

Boat electrofishing survey of fish abundance in the Ohau Channel, Rotorua, in 2014



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by

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Cover picture: View of the weir at the upstream end of the Ohau Channel, Rotorua, North Island, New Zealand.

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Executive summary

The aim of the survey was to provide on-going monitoring of the fish communities and abundance by boat electrofishing in the Ohau Channel, especially fish species that are taonga to Maori (eels, goldfish, and koura). In the current study, we present the findings from the eighth year of sampling (2014) and a summary of previous surveys.

We used the University of Waikato's 4.5 m-long, aluminium-hulled electrofishing boat to catch a total of 642 fish (11.3 kg) 11 sites on 9 December 2014, which comprised 2,914 lineal m and 11,656 m² in area. Koura and 4 fish species were present, with common bully most abundant (up to 27 fish 100 m⁻² at the site 5, edge habitat). Goldfish (up to 5.92 g m⁻²) was the next most abundant species, and was most abundant in sites 8-11 the lower channel, especially at site 11, the excavated side channel. Rainbow trout were next the most abundant species (up to 0.25 fish 100 m⁻²). Mean bully biomass (5.25 g m⁻²) was much higher than for smelt (0.07 g m⁻²). Koura had a patchy distribution; 5 individuals were caught.

Comparing catches over the 8 years of sampling, the abundance of common bullies in 2014 (4.81 fish 100 m⁻²) was consistent with catch rates in most post-wall years (after 2007; range 0.81-5.72 fish 100 m⁻²), but lower than in 2013. The cause of fluctuating bully abundance is not known, and was not accounted for by changes in water clarity expressed as black disc distance (BDD), water temperature, or water conductivity. Poor water clarity can reduce the efficiency of electrofishing, suggesting that bully density estimates might decrease with decreasing BDD. However, common bully densities in 2012 and 2011 were inversely related BDD. In 2014, catches of smelt, a similar sized fish to bullies, were extremely low.

Goldfish biomass increased initially 2009 and 2010 because of targeted fishing in the excavated side channel (site 11), which has dense macrophyte beds that provide good habitat for goldfish. The continued rise in goldfish density from 2012 on suggests a real increase in goldfish numbers has occurred. Eels were scarce in the Ohau Channel and catches were very variable. Longfin eels were caught in most years, and in 2012 and 2013 shortfin eels were also caught, but in 2014 no eels were caught.

Analysis of fish densities before and after wall closure is hampered by the single data point before closure. However, we now have 7 years of post-wall data, and comparison of means and standard deviations suggest that the number of bullies has decreased.

An intriguing trend of decreasing rainbow trout densities with increasing BDD, which is a measure of both water clarity and phytoplankton abundance, has occurred following wall construction (Figure 3). The trend is opposite to the usual decline of catch rate by boat electrofishing with reduced water clarity. The explanation for this is not immediately clear, and could be increased avoidance of the electrofishing boat by trout in clearer water. It is also possible that reduced BDD indicates high algal productivity in Lake Rotorua, which in turn could increase trout abundance in the Ohau Channel. This remains to be tested.

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1. Introduction

The Bay of Plenty Regional Council (BOPRC) contracted the University of Waikato to conduct a survey of the fish abundance in the Ohau Channel. Similar surveys using boat electrofishing had been previously carried out in each December from 2007 to 2012 (Brijs et al. 2008, 2009, 2010, Hicks et al. 2011, 2013, 2014; Table 1). The original purpose of this series of surveys was to apply an independent method to estimate the densities of common smelt and bullies in the Ohau Channel at fixed points along the bank which coincided with trap netting sites used by the National Institute of Water and Atmospheric Research (NIWA). Since the low number of smelt captured by a single day's boat electrofishing became apparent compared to the numbers captured by seasonal trapping (e.g., Rowe et al. 2008, 2009), the aim of the boat electrofishing survey was modified to provide on-going monitoring of the fish communities and abundance in the Ohau Channel, especially koura and fish species (eels and goldfish) that are taonga to Maori. In the current study, we present the findings from the eighth year of sampling (2014) and a summary of previous surveys.

Table 1. Summary of reports describing boat electrofishing in the Ohau Channel.

Report type	Report number	Fishing year	Authors
CBER report	66	2007	Brijs et al. (2008)
CBER report	97	2008	Brijs et al. (2009)
CBER report	112	2009	Brijs et al. (2010)
CBER report	124	2010	Hicks et al. (2011)
ERI report	26	2011, 2012	Hicks et al. (2013)
ERI report	47	2013	Hicks et al. (2014)
ERI report	65	2014	Hicks et al. (2015)

2. Methods

We used a 4.5 m-long, aluminium-hulled electrofishing boat with a 5-kilowatt 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 stainless steel droppers, created the fishing field at the bow, with the boat hull acting as the cathode. A total of 11 sites in the Ohau Channel were fished in 2014 (Table 1, Figure 1).

As in previous seasons, sites 2, 4, 8 and 10 coincided with NIWA trap netting sites. Electrofishing subsequently commenced upstream of NIWA trap locations and proceeded to move downstream past them. The remaining sites were spread throughout the Ohau Channel and generally incorporated different habitat characteristics representative of the entire channel. All of the sites had a fishing effort of 10 minutes across each of the habitats (Table 5), which included littoral areas, macrophyte beds and mid-channel habitats for the specified target species.

Table 2. Habitat types and dimensions of sites that were boat electrofished in the Ohau Channel on 9 December 2014.

Site	Description	Length (m)	Area (m ²)	Depth range (m)
1	Edge habitat below weir	329	1,316	0.7-2.1
2	Edge habitat by net site 1	308	1,232	0.5-1.2
3	Mid channel habitat by net site 1	405	1,620	0.5-1.1
4	Edge habitat by net site 2	207	828	0.7-2.1
5	Edge habitat by net site 3	251	1,004	0.5-1.2
6	Mid channel habitat	325	1,300	0.6-2.2
7	Edge habitat	225	900	0.5-1.1
8	Edge habitat near side channel	253	1,012	0.8-1.8
9	Willow edge	221	884	0.7-2.2
10	Edge habitat by net site 4	227	908	1.2-2.0
11	Side channel	163	652	0.5-1.2
Total		2,914	11,656	



Figure 1. Fishing transects sampled on 9 December 2014 in the Ohau Channel starting from Lake Rotorua and ending at Lake Rotoiti. Site codes correspond to locations in Table 1.

Prior to fishing, electrical conductivity was measured with a YSI 3200 conductivity meter and horizontal water visibility was measured using a black disc (Davies-Colley 1988). All sites were fished with the pulsator set to low range (50-500 V direct current) and a frequency of 60 pulses per second. The percent of range of the pulsator was set to 60%, which gave an applied current of 3-4 A root mean square. From past experience, an effective fishing field was noted to achieve a depth of about 2-3 m, and 2 m either side of the centre-line of the boat. This suggests that the boat fished a transect about 4-m wide, consistent with behavioural reactions of fish at the water surface, and so the linear distance fished, measured with hand-held Garmin GPSMAP 60Cx global positioning system, was multiplied by 4 m to calculate the area fished (Table 1).

All goldfish, smelt, and bullies were euthanised with an overdose of benzocaine after collection then transferred into labelled bags for weighing (g) and measurement (mm) back at the lab for processing. Trout and eels were then anaesthetised in Aqui-S, measured, and allowed to recover in labelled mesh bags (4-mm mesh) that were secured in the channel at each sample station. When all sites had been fished, holding bags at each sample station were recovered and the trout and eels were released at their point of capture.

3. Study site

The Ohau Channel begins below the weir that controls the outflow of Lake Rotorua; the current is relatively strong and fast at this point. As distance from the weir increases the current slows as the channel widens and deepens and an increase in the extent of macrophyte beds occurs. At the downstream end of the Ohau Channel before it discharges into Lake Rotoiti the littoral zone is mainly dominated by willows.

Water temperature at the starting point of fishing was 18.4°C at 1030 h NZDST on 9 December 2014 and the fishing depth ranged between 0.5 to 2.2 m (Table 1). Specific conductivity, i.e., standardised to 25°C, was 184.2 $\mu\text{S cm}^{-1}$, and ambient conductivity, which controls power transfer of the electrical field, was 163.0 $\mu\text{S cm}^{-1}$. The riparian zones of the Ohau Channel were consisted mainly of residential gardens and pasture in the upstream half of the channel (the Lake Rotorua end) and riparian willows in the downstream half of the channel (near Lake Rotoiti). Submerged macrophytes, such as pondweed (*Potamogeton crispus*) and parrot's feather (*Myriophyllum aquaticum*), were observed throughout the channel as well as the presence of freshwater mussels (*Echyridella menziesii*) in bare sandy areas. The black disc distance (BDD), which measures horizontal underwater visibility (Davies-Colley 1988), was 1.45 m in 2014, which was the second highest reading since 2007, just less than the 2.0 m that was measured in that year.

4. Results and discussion

Fish density and biomass by site

A total of 642 fish (11.3 kg) were caught at the 11 sites that were fished in 2014, which comprised 2,914 lineal m and 11,656 m² in area (Table 2). Koura and 4 fish species were present, with common bully the most abundant species (Table 3). Goldfish (56 fish) was the next most abundant species, and was most abundant in sites 8-11 the lower channel, especially at site 11, the excavated side channel. Rainbow trout were next the most abundant species (13 fish).

Common bullies had the highest densities of any fish species in 2014 (up to 27 fish 100 m⁻² at the site 5, edge habitat), but goldfish were more abundant than smelt at site 11 (Table 4). Mean bully biomass (5.25 g m⁻²) was much higher than for smelt (0.07 g m⁻²; Table 5). Koura had a patchy distribution; only 5 individuals were caught. Catch per unit effort (for time) reflected species density at each site (Table 6).

Table 3. Total number of each species in the Ohau Channel collected in 10-min passes at 11 sample sites with boat electrofishing on 9 December 2014. Blank cells indicate no catch for that species.

Site	Number of individuals per site								
	Common bully	Common smelt	Goldfish	Longfin eel	Shortfin eel	Rainbow trout	Brown trout	Koura	Total
1	11					1		1	13
2	10					3			13
3	6					4			10
4	7	1				1			9
5	270	4						3	277
6	8					2			10
7	58	2							60
8	142		9					1	152
9	13		8			1			22
10	3		2			1			6
11	33		37						70
Total	561	7	56	0	0	13	0	5	642

Table 4. Density of each species in the Ohau Channel collected in 10-min passes at 11 sample sites with boat electrofishing on 9 December 2014.

Site	Density (number 100 m ⁻²)								Total
	Common bully	Common smelt	Goldfish	Longfin eel	Shortfin eel	Rainbow trout	Brown trout	Koura	
1	0.84	0.00	0.00	0.00	0.00	0.08	0.00	0.08	1.0
2	0.81	0.00	0.00	0.00	0.00	0.24	0.00	0.00	1.1
3	0.37	0.00	0.00	0.00	0.00	0.25	0.00	0.00	0.6
4	0.85	0.12	0.00	0.00	0.00	0.12	0.00	0.00	1.1
5	26.89	0.40	0.00	0.00	0.00	0.00	0.00	0.30	27.6
6	0.62	0.00	0.00	0.00	0.00	0.15	0.00	0.00	0.8
7	6.44	0.22	0.00	0.00	0.00	0.00	0.00	0.00	6.7
8	14.03	0.00	0.89	0.00	0.00	0.00	0.00	0.10	15.0
9	1.47	0.00	0.90	0.00	0.00	0.11	0.00	0.00	2.5
10	0.33	0.00	0.22	0.00	0.00	0.11	0.00	0.00	0.7
11	5.06	0.00	5.67	0.00	0.00	0.00	0.00	0.00	10.7
Mean	5.25	0.07	0.70	0.00	0.00	0.10	0.00	0.04	6.2

Table 5. Areal biomass of fish and koura in the Ohau Channel collected in 10-min passes at passes at 11 sampling sites with boat electrofishing on 9 December 2014.

Site	Biomass (g m ⁻²)								Total
	Common bully	Common smelt	Goldfish	Longfin eel	Shortfin eel	Rainbow trout	Brown trout	Koura	
1	0.03	0.000	0.00	0.00	0.00	0.00	0.00	0.01	0.04
2	0.01	0.000	0.00	0.00	0.00	1.41	0.00	0.00	1.42
3	0.01	0.000	0.00	0.00	0.00	0.59	0.00	0.00	0.59
4	0.04	0.000	0.00	0.00	0.00	0.00	0.00	0.00	0.04
5	0.39	0.003	0.00	0.00	0.00	0.00	0.00	0.14	0.53
6	0.01	0.000	0.00	0.00	0.00	1.24	0.00	0.00	1.25
7	0.09	0.002	0.00	0.00	0.00	0.00	0.00	0.00	0.10
8	0.21	0.000	1.04	0.00	0.00	0.00	0.00	0.08	1.33
9	0.04	0.000	0.99	0.00	0.00	0.00	0.00	0.00	1.03
10	0.00	0.000	0.12	0.00	0.00	0.00	0.00	0.00	0.12
11	0.11	0.000	5.92	0.00	0.00	0.00	0.00	0.00	6.03
Mean	0.08	<0.001	0.73	0.00	0.00	0.29	0.00	0.02	1.13

Table 6. Catch per unit effort of common bully, common smelt, goldfish and rainbow trout in the Ohau Channel caught at passes at 11 sample sites with boat electrofishing on 9 December 2014.

Site	Time fished (min)	Catch per unit effort (fish min ⁻¹)			
		Common bully	Common smelt	Goldfish	Rainbow trout
1	10	1.10	0.00	0.00	0.10
2	10	1.00	0.00	0.00	0.30
3	10	0.60	0.00	0.00	0.40
4	10	0.70	0.10	0.00	0.10
5	10	27.00	0.40	0.00	0.00
6	10	0.80	0.00	0.00	0.20
7	10	5.80	0.20	0.00	0.00
8	10	14.20	0.00	0.90	0.00
9	10	1.30	0.00	0.80	0.10
10	10	0.30	0.00	0.20	0.10
11	10	3.30	0.00	3.70	0.00
Total	110				
Mean		5.10	0.06	0.51	0.12

Fish abundance by year

Comparing catches over the 8 years of sampling, the abundance of common bullies in 2014 (4.81 fish 100 m⁻²) was consistent with catch rates in most post-wall years (after 2007; range 0.81-5.72 fish 100 m⁻²), but lower than in 2013 (Table 7B). The cause of fluctuating bully abundance is not known, and was not accounted for by changes in water clarity expressed as black disc distance (BDD), water temperature, or water conductivity (Table 8). Poor water clarity can reduce the efficiency of electrofishing, suggesting that bully density estimates might decrease with decreasing BDD. However, common bully densities in 2012 and 2011 were inversely related BDD. In 2014, catches of smelt, a similar sized fish to bullies, were extremely low.

Goldfish biomass increased initially 2009 and 2010 because of targeted fishing in the excavated side channel (site 11), which has dense macrophyte beds that provide good habitat for goldfish. The continued rise in goldfish density from 2012 on suggests a real increase in goldfish numbers has occurred. Eels were scarce in the Ohau Channel and catches were very variable. Longfin eels were caught in most years, and in 2012 and 2013 shortfin eels were also caught, but in 2014 no eels were caught (Table 7A and B).

Analysis of fish densities before and after wall closure is hampered by the single data point for 2007 before closure. However, we now have 7 years of post-wall data, and comparison of means and standard deviations suggest that the number of bullies might have decreased after wall closure (Figure 2).

An intriguing trend of decreasing rainbow trout densities with increasing BDD, which is a measure of both water clarity and phytoplankton abundance, has occurred following wall construction (Figure 3). The trend is opposite to the usual decline of catch rate by boat electrofishing with reduced water clarity. The explanation for this is not immediately clear, and could be increased avoidance of the electrofishing boat by trout in clearer water. It is also possible that reduced BDD indicates high algal productivity in Lake Rotorua, which in turn could increase trout abundance in the Ohau Channel. This remains to be tested.

Table 7. A. Number of fish and koura and B. mean fish and koura densities in the Ohau Channel measured by boat electrofishing between 2007 and 2014. (Source of data: Brijs et al. 2008, 2009, 2010, Hicks et al. 2011, 2013, 2014, and this survey).

A. Number of fish and koura

Year	Total all species	Common bully	Common smelt	Goldfish	Longfin eel	Shortfin eel	Rainbow trout	Brown trout	Gambusia	Koura	Time fished (min)	Distance fished (m)	Area fished (m ²)
2007	1,267	1,099	140	9	2	0	17	0	0	0	82	1,582	6,328
2008	774	429	311	2	1	0	31	0	0	0	100	2,033	8,133
2009	353	149	152	8	1	0	43	0	0	0	101	2,721	10,884
2010	921	604	206	18	1	0	92	0	0	0	112	3,488	13,952
2011	399	298	39	28	4	0	25	2	1	2	129	2,721	10,884
2012	301	117	131	33	1	1	15	1	0	2	115	3,625	14,500
2013	1,025	583	373	42	1	1	23	1	0	1	112	2,871	11,484
2014	642	561	7	56	0	0	13	0	0	5	106	2,914	11,656

B. Mean fish and koura densities

Year	Density (individuals 100 m ⁻²)									
	Total all species	Common bully	Common smelt	Goldfish	Longfin eel	Shortfin eel	Rainbow trout	Brown trout	Gambusia	Koura
2007	20.02	17.37	2.21	0.14	0.03	0.00	0.27	0.00	0.00	0.00
2008	9.52	5.27	3.82	0.02	0.01	0.00	0.38	0.00	0.00	0.00
2009	3.24	1.37	1.40	0.07	0.01	0.00	0.40	0.00	0.00	0.00
2010	6.60	4.33	1.48	0.13	0.01	0.00	0.66	0.00	0.00	0.00
2011	3.67	2.74	0.36	0.26	0.04	0.00	0.23	0.02	0.01	0.02
2012	2.08	0.81	0.90	0.23	0.01	0.01	0.10	0.01	0.00	0.01
2013	8.93	5.08	3.25	0.37	0.01	0.01	0.20	0.01	0.00	0.01
2014	5.51	4.81	0.06	0.48	0.00	0.00	0.11	0.00	0.00	0.04

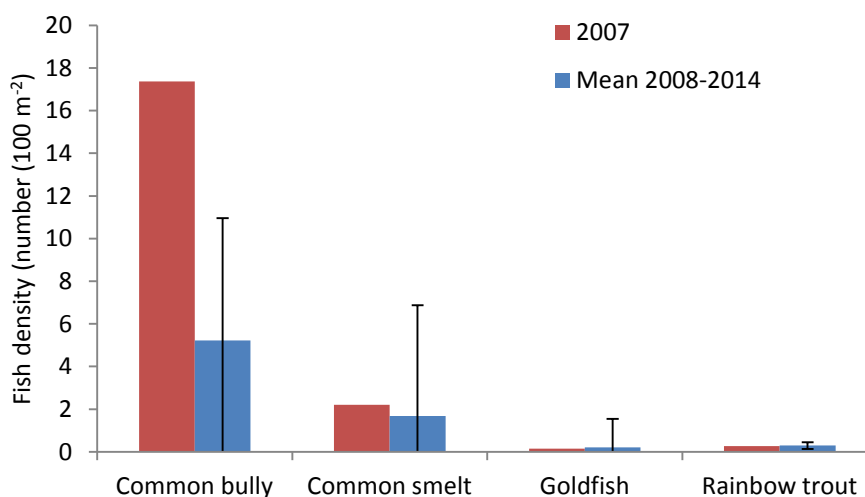


Figure 2. Comparison of fish densities in the Ohau Channel before wall closure (2007) compared to after wall closure (2008-2014). Error bars are 1 standard deviation.

Table 8. Conductivity and black disc distance measured in the in the Ohau Channel at the time of boat electrofishing surveys between 2007 and 2014. NZDST = New Zealand daylight saving time, i.e., UTC+13 h. UTC = Universal time coordinated. (Source of data: Brijs et al. 2008, 2009, 2010, Hicks et al. 2011, 2013, 2014, and this survey).

Date	Time (h NZDT)	Water temperature (°C)	Ambient conductivity ($\mu\text{S cm}^{-1}$)	Specific conductivity ($\mu\text{S cm}^{-1}$)	Black disc distance (m)
13-Dec-07	1015	18.8	159.3	180.9	2.00
11-Dec-08	1030	20.4	167.8	183.7	0.80
7-Dec-09	1045	19.4	172.4	193.4	0.65
7-Dec-10	1100	20.1	169.7	187.4	0.50
5-Dec-11	1030	17.8	148.5	173.5	0.85
4-Dec-12	0900	17.4	144.1	169.4	1.30
27-Nov-13	1100	20.9	169.3	183.5	0.80
9-Dec-14	1030	18.4	163.0	184.2	1.45

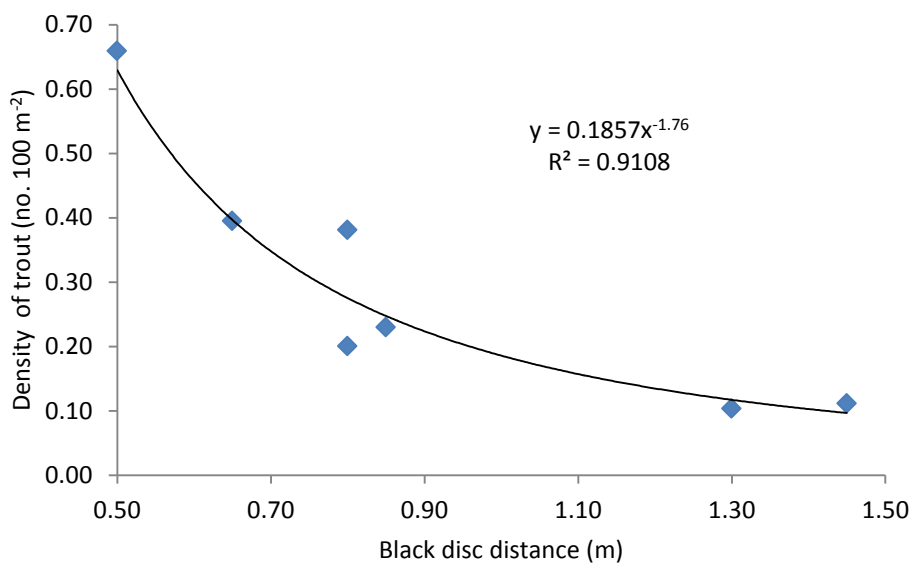


Figure 3. Relationship of rainbow trout density to black disc distance in the Ohau Channel between 2008 and 2014 following wall construction, excluding 2007 data before wall closure.

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