullet, rudd, brown bullhead catfish, perch, tench, goldfish, and koi carp (Hicks et al., 2005). The moderate conductivities of the 5 ponds in the Waitakere district allowed efficient power transfer from the water to the fish as the range of conductivities was about the same as the presumed conductivity of the fish. Goldfish have effective conductivities of about 100-160 μS cm^{-1} (Kolz and Reynolds 1989).

This survey demonstrates the ability of boat electrofishing to catch a broad cross section of fish species under conditions of low water temperatures where conventional netting techniques would be challenging or impossible. The wide range of fish sizes caught suggests that sampling was representative of the size ranges available for koi carp, tench, and perch. Common bullies and mosquitofish, however, were probably not caught in representative numbers. Of ecological concern for the Waitakere district is the dominance of the fish biomass by introduced koi carp in the Paremuka Ponds, which are an unwanted organism and have a deleterious impact on aquatic habitats (Roberts and Ebner, 1997).

5. Acknowledgements

We gratefully acknowledge the assistance in the field from Eddie Sides, Jonathan Ruffell and Jamie Steer (Boffa Miskell Ltd) and the assistance of Grant Tempero (University of Waikato) in the laboratory with ageing the koi carp and providing valuable information concerning the reproduction and condition of koi carp.

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