

Invasive Fish Survey of Lake Arapuni by Boat Electrofishing



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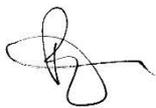
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Executive Summary

A boat electrofishing survey of Lake Arapuni was conducted on 2 February 2017 by the University of Waikato to investigate anecdotal reports of koi carp (*Cyprinus carpio*) presence in the lake. Nine 10-minute electrofishing transects were conducted around the littoral zone of the lake. This resulted in a total distance fished of 3.35 km and a total area fished of 1.34 ha. A total of 100 fish were captured, comprising three species: brown bullhead catfish (*Ameiurus nebulosus*), goldfish (*Carassius auratus*) and rudd (*Scardinius erythrophthalmus*); in addition, eels (*Anguilla* sp.) were observed but not captured.

Total captured fish biomass was 14.8 kg (11.7 kg/ha) with goldfish being the most abundant species (86 individuals), accounting for most of the biomass (86.8%). Rudd were the next most abundant species with nine individuals captured (1.0 kg/ha) followed by catfish (five individuals; 0.4 kg/ha). Rudd and catfish boat electrofishing biomass estimates should be regarded as minimal as capture rates for benthic species (catfish) and juveniles (rudd) are often lower than those of adult pelagic species. The reduced capture efficiency of benthic species is due to their preference for depths beyond the extent of the electrofishing field (approximately 2 m in extent from the anode), in addition benthic species are more likely to be missed by netters due to their reduced visibility. The smaller size (<100 mm FL) of juvenile fish makes them less susceptible to the electric field and therefore less likely to be captured in numbers representative of the community composition.

No koi carp were captured even though the area fished was typical of their preferred habitat. While the presence of koi carp in Lake Arapuni cannot be completely discounted, the survey results indicate that they are either absent from the lake or present in low numbers. Furthermore, the goldfish population was dominated by large adults (>150 mm FL), many of which were highly coloured and had markings similar to those of koi carp. It is likely that these larger coloured goldfish were mistaken for koi carp in previous sightings, especially as adult goldfish form small aggregations similar to those of koi carp. If koi carp are present in Lake Arapuni they are likely to be at biomass levels too low to mount viable control or eradication programmes given the large area and depth of the lake.

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Introduction

Common or koi carp (*Cyprinus carpio*) are an invasive fish species with a reported distribution in the Waikato River from Port Waikato to the base of the Karapiro dam (Hicks et al. 2010, Daniel et al. 2011), south of Cambridge. This species is known to have negative impacts on water quality (Crivelli 1983, Driver et al. 2005, Hicks and Ling 2015) and under New Zealand regulations has been declared a “noxious fish” (Freshwater Fisheries Regulations 1983) and an “unwanted organism” (Biosecurity Act 1993). However, there have been recent anecdotal reports of koi carp upstream of Lake Karapiro in Lake Arapuni (Daniel pers. comm.). There is also an associated proposal to carry out population control work (McCaughan pers. comm.) based on this information as part of the overall strategy for restoration of the Waikato River.

The University of Waikato has a continuing interest in invasive fish management and mapping of pest fish distributions. The University also has the only electrofishing boat in New Zealand suitable for conducting surveys for large benthopelagic species such as koi carp, rudd (*Scardinius erythrophthalmus*), brown bullhead catfish (*Ameiurus nebulosus*) and goldfish (*Carassius auratus*) in lake systems (Hicks et al. 2006). Therefore, a boat electrofishing survey was undertaken to determine if koi carp were present in Lake Arapuni, and if so provide an initial estimate of the population biomass and structure.

Methods

Study Site

Lake Arapuni is one of eight hydroelectric dams situated on the Waikato River and the penultimate in the series. Filled in 1929, it has an area of 9.4 km² and a maximum depth of 64 m (Collier et al. 2010). The lake undergoes thermal stratification and during summer periods may experience cyanobacterial blooms (Bilinska et al. 2005). The resident fish community has been augmented by the annual upstream transfer of juvenile eels (*Anguilla* sp.) since the summer of 1993-94 (Boubée 2014). Species records from the NIWA New Zealand Freshwater Fish Database for the lake include catfish, rudd, goldfish, common bully (*Gobiomorphus cotidianus*) and koura (freshwater crayfish) (*Paranephrops* sp.). Rainbow trout (*Oncorhynchus mykiss*) have also been stocked in the lake for recreational fishing (Daniel pers. comm.).

Survey methods

Boat electrofishing was conducted using a 4.5-m long, custom-made aluminium electric fishing boat equipped with a 5-kilowatt gas-powered pulsator (GPP, model 5.0, Smith-Root Inc, Vancouver, Washington, USA) which was powered by a 6-kilowatt custom-wound generator. Two anode poles, each with an array of six electrode droppers, created the fishing field at the bow, with the boat hull acting as the cathode. 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. It was assumed that the boat fished a transect approximately 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. Past experience has proven that separate 10-minute electroshocking events covering a variety of habitats have produced a good representation of fish species within the aquatic system (Hicks and Tempero 2011) and koi carp have been detected at areal biomasses of 10 kg/ha using this survey method (Collier and Grainger 2015).

A total of nine 10-minute electroshocking transects were conducted around the littoral zone of Lake Arapuni on 2 February 2017 (Figure 1). This totalled 90 minutes of boat electrofishing covering 3.35 km of the lake's perimeter, with a total area of 1.34 ha fished. Transect locations were selected to include the widest range of littoral habitats possible. To avoid unnecessary handling stress of native fish only invasive fish were collected, however as water clarity was comparative good the number of eels sighted by the netters during each transect was recorded. Narcotised invasive fish were euthanized with an overdose of anaesthetic (Benzocaine, CAS 94-09-7, Sigma) and then transported to shore for processing. Fish were identified, weighed (± 1 g) and length calculated from weight-length regression.

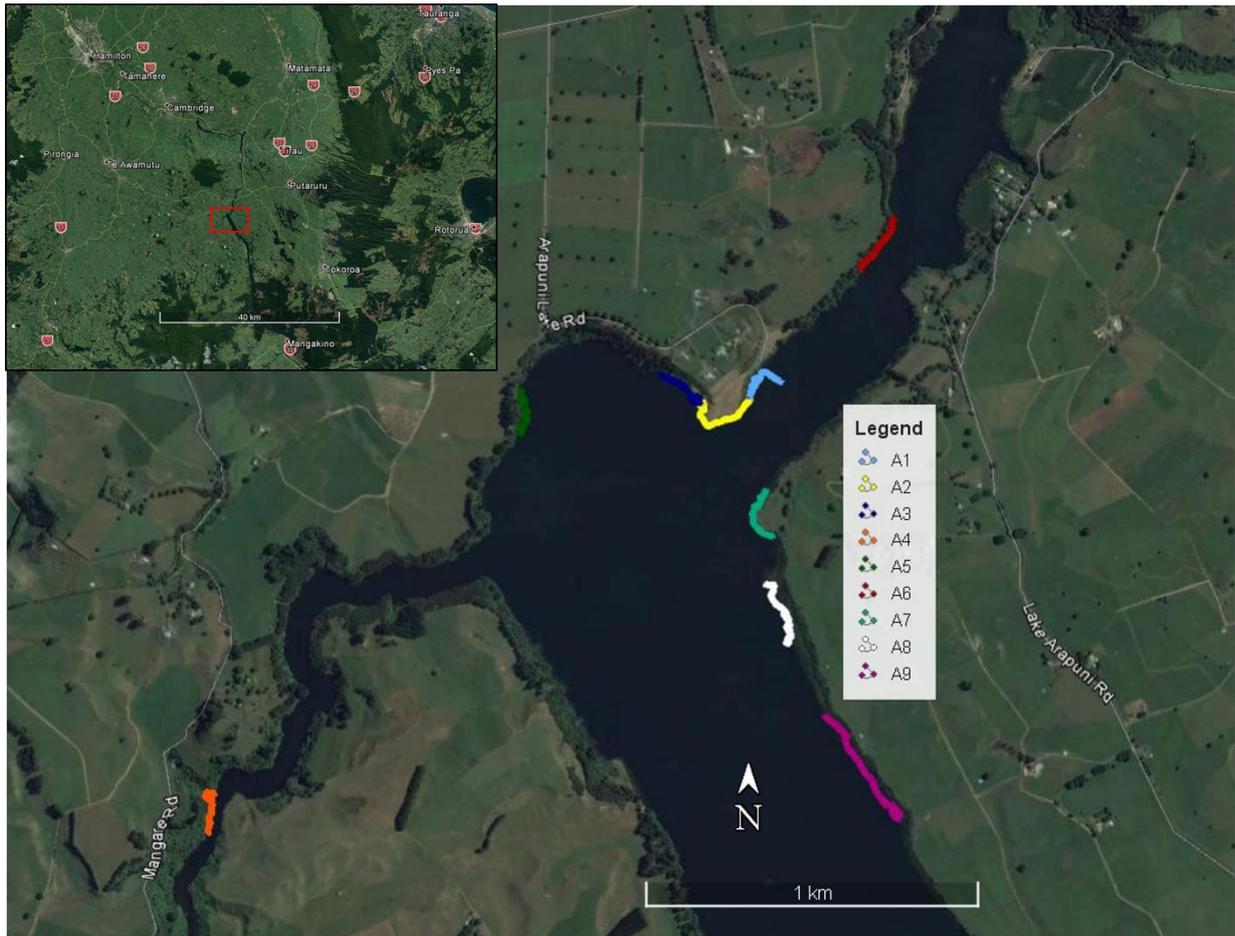


Figure 1. Boat electrofishing transects conducted on Lake Arapuni on 2 February 2017. A total of nine transects were conducted and are designated A1–A9.

Results

Boat electrofishing conditions were near optimal based on previous electrofishing surveys with a black disc measurement of 0.76 m, specific conductivity of 153.5 $\mu\text{S}/\text{cm}$ and water temperature was 21.1°C. A range of habitats were fished including steep rocky drop-offs, shallow (0.9 m) hard bottom and shallow (1.0 m) muddy bottom (Mangare Stream) areas. Riparian vegetation ranged from native trees to willow (*Salix* sp.) and pasture, macrophyte vegetation was dominated by hornwort (*Ceratophyllum demersum*), oxygen weed (*Egeria densa*) and small areas of raupo (*Typha orientalis*).

A total of 100 fish were captured comprising three species: brown bullhead catfish, goldfish and rudd. Distance and estimated area fished, number of fish captured and biomass for each transect are presented in Table 1. Eels were also seen but not captured (31 total) and appeared to be common in the lake (mean 3.4/transect). Total captured fish biomass was 14.8 kg (11 kg/ha); mean length, weight and biomass for each species are presented in Table 2. Goldfish were the most abundant species (86 individuals) with a large proportion of highly coloured individuals (Figure 2), some with markings resembling those of koi carp (Figure 3). Rudd were the next most abundant species (9 individuals) and large shoals of

juvenile rudd were also observed schooling in the shallow littoral zone of the lake. No koi carp, European perch or rainbow trout were captured.

Table 1. Distance and area fished, number of fish captured and biomass of fish caught by boat electrofishing from Lake Arapuni, February 2017.

Transect	Distance fished (m)	Area fished (m ²)	No. of Fish	Fish/100 m ²	Biomass (kg/ha)
A1	324	1296	13	1.0	12.3
A2	395	1580	11	0.7	9.5
A3	310	1240	9	0.7	11.0
A4	275	1100	9	0.8	16.3
A5	306	1224	2	0.2	2.3
A6	292	1168	7	0.6	7.8
A7	313	1252	23	1.8	29.7
A8	434	1736	12	0.7	9.4
A9	705	2820	14	0.5	7.0
Total/Mean	3354	13416	100	0.8	11.7

Table 2. Abundance and minimum biomass of individual species captured by boat electrofishing of Lake Arapuni, February 2017.

Species	Count	Biomass (kg)	Mean length (mm)	Mean weight (g)	Biomass (kg/ha)
Catfish	5	0.56	185.8	111.8	0.42
Goldfish	86	12.80	190.6	149.2	9.55
Rudd	9	1.38	201.2	153.0	1.03
Total	100	14.74	191.3	147.7	11.0

The length-frequency distribution of captured goldfish is presented in Figure 4 and is representative of typical boat electrofishing size bias with the population skewed towards larger individuals (i.e., > 150 mm FL).



Figure 2. Goldfish and rudd (bottom centre and centre right) caught during boat electrofishing of Lake Arapuni, February 2017.



Figure 3. Large coloured goldfish (wt 346 g), caught during boat electrofishing of Lake Arapuni, February 2017. Note the darker markings which are similar to those of koi carp. The marker pen is 140 mm long.

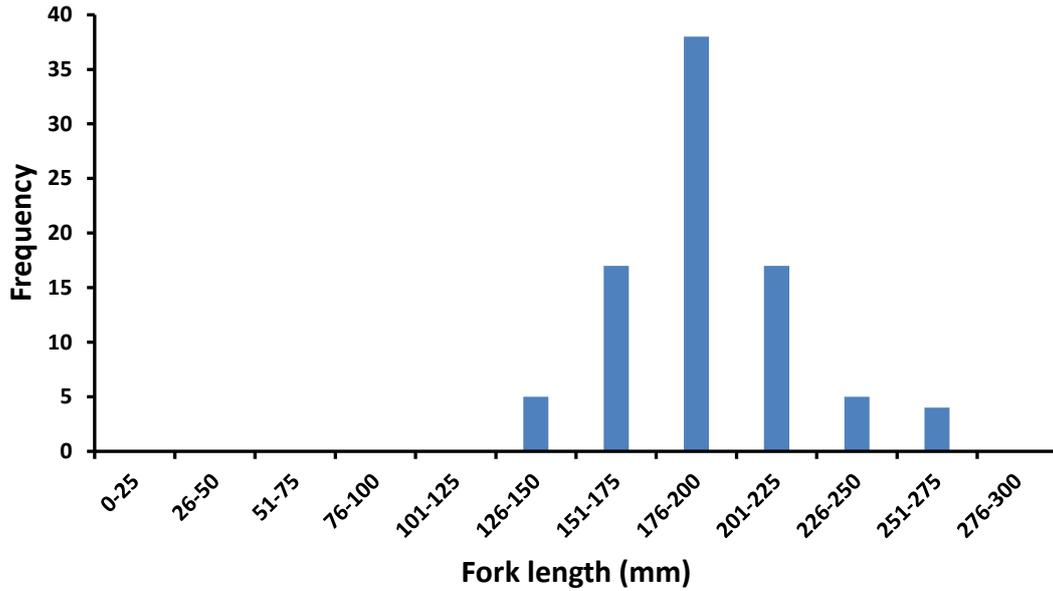


Figure 4. Length–frequency distribution of goldfish captured by boat electrofishing of Lake Arapuni. Lengths were extrapolated from weight-length regression of goldfish captured during previous boat electrofishing surveys within the Waikato region.

Discussion

The areal biomass of goldfish (9.6 kg/ha) in Lake Arapuni is towards the lower end of those recorded from boat electrofishing surveys of Waikato lakes (Figure 5). A number of larger adult fish were captured in comparison to smaller juvenile fish (<100 mm FL), however this is not unusual as larger individuals are more likely to be affected by the electrical field and therefore captured (Hicks et al. 2015).

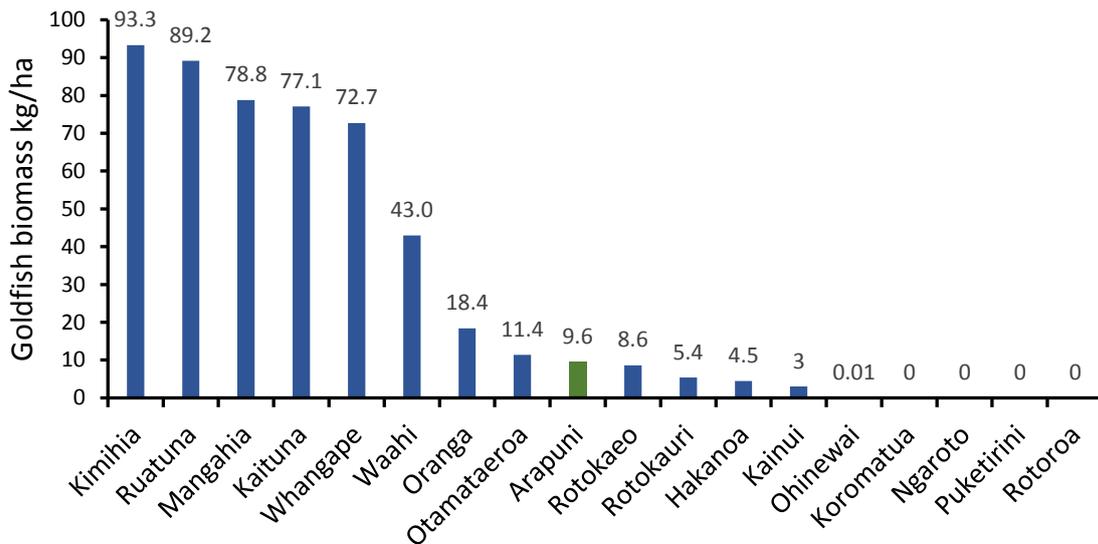


Figure 5. Areal biomass of goldfish captured from Waikato lakes during boat electrofishing surveys (data from Hicks et al. 2015).

Comparatively few catfish and rudd were captured; however, boat electrofishing capture efficiency rates for benthic species such as catfish are typically lower than those of more mobile benthopelagic species such as koi carp, goldfish and rudd (Hicks et al. 2015). Benthic fish are more likely to inhabit areas where the electrofishing field has reduced efficiency due to depth or dispersion by sediment; this results in greater rates of detection and escape by the fish. In addition, stunned benthic fish are more likely to be unrecovered due to reduced visibility or excessive depth. Small schools of juvenile rudd were sighted in the littoral shallows of the lake but were unable to be captured. The smaller size (<100 mm FL) of juvenile fish makes them less susceptible to the electric field and therefore less likely to be captured in numbers representative of the community composition. Therefore, electrofishing biomass estimates for rudd and catfish should be treated with caution.

The successful capture of goldfish in Lake Arapuni indicates that conditions were suitable for detecting the presence of koi carp. Previous boat electrofishing surveys of Waikato lakes have shown that when both species are present, the goldfish capture rate is a good indicator of koi carp capture efficiency (Hicks et al. 2015). While the presence of koi carp in Lake Arapuni cannot be completely discounted, the results of the electrofishing survey indicates that they are either absent from the lake or present in extremely low numbers.

Conclusion

The presence of many highly coloured adult goldfish and the failure to capture any koi carp from 90 minutes of boat electrofishing indicates that anecdotal reports of koi carp in Lake Arapuni are likely mistaken. Alternatively, if koi carp are present in Lake Arapuni they are

likely to be at biomass levels too low to mount viable control or eradication programmes given the size and depth of the lake. Electrofishing estimates of rudd and catfish biomass indicate established populations, however, a more comprehensive survey utilising a range of sampling methodologies to ascertain population numbers and structure should be undertaken before control programmes are initiated.

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