Boat electrofishing survey of common smelt and common bully in the Ohau Channel

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by

Jeroen Brijs
Brendan J. Hicks
Dudley G. Bell

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

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Email: b.hicks@waikato.ac.nz

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Reviewed by:

Rob Donald
Environment Bay of Plenty

Approved for release by:

Nicholas Ling
University of Waikato

Executive summary

We conducted a boat electrofishing survey of the Ohau Channel, which flows from Lake Rotorua to Lake Rotoiti, on 11 December 2008. The purpose of this was to repeat a survey that took place on 13 December 2007 concerning the longitudinal pattern in densities of common smelt (*Retropinna retropinna*) and common bully (*Gobiomorphus cotidianus*). We caught 776 fish comprising three native species and three introduced species in 2.03 km of fished distance at a total of 10 sites. Native species caught were common smelt, common bully and longfin eel (*Anguilla dieffenbachii*) and introduced species were rainbow trout (*Oncorhynchus mykiss*), goldfish (*Carassius auratus*) and mosquitofish (*Gambusia affinis*). The total area fished was 8,133 m^2 (0.813 ha) giving an estimated density of 9.5 fish 100 m^{-2}.

Although we caught fewer fish in total during this survey, numbers of common smelt caught were three-fold greater (311) compared to the 2007 survey (96). Common smelt densities varied among the 10 different sites ranging from 0 to 16.9 smelt 100 m^{-2}. In both 2007 and 2008, common smelt displayed a longitudinal pattern in their distribution along the Ohau Channel. Highest densities were found at sites 1 to 4 (6.5 to 16.9 fish 100 m^{-2}) with the exception of site 3 (0.2 fish 100 m^{-2}) which was a mid-channel habitat. Downstream of site 4, densities of common smelt decreased significantly (0 to 0.7 fish 100 m^{-2}), with only a few individuals captured at each of the remaining sites. Smelt were mainly found in the littoral zones and were generally absent from the mid-channel habitats. Length-frequency distributions gathered in 2008 showed at least two size classes in the smelt population with numbers of adult smelt exceeding numbers of juveniles, which was similar to the results found in the 2007 survey.

Common bully densities varied among the 10 different sites ranging from 0 to 14.2 fish 100 m^{-2}. Approximately 60% fewer common bullies were caught in 2008 compared to 2007. This decrease can largely be attributed to lower fishing efficiency due to the reduction in water visibility in 2008 compared to 2007 (black disc reading was 0.8 m in 2008 compared to 2.0 m in 2007). The combination of poor visibility and the bully's benthic habit made it much more difficult to see the common bullies. In both 2007 and 2008, common bullies showed variable densities throughout the Ohau Channel and the highest densities were associated with beds of macrophytes. There were very low common bully densities in the mid-channel habitats and the willow edge habitat. Size-frequency distribution data gathered in both 2007 and 2008 show that the common bully population is mainly made up of small bullies (<40 mm) which suggests that recruitment is occurring successfully. The numbers of rainbow trout caught were almost three-fold greater in 2008 (31) compared to 2007 (13) and they were mainly found in the two swiftly flowing mid-channel habitats (sites 3 and 6). In both sampling periods, high numbers of trout coincided with the presence of high densities of common smelt near by. Longfin eels and goldfish were captured in both 2007 and 2008 but in each year these fish species were captured at different sites and in low densities. Mosquitofish were observed in 2008 but no attempt was made to quantify them.

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. An identical survey had been previously carried out on the 13 December 2007. The purpose of the survey 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).

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.

We fished 10 sites in the Ohau Channel on 13 December 2007 (Table 1; Figure 1). The sites chosen for electrofishing were based around the sites that NIWA had used for their trap netting survey so that direct comparisons of fish densities using two different methods could be made. Sites 2, 4, 8 and 10 coincided with the NIWA trapping sites and fishing started upstream of the site and carried on downstream past the site. The remaining 6 sites were spread thoughout the Ohau Channel and were chosen for different habitat characteristics so that data representative of the whole channel was collected. All of the sites had a fishing effort of 10 minutes. We attempted to fish most of the habitats found, such as the littoral areas, macrophyte beds and mid-channel habitats for the target species. Eels and trout were also collected, weighed and measured.

Electrical conductivity was measured with a YSI 3200 conductivity meter and horizontal water visibility was measured using a black disc. Specific conductivity for the Ohau Channel, i.e., standardised to 25°C, was 183.7 µS cm^{-1}, 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. We adjusted the percent of range setting of the GPP to 70% to give an applied current of 3-4 A 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 the area fished from the linear distance measured with the onboard global positioning system.

3. Study site

On 11 December 2008 the water temperature was 20.4°C and the water depth fished ranged from 0.20 to 2.8 m. The littoral zones of the Ohau Channel 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. Although no attempt was made to measure the water current flowing through the Ohau Channel on 11 December 2008, it was noticeably faster than the previous fishing on 13 December 2007. This was due to relatively high rainfall events occurring just prior to fishing. The increased flow also had an effect on horizontal water visibility as the black disc reading was significantly lower in 2008 (0.8 m) compared to 2007 (2.0 m).

Table 1. Locations of the 10 sites fished on 11 December 2008 in the Ohau Channel.

		Start position for fishing		End position for fishing	
Site	**Habitat**	**NZMG Easting**	**NZMG Northing**	**NZMG Easting**	**NZMG Northing**
1	Edge habitat below weir	2801830	6345355	2801874	6345474
2	Edge habitat by net site 1	2801901	6345465	2802032	6345357
3	Mid channel habitat by net site 1	2801902	6345462	2802192	6345474
4	Edge habitat by net site 2	2801975	6345349	2802180	6345426
5	Edge habitat	2802184	6345454	2802169	6345590
6	Mid channel habitat	2802184	6345444	2802336	6345646
7	Edge habitat with side channel	2802281	6345656	2802456	6345636
8	Edge habitat by net site 3	2802663	6345573	2802698	6345728
9	Willow edge	2802689	6345737	2802672	6345845
10	Edge habitat by net site 4	2802770	6346147	2802901	6346235

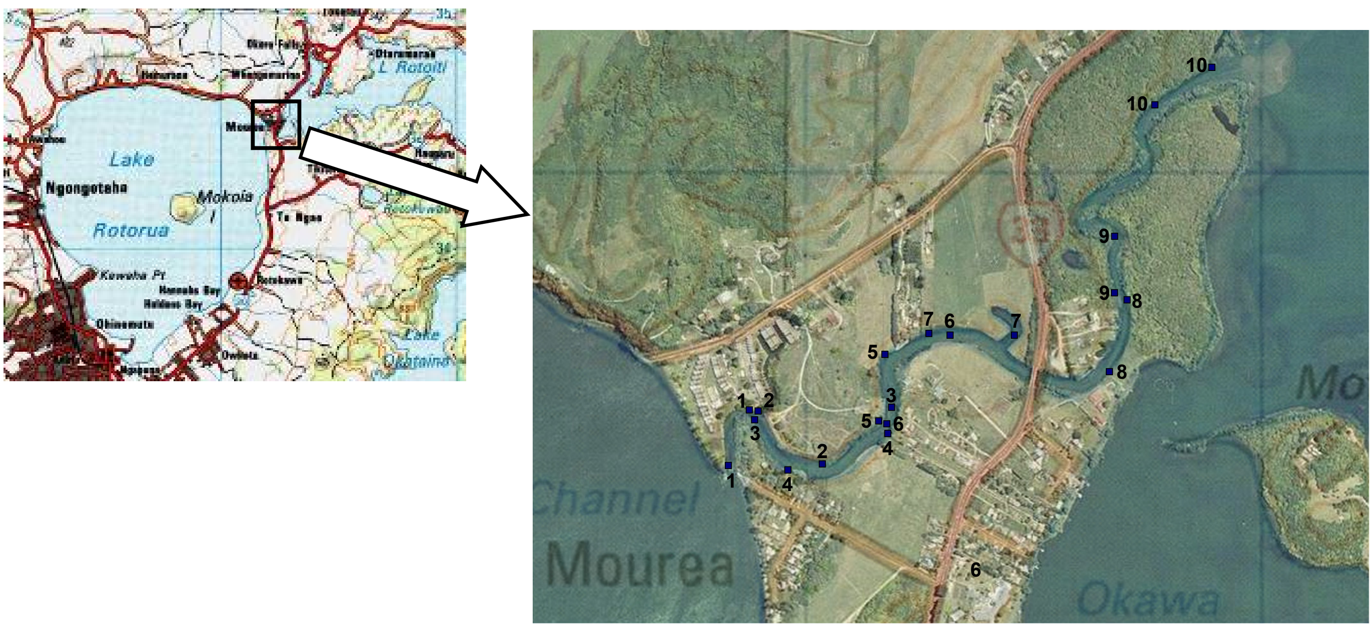

Figure 1. Sites fished on 11 December 2008 in the Ohau Channel which flows from Lake Rotorua to Lake Rotoiti. Site codes correspond to locations in Table 1.

The Ohau Channel begins where a weir has been constructed to control the outflow of Lake Rotorua (Figure 2) 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 (Figure 3) and an increase in the density 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 (Figure 4).

Figure 2. The weir between Lake Rotorua and the Ohau Channel where currents are relatively strong and fast. Photo: Brendan Hicks.

Figure 3. Halfway down the Ohau Channel at old oxbow on the true left bank. Photo: Brendan Hicks.

Figure 4. Willows dominating the true left bank of the lower Ohau Channel. Photo: Brendan Hicks.

4. Results

We caught 776 fish comprising three native and three introduced species in 2.03 km of fished length or an area of 8.12 km^2 from a total of 10 sites. Native species were common smelt (311), common bully (429) and longfin eels (1). The introduced species were rainbow trout (31), goldfish (2) (Table 2) and mosquitofish (not counted). No attempt was made to quantify the abundance or biomass of mosquitofish in the Ohau Channel because they are difficult to catch, being less susceptible to the electric field than other fish species.

The majority of common smelt were caught at sites 1, 2 and 4 (Table 2) which were all edge habitat sites at the upstream end of the Ohau Channel (close to Lake Rotorua). Densities of common smelt at these sites ranged from 6.5 to 16.9 fish 100 m^{-2} (Table 3). At site 3 (mid-channel habitat) and all sites downstream of site 4, smelt densities decreased significantly with densities ranging from 0 to 0.7 fish 100 m^{-2}. Catch per unit effort (CPUE) showed the same pattern with the highest CPUE (4.7 to 14.5 fish min^{-1}) found at sites 1, 2 and 4 (upstream end of channel), whereas site 3 (mid-channel habitat) and all of the other sites downstream had low CPUE ranging from 0 to 0.3 fish min^{-1} (Table 4). Biomasses of smelt were also highest at sites 1, 2 and 4, ranging from 5.89 to 17.31 g 100 m^{-2} whereas the rest of the sites had biomasses ranging from 0.00 to 0.73 g 100 m^{-2} (Table 3).

Common bully were caught at all of the sites along the Ohau Channel except for in the mid-channel habitats (sites 3 and 6; Table 2). Densities ranged from 0 to 14.2 fish 100 m^{-2} throughout the channel with the highest densities found at sites 4, 5 and 7 (11.1 to 14.2 fish 100 m^{-2}; Table 3). Common bully densities decreased upstream of site 4 (densities ranging from 0 to 5.8 fish 100 m^{-2}) and downstream of site 7 (densities ranging from 1.1 to 7.9 fish 100 m^{-2}). Sites 4, 5 and 7 were located in the middle section of the Ohau Channel and included large macrophyte beds. CPUE data (Table 4) also showed a similar trend with the highest CPUE found at sites 4, 5 and 7 (7.8 to 10.4 fish min^{-1}) whereas CPUE was lower at the other sites. The highest biomass (22.75 g 100 m^{-2}) of common bullies was found at site 8 where a high number of large bullies were captured. Biomasses ranged from 0.00 to 0.09 g m^{-2} at the other sites in the channel (Table 3).

A total of 31 rainbow trout were captured, with 26 of those being juveniles (FL< 200 mm). With the exception of the single juvenile rainbow trout found at site 10, all of the other rainbow trout were captured in the swiftly flowing mid-channel habitats (sites 3 and 6) (Table 2). The size of the rainbow trout ranged from 80 mm FL (juvenile) to 535 mm FL (adult) with a mean size of 190 mm FL. One 830 mm TL longfin eel was captured at site 2. Goldfish were only found at site 10 in relatively low densities.

Table 2. Numbers of fish caught by boat electrofishing at 10 sites in the Ohau Channel on 11 December 2008.

Lake Rotorua

Site	Habitat	Number of fish per site					
		Common bully	Common smelt	Goldfish	Longfin eels	Juvenile rainbow trout	Adult rainbow trout
1	Left bank edge habitat immediately below weir	23	104	0	0	0	0
2	Left bank edge habitat by trap site 1	42	47	0	1	0	0
3	Mid channel habitat by trap site 1	0	3	0	0	20	3
4	Right bank edge habitat by trap site 2	104	145	0	0	0	0
5	Right bank edge habitat	78	3	0	0	0	0
6	Mid channel habitat	0	0	0	0	5	2
7	Left bank edge habitat with side channel	104	1	0	0	0	0
8	Right bank edge habitat by trap site 3	54	3	0	0	0	0
9	Left bank willow edge	17	3	0	0	0	0
10	Left bank edge habitat by trap site 4	7	2	2	0	1	0
Total	774	429	311	2	1	26	5

Lake Rotoiti

Table 3. Densities and biomasses of common smelt and bullies at sites in the Ohau Channel that were fished on 11 December 2008.

Lake Rotorua

Site	Habitat	Total distance fished (m)	Area fished (m^2)	Bully density (fish 100 m^{-2})	Smelt density (fish 100 m^{-2})	Bully biomass (g 100 m^{-2})	Smelt biomass (g 100 m^{-2})
1	Left bank edge habitat immediately below weir	154	616	3.7	16.9	1.70	17.31
2	Left bank edge habitat by trap site 1	180	720	5.8	6.5	4.01	5.89
3	Mid channel habitat by trap site 1	393	1573	0.0	0.2	0.00	0.25
4	Right bank edge habitat by trap site 2	235	940	11.1	15.4	9.39	9.80
5	Right bank edge habitat	137	548	14.2	0.5	8.89	0.55
6	Mid channel habitat	306	1224	0.0	0.0	0.00	0.00
7	Left bank edge habitat with side channel	191	764	13.6	0.1	8.65	0.17
8	Right bank edge habitat by trap site 3	170	680	7.9	0.4	22.75	0.28
9	Left bank willow edge	109	436	3.9	0.7	6.38	0.73
10	Left bank edge habitat by trap site 4	158	632	1.1	0.3	3.22	0.35

Lake Rotoiti

Table 4. CPUE (fish min^{-1}) of common bully and common smelt in the Ohau Channel on 11 December 2008.

Lake Rotorua

Site	Habitat	Time fished (mins)	Bully CPUE (fish min^{-1})	Smelt CPUE (fish min^{-1})
1	Left bank edge habitat immediately below weir	10	2.3	10.4
2	Left bank edge habitat by trap site 1	10	4.2	4.7
3	Mid channel habitat by trap site 1	10	0	0.3
4	Right bank edge habitat by trap site 2	10	10.4	14.5
5	Right bank edge habitat	10	7.8	0.3
6	Mid channel habitat	10	0	0
7	Left bank edge habitat with side channel	10	10.4	0.1
8	Right bank edge habitat by trap site 3	10	5.4	0.3
9	Left bank willow edge	10	1.7	0.3
10	Left bank edge habitat by trap site 4	10	0.7	0.2

Lake Rotoiti

Common smelt in the Ohau Channel ranged from 34 mm to 64 mm FL. The length-frequency distribution (Figure 5) shows that there are at least two size classes of common smelt in the Ohau Channel. Lower numbers of juvenile smelt (34 mm – 45 mm FL) were present compared to adult smelt (45 mm – 64 mm FL) as the juveniles only made up 23% of the total catch. Closer examination of length-frequency distribution at each individual site revealed that the highest density of juveniles was found at site 4 with a density of 7.2 fish 100 m^{-2}.

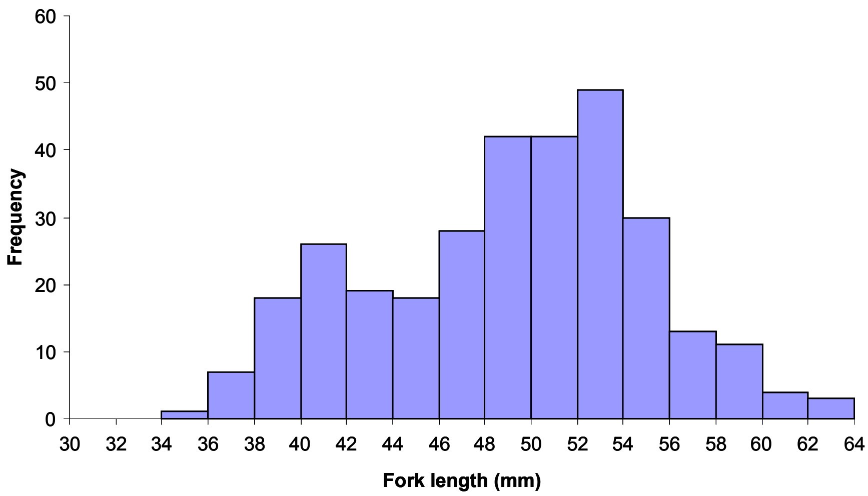

Figure 5. Length-frequency distribution of common smelt captured by boat electrofishing in the Ohau Channel on 11 December 2008.

Common bully in the Ohau Channel ranged from 20 mm to 87 mm. Size frequency data collected for common bully (Figure 6, Table 5) shows that the majority are in the smallest size class (< 35 mm). Generally as the size of the bullies increased, the numbers of individuals in the size class decreased. Table 5 shows that although the numbers of common bully captured in 2007 was more than double the amount captured in 2008, the proportions in each size class are fairly similar with over 80% of the catch in both years being smaller than 51 mm.

Table 5. Numbers and proportions of common bully in each size class in the Ohau Channel in 2007 and 2008.

	No. of common bullies		**% of total catch**	
FL (mm)	**2007**	**2008**	**2007**	**2008**
< 35	581	203	54	47
36 - 50	303	155	28	36
51 - 60	141	48	13	11
> 60	60	29	6	7
Total	1085	435	100	100

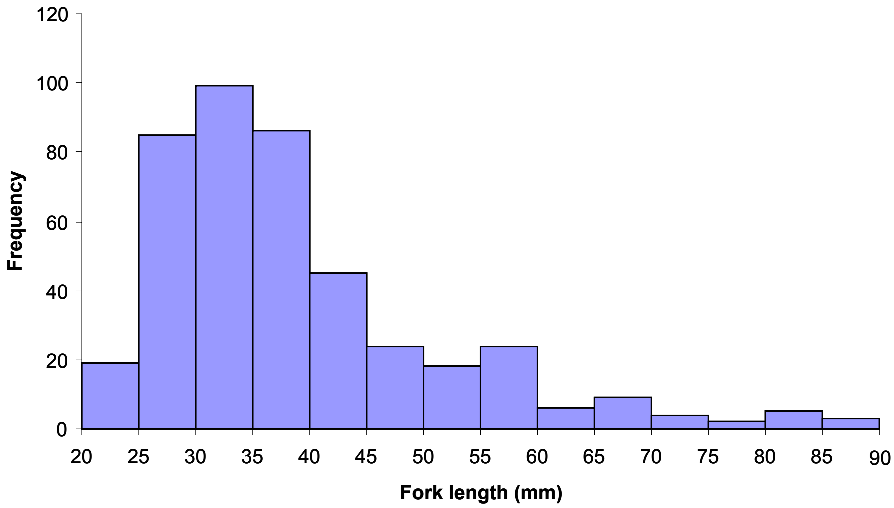

Figure 6. Length-frequency distribution of common bully captured by boat electrofishing in the Ohau Channel on 11 December 2008.

5. Conclusions

The Ohau Channel was fished in mid December in both 2007 and 2008. The moderate conductivity of the Ohau Channel (183.7 µS cm^{-1}) allowed efficient power transfer from the water to the fish because the range of conductivities was about the same as the presumed conductivity of the fish. Previous fishing with the electrofishing boat in the North Island, in similar conductivities and habitats, and with similar machine settings, has caught a full size range ofeels, smelt, bullies, grey mullet, rudd, brown bullhead catfish, perch, tench, goldfish, and koi carp (Hicks et al., 2005). Thus we consider that the fishing carried out on the Ohau Channel was representative of the sizes and species present. On 13 December 2007, a total of 1267 fish were caught which was comprised of 1099 common bullies, 96 common smelt, 8 goldfish, 2 longfin eels and 13 rainbow trout (Brijs et al., 2007). On 11 December 2008, a total of 774 fish were caught which comprised 429 common bullies, 311 common smelt, 2 goldfish, 1 longfin eel and 31 rainbow trout.

Numbers of common smelt caught increased three fold in 2008 compared to 2007. The increase in common smelt numbers could be due in part to the fact that we fished for 10 minutes at every site in 2008 whereas in 2007 we only fished for 5 minutes at some sites (Sites 2, 4, 8 and 10) and 10 minutes at other sites (Sites 1, 3, 5, 6, 7 and 9). However, we found in 2007 that changing the duration of the fishing effort from 5 minutes (average smelt density of 4.9 fish 100 m^{-2}) to 10 minutes (average smelt density of 3.1 fish 100 m^{-2}) did not have a great effect on the density of smelt caught (Brijs et al., 2008). An increase in smelt numbers could also be due to the increase in the flow of the Ohau Channel in 2008 compared to 2007, as this invariably caused an increase in the distance fished in the top 4 sites where there were relatively high flows. Successful capture of stunned fish relies on the electrofishing boat travelling at the same speed as the water column otherwise stunned fish quickly go out of the reach of the nets. Because of this we found that total distance fished for the top 4 sites increased by an average of 40% which resulted in more schools of smelt being hit by the electric field. Although the numbers of smelt captured increased three-fold in 2008, the average density (4.1 fish 100 m^{-2}) from 10 sites fished was not much higher than what was found in 2007 (3.2 fish 100 m^{-2}).

In both 2007 and 2008, common smelt displayed a longitudinal pattern in their distribution along the Ohau Channel. The highest densities were found at sites 1 through to 4 with the exception of site 3 which was a mid-channel habitat. Traps set by NIWA also found that the most upstream trap (NIWA trap 1) which is located near site 2, consistently caught more than 70% of the smelt caught by all four traps (Rowe et al., 2008). High catch rates of smelt in the upper section of the Ohau Channel could be due to the presence of a velocity barrier across the weir which can prevent the movement of smelt into Lake Rotorua and concentrate them directly below the weir (Rowe et al., 2008). In both sampling periods, we found that downstream of site 4, heading towards Lake Rotoiti, the densities of common smelt decreased significantly with only a few individuals captured at each of the remaining sites. However, latest trapping results from NIWA (3 and 17 December 2008) showed that 24-30% of the smelt were caught in their third trap located near site 8, where we found very low densities in both sampling periods. A reason for this could be that at this site the smelt are actively migrating up the Ohau Channel and not congregating making it difficult to capture large numbers with the electrofishing boat. Smelt were mainly found in the littoral zones as they were generally absent from the mid-channel habitats in the Ohau Channel. This could be due to the high water velocity in the mid-channel habitats as smelt have limited swimming capabilities compared to other New Zealand freshwater fishes (McDowall, 1998) and this may limit them to the low velocity edges of the channel. It could also be due to the presence of macrophyte beds in the littoral areas, which provide cover and habitat for smelt.

Length-frequency distributions gathered in 2008 showed at least two size classes in the smelt population with numbers of adult smelt exceeding numbers of juvenile smelt. In both 2007 and 2008, we found that only 22 and 23% of the total catch was comprised of juvenile smelt (<44 mm)respectively. In 2007, we found that in the upstream reaches of the Ohau Channel, directly below the weir, a high number of juveniles were captured. Previous studies in the Waikato River have shown that juvenile smelt migrate upstream during the day (Stancliff et al., 1988) and because site 1 was the most upstream in the Ohau Channel it is possible that the juvenile smelt migrate to this point and congregate. However, in 2008 we found a different pattern with the highest density of juveniles at site 4. This could be due to the high flow velocity present at site 1 in 2008 which may have prevented juvenile smelt from remaining at that site and preferring site 4 as the flow velocity decreased with increasing distance from the weir.

In 2008 there was a decrease of approximately 60% in the number of common bullies caught compared to the numbers caught in 2007. Because common bullies are primarily benthic, the decrease in the number of bullies captured can largely be attributed to the decrease in water visibility in 2008 compared to 2007 (black disc readings of 0.8 m and

2.0 m respectively). This is because it was much more difficult to spot them and thus a significant proportion of common bullies were able to avoid detection and capture. Although the total catch of common bullies was much lower in 2008, the proportions of common bullies in each size class was fairly similar in both years with over 80% of the catch in each year being smaller than 51 mm. In both 2007 and 2008, common bullies showed variable densities throughout the Ohau Channel and the highest densities were associated with the presence of macrophyte beds. There were very low common bully densities in the mid-channel habitats and the willow edge habitat. Mid-channel habitats may not be favourable for bullies due to the lack of macrophyte beds and the presence of strong currents whereas the willow edge may not be favourable for bully populations due to the presence of longfin eels. Self recruiting populations of eels have been shown to reduce the abundance of bullies in lakes (Rowe, 1999) and so the same pattern may be occurring in the Ohau Channel. The high proportion of small (<40 mm) common bully in both 2007 and 2008 strongly suggests that recruitment is occurring successfully.

In 2007, rainbow trout were seen in the upstream section of the Ohau Channel below the weir by sites 1, 2, 5 and 6. In 2008, the numbers of rainbow trout caught increased three fold and they were mainly found in the two swiftly flowing mid-channel habitats (sites 3 and 6). The upstream prevalence of trout (mainly at sites 1,2,3 and 4 in 2007 and site 3 in 2008) coincided with the local presence of higher densities of common smelt which is known to be a major prey for both brown and rainbow trout (Ward et al., 2005). In 2007 we found mainly adult trout (11 out of 13 fish caught) whereas in 2008 juvenile trout dominated (26 out of 31 fish caught). Longfin eels where only found in the downstream section of the Ohau Channel in amongst the willow dominated edges with relatively low flow velocities in 2007 but in 2008 the only longfin eel caught was found at site 2 in a back eddy. Unlike in 2007, no goldfish were found in the side channel (Site 7) in 2008 and instead they were present in low densities at site 10.

6. Acknowledgements

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