Boat electrofishing survey of common smelt and common bully in the Ohau Channel in December 2009

CBER Contract Report 112

Client report prepared for
Environment Bay of Plenty

by

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10 March 2010

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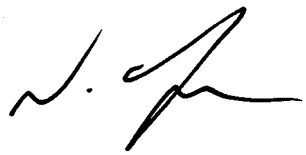

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Executive summary

We conducted a boat electrofishing survey of the Ohau Channel, which flows from Lake Rotorua to Lake Rotoiti, on 7 December 2009. The purpose of this was to repeat surveys that took place on 13 December 2007 and 11 December 2008 concerning the longitudinal pattern in densities of common smelt (*Retropinna retropinna*) and common bully (*Gobiomorphus cotidianus*). Due to run timing and possibly low water clarity and high water flows, catch rates were lower than those found in 2007 and 2008 as we only caught 353 fish comprising three native species and two introduced species in 2.72 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*) and goldfish (*Carassius auratus*). The total area fished was 10,884 m^2 (1.088 ha) giving an estimated density of 3.2 fish 100 m^{-2}.

Maximum densities of common smelt at sites along the Ohau Channel during the 2009 survey (4.8 and 4.3 fish 100 m^{-2} at sites 2 and 7 respectively) were lower than maximum densities of 10.6 fish 100 m^{-2} and 16.9 fish 100 m^{-2} found in surveys carried out in 2007 and 2008 respectively. Trapping results from NIWA during the same time periods also show a decrease in smelt capture rates as CPUE in 2009 (0.01 fish min^{-1}) was lower than CPUE in 2007 (1.97 fish min^{-1}) and 2008 (0.10 fish min^{-1}). In all three of the surveys (2007-2009), common smelt displayed a longitudinal pattern in their distribution along the Ohau Channel with higher densities (average densities of 2.0 to 7.9 fish 100 m^{-2} from 2007 to 2009) found in the upstream sites compared to the downstream sites (average densities of 0.3 to 0.9 fish 100 m^{-2} from 2007 to 2009). Both boat electrofishing and trapping at the four NIWA trap sites during the same time periods (2007 and 2009) show that at least 70% of common smelt were captured at trap site 1 and 2, which are located in the upper section of the Ohau Channel. Length-frequency distributions gathered in 2009 show that less than 1% of the total catch was juveniles compared to 22-23% of the catch in 2007 and 2008.

The numbers of common bullies captured in the Ohau Channel has decreased every survey by at least 60%. This decrease can largely be attributed to the decrease in water visibility and the increase in water flow each year. A higher proportion of larger bullies (>51 mm) were captured during 2009 (38%) compared to both 2007 and 2008 (<20%) but this may also be due to the poor water clarity and high flows as larger bullies are easier to spot and capture during these conditions. In all three surveys, common bullies showed variable densities throughout the Ohau Channel with the highest densities associated with the presence of macrophyte beds and the lowest densities associated with mid-channel and willow edge habitats. The highest numbers of trout were caught during the 2009 survey consisting of 19 juveniles and 24 adults and the majority of them were caught in the four most upstream sites. The upstream prevalence of trout in all of the surveys coincided with the local presence of higher densities of common smelt. Goldfish and longfin eels were still present in the Ohau Channel in 2009 but mosquitofish (*Gambusia affinis*) were not observed or captured during this survey.

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. Identical surveys had been previously carried out on 13 December 2007 and 11 December 2008. 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.

On 7 December 2009, 10 sites located at similar positions as in the previous surveys were fished in the Ohau Channel (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. All fish species were collected, weighed and measured. Longfin eels and rainbow trout (>100 mm) were released after being measured and weighed.

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^{o}C, was 193.4 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 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 the onboard global positioning system.

Trap capture of smelt by NIWA was carried out at four sites in the Ohau Channel between September and May in 2007, 2008, and 2009. Fine-mesh (2-mm) traps were set during daylight hours, and traps were lifted and the catch removed every 3-4 h between early morning and late evening (Rowe et al 2008). Traps were fishing continuously apart

from the 2-5 mins when each trap was lifted and emptied, and the fishing time thus varied with day length from about 10 h in May to about 14 h in December, with a day length of about 11.5 h in September (D. Rowe, NIWA Hamilton, pers. comm.).

3. Study site

On 7 December 2009 the water temperature was 19.4°C and the water depth fished ranged from 0.20 to 2.3 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 during any of the surveys, it was noted that water current was much higher during the 2008 and 2009 surveys compared to the 2007 survey. This was due to relatively high rainfall events occurring just prior to fishing in both 2008 and 2009. The lake level of Lake Rotorua was higher in both 2008 (279.76 m) and 2009 (279.80 m) compared to 2007 (279.66) which resulted in more water exiting Lake Rotorua via the Ohau Channel. The increased flow also had an effect on horizontal water visibility as the black disc reading was significantly lower in 2008 (0.8 m) and 2009 (0.65 m) compared to 2007 (2.0 m).

Table 1. Locations of 10 sites fished on 7 December 2009 in the Ohau Channel.

		Start position for fishing		End position for fishing	
Site	Habitat	NZTM Easting	NZTM Northing	NZTM Easting	NZTM Northing
1	Edge habitat below weir	1891685	5783859	1891739	5783960
2	Edge habitat by net site 1	1891755	5783959	1891857	5783854
3	Mid channel habitat by net site 1	1891980	5783897	1891757	5783939
4	Edge habitat by net site 2	1891818	5783841	1892022	5783912
5	Edge habitat	1892037	5783951	1892019	5784084
6	Mid channel habitat	1892042	5783944	1892216	5784132
7	Edge habitat with artificial enlargement	1892105	5784130	1892292	5784108
8	Edge habitat by net site 3	1892515	5784053	1892545	5784229
9	Willow edge	1892541	5784224	1892523	5784368
10	Edge habitat by net site 4	1892600	5784608	1892751	5784724

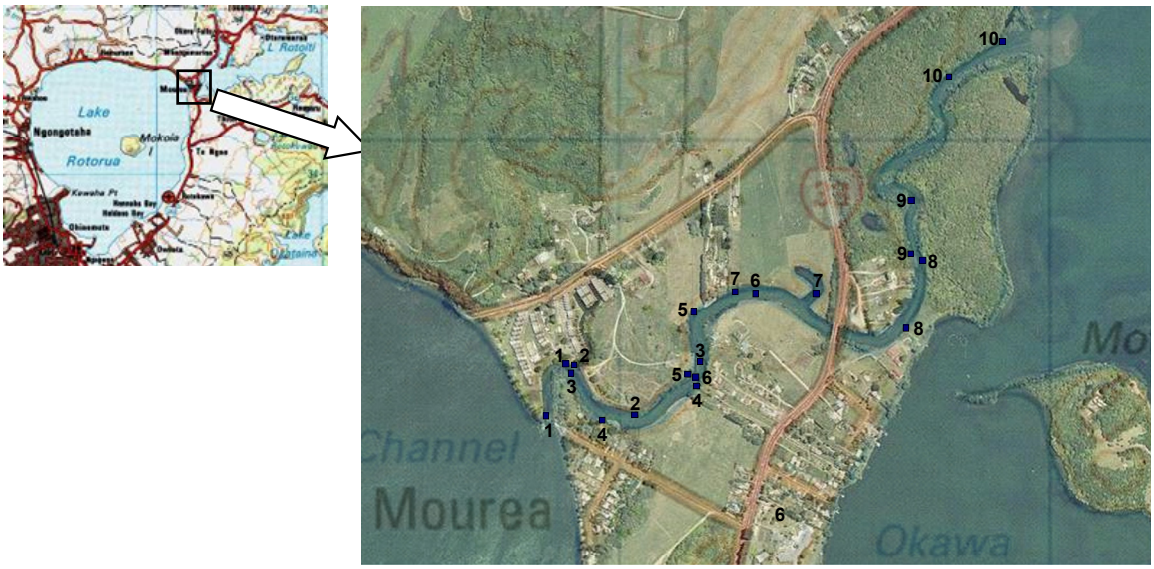

Figure 1. Sites fished on 07 December 2009 in the Ohau Channel which flows from Lake Rotorua to Lake Rotoiti. Site codes correspond to locations in Table 1.

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 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 (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 353 fish comprising three native and two introduced species in 2,722 m of fished length or an area of 10,884 m^2 from a total of 10 sites. Native species were common smelt (149), common bully (152) and longfin eels (1). The introduced species were rainbow trout (43) and goldfish (8) (Table 2). Mosquitofish were not observed or captured during this survey.

Densities of common smelt ranged from 0.0 to 4.8 fish 100 m^{-2} at sites located along the Ohau Channel. The majority of common smelt were caught at sites 2, 4 and 7 (Table 2) which were all edge habitat sites in the upstream half of the Ohau Channel (closer to Lake Rotorua). Densities of common smelt at these sites ranged from 2.5 to 4.8 fish 100 m^{-2} (Table 3). Other sites in the upstream half of the Ohau Channel (Sites 1,3, 5 and 6) had lower densities ranging from 0.0 to 1.3 fish 100 m^{-2}. Sites located in the deep, willow dominated edge habitat, further downstream in the Ohau Channel (Sites 8, 9 and 10) had even lower densities ranging from 0.0 to 0.2 fish 100 m^{-2}. Catch per unit effort (CPUE) showed the same pattern with the highest CPUE (2.9 to 5.0 fish min^{-1}) found at sites 2, 4 and 7 (upstream half of channel), whereas site 6 (mid-channel habitat) and all of the other sites downstream of site 7 had low CPUE ranging from 0 to 0.2 fish min^{-1} (Table 4). Boat electrofishing at the NIWA trap sites over the three surveys have shown

that over 80% of the common smelt that were captured at the trap sites were found at trap sites 1 and 2 which are located in the upper section of the Ohau Channel (Table 5). Table 5 also shows that numbers of common smelt captured at the trap sites in 2009 were the lowest recorded out of the three years the Ohau Channel has been surveyed.

Common bullies 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 0.0 to 3.0 fish 100 m^{-2} throughout the channel with the highest densities found at sites 1, 4, 8 and 10 (2.8 to 3.0 fish 100 m^{-2}; Table 3). Common bully densities were variable between sites with no clear pattern evident in their longitudinal distribution. CPUE data (Table 4) also showed a similar trend with the highest CPUE found at sites 1, 4, 8 and 10 (2.7 to 3.4 fish min^{-1}). Although site 4 had the highest number of common bullies (34), the highest biomasses (4.09 to 5.37 g 100 m^{-2}) were found at sites 1, 8 and 10 where the catch comprised a higher number of larger common bullies.

A total of 43 rainbow trout (biomass of 28.5 kg) were captured, with 19 of those being juveniles (FL< 200 mm). Rainbow trout were captured at most of the sites (except sites 5, 7 and 9) (Table 2). The highest densities of rainbow trout (0.8 to 1.0 fish 100 m^{-2}) were found in the swiftly flowing habitats (Sites 1, 3 and 6). The size of the rainbow trout ranged from 81 mm FL (juvenile) to 565 mm FL (adult) with a mean size of 285 mm FL. One 925 mm TL longfin eel was captured at site 1 and another one of similar size was observed but escaped capture at site 8. Goldfish were found at sites 7 and 10 with densities of 0.3 and 0.5 fish 100 m^{-2} respectively.

Table 2. Numbers of fish caught by boat electrofishing at 10 sites in the Ohau Channel on 7 December 2009.

			Number of fish per site					
	Site	Habitat	Common bully	Common smelt	Goldfish	Longfin eel	Juvenile rainbow trout	Adult rainbow trout
Lake Rotorua	1	Edge habitat below weir	29	7	0	1	3	5
	2	Edge habitat by net site 1	7	44	0	0	1	4
	3	Mid channel habitat by net site 1	0	8	0	0	8	5
	4	Edge habitat by net site 2	34	29	0	0	1	2
	5	Edge habitat	6	11	0	0	0	0
	6	Mid channel habitat	0	0	0	0	5	7
	7	Edge habitat with artificial enlargement	9	50	3	0	0	0
	8	Edge habitat by net site 3	27	0	0	0	1	0
	9	Willow edge	5	1	0	0	0	0
Lake Rotoiti	10	Edge habitat by net site 4	32	2	5	0	0	1
	Total	353	149	152	8	1	19	24

Table 3. Densities and biomasses of common smelt and bullies at sites in the Ohau Channel on 7 December 2009.

Lake Rotorua ↓ Lake Rotoiti

Site	Habitat	Total distance fished (m)	Area fished (m^2)	Common bully density (fish 100 m^{-2})	Common smelt density (fish 100 m^{-2})	Common bully biomass (g 100 m^{-2})	Common smelt biomass (g 100 m^{-2})
1	Edge habitat below weir	256	1024	2.8	0.7	5.37	0.88
2	Edge habitat by net site 1	228	912	0.8	4.8	1.10	6.58
3	Mid channel habitat by net site 1	311	1244	0.0	0.6	0.00	0.88
4	Edge habitat by net site 2	291	1164	2.9	2.5	1.63	3.61
5	Edge habitat	213	852	0.7	1.3	0.94	1.53
6	Mid channel habitat	400	1600	0.0	0.0	0.00	0.00
7	Edge habitat with artificial enlargement	289	1156	0.8	4.3	1.64	5.71
8	Edge habitat by net site 3	233	932	2.9	0.0	7.51	0.00
9	Willow edge	237	948	0.5	0.1	0.84	0.21
10	Edge habitat by net site 4	263	1052	3.0	0.2	4.09	0.38

Table 4. CPUE (fish min^{-1}) of common bully and common smelt in the Ohau Channel on 7 December 2009.

Lake Rotorua ↓ Lake Rotoiti

Site	Habitat	Time fished (mins)	Common bully CPUE (fish min^{-1})	Common smelt CPUE (fish min^{-1})
1	Left bank edge habitat immediately below weir	10	2.9	0.7
2	Left bank edge habitat by trap site 1	10	0.7	4.4
3	Mid channel habitat by trap site 1	10	0.0	0.8
4	Right bank edge habitat by trap site 2	10	3.4	2.9
5	Right bank edge habitat	10	0.6	1.1
6	Mid channel habitat	10	0.0	0.0
7	Left bank edge habitat with artificial enlargement	10	0.9	5.0
8	Right bank edge habitat by trap site 3	10	2.7	0.0
9	Left bank willow edge	10	0.5	0.1
10	Left bank edge habitat by trap site 4	10	3.2	0.2

Table 5. Numbers and proportions of common smelt captured at each NIWA trap site in the Ohau Channel by boat electrofishing from 2007 to 2009.

		2007		2008		2009	
NIWA trap site	Site code	No. of smelt	% of total per trap site	No. of smelt	% of total per trap site	No. of smelt	% of total per trap site
1	2	37	44	47	24	44	58
2	4	37	44	145	74	29	39
3	8	10	11	3	1	0	0
4	10	1	1	2	1	2	3
Total		85	100	197	100	75	100

Common smelt in the Ohau Channel ranged from 42 mm to 78 mm FL. The length-frequency distribution (Figure 5) shows that there are at least two size classes although there was only a single juvenile smelt (<45 mm) present . The mean fork length of common smelt was 59 mm. Common bully captured in the Ohau Channel on 7 December 2009 ranged from 24 mm to 84 mm (Figure 6). Size frequency data collected for common bullies from 2007 to 2009 (Table 6) shows that the majority of the population is comprised of the smaller size classes (<50 mm). Generally as the size of the bullies increased, the numbers of individuals in the size class decreased. Table 6 shows that the proportions of the population in each size class are fairly similar between 2007 and 2008 with over 80% of the catch in both years being smaller than 51 mm whereas in 2009 a higher proportion of larger bullies were caught.

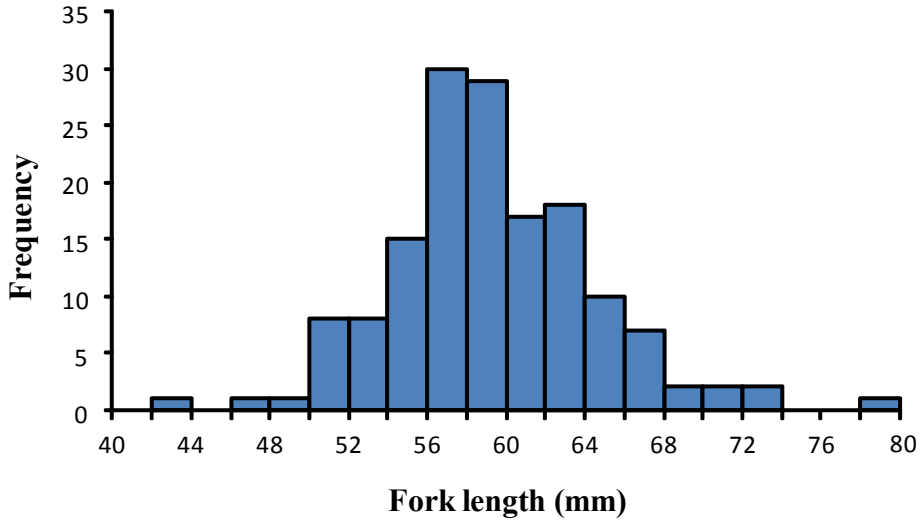

Figure 5. Length-frequency distribution of common smelt captured by boat electrofishing in the Ohau Channel on 7 December 2009.

Table 6. Numbers and proportions of common bully in each size class in the Ohau Channel from 2007 to 2009.

	No. of common bullies			% of total catch		
Size Class	**2007**	**2008**	**2009**	**2007**	**2008**	**2009**
< 35 mm	581	203	37	54	47	25
36 - 50 mm	303	155	57	28	36	38
51 - 60 mm	141	48	27	13	11	18
> 60 mm	60	29	28	6	7	19
Total	1085	435	149	100	100	100

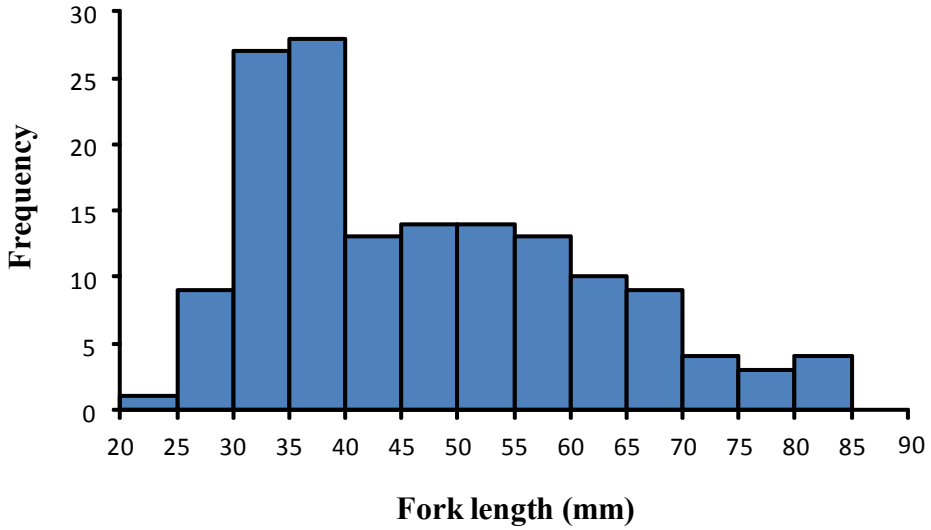

Figure 6. Length-frequency distribution of common bully captured by boat electrofishing in the Ohau Channel on 7 December 2009.

A site-by-site comparison of boat electrofishing smelt capture with NIWA's trapping catches shows that trapping caught far more smelt than electrofishing (Table 7). Both methods caught more smelt in the upper sites than in the lower sites. More smelt were consistently caught at trap site 1 than at other sites in the NIWA trapping, whereas most smelt were captured at sites 1 and 2 by boat electrofishing.

Table 7. Capture of common smelt in the Ohau Channel in December 2007, 2008, and 2009 by two independent methods (NIWA trapping data Rowe, unpublished). NIWA traps were set in the early morning, checked every 3-4 hours during daylight hours, and lifted in late evening. Boat electrofishing consisted of a ten minutes sampling at each site.

	Trap site			
	1	2	3	4
NIWA trapping data				
3/12/2007	5947	62	124	62
17/12/2007	6001	553	632	711
3/12/2008	1889	25	604	0
17/12/2008	286	0	123	0
17/12/2009	49	4	0	2
Boat electrofishing data				
11/12/2007	37	37	10	1
13/12/2008	47	145	3	2
7/12/2009	44	29	0	2

Trapping between September and May shows that smelt catches are highly seasonal, generally reaching a maximum in December (2007) or October (2008 and 2009; Fig. 7).

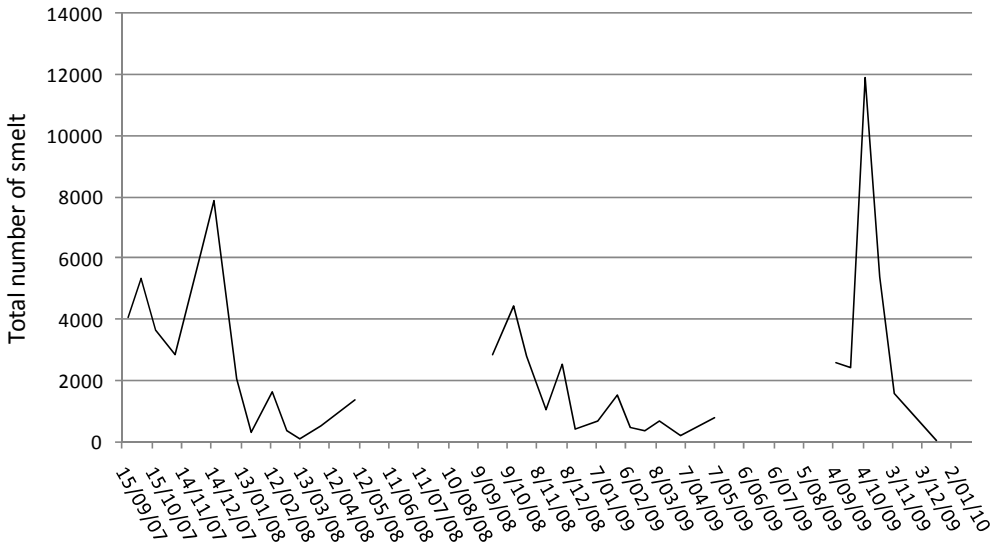

Figure 7. Seasonal smelt catches from trapping at 4 sites in the Ohau Channel (data from NIWA; Rowe unpublished data). Traps were set in the early morning, checked every 3-4 hours during daylight hours, and lifted in late evening.

5. Conclusions

The Ohau Channel was fished in early to mid December in all three surveys (2007, 2008 and 2009). The specific conductivity of the Ohau Channel in the three surveys ranged between 180 and 195 μS cm^{-1}, allowing efficient power transfer from the water to the fish as the range of conductivities was similar to 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 of eels, 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. The original survey on 13 December 2007 captured a total of 1267 fish, which was comprised mainly of common bullies and common smelt. Goldfish, longfin eels and rainbow trout were also captured but in much lower numbers (Brijs et al., 2008). A reduction in the total amount of fish caught occurred in the second survey (11 December 2008) with a total catch of 774 fish. The number of common bullies captured halved whereas the numbers of common smelt increased threefold. Goldfish, longfin eels and rainbow trout were again captured but

still in relatively low numbers (Brijs et al., 2009). A further reduction in the total catch occurred during the latest survey with only 353 fish captured, which comprised similar proportions of common bullies and smelt.

Maximum densities of common smelt at sites along the Ohau Channel during the 2009 survey were lower than in surveys carried out in 2007 and 2008 (Brijs et al., 2008; Brijs et al., 2009). CPUE was also lower in 2009 compared to 2008. Trapping results for December from NIWA (Rowe, unpublished data) during the same time period also show the same trend with a lower CPUE in 2009 (0.01 fish min^{-1}) compared to 2007 (1.97 fish min^{-1}) and 2008 (0.10 fish min^{-1}). This reduction was due to changes in seasonal run timing. In 2007, the run peaked in December, whereas in 2008 and 2009, NIWA trapping results show that peak runs occurs in October (Rowe, unpublished data).

In all three of the surveys (2007-2009), common smelt displayed a longitudinal pattern in their distribution along the Ohau Channel with higher densities (average densities of 2.0 to 7.9 fish 100 m^{-2} from 2007 to 2009) found in the upstream sites (closer to Lake Rotorua) compared to the downstream sites (average densities of 0.3 to 0.9 fish 100 m^{-2} from 2007 to 2009). A large school of smelt (50 individuals) were captured at site 7 during the latest survey but it is possible that they were in the process of migrating upstream as they were all caught at the same instant and it was noted that they were swimming upstream as the electric pulse hit them. Comparisons between boat electrofishing and trapping results during the same time periods (Rowe et al., 2008; Rowe, unpublished data) show that from 2007 to 2009 at least 70% of common smelt that were captured at the trap sites by either trapping or electrofishing were found at trap site 1 and 2 which are located in the upper section of the Ohau Channel. Common smelt were mainly found in the shallow, littoral zones as they were generally absent from the mid-channel and deep, willow edge habitats in all of the surveys.

Length-frequency distributions gathered in 2009 show at least two size classes in the smelt population. In 2007 and 2008, 22 to 23% of the total catch was comprised of juvenile smelt (<44 mm) respectively whereas in 2009 less than 1% of the total catch were juveniles. The proportion of juveniles captured by electrofishing in 2009 was lower than the proportion captured by the traps during the same time period which was around 14% (Rowe, unpublished data).

The numbers of common bullies captured in the Ohau Channel has decreased every year by at least 60%. Initially 1085 common bullies were captured in 2007 and by 2009 we only captured 149. Because common bullies are primarily benthic, the decrease in the number of bullies captured can largely be attributed to the decrease in water visibility each year. In 2007, the horizontal water visibility reading (black disc) was high (2.0 m) whereas in 2008 and 2009 it was much lower with black disc readings of 0.8 and 0.65 m respectively. Combined with the high flows present during 2008 and 2009, it was increasingly difficult to observe and capture common bullies as the boat was travelling at the same speed as the current reducing the amount of time available to scan the water body for the fish. In 2007 and 2008, the proportions of common bullies in each size class were fairly similar with over 80% of the catch in each year being smaller than 51 mm.

However in 2009, the proportion of common bullies smaller than 51 mm was only 62% and a higher proportion of larger bullies were captured. This is also most likely due to the poor water visibility and high flows as larger bullies are easier to see and capture thus biasing the size distribution. In all three surveys, common bullies showed variable densities throughout the Ohau Channel with the highest densities associated with the presence of macrophyte beds and the lowest densities associated with mid-channel and willow edge habitats.

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). In 2009, the highest number of trout were caught (43 individuals) and nearly all of them were caught in the four most upstream sites (Sites 1-4) and site 6 (mid-channel habitat). The upstream prevalence of trout in all of the surveys coincided with the local presence of higher densities of common smelt which is known to be a major prey for rainbow trout (Ward et al., 2005). In 2007 we found mainly adult trout (11 out of 13 fish caught), in 2008 juvenile trout dominated (26 out of 31 fish caught) and in 2009 it was fairly even (19 out of 43 fish were juveniles).

6. Acknowledgements

We gratefully acknowledge the assistance in the field from Dai Morgan and Bernard Simmonds from the University of Waikato as well as the contract funding provided by Environment Bay of Plenty.

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