

# Boat electrofishing survey of the Awaiti and Bancrofts canals (Tee Head Canal), Piako River system



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Cover picture: Bancrofts Canal, 21 Feb 2018, showing dense beds of reed sweet grass and water pepper at the margins. Photo credit: Brendan Hicks.

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## Executive summary

This purpose of this survey of Awaiti and Bancrofts canals was to establish the presence of fish in the canals and to determine their relative density and biomass by boat electrofishing. These canals drain the Kopuatai Peat Dome and adjacent farmland into Tee Head Canal, which is part of the Piako River system in the Waikato Region. Awaiti Canal had patches of the emergent macrophyte Eurasian reed sweet grass (*Glyceria maxima*) and floating common duckweed (*Lemna minor*). Bancrofts Canal had dense beds of reed sweet grass and water pepper (*Persicaria hydropiper*, syn. *Polygonum hydropiper*) that extended into the water along most of its margin to the extent that the bank was not visible. The water of both canals was tannin-stained, but Bancrofts Canal had heavier staining than Awaiti Canal.

We boat electrofished five sites in Awaiti Canal and five sites in Bancrofts Canal for 10 mins each on 21 February 2018. Water temperature was 24.3°C in Awaiti Canal and 23.1°C in Bancrofts Canal. In Awaiti Canal, ambient electrical conductivity was 313.5  $\mu\text{S cm}^{-1}$ , specific conductivity was 317.6  $\mu\text{S cm}^{-1}$ , and black disc distance was 0.18 m. In Bancrofts Canal, ambient conductivity was 174.3  $\mu\text{S cm}^{-1}$ , and specific conductivity was 180.8  $\mu\text{S cm}^{-1}$ .

We caught 31 fish in total, 28 in Awaiti Canal and 3 in Bancrofts Canal. Species included shortfin eels (*Anguilla australis*), inanga (*Galaxias maculatus*), goldfish (*Carassius auratus*), brown bullhead catfish (*Ameiurus nebulosus*) and gambusia (*Gambusia affinis*). Two inanga at site 4 (Awaiti Canal) were retrieved dead on capture, as was the one eel retrieved in Bancrofts Canal.

Fish densities were very low, up to a maximum of 1.02 fish 100 m<sup>-2</sup> for all species combined at site 3 in Awaiti Canal. Only gambusia were found alive in Bancrofts Canal. Biomass per site and areal biomass were similarly very low, and this was partly attributable to the small size of individuals, which suggested that, with the exception of gambusia, they were young, newly recruited fish.

Awaiti Canal had a low diversity of small fish species that are generally tolerant of poor water quality. This fish diversity is particularly low considering the close proximity of the sites to the coast (about 30 km from the Firth of Thames). The most diverse fish communities in New Zealand are found close to the coast. Typical mean eel densities in the Waikato River assessed by boat electrofishing were 0.7-1.3 eels 100 m<sup>-2</sup> compared to the mean of 0.12 fish 100 m<sup>-2</sup> (range of 0-0.29 eels 100 m<sup>-2</sup>) at the five sites Awaiti Canal. Bancroft Canal had only gambusia, and the one shortfin eel found dead could have drifted in or died in the canal, probably as result of low DO concentrations.

## 1. Introduction

The Waikato Regional Council contracted the University of Waikato to conduct a boat electrofishing to survey the Awaiti and Bancrofts canals (Tee Head Canal), Piako River system. The purpose of this survey was to establish the presence of fish in the canals and to determine their relative density and biomass.

## 2. Study sites

The Awaiti Canal (37°23'38.32"S, 175°35'37.37"E) and Bancrofts Canal (37°23'57.18"S, 175°36'21.74"E) drain the Kopuatai Peat Dome and adjacent farmland into Tee Head Canal, which is part of the Piako River system in the Waikato Region (Figures 1 and 2). Awaiti Canal had patches of the emergent macrophyte Eurasian reed sweet grass (*Glyceria maxima*) and floating common duckweed (*Lemna minor*) (Figure 3). Bancrofts Canal had dense beds of reed sweet grass and water pepper (*Persicaria hydropiper*, syn. *Polygonum hydropiper*) that extended into the water along most of its margin to the extent that the bank is not visible (Figure 4). The water of both canals was tannin-stained, but Bancrofts Canal had heavier staining than Awaiti Canal (Figure 5).

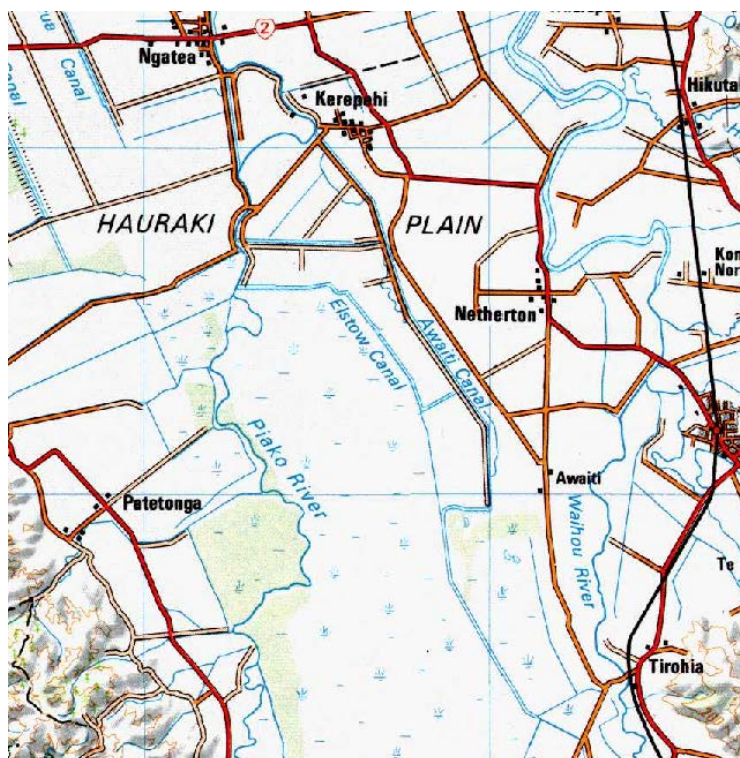


Figure 1. Location of the Awaiti Canal in the Piako River catchment.

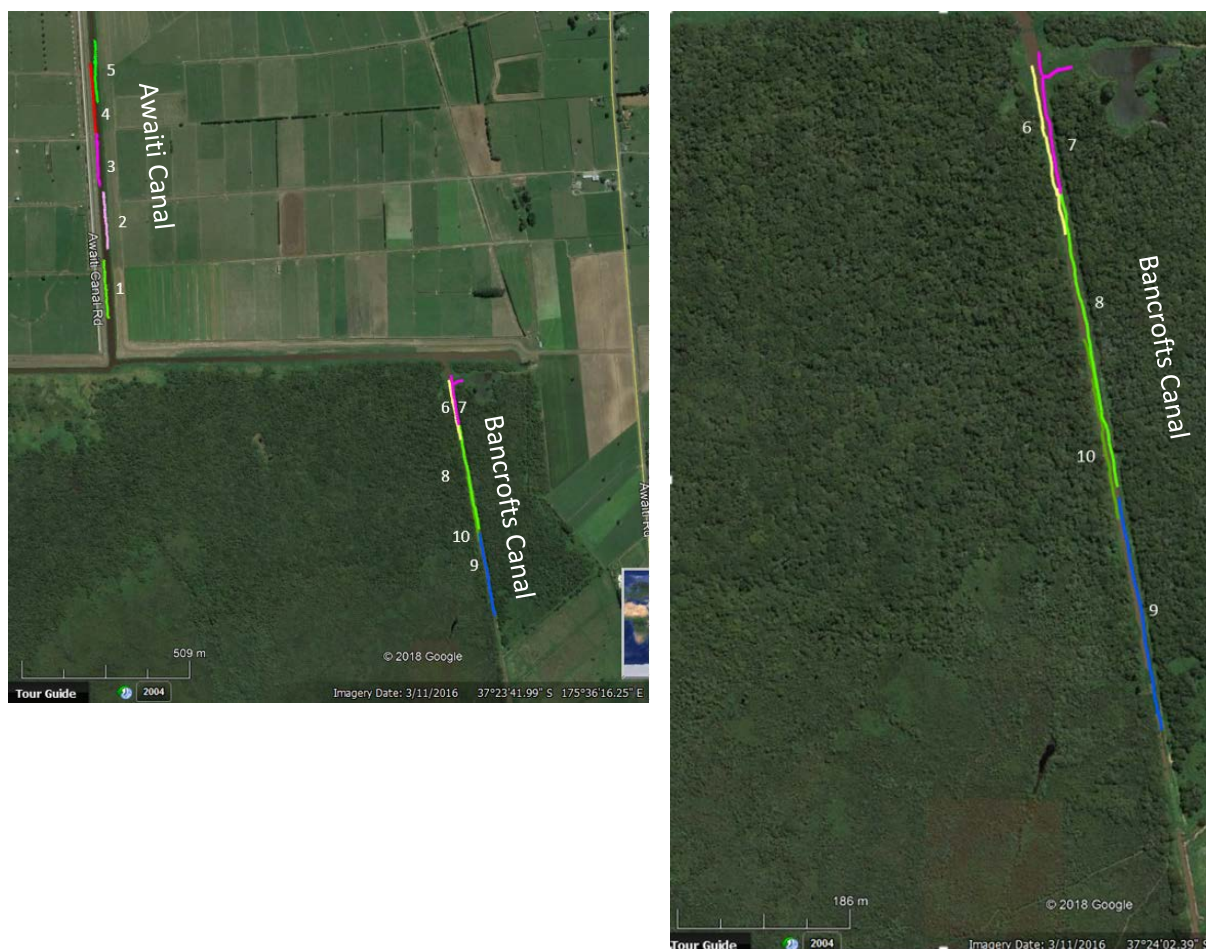


Figure 2. Boat electrofishing sites on Awaiti and Bancrofts canals (left) and the sites in Bancrofts Canal in more detail (right).



Figure 3. Awaiti Canal showing marginal reed sweet grass and floating common duckweed. Photo: Brendan Hicks.



Figure 4. Bancrofts Canal showing dense water pepper at the margins and floating patches of common duckweed moving with the incoming tide. Photo: Brendan Hicks.



Figure 5. Heavily tannin-stained water from the Bancrofts Canal, 21 Feb 2018. Photo: Brendan Hicks.

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### 3. Methods

To conduct the electrofishing we used a 4.5 m-long, aluminium-hulled electrofishing boat with a 5-kilowatt petrol-powered pulsator (GPP model 5.0, Smith-Root Inc, Vancouver, Washington, USA) powered by a 6-kilowatt custom-wound Honda generator. Two anode poles, each with an array of six 1-m long stainless steel wire droppers, created the fishing field in front of the bow, with the boat hull acting as the cathode.

All sites were boat electrofished on 21 February 2018 with the pulsator set to low range (50-500 V) with direct current and 40-50 percent of range (POR) and pulses per second (PPS) to give a consistent applied current of 3-4 amps root mean square. We assumed from past experience (Hicks et al. 2006) that an effective fishing field was developed to a depth of 2-3 m, and 2 m either side of the centre line of the boat. The boat therefore fished a transect 4 m wide, which was generally consistent with behavioural reactions of fish at the water surface. This assumption was used to calculate the area fished from the linear distance measured with a hand-held Garmin GPSMAP 60Cx global positioning system.

We fished five sites in Awaiti Canal and five sites in Bancrofts Canal for 10 mins each (Table 1). Water temperature was 24.3°C in Awaiti Canal and 23.1°C in Bancrofts Canal. Electrical conductivity was measured with a YSI 3200 conductivity meter and horizontal visibility through the water was measured using a black disc (Davies-Colley 1988). In Awaiti Canal, ambient electrical conductivity was 313.5  $\mu\text{S cm}^{-1}$ , specific conductivity was 317.6  $\mu\text{S cm}^{-1}$ , and black disc distance was 0.18 m. In Bancrofts Canal, ambient conductivity was 174.3  $\mu\text{S cm}^{-1}$  and specific conductivity was 180.8  $\mu\text{S cm}^{-1}$ , but black disc distance was not measured.

We fished for 1 hour 40 mins in total, covering a distance of 2,418 m (9,672 m<sup>2</sup>). Fork length (FL) was recorded for goldfish and catfish, and total length (TL) was measured for eels and inanga to the nearest millimetre. Weight was measured to the nearest g, except for eels, for which it was calculated from length with length-weight regressions from Jellyman et al. (2013). All native fish were released after allowing recovery from AQUIS anaesthetic. Goldfish, catfish, and gambusia were humanely sacrificed with an overdose of anaesthetic and removed from the site for disposal.



Table 1. Lengths, areas and depth ranges of 10 sites boat electrofished in the Awaiti and Bancrofts canals (Tee Head Canal), Piako River system on 21 February 2018 (see Fig. 1 for site locations). TLB = true left bank and TRB = true right bank.

Site	Description	Bank	Length (m)	Area (m <sup>2</sup> )	Depth range (m)
1	Awaiti Canal edge habitat	TLB	217	868	0-0.6
2	Awaiti Canal edge habitat	TRB	226	904	1.1
3	Awaiti Canal edge habitat	TLB	221	884	0.6-1.2
4	Awaiti Canal edge habitat	TLB	228	912	0.5-1.4
5	Awaiti Canal edge habitat	TRB	262	1048	0.2-2.1
6	Bancroft Canal edge habitat	TLB	216	864	0.6-1.1
7	Bancroft Canal edge habitat	TRB	235	940	0.5-1.3
8	Bancroft Canal edge habitat	Mid channel	334	1336	0.7-1.1
10	Bancroft Canal edge habitat	Mid channel	265	1060	0.8
11	Bancroft Canal edge habitat	Mid channel	214	856	0.8-1.1
Total			2,418	9,672	

## 4. Results

We caught 31 fish in total, 28 in Awaiti Canal and 3 in Bancrofts Canal (Table 2A). Species included the native shortfin eels (*Anguilla australis*) and inanga (*Galaxias maculatus*), and the introduced goldfish (*Carassius auratus*), brown bullhead catfish (*Ameiurus nebulosus*) and gambusia (*Gambusia affinis*). Two inanga at site 4 (Awaiti Canal) were retrieved dead on capture, as was the shortfin eel retrieved from Bancrofts Canal. One live shortfin eel was seen in Bancrofts Canal but not captured, so was not included in Tables 2 or 3.

Fish densities were very low, up to a maximum of 1.02 fish 100 m<sup>-2</sup> for all species combined at site 3 in Awaiti Canal (Table 2B). Only gambusia and one shortfin eel were found alive in Bancrofts Canal. Biomass per site (Table 2C) and areal biomass were similarly very low, and this was partly attributable to the small size of individuals (Table 3), which suggested that, with the exception of gambusia, they were young, newly recruited fish.

Table 2. Fish caught by boat electrofishing at 10 sites in the Awaiti and Bancrofts canals (Tee Head Canal), Piako River system on 21 February 2018 (see Fig. 1 for site locations). Numbers include dead fish (two inanga at site 4 and one shortfin eel at site 10).

A. Number of fish

Site	Number of individuals per site					Total
	Catfish	Gambusia	Goldfish	Inanga	Shortfin eel	
1	0	3	1	1	0	5
2	0	1	0	0	1	2
3	1	2	2	3	1	9
4	3	0	0	3	1	7
5	0	1	1	0	3	5
6	0	0	0	0	0	0
7	0	0	0	0	0	0
8	0	0	0	0	0	0
9	0	1	0	0	0	1
10	0	1	0	0	1	2
Total	4	9	4	7	7	31

B. Density of fish

Site	Density (number 100 m <sup>-2</sup> )					Total
	Catfish	Gambusia	Goldfish	Inanga	Shortfin eel	
1	0.00	0.35	0.12	0.12	0.00	0.58
2	0.00	0.11	0.00	0.00	0.11	0.22
3	0.11	0.23	0.23	0.34	0.11	1.02
4	0.33	0.00	0.00	0.33	0.11	0.77
5	0.00	0.10	0.10	0.00	0.29	0.48
Awaiti mean	0.09	0.16	0.09	0.16	0.12	0.61
6	0.00	0.00	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	0.00	0.00
9	0.00	0.09	0.00	0.00	0.00	0.09
10	0.00	0.12	0.00	0.00	0.12	0.23
Bancroft mean	0.00	0.04	0.00	0.00	0.02	0.07

C. Fish biomass per site

Site	Biomass (g) per site				Total
	Catfish	Goldfish	Inanga	Shortfin eel	
1	0.0	101.0	1.2	0.0	102
2	0.0	0.0	0.0	1.0	1
3	7.5	25.7	4.2	11.7	49
4	24.6	0.0	4.1	88.0	117
5	0.0	20.0	0.0	173.0	193
6	0.0	0.0	0.0	0.0	0
7	0.0	0.0	0.0	0.0	0
8	0.0	0.0	0.0	0.0	0
9	0.0	0.0	0.0	0.0	0
10	0.0	0.0	0.0	38.1	38
Total	32.2	146.7	9.5	311.7	500

Table 2 (continued)

## D. Areal fish biomass

Site	Biomass (g m <sup>-2</sup> )				
	Catfish	Goldfish	Inanga	Shortfin eel	Total
1	0.000	0.116	0.001	0.000	0.118
2	0.000	0.000	0.000	0.001	0.001
3	0.009	0.029	0.005	0.013	0.055
4	0.027	0.000	0.004	0.096	0.128
5	0.000	0.019	0.000	0.165	0.184
Awaiti mean	0.007	0.033	0.002	0.055	0.097
6	0.000	0.000	0.000	0.000	0.000
7	0.000	0.000	0.000	0.000	0.000
8	0.000	0.000	0.000	0.000	0.000
9	0.000	0.000	0.000	0.000	0.000
10	0.000	0.000	0.000	0.044	0.044
Bancroft mean	0.000	0.000	0.000	0.009	0.009

Table 3. Mean weight of fish caught by boat electrofishing at 10 sites in the Awaiti and Bancrofts canals (Tee Head Canal), Piako River system on 21 February 2018.

Site Row Labels	Mean individual weight (g)			
	Catfish	Goldfish	Inanga	Shortfin eel
1		101.0	1.2	
2				1.0
3	7.5	12.9	1.4	11.7
4	8.2		1.4	88.0
5		20.0		57.7
6				
7				
8				
9				
10				38.1
Overall mean	8.0	36.7	1.4	44.5

## 5. Discussion

Awaiti Canal had a low diversity of small fish species that are generally tolerant of poor water quality. This fish diversity is particularly low considering the close proximity of the sites to the coast (about 30 km from the Firth of Thames). The most diverse fish communities are found close to the coast (Hicks et al. 2005a, Jowett and Richardson 1996). Typical mean eel densities in the Waikato River assessed by boat electrofishing were 0.7-1.3 eels 100 m<sup>-2</sup> (Hicks et al. 2005) compared to the mean of 0.12 fish 100 m<sup>-2</sup> (range of 0-0.29 eels 100 m<sup>-2</sup>) in five sites Awaiti Canal. Bancrofts Canal had only gambusia and one shortfin eel that was found dead, which could have drifted in dead or died in the canal, probably as result of low DO concentrations.

We did not measure dissolved oxygen (DO), but previous spot measurements at sites close by in drains on the boundary of the Kopuatai Peat Dome have found very low DO concentrations (0.66-0.95 mg L<sup>-1</sup> in June 2015; Bartels 2015). These are extremely low DO concentrations that are below the threshold for survival of most fish. Any fish survival would depend on higher DO concentrations very close to the water surface. Sonde data recorded every 15 mins between 15 December 2017 and 12 January 2018 from a mean depth of 0.39 m (range 0.001-0.901 m) showed that DO concentrations at a fixed location fluctuated daily, dropped periodically to zero, and were mostly <40% saturation (<1 mg L<sup>-1</sup>; NIWA unpublished data). DO concentrations in the surface layer (< 4 cm depth) were close to 100% saturation. The varying timing of these drops in DO concentration suggests that they were related to changing tidal height rather than to diel fluctuations and probably reflect a strongly stratified water column.

Fish abundance estimates referred to in this report are all derived from single-pass boat electrofishing, so the estimates of relative abundance are robust. However, these are not estimates of absolute abundance, which can be derived from removal electrofishing (Hicks et al. 2006). It is most likely that the abundance of eels was underestimated in this survey because previous boat electrofishing has shown that first-pass estimates can be as low as 5-19% of the population estimate from shortfin eels (Hicks et al. 2006; Hicks, unpublished data). A previous survey of sites in the general vicinity of Tee Head Canal in June 2015 caught larger numbers of shortfin eels in Elstow Canal than in our survey, but no fish were caught in Bancrofts Canal (Bartels 2015).

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## 6. Acknowledgements

We thank Michael Lake and Naomi Crawford of Waikato Regional Council for assistance in the field. All photos were taken by Brendan Hicks. We are very grateful for access to NIWA's sonde data for the dissolved oxygen concentrations.

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