Boat electrofishing survey of the Waimapu and Kopurererua streams, Bay of Plenty, Waitara River, and a pond at Mokoia, Taranaki

CBER Contract Report 40

Client report prepared for
Environment Bay of Plenty
and the
Department of Conservation

by

Brendan J. Hicks

Dudley G. Bell

C. Alex Ring

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

28 June 2005

Email: b.hicks@waikato.ac.nz

THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato

CBER University of Waikato
Centre for Biodiversity and Ecology Research

Contents

Page number

Executive summary 3
1. Introduction 4
2. Methods 4
3. Results 8
Waimapu Stream 8
Kopurererua Stream 9
Waitara River 11
Private pond near Mokoia 11
4. Conclusions 14
5. Acknowledgements 15
6. References 15

Tables

Table 1. Locations of sites fished in the Waimapu and Kopurerua streams, Waitara River, and a pond on private land near Mokoia in 2005. NZFFDB, New Zealand Freshwater Fish Database card number; * koi carp found. 6
Table 2. Electrical conductivity of the fished sites. 8
Table 3. Number of fish caught in the lower Waimapu Stream on 15 April 2005. 9
Table 4. Density of fish caught in the lower Waimapu Stream on 15 April 2005. 9
Table 5. Lengths and weights of koi carp caught in the private pond near Mokoia, Taranaki, on 9 June 2005. 13

Figures

Figure 1. Sites fished in the lower Waimapu Stream on 15 April (filled circles) and 14 June (open circles) 2005. 5
Figure 2.The reach fished in the Kopurererua Stream on 15 June 2005. Open circles indicate the upstream and downstream ends of the fished reach. Single giant bullies were found at each of the sites indicated by the filled circles. 7
Figure 3. The main channel of the lower Waimapu Stream at site 1 where two koi carp were caught on 15 April 2005. 10
Figure 4.The koi carp caught in the Waimapu Stream on 15 April 2005. A. 7.9 kg male and B. 6.9 kg female. 10
Figure 5. The Waimapu Stream at site 2 on 15 April 2005 in the vicinity of where koi carp were originally seen. 11
Figure 6. A 200-mm total length giant bully caught in the tidal reach of the Waitara River, Taranaki on 8 June 2005. 12
Figure 7. Edge habitat of the Waitara River showing its tidal nature, cobble and sand substrate, and lack of aquatic macrophytes. 12
Figure 8. Pond on private farmland near Mokoia, southern Taranaki, from which 16 koi carp were removed on 9 June 2005. 13
Figure 9. Thirteen of the sixteen koi carp that were removed from a pond on private land near Mokoia, southern Taranaki, on 9 June 2005. The folding measuring board immediately above the fish is 1 m long. 14

Executive summary

We conducted boat electrofishing surveys at four sites to establish the presence of, and to remove, koi carp (*Cyprinus carpio*). We fished the lower Waimapu Stream, Bay of Plenty, on 15 April and 14 June 2005, and the adjacent Kopurererua Stream on 15 June 2005. We caught and removed two large koi carp (a 7.9 kg male and a 6.9 kg female) from the Waimapu Stream in 15 April, but saw no other koi carp in 3.2-km reaches of both streams on 14-15 June. We did, however, catch a wide diversity of native fish species, including common smelt, shortfin and longfin eels, yelloweye mullet, brown and rainbow trout, giant bullies, and black flounder. We also caught a lamprey macrophthalmia in the Waimapu Stream.

No koi carp were found in a 2.4-km tidal reach of the Waitara River, northern Taranaki, on 8 June 2005, but we did catch a sparse native fish assemblage of adult inanga, shortfin eels, a few common smelt, black flounder, yelloweye mullet, and a 200-mm giant bully.

We caught and killed 16 large koi carp (total weight 58.5 kg) from a pond on private farmland near Mokoia, southern Taranaki, on 9 June 2005. This pond had a perimeter of 215 m, a surface area of 951 m^2, and maximum depth of 2.0 m. These fish were removed by depletion fishing in 7 circuits of the pond. We caught 9, 3, 1, 1, 1, 1, and 0 carp in successive circuits. The Zippin method of population estimation (± 95 % confidence interval) suggests that there were 16±1 koi carp in the pond, so it is possible that we eradicated all of the koi. All the carp were the same age and no juveniles were found, so it appears that the carp had not breed successfully in this pond.

1. Introduction

The Department of Conservation and Environment Bay of Plenty contracted the Centre for Biodiversity and Ecology Research (CBER), part of the Department of Biological Sciences, University of Waikato, to undertake a boat electrofishing survey of four North Island, New Zealand, locations to establish the presence of, and to remove, koi carp (*Cyprinus carpio*). These locations were the Waimapu and Kopurererua streams, Bay of Plenty, the Waitara River, and a pond on private land near Mokoia, southern Taranaki. The Waimapu and Kopurererua streams flow into Tauranga Harbour on the east coast. Large orange fish resembling koi carp were seen by a whitebaiter in the Waimapu Stream in December 2004, and were seen in the Kopurererua Stream in 1999.

The Waitara River flows out to the west coast at Waitara, Taranaki, and in December 2004 a whitebaiter caught a koi carp in this river in the tidal reach near the old meat works (NZ Map Grid 2617283.28 6244546.23). Koi carp were also reported to be in an artificially dammed pond on private land near Mokoia, Taranaki. This pond is on a tributary that eventually joins the Manawapou River.

2. Methods

We used a 4.5-m long electrofishing boat 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 droppers, create the fishing field at the bow, with the boat hull acting as the cathode.

We fished sites in the lower Waimapu Stream on 15 April and 14 June 2005 (Table 1; Fig. 1). Specific conductivity, i.e., standardised to 25^{o}C, ranged from 66 to 81 μS cm^{-1}, but ambient conductivities ranged from 47 to 61 μS cm^{-1} because of the low water temperatures (Table 2; 10.0-12.7^{o}C). At 1015 h on 15 April, conductivity measured at the swing bridge (Fig. 1) was clearly influenced by seawater, and showed a halocline, i.e., the water was more salty at the bottom than at the surface. Ambient conductivity 5 cm below the water surface was 740 μS cm^{-1}, but increased to 1300 μS cm^{-1} at a depth of 1.3 m (Table 2). While boat electrofishing is possible in these conductivities, its efficiency is likely to be less than at lower conductivites. On 14 June, ambient conductivity at the swing bridge not influenced by seawater.

The low conductivity at the upper sites required fishing with the GPP set to high range (50-1000 V direct current) and a frequency of 60 pulses per second. We adjusted the percent of range setting of the GPP to 60% to give an applied current of 2 amps 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 global positioning system.

The Kopurererua Stream also had low conductivities and temperatures (Table 2) at the fished sites (Fig. 2).

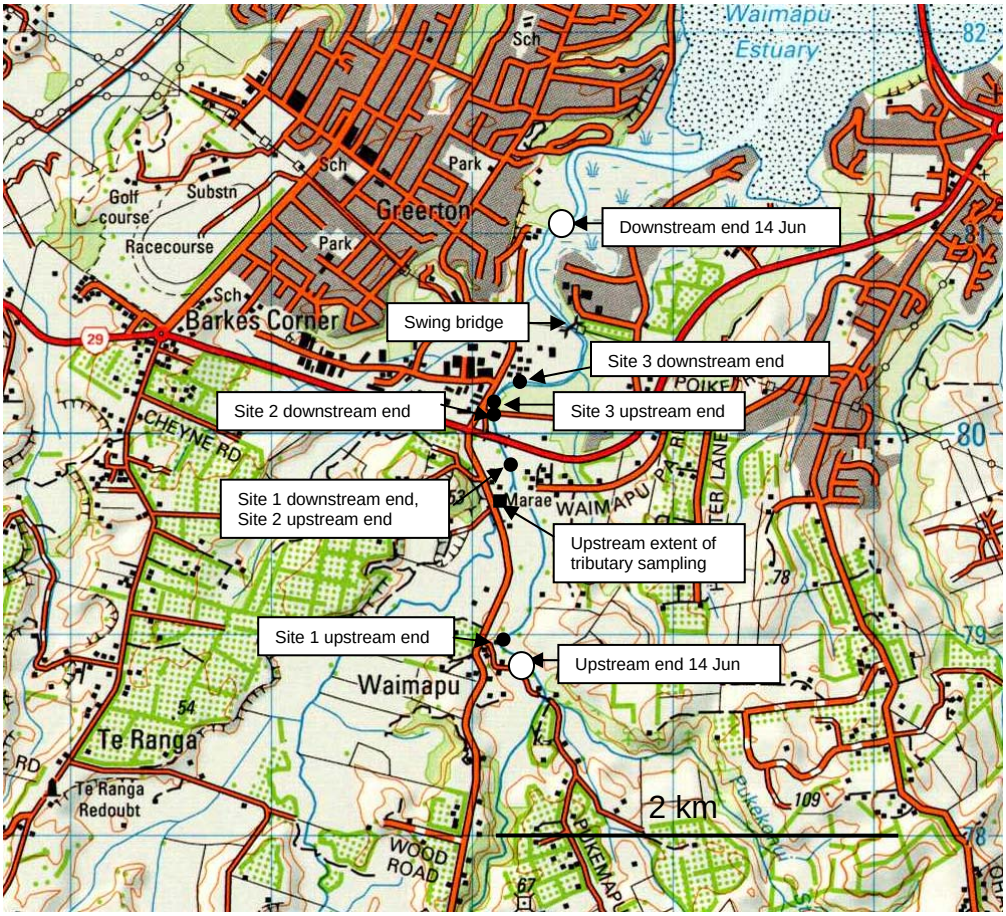


Figure 1. Sites fished in the lower Waimapu Stream on 15 April (filled circles) and 14 June (open circles) 2005.

Table 1. Locations of sites fished in the Waimapu and Kopurerua streams, Waitara River, and a pond on private land near Mokoia in 2005. NZFFDB, New Zealand Freshwater Fish Database card number; * koi carp found.

				Direction of	NZ map grid		Distance	Area
Waypoint	Date	Location	NZFFDB	fishing	Easting	Northing	fished (m)	fished (m^2)
Waimapu Stream								
67	15-Apr-05	Site 1	20743		2787150.2	6379873.8		
75*	15-Apr-05	Site 1	20743	Upstream	2787169.2	6379826.4		
68	15-Apr-05	Site 1	20743	Downstream	2787187.2	6379007.4	867	3469
67	15-Apr-05	Site 1	20743	Upstream	2787150.2	6379873.8	867	3469
69	15-Apr-05	Site 2	20743		2787149.0	6379884.9		
70	15-Apr-05	Site 2	20743	Downstream	2787097.3	6380064.8	187	749
71	15-Apr-05	Site 2	20743	Upstream	2787146.3	6379877.9	193	773
72	15-Apr-05	Site 3	20743		2787083.7	6380108.0		
73	15-Apr-05	Site 3	20743	Downstream	2787185.8	6380252.5	177	707
74	15-Apr-05	Site 3	20743	Upstream	2787092.4	6380106.9	173	692
76	15-Apr-05	Site 3	20743		2787090.3	6380160.8		
124	14-Jun-05		20744		2787236.4	6379084.2		
126	14-Jun-05		20744	Downstream	2787443.7	6381244.9	3237	12946
Kopurererua Stream								
129	15-Jun-05		20745		2785851.1	6382621.4		
135	15-Jun-05		20745	Downstream	2787912.3	6384498.5	3252	13008
Waitara River								
110	8-Jun-05	Site 1	20746		2618347.0	6242037.3		
111	8-Jun-05	Site 1	20746	Downstream	2617875.8	6242540.1	763	3052
112	8-Jun-05	Site 2	20746		2617995.4	6242495.7		
113	8-Jun-05	Site 2	20746	Downstream	2617810.0	6242742.5	345	1380
114	8-Jun-05	Site 3	20746		2617589.4	6243198.2		
116	8-Jun-05	Site 3	20746	Downstream	2617580.2	6243314.9	314	1256
117	8-Jun-05	Site 4	20746		2617625.1	6243563.1		
118	8-Jun-05	Site 4	20746	Downstream	2617418.2	6243776.0	406	1624
119	8-Jun-05	Site 5	20746		2617364.9	6243924.5		
120	8-Jun-05	Site 5	20746	Downstream	2617530.6	6244102.5	303	1212
121	8-Jun-05	Site 6	20746		2617503.3	6244369.6		
122	8-Jun-05	Site 6	20746	Downstream	2617283.3	6244546.2	282	1128
Private pond at Mokoia								
123*	9-Jun-05		20747		2628097.9	6173871.9	215	951

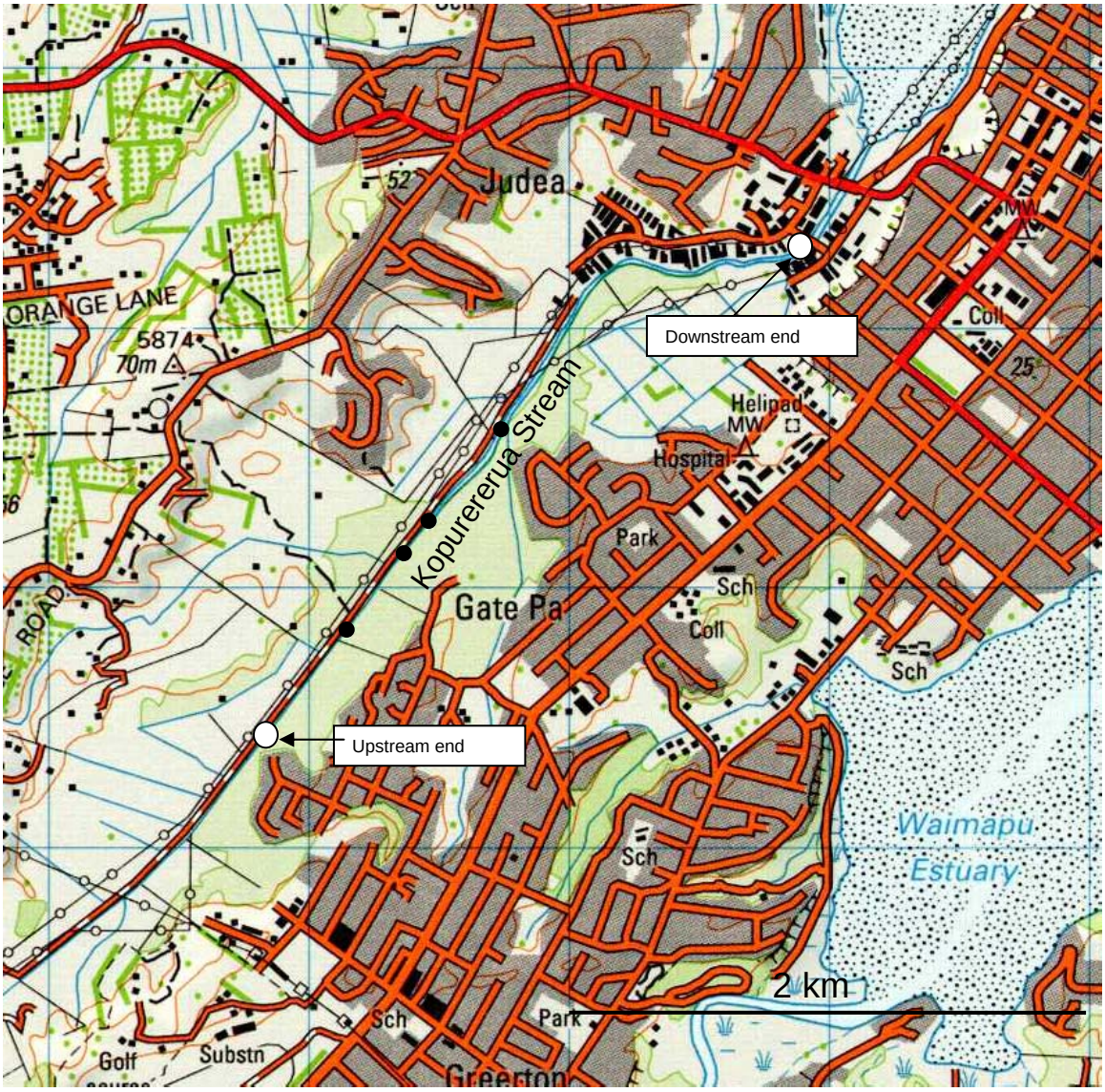


Figure 2.The reach fished in the Kopurererua Stream on 15 June 2005. Open circles indicate the upstream and downstream ends of the fished reach. Single giant bullies were found at each of the sites indicated by the filled circles.

Table 2. Electrical conductivity, temperature, and underwater visibility at the fished sites.

Site	Date	Ambient conductivity (μS cm^{-1})	Specific conductivity (μS cm^{-1})	Water temperature (^{o}C)	Black disc (m)	Depth (m)
Waimapu Stream Site 1	15-Apr-05	61	81	11.9	2	1-2
Waimapu Stream Site 2	15-Apr-05	58	77	12.7	2	1.4-1.9
Waimapu Stream Site 3	15-Apr-05	58	77	12.7	2	1.3-1.8
Waimapu Stream, swing bridge at surface	15-Apr-05	740	959	13.0	2	1.2
Waimapu Stream, swing bridge at 1.3 m depth	15-Apr-05	1300	1685	13.0	2	1.2
Waimapu Stream Site 1	14-Jun-05	47	66	10.0	2	1.2
Waimapu Stream, swing bridge at surface	14-Jun-05	66	93	9.7	2	1.2
Waimapu Stream, swing bridge at 1.3 m depth	14-Jun-05	58	81	9.6	2	1.2
Kopurererua Stream	15-Jun-05	53	73	10.4	0.39	1.5
Waitara River Site 1	8-Jun-05	67	96	9.4	0.62	0-2.0
Waitara River Site 2	8-Jun-05	67	96	9.4	0.62	0-2.0
Waitara River Site 3	8-Jun-05	67	96	9.4	0.62	0-2.0
Waitara River Site 4	8-Jun-05	579	1060	9.5	0.62	0-2.0
Waitara River Site 5	8-Jun-05	579	1060	9.5	0.62	0-2.0
Waitara River Site 6	8-Jun-05	5330	7370	10.2	0.62	0-2.0
Mokoia Pond	9-Jun-05	185	265	9.1	1.9	0.2-2.0

3. Results

Waimapu Stream

On 15 April 2005 we caught 377 fish comprising three introduced and nine native fish species at 3 sites in 2.5 km of fished length of the lower Waimapu Stream (Fig. 1, Tables 3, 4). Common smelt were the most numerous species, followed by shortfin eels. Relatively few yellow-eye mullet, longfin eels, trout, and bullies were caught. Shrimp were very abundant.

We caught two koi carp within 5 mins of commencing fishing at site 1 (Table 1). A female (680 mm fork length, 6.980 kg) and a male (630 mm fork length, 7.893 kg) were captured together at latitude 37.74054752^{o}S and longitude 176.1430444^{o}W (New Zealand map grid coordinates easting 2787169.17, northing 6379826.41). Both were 9-10 years old as determined by their scales. The gonads of both fish were poorly developed. No juvenile koi were found.

On 14 June 2005 fishi0
ng in the Waimapu Stream was started at the most upstream navigable point (Fig. 2), which was immediately below a large willow tree that spanned and blocked the channel. We fished downstream for 3.2 km, until high conductivity at the upstream end of the salt wedge rendered fishing ineffective. The fished reach included the three sites that were fished on 15 April. We also fished a tributary on the true left bank upstream as far as a pipe across the river that prevented further upstream navigation. This fishing caught eels, common smelt, rainbow trout, and juvenile black flounder about 110-150 mm long. Yelloweye mullet were extremely numerous, with one school extending for about 70 m and filling the 6-m wide channel from bank to bank and from the surface to the bed in 1.2 m of water depth. No koi carp were caught or seen on this occasion.

Kopurererua Stream

On 15 June 2005 fishing was started at the most upstream navigable point (Fig. 2), which was immediately below a pipe that spanned the channel about 30 cm above the water level. We caught shortfin eels, common smelt, rainbow trout, inanga, yelloweye mullet, juvenile black flounder, giant bullies, and freshwater crayfish. The four giant bullies (175-179 mm total length) were all caught in marginal vegetation at the true right side of the channel 1-2 km upstream of the tidal wedge (Fig. 2). No koi carp were caught or seen.

Table 3. Number of fish caught in the lower Waimapu Stream on 15 April 2005.

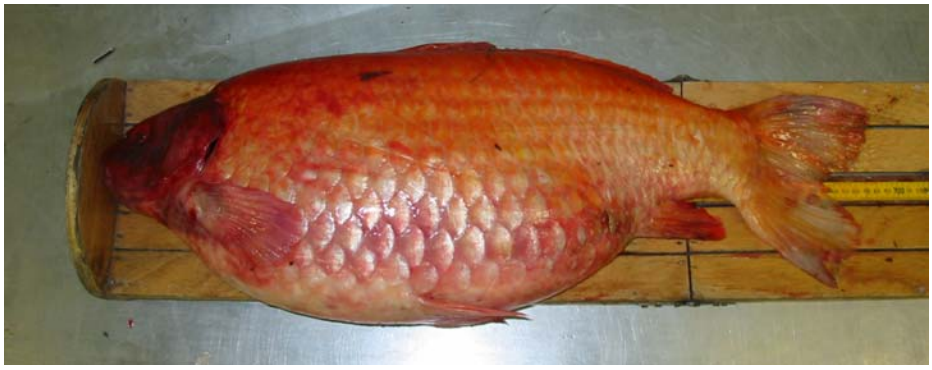
Fish species	Number of fish			
	Site 1	Site 2	Site 3	Total
Introduced species				
Brown trout	3	0	0	3
Rainbow trout	1	0	1	2
Koi	2	0	0	2
Native species				
Common bully	2	0	0	2
Common smelt	216	44	70	330
Giant bully	0	1	0	1
Inanga	2	8	2	12
Lamprey macrophthalmia	1	0	0	1
Longfin eel	1	0	0	1
Shortfin eel	15	2	0	17
Stargazer	1	0	0	1
Yelloweye mullet	4	1	0	5
Total	248	56	73	377

Table 4. Density of fish caught in the lower Waimapu Stream on 15 April 2005.

Site	Length fished (m)	Area fished (m^2)	Fish density (fish 100 m^{-2})
1	1734	6937	3.6
2	381	1522	3.7
3	350	1399	5.2
Total	2465	9858	3.8

Figure 3. The main channel of the lower Waimapu Stream at site 1 where two koi carp were caught on 15 April 2005.

A. Male



B. Female

Figure 4.The koi carp caught in the Waimapu Stream on 15 April 2005. A. 7.9 kg male and B. 6.9 kg female.

Figure 5. The Waimapu Stream at site 2 on 15 April 2005 in the vicinity of where koi carp were originally seen.

Waitara River

We fished 2.4 km of edge habitat in the Waitara River, Taranaki, on 8 June 2005. We caught adult inanga, shortfin eels, a few common smelt, black flounder, and yelloweye mullet. At NZ map grid 2617364.89 6243924.51 we caught a 200-mm giant bully (Fig. 6). No koi carp were caught or seen, and the tidal habitat in the fished reach appeared to be unlikely habitat for these fish, with no macrophyte beds, limited cover, and tidally fluctuating water levels (Fig. 7).

Private pond near Mokoia

We used a Hitachi EX100 digger to lift the electrofishing boat into a private pond near Mokoia, southern Taranaki. We determined with GPS coordinates that the pond was 93 m long with a mean width of about 12 m, and a surface area of 951 m^2. Maximum depth was 2 m (Fig. 8). In seven consecutive passes around the pond a through the centre we caught 16 koi carp totalling 58.5 kg in weight (fork length 424-535 mm; Fig. 9, Table 5). The fish were 6-7 years old as determined by their scales, and the estimated biomass of koi in this pond was 62 g m^{-2}. Removal was achieved by depletion fishing in 7 circuits of the pond that caught 9, 3, 1, 1, 1, 1, and 0 carp in each successive circuit. The Zippin method of population estimation (± 95 % confidence interval) suggests that there were 16±1 koi carp in the pond, so it is possible that we eradicated all of the koi. No juveniles were found.

We also saw about 20 shortfin eels and several freshwater crayfish. From the length range of the koi carp there was no evidence that they had reproduced successfully despite their presence in the pond for at least 4-5 years, according to the land owner. Of

the fished that were sexed, there were 9 males and 5 females. The gonads were in various stages of development, from fully ripe to almost undeveloped. One fish had no gonads but instead had a large, internal tumour.

Figure 6. A 200-mm total length giant bully caught in the tidal reach of the Waitara River, Taranaki on 8 June 2005.

Figure 7. Edge habitat of the Waitara River showing its tidal nature, cobble and sand substrate, and lack of aquatic macrophytes.

Figure 8. Pond on private farmland near Mokoia, southern Taranaki, from which 16 koi carp were removed on 9 June 2005.

Table 5. Lengths and weights of koi carp caught in the private pond near Mokoia, Taranaki, on 9 June 2005.

Length (mm)	Weight (g)	Sex
414	2167	m
424	2773	
447	2847	m
448	3748	f
455	3189	m
456	3248	f
456	3635	m
464	3143	m
474	2599	m
475	2269	m
498	5276	f
510	4550	m
510	4950	
518	5593	f
520	4842	m
535	3676	f

Figure 9. Thirteen of the sixteen koi carp that were removed from a pond on private land near Mokoia, southern Taranaki, on 9 June 2005. The folding measuring board immediately above the fish is 1 m long.

4. Conclusions

Electrofishing was highly effective in all the habitats fished, as shown by the fish catches. We can be sure that where no koi carp were found, they are either absent or present only at very low densities. That no juveniles were found is an encouraging sign that koi carp do not appear to have bred successfully in these habitats. This contrasts with the lower Waikato where we have caught large numbers of koi carp of a wide size range (20 to 700 mm) using the same electrofishing boat (Hicks et al. 2005). The presence of koi in the Waimapu Stream is disappointing, and adds to the occurrence of koi carp in private pond near Apata, Bay of Plenty (Hicks et al. 2004). In an encouraging development, however, no koi carp have been seen in the pond at Apata since five fish were removed in February 2004. Our failure to find koi in the Kopurererua Stream does not rule out their presence there, but if any koi remain, no breeding appears to have taken place.

Whether we managed to remove all the koi from the pond near Mokoia remains to be seen, but the risk of their further spread and reproduction from this location has been effectively eliminated. Although no koi were found in the Waitara River despite their reported capture in December 2004, their successful establishment in this river appears unlikely.

Given the presence or reports of koi in adjacent locations in or near tidal reaches suggests that it is important to establish the salinity tolerance of koi carp, which would determine whether koi carp could move between catchments via the sea. While some literature suggests that common carp can survive even in full sea water (Balon 1995), other studies show that they do not thrive under saline conditions (Wang et al. 1995). However, as koi carp in New Zealand are likely to be an Asian subspecies, inferences drawn from studies of common carp should be viewed with caution, and independent studies are needed to establish the salinity tolerance of New Zealand's koi carp.

5. Acknowledgements

We gratefully acknowledge the assistance of Matt Bloxham, Phil Dykzeul, Matt Osborne, Barry Ovenden, Katrina Merrifield, and John Heaphy. The survey was funded by the Department of Conservation and Environment Bay of Plenty.

6. References

Balon, E.K. 1995. Origin and domestication of the wild carp, *Cyprinus carpio*: from Roman gourmets to the swimming flowers. Aquaculture 129: 3-48.

Hicks, B.J., D.G. Bell, C.A. Ring, and G.W. Tempero. 2004. Boat electrofishing survey of Apata Pond and Lake McLaren. CBER Contract Report No. 33. Client report prepared for the Department of Conservation, Bay of Plenty Conservancy, and Environment Bay of Plenty. Centre for Biodiversity and Ecology Research, Department of Biological Sciences, The University of Waikato, Hamilton. 14p.

Hicks, B.J., N. Ling, M.W. Osborne, D.G. Bell, and C.A. Ring. 2005. Boat electrofishing survey of the lower Waikato River and its tributaries. CBER Contract Report No. 39. Client report prepared for Environment Waikato. Centre for Biodiversity and Ecology Research, Department of Biological Sciences, The University of Waikato, Hamilton.

Wang, J., H. Lui, H. Po, L. Fan. 1997. Influence of salinity on food consumption, growth and energy conversion efficiency of common carp (*Cyprinus carpio*) fingerlings. Aquaculture 148:115-124. http://nis.gsmfc.org/nis_factsheet.php?toc_id=183