Smelt monitoring in the Ohau Channel and Lake Rotoiti (January-May 2014)

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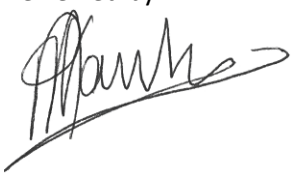

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Executive summary

Monitoring smelt runs up the Ohau Channel over the 2013/2014 summer period indicated that a large run of adult smelt occurred in October 2013 and that a small run of juvenile smelt occurred in February 2014. These runs add to the runs of juvenile and adult smelt recorded in the Ohau Channel over the past six years since the diversion wall was completed in 2008. Collectively, they show that the wall does not prevent the migration of smelt up the Ohau Channel. The large run of smelt observed in October 2013 indicates that large runs still occur up the Channel, hence the diversion wall is also unlikely to have reduced run-size. Although the wall may have altered the frequency of the smelt runs, there is no reliable way of assessing this because data were not obtained prior to construction of the wall.

Recruitment of larval smelt in Lake Rotoiti was comparatively high in spring 2012 and low in spring 2013. Trap data obtained in October 2013 indicated that smelt runs were larger than usual, but runs of juveniles in summer 2014 were lower than usual. Hence, it appears that the extent of larval recruitment in the lake may influence the size of the smelt population in the lake and subsequently the size of smelt runs up the Channel. However, given the complex dynamics of smelt growth and mortality, this relationship may not always hold, especially when smelt recruitment is low, and or mortality from trout predation is higher than usual.

Given that such a relationship may exist (at least at times of high and low larval recruitment), the relatively low level of larval smelt recruitment recorded in Lake Rotoiti in September 2013 could be expected to result in low to moderate-sized runs of smelt in both the autumn and spring of 2014. The run of juveniles in autumn 2014 was relatively low. Further smelt monitoring in the Ohau Channel is scheduled for the period September 2014 to May 2015 and, if there is a strong relationship between larval recruitment in the lake and run size up the Ohau Channel, then the spring run in 2014 will also be low.

1 Introduction

In 2008, a diversion wall was installed at the outlet of the Ohau Channel in Lake Rotoiti to divert the nutrient-enriched water from Lake Rotorua out of Lake Rotoiti and down the Kaituna River. In time, this diversion is expected to reduce nutrient loading into Lake Rotoiti and hence further deterioration in its water quality.

Eastern Region Fish and Game Council were concerned that this diversion wall may reduce the migrations of smelt up the Ohau Channel from Lake Rotoiti and thereby affect the trout fishery in the Channel. In addition, there were concerns that changes to smelt migrations up the Channel could affect the population dynamics of smelt in Lake Rotoiti, resulting in an impact on the trout fishery in this lake. Local iwi were also concerned that their fishery for smelt in the Ohau Channel would be affected.

Studies were therefore initiated by the Bay of Plenty Regional Council between 2005 and 2008 to provide more information on smelt migrations up the Channel prior to the installation of the wall, thus providing a pre-wall baseline for assessing any future potential impacts of the diversion wall on smelt runs (Rowe et al. 2006; 2008). These studies were continued on a near annual basis after the diversion wall was completed in July 2008 to provide further information on the smelt migrations, and to establish any effects of the wall on smelt in the Channel and in Lake Rotoiti (Rowe et al. 2009, 2010, 2011, 2012, 2013).

The results from 3-5 weekly trapping of smelt runs up the Ohau Channel up to June 2013 has shown that runs of both juvenile and adult smelt continued to occur after the wall was constructed. Hence the wall has not prevented the migration of either adult or juvenile smelt through the Ohau Channel (Rowe et al. 2013). However, later concerns regarding the potential impacts of the wall on the size and frequency of smelt runs meant that monitoring has continued, even though the absence of pre-wall data prevents detection of any change in the size or frequency or runs.

In addition, annual monitoring of larval abundance and acoustic monitoring of adult smelt abundance in Lake Rotoiti was carried out each year until 2012 to determine whether a collapse in the smelt population could occur in the lake as a consequence of the wall's construction. As this would have been expected within three years of the wall being completed (because smelt live for two years in this lake), and there was no indication of this occurring by 2012, acoustic monitoring was halted. However, annual monitoring of the larval abundance of smelt in Lake Rotoiti has continued as changes in larval recruitment could determine the size of the smelt population in the lake and hence the size of runs up the Ohau Channel.

Results up to 2013 indicated that of the by-catch, koaro were a rare component but tended to be present in samples mainly in December. In comparison, the catch rate of common bullies is much higher than for koaro, but has shown a steady decline since 2007 (Rowe et al. 2013).

In considering all the results available up to November 2013, the Technical Advisory Group advising the Bay of Plenty Regional Council recommended that smelt monitoring in the Ohau Channel and larval smelt monitoring in Lake Rotoiti be continued until 2017, when renewal of the resource consent will be required.

In this report, we present the results of smelt monitoring carried out in the Ohau Channel in October 2013 and between January 2014 and May 2014 as well as the measurements of larval smelt density in Lake Rotoiti carried out for the 2013/2014 summer season. These data are interpreted with respect to the baseline data obtained before the wall was constructed and the monitoring results obtained annually since then.

This report forms a part of the requirements for the current NIWA contract with the Bay of Plenty Regional Council. Further monitoring will be carried out between September 2014 and May 2015, with a further report submitted for results obtained over this period in July 2015.

2 Methods

2.1 Smelt runs in the Ohau Channel

The locations of the sites used to monitor smelt movements in the Ohau Channel over the past 8 years are shown in Figure 2-1. Only trap sites 1 and 2 were used after 2012 as the contribution of Sites 3 and 4 was generally minor (Rowe et al. 2011) and Sites 1 and 2 have been monitored since 2006 so provide a longer record for comparing temporal changes.

Figure 2-1: Location of sampling sites used for smelt trapping in the Ohau Channel. Only sites 1 and 2 were trapped in 2014. Inset shows a smelt trap and the platform below which it is set.

Trapping was carried out twice in October 2013 (in response to observations of a large and prolonged run off smelt at that time), and at three to four weekly intervals during the five month period from January 2014 to May 2014. Traps were placed close to the bank at each site, facing downstream in order to capture upstream migrants. The traps were triangular with a 1 m by 0.5 m wide opening tapering to a 20 cm wide capture compartment (Figure 2-1). Mesh size was 2 mm. Traps were usually set close to daybreak and the catch removed every 3-4 hours until late evening. The total number of smelt caught per trap per day and the total time for which the trap was fished per day were recorded. Depending on the number of fish present, all or a subsample were used to determine the proportions of juveniles and adults in the catch. Both the length (under or over 45 mm total length) and coloration of smelt were used to distinguish juveniles from adults. The daily catch per unit of effort (CPUE) for smelt on each sampling date was calculated as the total daily catch for the two traps divided by the total trapping time in minutes.

Shag numbers (both on the banks and in trees lining the channel) were also counted along the channel's entire length on each sampling occasion between January and May 2014. Shags are predators of smelt and their abundance provides an additional measure to detect the presence of high densities of adult migratory smelt (Rowe et al. 2010, 2011).

In addition to the smelt monitoring, water temperatures (Tidbit© data loggers), water clarity (black disc visibility), water velocities near the entrance to each trap, the discharge of water through the

channel, and the by-catch of other species (common bullies, koaro, trout, koura) were also recorded, except in October 2013.

2.2 Larval smelt density in Lake Rotoiti

Larval smelt in Lake Rotoiti have been sampled annually to determine whether annual changes in larval abundance (reflecting recruitment) could account for any marked variations in adult smelt abundance in the lake and hence in the Channel. In the Rotorua lakes, smelt have an extended spawning period lasting from spring until the end of summer. After hatching, the transparent larvae become pelagic and remain in the water column at depths down to 50 m until they reach a length of around 25 mm, after which they become pigmented and move towards the lake surface where they form large schools to minimise predation from trout.

The peak months for smelt reproduction in Lake Rotoiti are unknown, and may vary between years, but spawning is known to occur mainly in spring and can occur sporadically through to autumn (Blair 2012). Given their size range (see Rowe et al. 2013) and likely growth rate, larvae can be expected to be present in the hypolimnetic zone for up to 5 months post-hatch. Hence larvae will be present in all months of the year, but highest densities are expected from September to May. Measurements of larval smelt abundance in Lake Rotoiti are therefore carried out in both December and April to encompass, and slightly lag, the main spawning periods of spring and summer.

Vertical drop netting using a closable Wisconsin plankton net (mouth area of 0.25 m^2, mesh size 250 µm) was used to sample larval smelt throughout the water column (surface to near the lake-bottom) of Lake Rotoiti in both December 2013 and April 2014, as per previous years. Sampling was carried out at 31 sites located throughout the lake. Larval fish sampled from the water column at each site were sorted into species (larval bullies vs. larval smelt), counted and measured to the nearest millimetre. Secchi disc depth was also measured because the overall number of smelt larvae in lakes has been found to co-vary with water clarity, which reflects trophic status in the Rotorua lakes (Rowe & Taumoepeau 2004). The lake-wide mean CPUE of larval smelt over the whole spawning season (December plus April data) was calculated for the 2013/2014 period and plotted against secchi disc depth to indicate any change in density, independent of changes in water clarity and trophic status. The data for the 2013/2014 season were then compared to those for previous seasons to determine any marked change or long-term trends in larval smelt density.

3 Results

3.1 Smelt runs in the Ohau Channel

Flow rates in the Ohau Channel on the days in 2014 when smelt were being trapped were within the range for those recorded in previous years for the months January-May and were not noticeably higher or lower than in the past (Figure 3-1).

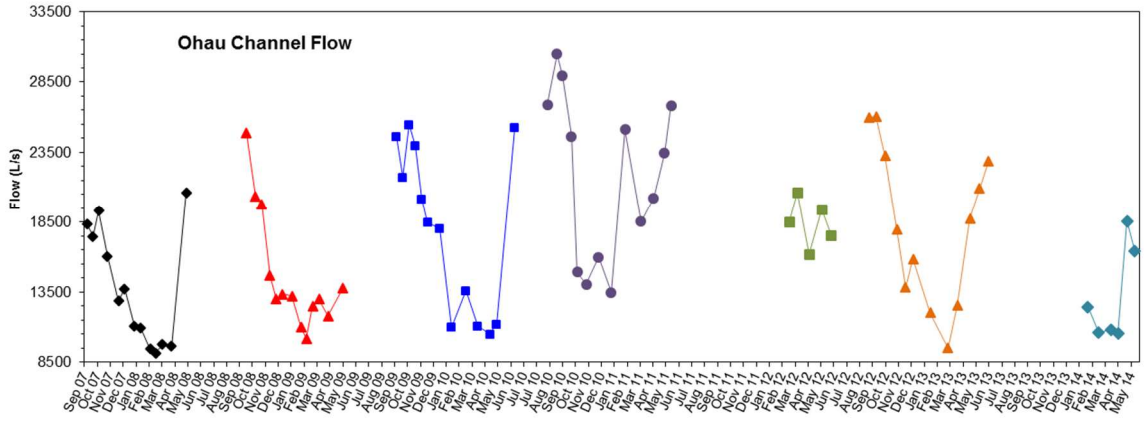

Figure 3-1: Flow rates in the Ohau Channel at the times when smelt were being trapped between 2007 and 2014.

Water clarity measurements in the Ohau Channel during autumn months in 2014 (Figure 3-1) were again relatively high compared with those recorded between 2007 and 2011. These clarity records are snapshots obtained at the time of sampling and so may not always reflect longer term trends in the clarity of lake water entering the Channel. Nevertheless, the higher values noted over the past three years are thought to reflect an improvement in water quality in Lake Rotorua after 2011. The values for water temperatures (Figure 3-3) in the Ohau Channel were also similar to those recorded in the past, hence there were no major changes in these variables that could be expected to affect smelt migrations. The influence of flow rate water temperature and clarity on the timing of smelt migrations up the Channel was examined in 2012 and no relationship was found (Rowe et al. 2012).

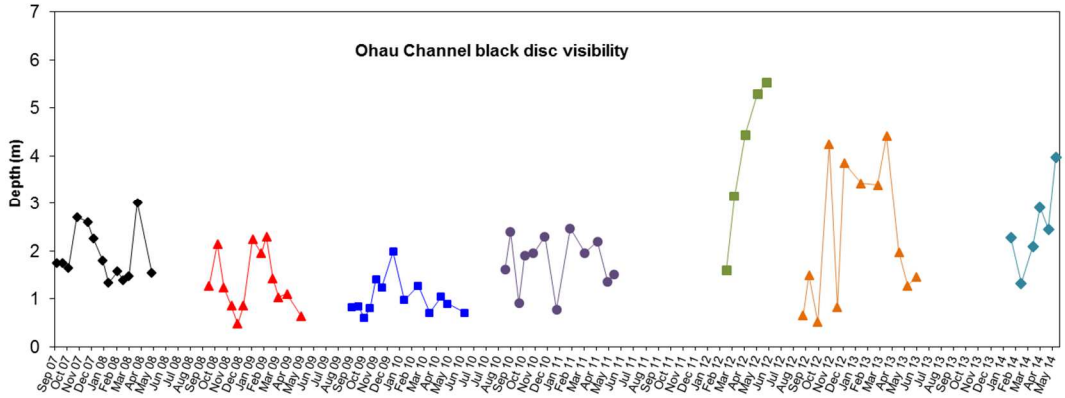

Figure 3-2: Water clarity (as measured by secchi disc depth) on the days when smelt were trapped between 2007 and 2014.

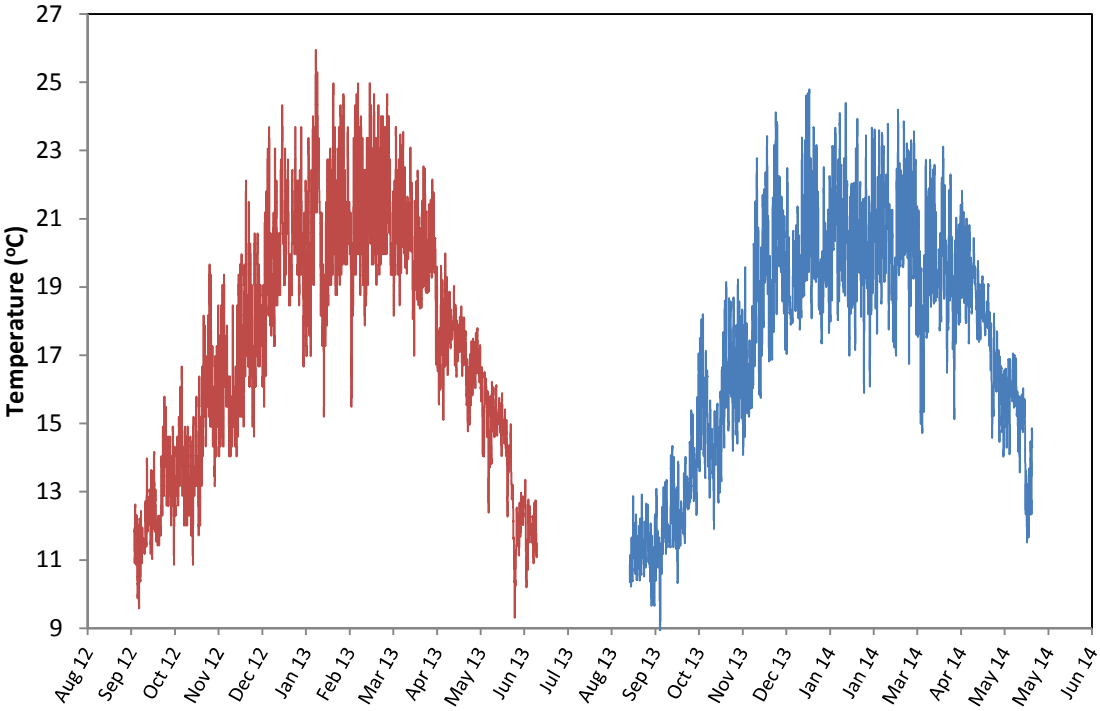

Figure 3-3: Water temperatures in the Ohau Channel during the sampling periods in 2012-2014.

A relatively large run of adult smelt occurred in October 2013 and a small run of mainly juvenile smelt was recorded in February 2014. No runs of juveniles were reported or recorded in other months sampled during summer 2014 (Figure 3-4). This seasonal timing is consistent with previous years when runs of mainly adult smelt occurred in spring months and juvenile smelt in summer months (Table 3-1).

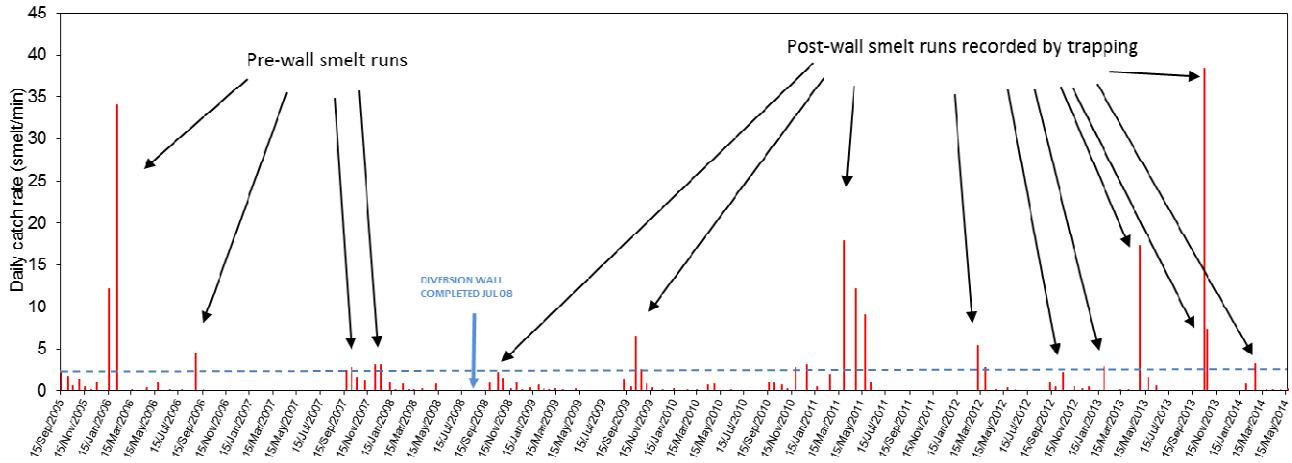

Figure 3-4: Smelt catch rates recorded in the Ohau Channel between 2005 and 2014 showing times when runs of smelt were recorded. The diversion wall was installed in July 2008 (solid blue line). The CPUE threshold (2 smelt/minute) defining a run is shown by the blue-dashed line.

Table 3-1: Dates and composition (adult vs juvenile) of smelt runs in the Ohau Channel between 2005 and 2014. A run of smelt is defined as 2 or more fish/minute in the two traps combined as defined in Rowe et al. (2012).

Date	Catch rate (smelt/min.)	Proportion of adults (%)
15 Sep 05	2.3	NA
5 Feb 06	34.1	NA
28 Aug 06	4.6	NA
20 Sep 07	2.4	78
17 Dec 07	3.2	80
15 Oct 08	2.1	96
7 Oct 09	6.5	100
21 Dec 10	3.2	36
29 Mar 11	17.9	28
8 Mar 12	5.5	20
16 Oct 12	2.2	100
29 Jan 13	3.0	24
2 May 13	17.3	31
22 Oct 13	38.7	98
24 Feb 14	3.2	36

The mean percent of adult smelt trapped from monthly samples collated over the past 10 years (Figure 3-5) indicates that, whereas smelt runs can occur in most months of the year, adults predominate in both spring (September, October, November) and autumn months (April, May, June), whereas juveniles dominate only in summer months (January, February, March). Adult smelt in Lake Rotoiti spawn over summer months with peaks in activity during spring and autumn (Blair 2012). Hence the runs of adults in the Ohau Channel coincide with smelt spawning activity patterns.

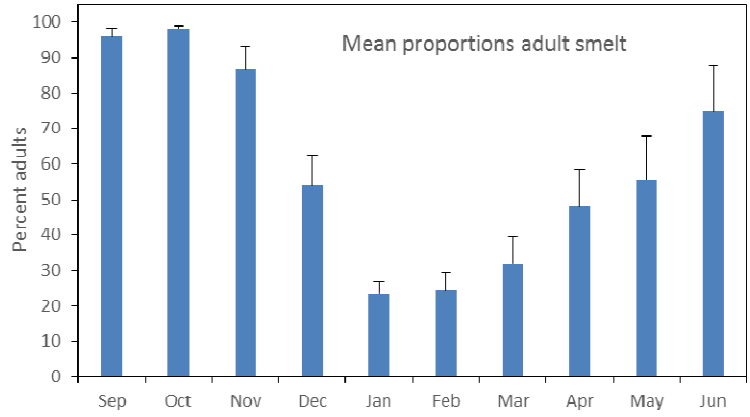

Figure 3-5: Mean percent composition of the smelt catch for each month over the period 2005-2014. Bars are standard errors.

Rowe et al. (2013) noted a gradual but statistically significant decline in the catch rates for common bullies over the seven years between 2007 and 2013. However, in 2014, the mean catch rate for bullies was higher than in both 2012 and 2013 (Figure 3-6, ANOVA, F = 2.6, P = 0.01). Hence the seven year trend of declining bullies appears to have halted, at least in 2014.

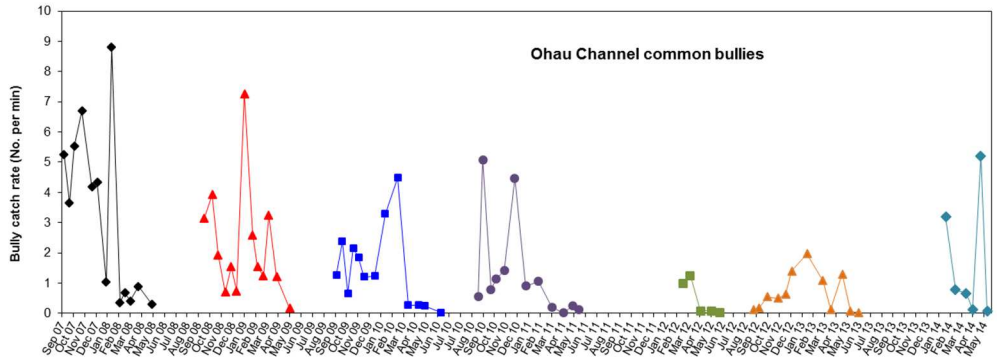

Figure 3-6: Catch rates for common bully in the Ohau Channel between 2007 and 2014.

3.2 Larval smelt densities in Lake Rotoiti

The catch rate of larval smelt in Lake Rotoiti was 1.29 larvae/haul in December 2013 and 2.45 in April 2014 (Table 3-2). Over both months (i.e., for the 2013/14 season), the overall mean catch rate was 1.86 larvae/haul and this was lower than in the past two seasons, but still higher than the comparable figures obtained in the 2005/06, 2007/08 and 2008/09 and 2010/11 summer seasons.

Table 3-2: Mean catch rates of smelt larvae in Lake Rotoiti in December and April of each summer since 2005/06. Shaded cells indicate a statistically significant (ANOVA, P < 0.05) higher mean density between the spring and autumn samples.

Summer	Net hauls per survey	Mean catch rate (No. net^{-1} ± SE) per survey		
		December	April	Overall
2005/2006	15	0.60 ± 0.74	0.47 ± 0.52	0.53 ± 0.63
2007/2008	31	0.65 ± 1.28	0.94 ± 1.15	0.79 ± 1.22
2008/2009	31	1.00 ± 1.34	0.42 ± 0.76	0.71 ± 1.12
2009/2010	31	2.52 ± 1.39	1.68 ± 1.49	2.10 ± 1.49
2010/2011	31	0.81 ± 1.22	0.97 ± 1.14	0.89 ± 1.17
2011/2012	31	4.07 ± 0.48	2.58 ± 0.39	3.32 ± 0.32
2012/2013	31	10.50 ± 1.60	0.45 ± 0.14	5.47 ± 1.02
2013/2014	31	1.29 ± 0.19	2.45 ± 0.49	1.86 ± 0.27

In the past, smelt larvae have always been more abundant in December than in April (Table 3-2), indicating higher recruitment in spring than over summer/autumn months. However, the abundance of larvae in December 2013 was relatively low, and much lower than in December 2012. This suggests poor spring recruitment (of larvae) compared with the previous two years. The abundance of smelt larvae in April 2014 was higher than in the past two years, but comparable with that obtained in April 2012. As a consequence, the overall abundance of smelt larvae as assessed by

spring and autumn sampling was lower in the 2013/14 season than in the past two seasons (Table 3-2).

As there is a relationship between larval smelt abundance and water clarity across the Rotorua Lakes (Rowe & Taumoepeau 2004, Figure 3-7), and the spot measurements of water clarity taken in Lake Rotoiti in 2013/14 were lower than at the same times in 2012/13, some reduction in larval smelt abundance might be expected in 2013/14. However, the decline for 2013/14 was relatively large and suggests that other factors may have combined to influence smelt recruitment in 2013/2014.

Most of the net samples obtained in April 2014 contained high densities of the large cladoceran, daphnia. As this is a major prey species for smelt, its high occurrence at this time could be due to reduced predation pressure on zooplankton by smelt over the previous spring and summer.

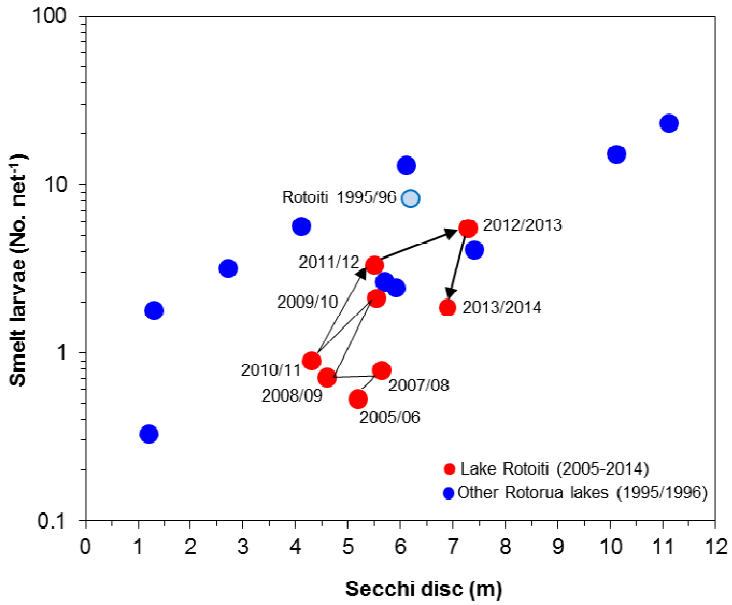

Figure 3-7: Abundance of smelt larvae in Lake Rotoiti in relation to mean secchi disc depth. Secchi disc depth in the Rotorua lakes is a measure of water clarity as influenced mainly by plankton abundance and hence trophic status. Lakes with a high secchi disc depth are clearer and less productive than those with a low secchi depth (Note the log scale for larval smelt abundance).

4 Conclusions

Monitoring in October 2013 indicated that a large run of adult smelt occurred at this time. Subsequent monitoring over the 2013/2014 summer indicated that a small run of mainly juvenile smelt occurred in February 2014. These observations adds to the records of juvenile smelt runs recorded in the Ohau Channel since the diversion wall was completed in 2008. The run of adult smelt in October 2013 was the largest recorded since monitoring began and indicates that run size is as high as it was before the diversion wall was completed.

Runs of adult smelt in the Ohau Channel were relatively high in spring 2013 following high larval abundance during spring 2012. Conversely, runs of smelt up the Channel were relatively small in autumn 2014 following low larval recruitment in spring 2013. These inter-annual differences in relative abundance suggest that there may be a relationship between the extent of larval smelt recruitment in the lake in spring and the size of runs for juvenile and/or adult smelt up the Ohau Channel in the following year. Such a relationship would imply that high larval recruitment in spring results in a high population of juveniles and subsequently adult smelt in the lake, and vice versa. However, such a relationship may only hold for years when there is relatively high or low larval recruitment. It may not always hold because smelt population dynamics can be strongly influenced by the extent of trout predation related to changes in stocking rates and/or angler harvest (Blair 2012). Further monitoring of both smelt runs up the Ohau Channel and larval smelt abundance in the lake is required to establish whether such a relationship exists and can be used to predict the size of runs in the Ohau Channel. In this respect, the relatively low level of larval recruitment recorded over the 2013/14 smelt spawning season would be expected to result in a small (or nil) run of adults in spring 2014.

The high catch rates for common bullies recorded between January and April 2014 indicated that the steady decline in bullies noted over previous years appears to have now halted. Future monitoring will be able to either confirm this, or indicate that it was a temporary change.

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