Boat electrofishing surveys of fish populations in the Ohau Channel in 2011 and 2012

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by

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Cover picture: Jeroen Brijs holding a longfin eel (*Anguilla dieffenbachii*) captured from the Ohau Channel

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Executive summary

The aim of the survey was to provide on-going monitoring of the fish communities and abundance 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 fifth and sixth years of sampling (2011 and 2012) in view of previous surveys using boat electrofishing in the Ohau Channel.

We used a 4.5 m-long, aluminium-hulled electrofishing boat with a 5-kilowatt 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 2011 and 2012, 10 of which were locations fished in previous surveys.

A total of 399 fish (29.4 kg) were caught in 2011 and 301 fish (12.8 kg) were caught in 2012 from 10 sites in 2011 (2,420 linear m, 9,680 m^2 area) and 11 sites in 2012 (3,625 linear m, 14,500 m^2 area). Koura and 7 fish species were present in both years, with common bully the most abundant in 2011 and common smelt the most abundant in 2012. One shortfin eel was found at site 2 in 2012. Common smelt were more abundant in 2012 (131 fish) than in 2011 (39 fish). Goldfish were most abundant in sites the lower channel, especially at site 7.

As reflected in total numbers, common bullies had the highest densities of any fish species in 2011 (up to 7.4 fish 100 m^{-2}), the majority of which were taken from edge habitats at sites 4, 5 and site 7. In 2012, common bully abundance was much reduced. However, despite the lower bully densities in 2012, mean bully biomass was higher in 2012 (1.00 g m^{-2}) than in 2011 (0.04 g m^{-2}) because bullies were smaller in 2011.

Common smelt had variable densities in the Ohau Channel, the largest number of which was found in and around the excavated side branch at site 7 edge habitats (up to 14.7 fish 100 m^{-2}) below the weir (site 1).

Mean density of rainbow trout in the Ohau Channel was similar in both years (0.27 fish 100 m^{-2} in 2011 and years (0.24 fish 100 m^{-2} in 2012). Mean biomass of rainbow trout was much greater in 2012 (0.69 g m^{-2} in 2011, 11.2 g m^{-2} in 2012) Goldfish densities were greater in 2012, partly because goldfish at site 7 were targetted in 2012, and mean biomass was correspondingly greater (0.48 g m^{-2} in 2011, 47.7 g m^{-2} in 2012). Site 7 had 282 g m^{-2} of goldfish biomass in 2012.

Catch per unit effort (CPUE) for common bullies in 2011 was twice that in 2012, reflecting lower densities in 2012. Common smelt CPUE in 2012, however, was 5 times greater than in 2011. Despite the much higher biomass of goldfish in 2012, CPUE was much the same.

CPUE for rainbow trout was consistent throughout most of the sites in 2011, but in 2012 was greater in the upstream sites (1-7) than in the lower sites. CPUE was higher in 2010 (4.1 and 2.3 fish per min^{-1} in mid-channel sites 3 and 6 respectively).

The increased goldfish biomass in 2012 arose because of targetted fishing in the excavated side branch, which clearly offers good habitat for goldfish. In 2012, the first shortfin eel encountered in these surveys was caught. The abundance of common bully appears to have a clear trend of reducing abundance since these surveys started in 2007. The cause of this is not apparent, and not accounted for by water clarity expressed as black disk (BD) distance or water conductivity (Table 7). Poor water clarity can reduce the efficiency of electrofishing, but BD was greater in 2012 than in 2011. It is possible that smelt abundance has declined too, but the relatively inefficient sampling resulting from boat electrofishing must be considered. Independent verification is required.

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1. Introduction

Environment Bay of Plenty (EBOP) contracted the Centre for Biodiversity and Ecology Research (CBER) to conduct a survey of common smelt and common bully abundance by boat electrofishing in the Ohau Channel. Similar surveys had been previously carried out in December of 2007, 2008, 2009 and 2010 (Brijs et al. 2008, 2009, 2010, Hicks et al. 2011). 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, the aim of the survey has been modified to provide on-going monitoring of the fish communities and abundance 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 fifth and sixth years of sampling (2011 and 2012) in view of previous surveys using boat electrofishing in the Ohau Channel.

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 2011 and 2012, 10 of which were locations fished in previous surveys (Tables 1A and 1B), with 1 additional site fished in 2012 that was near the excavated side branch immediately upstream of State Highway 33 (site 11, Table 1B, Figure 1).

Table 1. Fishing transect locations (latitude and longitude) from start to finish and habitat types sampled on A. 5 December 2011 and B. 4 December 2012 in the Ohau Channel.

A. 5 December 2011

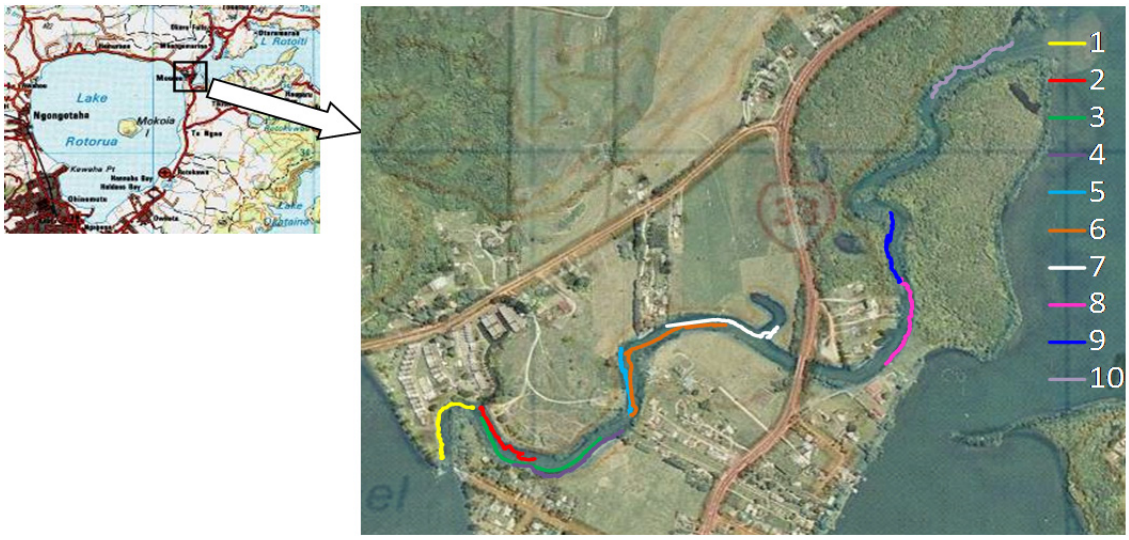
Site	Habitat	Start position for fishing Lattitude/longitude	End position for fishing Lattitude/longitude
Lake Rotorua			
Site 1	Edge habitat below weir	S37 47.285 E175 17.279	S38 02.706 E176 19.472
Site 2	Edge habitat by net site 1	S37 47.285 E175 17.279	S38 02.757 E176 19.530
Site 3	Mid channel habitat by net site 1	S37 47.282 E175 17.279	S38 02.744 E176 19.623
Site 4	Edge habitat by net site 2	S37 47.285 E175 17.279	S38 02.735 E176 19.648
Site 5	Edge habitat	S38 02.709 E176 19.669	S38 02.631 E176 19.656
Site 6	Mid channel habitat	S37 47.282 E175 17.279	S38 02.617 E176 19.811
Site 7	Edge habitat with artificial enlargement	S37 47.285 E175 17.279	S38 02.636 E176 19.867
Site 8	Edge habitat by net site 3	S37 47.285 E175 17.279	S38 02.557 E176 20.017
Site 9	Willow edge	S37 47.285 E175 17.279	S38 02.508 E176 19.987
Site 10	Edge habitat by net site 4	S37 47.285 E175 17.279	S38 02.273 E176 20.136
Lake Rotoiti			

B. 4 December 2012

Site	Habitat	Start position for fishing Lattitude/longitude	End position for fishing Lattitude/longitude
Lake Rotorua			
Site 1	Edge habitat below weir	S38 02.762 E176 19.431	S38 02.705 E176 19.465
Site 2	Edge habitat by net site 1	S38 02.337 E176 20.038	S38 02.282 E176 20.124
Site 3	Mid channel habitat by net site 1	S38 02.614 E176 19.832	S38 02.619 E176 19.829
Site 4	Edge habitat by net site 2	S38 02.762 E176 19.431	S38 02.762 E176 19.534
Site 5	Edge habitat	S38 02.714 E176 19.479	S38 02.732 E176 19.641
Site 6	Mid channel habitat	S38 02.752 E176 19.498	S38 02.756 E176 19.617
Site 7	Edge habitat with artificial enlargement	S38 02.710 E176 19.671	S38 02.631 E176 19.656
Site 8	Edge habitat by net site 3	S38 02.720 E176 19.664	S38 02.602 E176 19.748
Site 9	Willow edge	S38 02.599 E176 19.729	S38 02.613 E176 19.824
Site 10	Edge habitat by net site 4	S38 02.599 E176 19.729	S38 02.549 E176 20.012
Site 11	Site 7 goldfish	S38 02.628 E176 20.004	S38 02.502 E176 19.989
Lake Rotoiti			

As in previous seasons, electrofishing sites were selected in accordance with NIWA trap netting locations so that direct comparisons of fish densities using two different methods could be made. In particular, 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 6-25 minutes across each of the habitats (Table 5), which included littoral areas, macrophyte beds and mid-channel habitats for the specified target species.

A. 2011



B. 2012

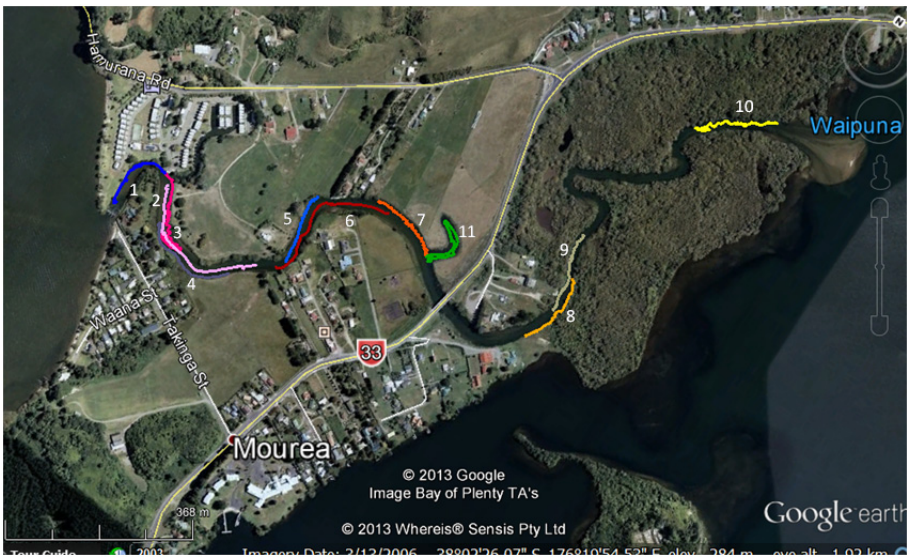


Figure 1. Fishing transects sampled on A. 5 December 2011 and 4 December 2012 in the Ohau Channel starting from Lake Rotorua and ending at Lake Rotoiti. Site codes correspond to locations in Table 1A and B.

All smelt and bullies were anaesthetised in benzocaine after collection then transferred into labelled bags for weighing (g) and measurement (mm) back at the lab. Because of the longer time period required to anaesthetise and revive eels and trout (for release), we fished all 10 or 11 sites consecutively with trout and eels from each sampling station placed in labelled mesh bags (4-mm mesh) and secured in the channel at each sample station. When all sites had been fished, holding bags at each sample station were recovered using the GPS coordinates. Fish were then anaesthetised in benzocaine, measured, and monitored for recovery before being released at their sample location.

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). Specific conductivity, i.e., standardised to 25^{o}C, was 173.5 µS cm^{-1} in 2011 and 169.4 µS cm^{-1} in 2012, and ambient conductivity, which controls power transfer of the electrical field, was 148.5 µS cm^{-1} in 2011 and 144.1 µS cm^{-1} in 2012 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. With the percent of range of the GPP set to 50% in 2011 and 60% in 2012, 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 denotes that the boat fished a transect about 4-m wide, which was 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 the on-board GPS.

3. Study site

Water temperature at the starting point of fishing was 17.8^{o}C at 1000 h NZDST on 5 December 2012 and 17.4^{o}C at 0900 h NZDST on 4 December 2012 and the fishing depth ranged between 0.4 to 2.8 m. The littoral zones of the Ohau Channel remained much the same as in previous seasons and consisted mainly of residential gardens and pasture in the upstream half of the channel (Lake Rotorua end) and riparian willows in the downstream half of the channel (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 menziesi*) in bare sandy areas. The black disc visibility (BD), which measures horizontal underwater visibility, was 0.85 m in 2011 and 1.3 m in 2012, which was greater that in recent surveys; the BD was 0.50 m in 2010, 0.65 m in 2009, 0.8 m in 2008 and 2.0 m in 2007.

The Ohau Channel begins where a weir has been constructed to control the outflow of Lake Rotorua and 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.

4. Results

A total of 399 fish (29.4 kg) were caught in 2011 and 301 fish (12.8 kg) were caught in 2012 from 10 sites in 2011 (2,420 linear m, 9,680 m^2 area, Table 2A) and 11 sites in 2012 (3,625 linear m, 14,500 m^2 area, Table 2B). Koura and 7 fish species were present in both years, with common bully the most abundant in 2011 and common smelt the most abundant in 2012. One shortfin eel was found at site 2 in 2012 (Table 2B). Common smelt were more abundant in 2012 (131 fish) than in 2011 (39 fish). Goldfish were most abundant in sites the lower channel, especially at site 7.

As reflected in total numbers (Table 2), common bullies had the highest densities of any fish species in 2011 (up to 7.4 fish 100 m^{-2}), the majority of which were taken from edge habitats at sites 4, 5 and site 7 (Table 3A). In 2012, common bully abundance was much reduced (Table 3B). However, despite the lower bully densities in 2012, mean bully biomass was higher in 2012 (1.00 g m^{-2}) than in 2011 (0.04 g m^{-2}; Table 4) because bullies were smaller in 2011.

Common smelt had variable densities in the Ohau Channel, the largest number of which was found in and around the excavated side branch at site 7 edge habitats (up to 14.7 fish 100 m^{-2}, Table 3B) below the weir (site 1).

Mean density of rainbow trout in the Ohau Channel was similar in both years (0.27 fish 100 m^{-2} in 2011 and years (0.24 fish 100 m^{-2} in 2012; Table 3). Mean biomass of rainbow trout was much greater in 2012 (0.69 g m^{-2} in 2011, 11.2 g m^{-2} in 2012) Goldfish densities were greater in 2012 (Table 3), partly because goldfish at site 7 were targetted in 2012, and mean biomass was correspondingly greater (0.48 g m^{-2} in 2011, 47.7 g m^{-2} in 2012, Table 4). Site 7 had 282 g m^{-2} of goldfish biomass in 2012 (Table 4B).

Catch per unit effort (CPUE) for common bullies in 2011 was twice that in 2012 (Table 5), reflecting lower densities in 2012 (Table 3). Common smelt CPUE in 2012, however, was 5 times greater than in 2011 (Table 5). Despite the much higher biomass of goldfish in 2012, CPUE was much the same.

CPUE for rainbow trout was consistent throughout most of the sites in 2011, but in 2012 was greater in the upstream sites (1-7) than in the lower sites (Table 5). CPUE was higher in 2010 (4.1 and 2.3 fish per min^{-1} in mid-channel sites 3 and 6 respectively; Hicks et al. 2011).

Table 2. Total number of each species in the Ohau Channel collected in 10-min passes at 10 or 11 sample sites with boat electrofishing A. 5 December 2011 and B. 4 December 2012.

A. 5 December 2011

Site	Habitat	Distance fished (m)	Area fished (m^2)	Number of individuals per site								
				Common bully	Common smelt	Goldfish	Longfin eel	Gambusia	Rainbow trout	Brown trout	Koura	Total
Site 1	Edge	330	1,320	37	2	0	2	0	5	0	0	46
Site 2	Edge	150	600	4	0	0	0	0	3	1	1	9
Site 3	Mid channel	190	760	0	0	0	0	0	3	1	0	4
Site 4	Edge	260	1,040	57	15	0	1	0	1	0	0	74
Site 5	Edge	160	640	49	0	0	0	0	0	0	0	49
Site 6	Mid channel	380	1,520	0	0	0	0	0	7	0	0	7
Site 7	Edge	430	1,720	127	19	9	0	1	0	0	1	157
Site 8	Edge	150	600	11	2	2	1	0	3	0	0	19
Site 9	Edge	180	720	9	1	0	0	0	3	0	0	13
Site 10	Edge	190	760	4	0	17	0	0	0	0	0	21
Total		2,420	9,680	298	39	28	4	1	25	2	2	399

B. 4 December 2012

Site	Habitat	Distance fished (m)	Area fished (m^2)	Number of individuals per site								
				Common bully	Common smelt	Goldfish	Longfin eel	Shortfin eel	Rainbow trout	Brown trout	Koura	Total
Site 1	Edge	260	1,040	0	0	0	1	0	4	0	0	5
Site 2	Edge	362	1,448	1	7	0	0	1	6	0	0	15
Site 3	Mid channel	339	1,356	4	12	0	0	0	1	1	0	18
Site 4	Edge	686	2,744	27	18	0	0	0	0	0	0	45
Site 5	Edge	376	1,504	18	22	0	0	0	0	0	1	41
Site 6	Mid channel	292	1,168	0	0	0	0	0	2	0	0	2
Site 7	Edge	229	916	19	0	10	0	0	1	0	1	31
Site 8	Edge	346	1,384	7	1	1	0	0	0	0	0	9
Site 9	Edge	295	1,180	9	24	0	0	0	0	0	0	33
Site 10	Edge	217	868	6	2	5	0	0	0	0	0	13
Site 11	Site 7 oxbow	223	892	26	45	17	0	0	1	0	0	89
Total		3,625	14,500	117	131	33	1	1	15	1	2	301

Table 3. Density of each species in the Ohau Channel collected in 10-min passes at 10 or 11 sample sites with boat electrofishing A. 5 December 2011 and B. 4 December 2012.

A. 5 December 2011

Site	Habitat	Distance fished (m)	Area fished (m^2)	Density (number 100 m^{-2}) Common bully	Common smelt	Goldfish	Longfin eel	Gambusia	Rainbow trout	Brown trout	Koura	Total
Site 1	Edge	330	1,320	2.80	0.15	0.00	0.15	0.00	0.38	0.00	0.00	3.48
Site 2	Edge	150	600	0.67	0.00	0.00	0.00	0.00	0.50	0.17	0.17	1.50
Site 3	Mid channel	190	760	0.00	0.00	0.00	0.00	0.00	0.39	0.13	0.00	0.53
Site 4	Edge	260	1,040	5.48	1.44	0.00	0.10	0.00	0.10	0.00	0.00	7.12
Site 5	Edge	160	640	7.66	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.66
Site 6	Mid channel	380	1,520	0.00	0.00	0.00	0.00	0.00	0.46	0.00	0.00	0.46
Site 7	Edge	430	1,720	7.38	1.10	0.52	0.00	0.06	0.00	0.00	0.06	9.13
Site 8	Edge	150	600	1.83	0.33	0.33	0.17	0.00	0.50	0.00	0.00	3.17
Site 9	Edge	180	720	1.25	0.14	0.00	0.00	0.00	0.42	0.00	0.00	1.81
Site 10	Edge	190	760	0.53	0.00	2.24	0.00	0.00	0.00	0.00	0.00	2.76
Mean		242	968	2.76	0.32	0.31	0.04	0.01	0.27	0.03	0.02	3.76

B. 4 December 2012

Site	Habitat	Distance fished (m)	Area fished (m^2)	Density (number 100 m^{-2}) Common bully	Common smelt	Goldfish	Longfin eel	Shortfin eel	Rainbow trout	Brown trout	Koura	Total
Site 1	Edge	260	1,040	0.10	0.67	0.00	0.00	0.10	0.58	0.00	0.00	1.44
Site 2	Edge	362	1,448	0.28	0.83	0.00	0.00	0.00	0.07	0.07	0.00	1.24
Site 3	Mid channel	339	1,356	1.99	1.33	0.00	0.00	0.00	0.00	0.00	0.00	3.32
Site 4	Edge	686	2,744	0.66	0.80	0.00	0.00	0.00	0.00	0.00	0.04	1.49
Site 5	Edge	376	1,504	0.00	0.00	0.00	0.00	0.00	0.13	0.00	0.00	0.13
Site 6	Mid channel	292	1,168	1.63	0.00	0.86	0.00	0.00	0.09	0.00	0.09	2.65
Site 7	Edge	229	916	0.76	0.11	0.11	0.00	0.00	0.00	0.00	0.00	0.98
Site 8	Edge	346	1,384	0.65	1.73	0.00	0.00	0.00	0.00	0.00	0.00	2.38
Site 9	Edge	295	1,180	0.51	0.17	0.42	0.00	0.00	0.00	0.00	0.00	1.10
Site 10	Edge	217	868	3.00	5.18	1.96	0.00	0.00	0.12	0.00	0.00	10.25
Site 11	Site 7 oxbow	223	892	13.12	14.69	3.70	0.11	0.11	1.68	0.11	0.22	33.74
Mean		330	1,318	2.06	2.32	0.64	0.01	0.02	0.24	0.02	0.03	5.34

Table 4. Areal biomass of each species in the Ohau Channel collected in 10-min passes at 10 or 11 sample sites with boat electrofishing A. 5 December 2011 and B. 4 December 2012.

A. 5 December 2011

Site	Habitat	Distance fished (m)	Area fished (m^2)	Biomass ($g\ m^{-2}$) Common bully	Common smelt	Goldfish	Longfin eel	Gambusia	Rainbow trout	Brown trout	Total
Site 1	Edge	330	1,320	-	0.00	0.00	1.78	0.00	0.04	0.00	1.83
Site 2	Edge	150	600	-	0.00	0.00	0.00	0.00	2.82	5.64	8.46
Site 3	Mid channel	190	760	0.00	0.00	0.00	0.00	0.00	1.97	2.91	4.88
Site 4	Edge	260	1,040	0.05	0.01	0.00	8.62	0.00	0.05	0.00	8.74
Site 5	Edge	160	640	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.07
Site 6	Mid channel	380	1,520	0.00	0.00	0.00	0.00	0.00	1.94	0.00	1.94
Site 7	Edge	430	1,720	0.11	0.01	0.47	0.00	0.00	0.00	0.00	0.58
Site 8	Edge	150	600	0.02	0.00	0.67	3.09	0.00	0.05	0.00	3.83
Site 9	Edge	180	720	0.03	0.00	0.00	0.00	0.00	0.01	0.00	0.05
Site 10	Edge	190	760	0.03	0.00	3.65	0.00	0.00	0.00	0.00	3.68
Mean		242	968	0.04	0.00	0.48	1.35	0.00	0.69	0.85	3.40

B. 4 December 2012

Site	Habitat	Distance fished (m)	Area fished (m^2)	Biomass ($g\ m^{-2}$) Common bully	Common smelt	Goldfish	Longfin eel	Shortfin eel	Rainbow trout	Brown trout	Total
Site 1	Edge	260	1,040	0.00	0.00	0.00	353.85	0.00	1.89	0.00	355.74
Site 2	Edge	362	1,448	0.10	0.24	0.00	0.00	57.52	71.19	0.00	129.06
Site 3	Mid channel	339	1,356	0.12	0.46	0.00	0.00	0.00	17.13	129.73	147.44
Site 4	Edge	686	2,744	1.46	0.24	0.00	0.00	0.00	0.00	0.00	1.70
Site 5	Edge	376	1,504	0.63	0.59	0.00	0.00	0.00	0.00	0.00	1.21
Site 6	Mid channel	292	1,168	0.00	0.00	0.00	0.00	0.00	6.38	0.00	6.38
Site 7	Edge	229	916	1.36	0.00	158.33	0.00	0.00	10.68	0.00	170.37
Site 8	Edge	346	1,384	1.22	0.02	13.13	0.00	0.00	0.00	0.00	14.37
Site 9	Edge	295	1,180	0.28	0.65	0.00	0.00	0.00	0.00	0.00	0.92
Site 10	Edge	217	868	2.58	0.15	71.28	0.00	0.00	0.00	0.00	74.01
Site 11	Site 7 oxbow	223	892	3.25	2.46	282.19	0.00	0.00	15.71	0.00	303.62
Mean		330	1,318	1.00	0.44	47.72	32.17	5.23	11.18	11.79	109.53

Table 5. CPUE (fish min^{-1}) of common bully, common smelt, goldfish and rainbow trout in the Ohau Channel caught on A. 5 December 2011 and B. 4 December 2012.

A. 5 December 2011

Site	Time fished (min)	Catch per unit effort (fish per min^{-1}) Common bully	Common smelt	Goldfish	Rainbow trout
Site 1	10.0	3.70	0.20	0.00	0.50
Site 2	9.0	0.44	0.00	0.00	0.33
Site 3	12.0	0.00	0.00	0.00	0.25
Site 4	25.0	2.28	0.60	0.00	0.04
Site 5	11.0	4.45	0.00	0.00	0.00
Site 6	9.0	0.00	0.00	0.00	0.78
Site 7	19.0	6.68	1.00	0.47	0.00
Site 8	6.0	1.83	0.33	0.33	0.50
Site 9	12.0	0.75	0.08	0.00	0.25
Site 10	16.0	0.25	0.00	1.06	0.00
Total	129.0				
Mean		2.04	0.22	0.19	0.27

B. 4 December 2012

Site	Time fished (min)	Catch per unit effort (fish per min^{-1}) Common bully	Common smelt	Goldfish	Rainbow trout
Site 1	8.0	0.00	0.00	0.00	0.50
Site 2	10.0	0.10	0.70	0.00	0.60
Site 3	10.0	0.40	1.20	0.00	0.10
Site 4	10.0	2.70	1.80	0.00	0.00
Site 5	10.0	1.80	2.20	0.00	0.00
Site 6	11.0	0.00	0.00	0.00	0.18
Site 7	10.0	1.90	0.00	1.00	0.10
Site 8	10.0	0.70	0.10	0.10	0.00
Site 9	10.0	0.90	2.40	0.00	0.00
Site 10	10.0	0.60	0.20	0.50	0.00
Site 11	16.0	1.63	2.81	1.06	0.06
Total	115.0				
Mean		0.98	1.04	0.24	0.14

5. Discussion

The increased goldfish biomass in 2012 arose because of targetted fishing in the excavated side branch, which clearly offers good habitat for goldfish. In 2012, the first shortfin eel encountered in these surveys was caught. The abundance of common bully appears to have a clear trend of reducing abundance since these surveys started in 2007 (Table 6). The cause of this is not apparent, and not accounted for by water clarity expressed as black disk (BD) distance or water conductivity (Table 7). Poor water clarity can reduce the efficiency of electrofishing, but BD was greater in 2012 than in 2011 when common bully densities were lower. It is possible that smelt abundance has declined too, but the relatively inefficient sampling resulting from boat electrofishing must be considered. Independent verification is required.

Table 6. Fish and koura densities in the Ohau Channel measured by boat electrofishing between 2007 and 2012. (Source of data for 2007-2010: Brijs et al. 2008, 2009, 2010, Hicks et al. 2011).

	Density (individuals 100 m^{-2})									Time fished	Distance fished	Area fished
Year	Common bully	Common smelt	Goldfish	Longfin eel	Shortfin eel	Rainbow trout	Brown trout	Koura	Total	(min)	(m)	(m^2)
2007	22.28	3.30	0.14	0.03	0.00	0.41	0.00	0.00	26.16	82	1,582	6,328
2008	6.14	4.12	0.03	0.01	0.00	0.22	0.00	0.00	10.52	100	2,033	8,133
2009	1.45	1.46	0.07	0.01	0.00	0.36	0.00	0.00	3.34	101	2,721	10,884
2010	4.34	1.65	0.16	0.01	0.00	0.53	0.00	0.10	6.79	112	3,488	13,952
2011	2.76	0.32	0.31	0.04	0.00	0.27	0.03	0.02	3.75	129	2,721	10,884
2012	0.86	0.99	0.33	0.01	0.01	0.12	0.01	0.02	2.35	115	3,625	14,500

Table 7. Specific conductivity measured in the in the Ohau Channel at the time of boat electrofishing surveys between 2007 and 2012. NZDT = New Zealand daylight time, i.e., UTC+13 h. UTC = Universal time coordinated. (Source of data for 2007-2010: Brijs et al. 2008, 2009, 2010, Hicks et al. 2011).

Date	Time (h NZDT)	Water temperature (^oC)	Ambient conductivity (µS cm^{-1})	Specific conductivity (µS cm^{-1})	Black disk distance (m)
13/12/2007	1015	18.8	159.3	180.9	2.00
11/12/2008	1030	20.4	167.8	183.7	0.80
7/12/2009	1045	19.4	172.4	193.4	0.65
7/12/2010	1100	20.1	169.7	187.4	0.50
5/12/2011	1030	17.8	148.5	173.5	0.85
4/12/2012	0900	17.4	144.1	169.4	1.30

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