Monitoring of fish values in the City Rivers: 2nd round;

Avon River

Prepared for:

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AEL Report No. 59

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Waimairi Stream, north branch

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Contents

1 Executive Summary

During 2008 and 2009, AEL conducted a number of fish sampling programmes in the Avon River catchment. These were: a netting programme at three sites in the lower river in and about the mainstem, electric fishing of three tributaries in the middle reach of the river and electric fishing of four upper river tributaries,. In addition, a trout spawning survey (redd count) was undertaken in July 2008. These were all intended to be a follow-up of surveys which were undertaken by MAF Fisheries staff in 1991-92.

The winter 2008 trout spawning survey has been previously documented, but upon request from CCC, the results are summarised in this document, along with the findings of the fish surveys described above.

At the lower reach sites, a number of species which are representative of sites close to the sea was recorded, although generally at lower numbers than were recorded in 1992. . However, much of this variation can be explained by a difference in sampling effort and the inherent difficulty of representatively sampling large bodies of water such as those.

The middle reach tributary sites were more readily sampled in a representative manner, and the species assemblage in those was similar to that recorded in 1992. One difference was that we did not record trout from any of the three streams, although they were present in one, Taylors Drain, at quite high densities in 1992. In contrast, the density of upland bully that we recorded from Taylors Drain was much higher than that recorded there in 1992. Also of note was that in one of these middle reach streams (Dudleys Creek), we recorded four species of bully, one of which (blue-gilled bully), was an unusual catch for a stream of this sort.

Four species (longfin eel, shortfin eel, upland bully and brown trout) were recorded from the upper river tributaries. The densities of brown trout were much lower than those recorded from them in 1992. The highest number of trout redds (54) was recorded in Wairarapa Stream, and the lowest number (none) from the South Branch of Waimairi Stream, but oddly, the highest number of juvenile trout recorded the following year was from the Waiamiri Stream south branch, whereas only one individual was recorded from Wairarapa Stream.

In contrast to trout numbers, the densities of upland bully were generally far higher than were recorded in 1992. This is probably because trout are significant predators of bullies, and they may have depressed the bully populations when their numbers were higher.

Overall, it appears that the brown trout population of the Avon River has declined substantially since 1992, and this decline is paralleled by a reduction in trout spawning activity. However, at the same time, and probably as a result, the densities of upland bully have increased. It is recommended that an effort be made to determine the cause of the decline in the brown trout population, with a focus on examining the quality of spawning gravels.

Further, in some streams where native fish predominate, they would probably benefit from the addition of cover from riparian vegetation such as *Carex* sp.

2 Introduction

This document reports on the fish communities at three sites on the lower Avon River, which were sampled in May 2008, and a brown trout spawning survey conducted in July 2008. In addition in April 2009, a fish survey was conducted in three tributaries in the mid-reach of the river, and sampling of four upper river tributaries in the same month.

The purpose of this report is to integrate the trout spawning report released previously (Taylor & Bray 2008), with a re-survey of specific fish habitats which where were surveyed as part of the inaugural fish survey in the 1990s (Eldon & Kelly 1992). These and other previous surveys are outlined below.

3 Background

The inaugural fisheries survey of the Avon River was conducted over the 1991/1992 summer (Eldon & Kelly 1992). That work involved sampling 33 sites, and a trout spawning survey conducted in June, July and August 1991. The sites sampled in their survey were a subset of those included by the former Christchurch Drainage Board (now part of Christchurch City Council) in its benthic invertebrate sampling of the river (Robb 1980). The current survey involved a resurvey of a subset of the sites sampled by Eldon and Kelly in 1991 and 1992.

In 2003, an ecological assessment, of invertebrate and fish values, was undertaken within the middle reach of the Avon River mainstem, between Fendalton Road and Fitzgerald Avenue (McMurtrie & Taylor 2003). In addition to the 191 study, other relevant earlier fisheries studies include a 2002 trout spawning in the Avon River (Taylor & Burrell 2002), and the 2008 survey (Taylor & Bray 2008), which is also recompiled into this report.

4 Catchment description

The Avon River rises as a series of springs in the north-western suburbs of Christchurch, which provide the flow for the headwaters of the Waimairi, Wai-iti, Wairarapa, and Okeover Stream, and (in turn) the Avon River mainstem (Daglish 1985). These streams all converge above Mona Vale. Further downstream, Addington Drain and Riccarton Drain flow into the river from the west. Lower still in the catchment, Taylors Drain, Dudleys Stream, St Albans Stream, Shirley Stream, and Corsers Stream contribute flow from the north. The springs that feed the headwater streams source their groundwater from the Waimakariri River. The catchment area (ca. 84 km^2) is totally flat, and about 80% of it is urbanised. The river discharges into the Avon-Heathcote Estuary, and it is tidally-influenced for about 12km inland (to Fitzgerald Avenue), and depending on the height of the tide, saline water penetrates upstream to about Avondale Road (ca. 5.5 km upstream from the Estuary).

5 Methods

The survey programme comprised four phases:

1. netting of the fish community at three sites on and about the mainstem of the lower river in May 2008,
2. electric fishing on three middle river reach tributaries in April 2009,
3. electric fishing of four upper river tributaries, also in April 2009, and
4. a trout spawning survey.

Netting techniques were all passive, and all fish were returned to the resident habitat unharmed. Similarly, all fish captured using the electric fishing machines were returned to the habitat in which they were identified.

5.1 Lower river fish

The fish community of the lower river was sampled at three sites on or about the mainstem, using a series of baited fyke nets. The nets were set during the evening of 5 May 2008 and lifted the next morning. The locations of these sampling sites are shown in figure 1, the sites collated in Table 1, and illustrated in Appendix I. The three sites were: the true right bank of the mainstem of the river above Avondale Bridge, the main river at Cockayne Reserve, and Porritt Park loop at Kerrs Reach.

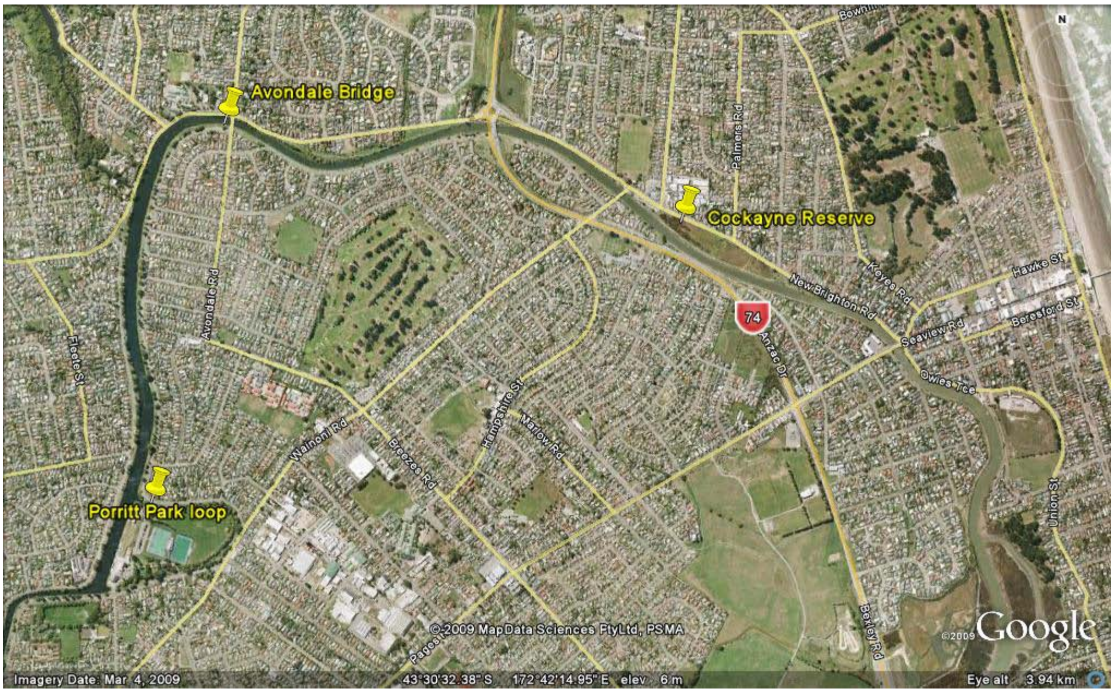

Figure 1. The lower river sampling sites

Table 1. Netting sites in the lower river.

Site	CDB site no.	Grid ref (NZ-260 series)	Number of fyke nets set	Comments
Avondale	181	M35: 847-452	4 large	One net with a twisted wing.
Porritt Park loop	175	M35: 844-436	2 small	One net poorly set
Cockayne Reserve	188	M:35: 848-451	2 small	One net set in shallow water

5.2 Fishing methods in the middle-river tributaries

Sites on the three middle-river reach tributaries were electric fished on 3/4/09. This was undertaken using a Kainga EFM 300 packset machine set to 200 volts; with the operator working downstream towards an assistant with a stop net. The locations of these sites are shown in figure 2, the sites described in Table 2, and illustrated in Appendix II.

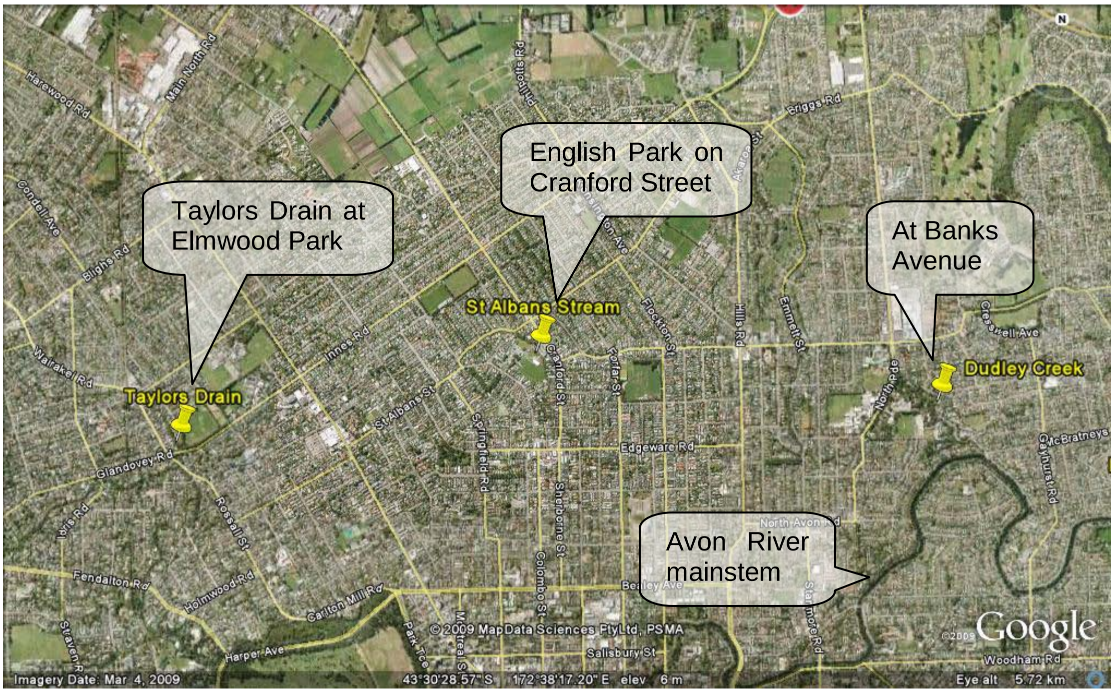

Figure 2. The three tributary sites in the middle reaches. The mainstem of the Avon River is also indicated.

Table 2. Electric fishing sites in the middle river tributaries.

Tributary	Site	CDB site no.	260 series, grid ref (centre of site)	Site length (m)	Area sampled (m^2)	Fishing time (minutes)
St Albans Stm	English Park	88	M:35 806-443	33	39	17
Taylors Drain	Elmwood Park	52	M:35 784-438	30	76.5	40
Dudley Creek	Banks Ave	109	M:35 829-439	74	326	44

5.3 Fishing methods in the upper-river tributaries

Fishes at four sites in the upper river tributaries were sampled by electric fishing on 7 April 2009, using the same approach as above. The locations of these sites are shown in figure 3, details of the four sites provided in Table 3, and the sites illustrated in Appendix III.

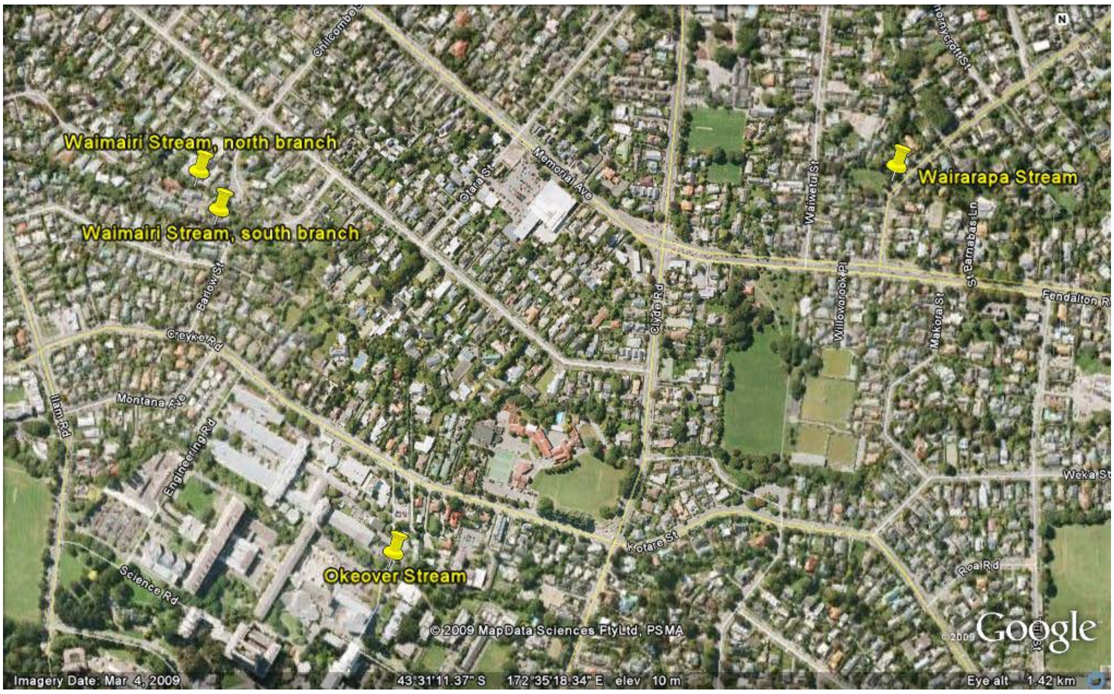

Figure 3. Locations of the tributary sampling sites in the upper reaches.

Table 3. Details of sampling sites in the upper river.

Tributary	Site	CDB site no.	NZMG 260 grid ref (centre of site)	Site length (m)	Area sampled (m^2)	Fishing time (minutes)
Waimairi Stream, South Branch	Barlow St	7	M35: 762-431	34	108	19
Waimairi Stream, North Branch	Below dam	7	M35: 762-432	85	203	57
Wairarapa Stream	Glandovey	66	M35: 772-432	33	145	50
Okeover Stream	Forestry Rd	CL4	M35: 764-426	38	92	19

5.4 Trout spawning survey methods

The reach surveyed for trout spawning commenced at the Barbadoes Street Bridge, then proceeded upstream along the Avon River mainstem to Mona Vale gardens. At that point the tributaries of Waimairi and Wairarapa Streams enter the mainstem. The survey proceeded upstream along the main courses of both of these tributaries, and finished at Ilam Road. Okeover Stream, a tributary of Waimairi Stream not previously surveyed, was also investigated.

The surveys were conducted at baseflow on the 3 July (mainstem), 8 July (Waimairi Stream), 10 July (Wairarapa Stream, upper Avon). The surveys preceded a number of high-flow events that occurred from the middle to the end of July, and also a silt discharge from the lower Millbrook into the Avon mainstem on 18 July 2008.

Along the mainstem - between Barbadoes Street and Mona Vale - the survey was conducted by two field workers, one on each bank. This was necessary because the width of the channel made it difficult for a single field-worker to survey the channel effectively. Upstream of Mona Vale, only one surveyor was necessary. All the reaches surveyed in the 1991 and 2002 surveys were resurveyed in 2008. However, a reach which was surveyed in 1991 (mainstem between Straven Road and Mona Vale), but inadvertently missed in 2002, was re-surveyed in 2008.

The riverbed was visually surveyed for redds, trout and partially excavated redds. The relative age of redds was estimated by visually assessing periphyton cover on the redd relative to adjacent gravels. Freshly excavated redds were comprised of relatively clean gravel, whereas older redds possessed more periphyton. The size of observed trout was also estimated where possible. Observers wore Polaroid sunglasses, and restricted surveying times to between 10am and 4pm, when the sun was high in the sky, thereby maximising visibility. The locations of trout redds were logged onto a high-sensitivity 12-channel GPS recorder, and the relative size and age of redds were recorded. Also recorded were details and locations of weirs, which may impede trout passage.

5.5 Statistical Analysis

Data processing consisted of the construction of maps of trout redd distribution by downloading the GPS data into Google Earth Plus. In the dedicated trout spawning report (Taylor & Bray 2008), the spatial data was statistically analysed with SigmaStat (ver. 3.1), with the longitudinal distribution analysed statistically using t-tests where its distribution was normal, and non-parametrically (Mann-Whitney Rank Sum tests) when the distribution could not be normalised. However, the results of the statistical analysis are summarised in this document, and not cited in detail.

The catch per 100 square metres of stream sampled was calculated as a measure of catch per unit effort for the electric fishing. This was the convention in the earlier reports, and is repeated here. For the purpose of clarifying the text, this is referred to as numbers of fish, but it relates specifically to the numbers of fish over a standardised area of 100m^2.

6 Results

6.1 Lower river fish

Table 4 shows the results of the netting programme in the lower river. These sites are all within the tidal influence, and the results are typical of sites which are tidally-influenced, although they do not include two species - common smelt (*Retropinna retropinna*) and inanga (*Galaxias maculatus*) - which are commonly found in the tidal reaches.

Table 4. Netting results from the lower Avon River.

Site	Species	Scientific name	Number recorded	Size range (mm)
Avondale Bridge	Yellow-eyed mullet	*Aldrichetta forsteri*	2	206-223
Avondale Bridge	Giant bully	*Gobiomorphus gobioides*	3	99-133
Avondale Bridge	Shortfin eel	*Anguilla australis*	1	477
Avondale Bridge	Longfin eel	*Anguilla dieffenbachii*	1	790
Cockayne Reserve	Giant bully	*Gobiomorphus gobioides*	1	148
Porritt Park loop	Common bully	*Gobiomorphus cotidianus*	11	86-111
Porritt Park loop	Giant bully	*Gobiomorphus gobioides*	7	95-158

There was relative high giant bully numbers recorded, especially at the Porritt Park loop. Some of the catch of this species from that site are shown in figure 4. Only one of this species was captured at Cockayne Reserve, but it was a large individual (148mm T.L.).

Figure 4. Anesthetised giant bullies from the Porritt Park loop. The dark colouration and long lower jaw is characteristic of this species.

6.2 Fish in the middle-river tributaries

Table 5 shows the results of electric fishing in the middle-river reach tributaries. The Dudley Creek site had an unusual bully species community, in that it is unusual for upland bully to be recorded with giant bully, and highly unusual for blue-gilled bully to be found with giant bully.

Table 5. Results of electric fishing from middle river reach tributaries

Site	Species	Scientific name	Number	Number per 100 m^2	Size range (mm)
Dudley Creek	Giant bully	*Gobiomorphus gobioides*	2	0.6	118- 152
	Common bully	*Gobiomorphus cotidianus*	39	12.0	25- 100
	Upland bully	*Gobiomorphus breviceps*	7	2.1	26 -54
	Blue-gilled bully	*Gobiomorphus hubbsi*	1	0.3	35
	Shortfin eel	*Anguilla australis*	25	7.7	104- 715
Taylors Drain	Upland bully	*Gobiomorphus breviceps*	11	14.4	38 -71
	Shortfin eel	*Anguilla australis*	5	6.5	224- 528
St Albans Stream	Shortfin eel	*Anguilla australis*	4	10.3	168-552
	Upland bully	*Gobiomorphus breviceps*	4	10.3	41-72

6.3 Fish in the upper-river tributaries

Upland bully was the predominant species at all of those sites (Table 6). Small brown trout, of good condition (Fig. 5), were relatively abundant in both branches of Waimairi Stream.

Figure 5. Well-conditioned, anaesthetised juvenile brown trout from the South Branch of the Waimairi Stream.

Table 6. Results of electric fishing the upper Avon River tributaries

Site	Species	Scientific Name	Number	Number per 100 m^2	Size range (mm)
Waimairi Stream South Branch	Upland bully	*Gobiomorphus breviceps*	21	19.4	37-75
	Brown trout	*Salmo trutta*	7	6.5	90-189
	Shortfin eel	*Anguilla australis*	1	0.9	250
Waimairi Stream Nth Branch	Longfin eel	Anguilla dieffenbachii	1	0.5	559
	Shortfin eel	*Anguilla australis*	3	1.5	340-555
	Brown trout	*Salmo trutta*	9	4.4	65-229
	Upland bully	*Gobiomorphus breviceps*	27	13.3	45-81
Wairarapa Stream	Brown trout	*Salmo trutta*	1	0.7	103
	Upland bully	*Gobiomorphus breviceps*	27	18.6	34-83
	Longfin eel	*Anguilla dieffenbachii*	3	2.1	182-281
Okeover Stream	Shortfin eel	*Anguilla australis*	2	2.2	331-730
	Upland bully	*Gobiomorphus breviceps*	27	29.3	38-68

6.4 Distribution of trout redds

6.4.1 Avon River mainstem

Locations of all identified brown trout spawning nests (called redds) in the Avon Catchment are mapped as an overview in App IV a, with close-up maps for Waimairi Stream (App IV, Fig. b), and Wairarapa Stream (App. IV, Fig. c). These maps overlay the more recent 2008 redd distribution (yellow icons) with the 2002 distribution (blue icons).

In the Avon River mainstem, trout redds were well-distributed, with redds recorded from as far downstream as the Madras Street Bridge, then sporadically through the CBD (Central Business District) (Appendix IV Fig. a). The distribution extended upstream to the weirs at Mona Vale and Christchurch Girls High School. These high weirs impound water behind them through the Mona Vale gardens, and the slow-flowing impounded habitat is unsuitable for trout spawning. Upstream of the weirs, only a single redd was found downstream of the Christchurch Boys High School weir in winter 2008, and at the same location as in 2002. No redds were found in the upper reaches of the Avon mainstem in 2008 or 2002, although low numbers were recorded in 1991. Redds in the mainstem were often clustered close together, and occasionally superimposed, for example downstream of the Mona Vale weir.

Total redd numbers were lower in the Avon River mainstem compared to 2002, and especially so when compared with redd numbers from 1991. Reductions in the number of redds were evident in most of the 14 surveyed reaches, and some of the reaches used for spawning in the past would now appear to not support trout spawning . A substantial decrease in redd numbers was reported at the once-favoured spawning habitat near the Harper Avenue Bridge (Carlton Mill Corner). At that location, redd counts have decreased from 46 redds in 1991, to 11 in 2002, to only 4 in 2008. Also, the long straight reach of the Avon River mainstem along Park Terrace was not utilised for trout spawning in 2008 or 2002, although 11 redds were recorded from this habitat in 1991.

In 2008, fifteen completed redds were recorded from the north branch of Waimairi Stream, but none from the south branch, and 54 from Wairarapa Stream between Ilam Road and Garden Road. This survey indicated a similar number of redds as in 2002, but a decrease in the utilisation of the lower Wairarapa Stream, and the mainstem of the Avon River. However, there has been a compensatory increase in the number of redds in the upper Wairarapa Stream. Compared to redd numbers counted in 1991, the mainstem spawning grounds at Carlton Mill Corner and Mona Vale had relatively few redds, and the long reach of suitable spawning gravel alongside Park Terrace is no longer utilised by spawning trout. Trout spawning in Waimairi Stream continues at a fairly consistent low level, but with a statistically significant shift for trout to utilise more upstream gravels. A more detailed breakdown of these results may be found in (Taylor & Bray 2008).

6.4.2 Waimairi Stream

Numbers of trout redds in Waimairi Stream exhibited no temporal trend over the three surveys, with trout redd numbers varying from 13 identified in 1991, 23 in 2002, to 15 in 2008. No redds have been recorded in the south branch of Waimairi Stream since the inaugural 1991 survey. Almost all redds in 2008 were recorded over a 1 km reach between Straven Road and Clyde Road (Appendix IV, Fig. b). This reach was the same one utilised in 2002, but two redds this season (2008) were recorded upstream of Clyde Road. If the redd locations for the two spawning seasons are superimposed, it would appear that the trout have used different sections of the reach for spawning. These translocations exceed the error of the GPS geo-referencing (± 10 m). Based on GPS data from 2002 and 2008, there was a significant upstream shift in distribution of trout redds in Waimairi Stream (Fig. 4b) ($t_{one\text{-}tail}$ = 1.70, $p < 0.05$).

6.4.3 Wairarapa Stream

In 2008, the most downstream redds were recorded near the Railway Line Bridge, but most redds were recorded much further upstream in a long (1.5 km) reach from near Glandovey Road upstream to Ilam Road (Appendix IV, Fig. c). Within this reach, redds were particularly concentrated between Wai-iti Terrace and Ilam Road, near the school grounds of Cobham Intermediate. A local resident along this reach claimed that she had not seen so much trout spawning activity for many years (pers. obs.).

Wairarapa Stream has always been well utilised for trout spawning. Comparing the 1991, 2002, and 2008 surveys, trout redd numbers have varied in Wairarapa Stream. In 1991, 82 redds were recorded, but 35 redds recorded in 2002, and 56 fully excavated redds recorded in the 2008 season. Compared to 1991, there was little spawning in the reaches downstream of Idris Road, both in 2008 or 2002 (Table 1), although there was a number of redds found in a reach downstream of the railway bridge where redds have not been recorded previously. The reach between Idris Road and Garden Road, in particular, has demonstrated a marked decrease in utilisation from 28 redds in 1991, to 1 in 2002, and 4 in 2008. This decline in redd numbers warrants some further investigation as to the cause, although it is suspected to be caused by weed growth, and subsequent sedimentation of the bed. The CREAS dataset may prove useful in respect to analysing temporal shifts in physical habitat features associated with trout spawning habitat. However, while there is some indication of upstream movement in the distribution of trout redds in this tributary, this shift was not significant over the entire length of Wairarapa Stream (Mann-Whitney T = 1476, n.s. p=0.337). Unfortunately, like the Avon River redd distribution, the distribution in this waterway was multi-modal, and could not be transformed adequately to apply a parametric t-test.

7 Discussion

7.1 Lower River

The species recorded from the lower Avon River were virtually the same as those recorded by Eldon and Kelly (1992) using similar sampling equipment, except that the earlier survey also recorded a single brown trout and single black flounder. As well as that, using a fine-meshed seine net, they recorded inanga, smelt, and triplefin. The triplefin is an estuarine species, so it was something of an oddity in their catch, and its distribution could vary depending on the state of the tide when netting takes place. Seine netting was not used by us on this brief survey. It would be expected that inanga and smelt would have escaped through the mesh of the fyke nets, so would not be expected in our catch.

Our results indicate a lower catch rate of some species in the lower river in 2009 than in 1991. For example, we captured only 11 giant bully, which although it is a reasonably large number for this species (because it is usually only recorded in small numbers; (McDowall 1997)), it is by no means anything like as many as the large catch (70 specimens), recorded using a similar sampling effort by Eldon and Kelly (1992). The numbers of eels captured by us were also lower, but numbers of common bully were similar or even higher than previously. However, a large amount of variability can be expected when sampling such a large body of water with a small amount of gear. Such large, tidal bodies of water are notoriously difficult to fish in a thorough, quantitative manner (McDowall 1997), especially when fish move with the tide cycle. Apart from fish species inventories, deriving statistically significant comparisons of fish numbers would require a greater degree of fishing effort than what was expended from this survey. However, if this is of interest to CCC, then more effort, using a greater variety of techniques could be used in the future.

7.2 Middle reach tributaries

In the small tributary streams, the fishing results could be expected to be more representative of the fish community, and therefore more readily comparable with the results of the previous survey. Indeed, in Dudley Creek, our catch rates, expressed as fish numbers per hundred metres of area fished, were generally similar to those of Eldon and Kelly (1992). Differences in species composition in that stream were that we recorded a single blue-gilled bully, whereas they captured a longfin eel. We recorded higher densities of common bully and upland bully there, but they recorded significantly higher concentrations of shortfin eels. The density of shortfin eels that we recorded from St Albans Stream was almost identical to that which Eldon and Kelly recorded, but we recorded about half the density of upland bully in that stream. They also recorded inanga there, which we did not capture, although this is likely to be a seasonal bias, as many inanga are likely to migrate to the lower reaches during February and March, after which they are thought to die (McDowall 1990). In Taylors Drain we recorded a similar density of shortfin eels to Eldon and Kelly, but we did not record brown trout, which they did at 14.6 and 31.6/100m^2 (they sampled two reaches close together in this stream). However, the density of upland bullies that we recorded there was far higher than theirs (14.4 compared with 3.7 and 5.2/100m^2).

It is extremely unusual to record the species in the same habitat as giant bullies, which are a lower river reach/estuary dweller (McDowall 1997). However, it might have been that the specimen, which was small (35 mm), was in the process of migrating from the sea to the adult habitat. Bluegill bullies, and in some number, have been recorded from mainstem (McMurtrie & Taylor 2003), and even from a atypically fast-flowing boxed drain habitat in the horseshoe lake catchment (Taylor & McMurtrie 2003).

7.3 Upper reach tributaries

In the upper reach tributaries, the numbers of brown trout that we recorded in every stream were much lower than those recorded by Eldon and Kelly, but the numbers of upland bully were much higher in every case, except in Okeover Stream, where bullies were only at a slightly higher numbers than previously (29.3 compared with 24.4/100m^2). It is quite probable that this observed increase in the abundances of upland bully populations, in parallel with reductions in brown trout populations (which was also noted in Taylors Drain), is an example of cause and effect, since trout predate heavily upon bullies (McDowall 1990). Similarly, it was noted during a fisheries survey of the Heathcote River that there was an inverse relationship between the densities of brown trout (which were not recorded in the Heathcote) and native fishes (notably inanga, which were abundant) in that catchment (Eldon *et al.* 1989).

Densities of longfin and shortfin eels were similar between our survey and that in 1991. Eldon and Kelly (1992) also recorded a single lamprey, which was a species that was absent from our sampling. However, little can be drawn from this observation.

7.4 Habitat considerations for trout spawning

Brown trout lay their eggs in nests (which are called redds) in riverbed gravel, and these fish have particular physical and hydraulic requirements. They select relatively clean but stable gravel about 5 cm in diameter. D.F. Hobbs, writing in 1948 described it this way "Trout prefer to spawn where there is a moderate current over relatively stable gravels, usually to 5cm in diameter, moderately consolidated with finer binding materials. Trout avoid loose, clean shingle. While they can move very consolidated underlying material, they avoid areas where surface stones sit, as it were, waist deep in embedding silts (Hobbs 1948).

The results of the trout spawning survey have already been reported in depth (Taylor & Bray 2008). The amount of trout spawning activity declined greatly between 1992 and 1998. Of note in relation to the current report was the fact that there appeared to be little co-relation between the number of redds in the upper tributaries and the subsequent numbers of juvenile trout recorded from those sites. Thus, although the vast majority of the spawning activity was located in the Wairarapa Stream in 2008 (54 redds were noted there), only one juvenile trout was captured in that stream in April 2009. In contrast, there were a relatively large number of juveniles captured in the south branch of Waimairi Stream, where there was no spawning recorded at all. This latter site had the highest trout density that we recorded (6.5/100 m^2). The separation noted between spawning sites and juvenile rearing areas is probably because trout are known to utilise different habitats for spawning and for juvenile rearing (Kalleberg 1958), and there was no barrier to their migration between the streams. Further, juvenile trout (parr) become territorial at a young age, which would also facilitate dispersal from spawning grounds. However, the density of trout that we recorded from the Waimairi Stream south branch (i.e., 6.5/100 m^2) was low compared with the 38.4/100m^2 recorded by Eldon and Kelly for the same site, which was the highest trout density that they recorded during their survey.

Given the demonstrable loss of spawning habitat in the Avon River mainstem, further investigation is required in establishing the reasons for the decline, especially in the previously major spawning grounds adjacent to Carlton Mill Corner, and Christchurch Girls High School.

In this context, the largely adverse effect of interstitial sediment on stream ecology, and in particular to trout egg health is of interest. AEL is currently developing methods in which trout redd health can be quantified, with the likelihood that these methods will be applied to Avon River habitats in the future.

Cover for brown trout is an important habitat component. Cover is the refuge offered by overhanging bankside vegetation, or instream weed. From these locations, fish can rest out of the current, or hide from potential prey or predators. During the spawning season, large (i.e. > 30 cm F.L.) brown trout swim upstream into the upper Avon River catchment, and may occupy these shallow habitats for several weeks. During the final stages of maturation these large fish will take refuge along the banks. It is therefore important that riparian vegetation is left to grow over the water's edge during the winter months, particularly along the spawning reaches. The type of cover required does not differ materially from that required for native fish, e.g. overhanging tussock sedge (*Carex secta*), or long fescue grasses. However, cover for large trout could be expected to overhang the wetted margin by more than 30 cm to provide benefit for large trout. Long grasses alongside the banks of the Avon River through Hagley Park is left uncut to provide cover for spawning trout, and juvenile trout can be found in cover along the banks can be found in some numbers (Fig. 6).

Figure 6. Long tall fescue grass provides cover for adult and juvenile brown trout near a trout spawning ground adjacent to Hagley Park (photo from McMurtrie & Taylor 2003).

7.5 Conclusions

Overall, there appeared to have been a decrease in the abundance of brown trout in the Avon River since 1991, and a resultant reduction in trout spawning activity. Eldon and Kelly (1992) noted that, based on anglers' records, there appeared to be a similar decline in trout numbers in the years between 1962 and 1968. Diaries from 1962 recorded that a reasonable number of fish were captured, but in 1968 there were very few. Historically, the Avon River had been rated as a good trout fishery (Donne, 1927). The reason why brown trout numbers have steadily decreased over this time is not obvious. The trout spawning survey indicated that the availability of spawning gravel would not appear to be limiting, and for example, there was unutilised gravel at Carlton Mill which has previously been a favoured spawning site. However, the quality of the gravel might be an issue. The concentrations of dissolved oxygen passing through spawning gravels (intra-gravel dissolved oxygen concentrations - IGDO), is one aspect of the quality of spawning sites. Work is currently in progress by AEL to assess IGDO concentrations at some spawning sites in the river, and this work might shed some light on the issue.

One potential positive aspect of the reduction in the observed brown trout populations is that the abundance of small native fishes, namely upland bully, appeared to have increased, particularly in the upper reach tributary streams. In contrast, native fish populations appear to have decreased in some middle reach tributaries. However, Dudley Creek was an exception in this respect; it has held its own since 1991 with respect to both species diversity and abundance, although its appearance is still similar to when Eldon and Kelly (1992) described it as "Looking like the broadside capability of an old warship…" As a result, it could probably benefit from some riparian planting, especially by overhanging sedges of the genus *Carex*, which are highly suitable for providing cover for fish. The beneficial aspects of existing riparian plantings, including *Carex,* are discussed in a study of how fish communities were associated covered in some depth in an investigation in how existing bank treatments along the Avon River benefit fish communities (McMurtrie & Taylor 2003).

8 Recommendations

We reiterate the recommendations made previously in the report on trout spawning in the catchment (Taylor & Bray 2008), specifically:

- Monitoring of the physical nature of the trout spawning reaches in the lower Wairarapa Stream should be undertaken (i.e. Between Idris Road and Garden Road), which appears to have suffered a decline in trout spawning activity.

- The continuing loss of trout spawning reaches in the mainstem is of concern, and we consider that some emphasis should be placed on establishing the causes for that, and implementing any management options recommended from other research work conducted by AEL.

- In addition, some tributaries which are more suitable as native fish habitat than trout habitat, such as Dudley Creek, could benefit from the provision of cover by riparian planting. For small native fish, we found from field experimentation, that long introduced grass or native Carex, **which overhang the water by 30 cm,** both work well at increasing cover for native fish.

9 Acknowledgements

Jonathan Bray assisted with the field work. We acknowledge funding from the Christchurch City Council, who funded this study as part of their ecological monitoring programme for Christchurch's waterways.

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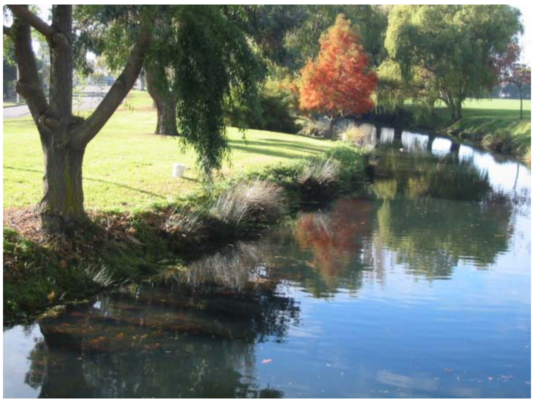
11 Appendix I. Lower river sampling sites

The Avondale site, looking downstream from Avondale bridge

A fyke net set in Cockayne Reserve



The Porritt Park loop Area

12 Appendix II. Lower river tributary sites

St Albans Stream at English Park, looking upstream

St Albans Stream at English Park, looking downstream

Dudley Creek at Banks Avenue, looking downstream

Dudley Creek at Banks Avenue, looking upstream

Taylors Drain at Elmwood Park, looking upstream

Taylors Drain at Elmwood Park, looking downstream

13 Appendix III. Upper river tributary sites


Okeover stream at Forestry Road, looking upstream


Okeover stream at Forestry Road, looking downstream


Wairarapa Stream at Glandovey Road, looking upstream.


Wairarapa Stream at Glandovey Road, looking downstream.


Waimairi Stream South Branch, looking downstream.


Waimairi Stream South Branch, looking upstream.

Appendix III cotd. Upper river tributary sites

Waimairi Stream North Branch, looking upstream.

Waimairi Stream North Branch, looking downstream.

14 Appendix IV. Locations of brown trout redds

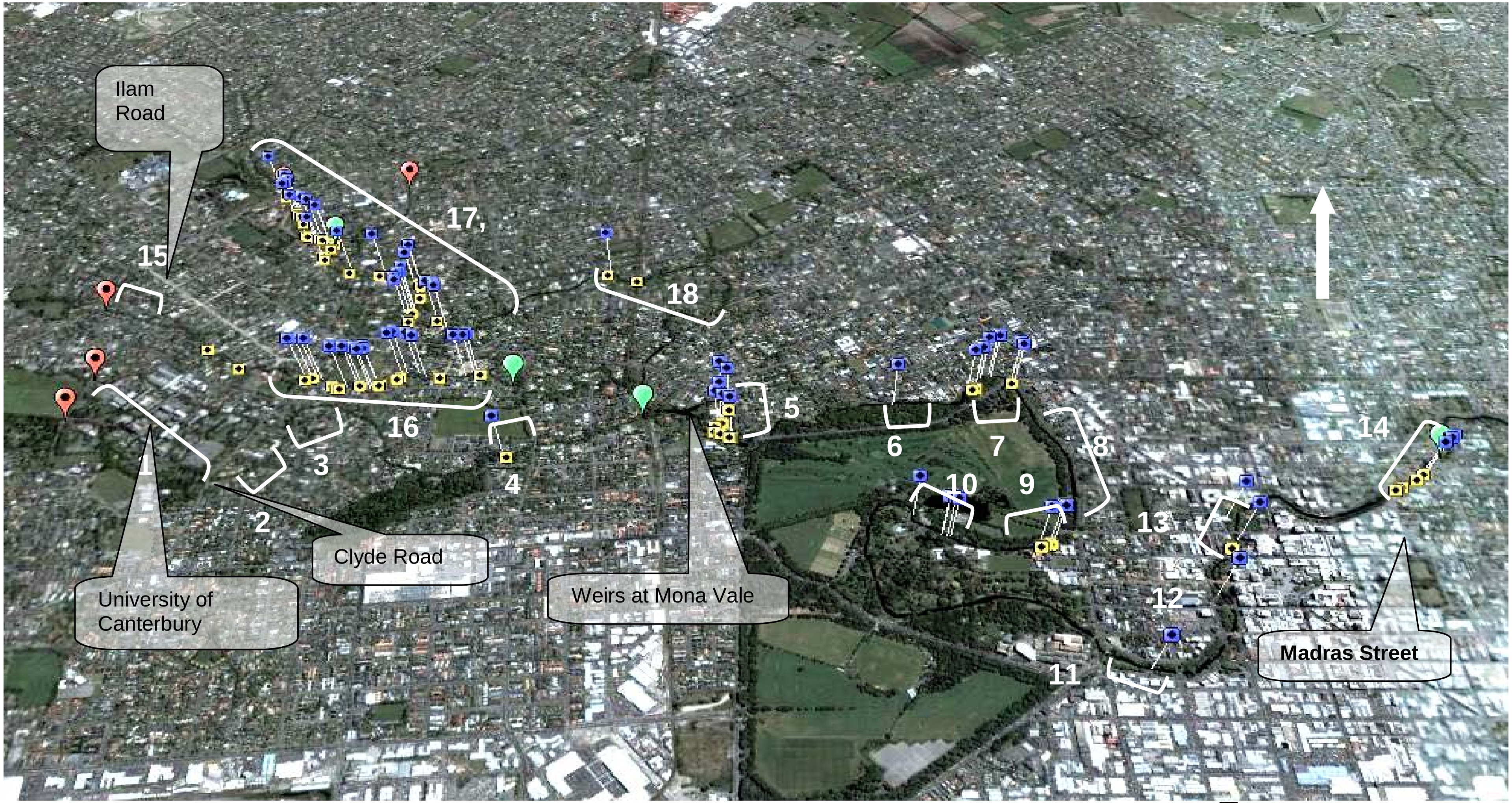


Figure a. Avon catchment showing redd sites (GPS coordinates) from the 2002 survey, and redds from the 2008 survey. The 2002 sites have been elevated above the stream to allow greater visual clarity. Start of survey and end of survey markers are also indicated.

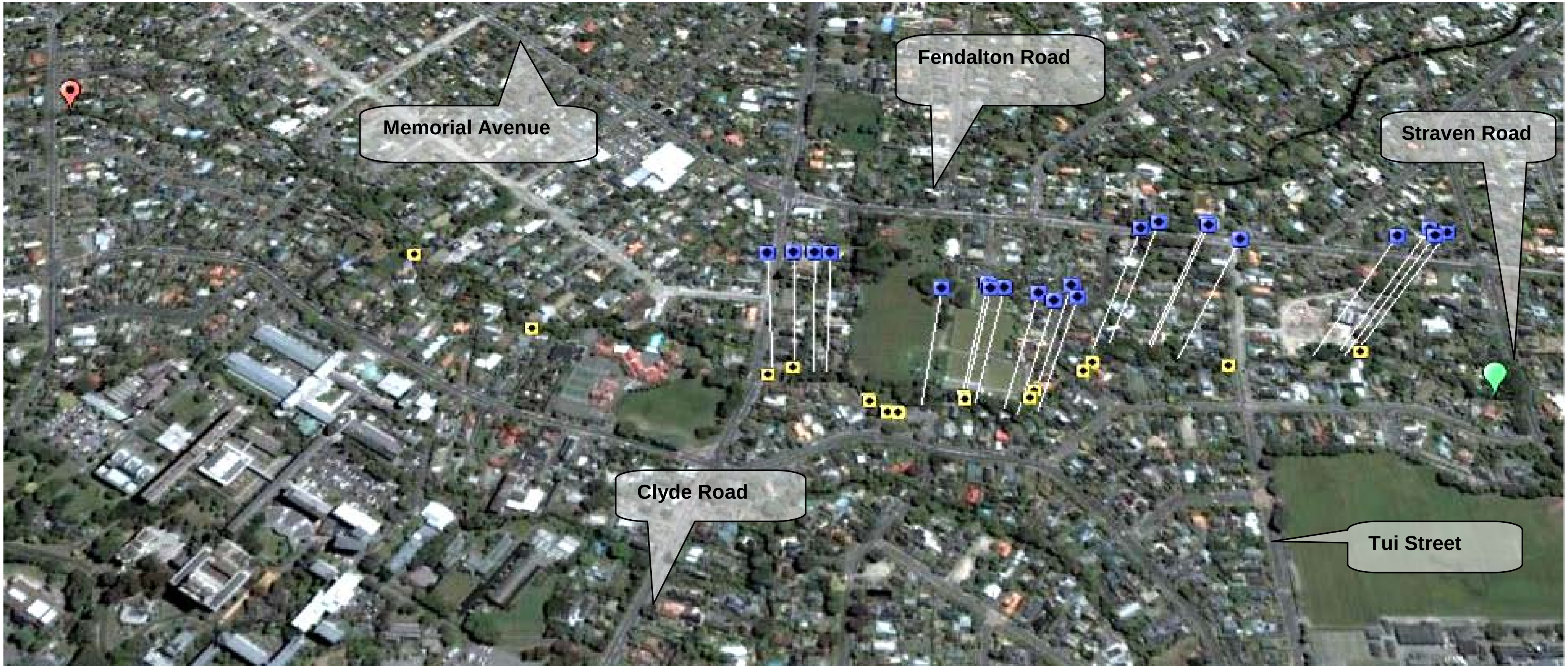


Figure b. Waimairi Stream showing redd sites (GPS coordinates) from the 2002 survey , and redds from the 2008 survey . The 2002 sites have been elevated above the stream to allow greater visual clarity. Start of survey and end of survey markers are also indicated. The reach and associated reach number (in white font) are tabulated in the text (Table 1 *in* Taylor & Bray 2008).

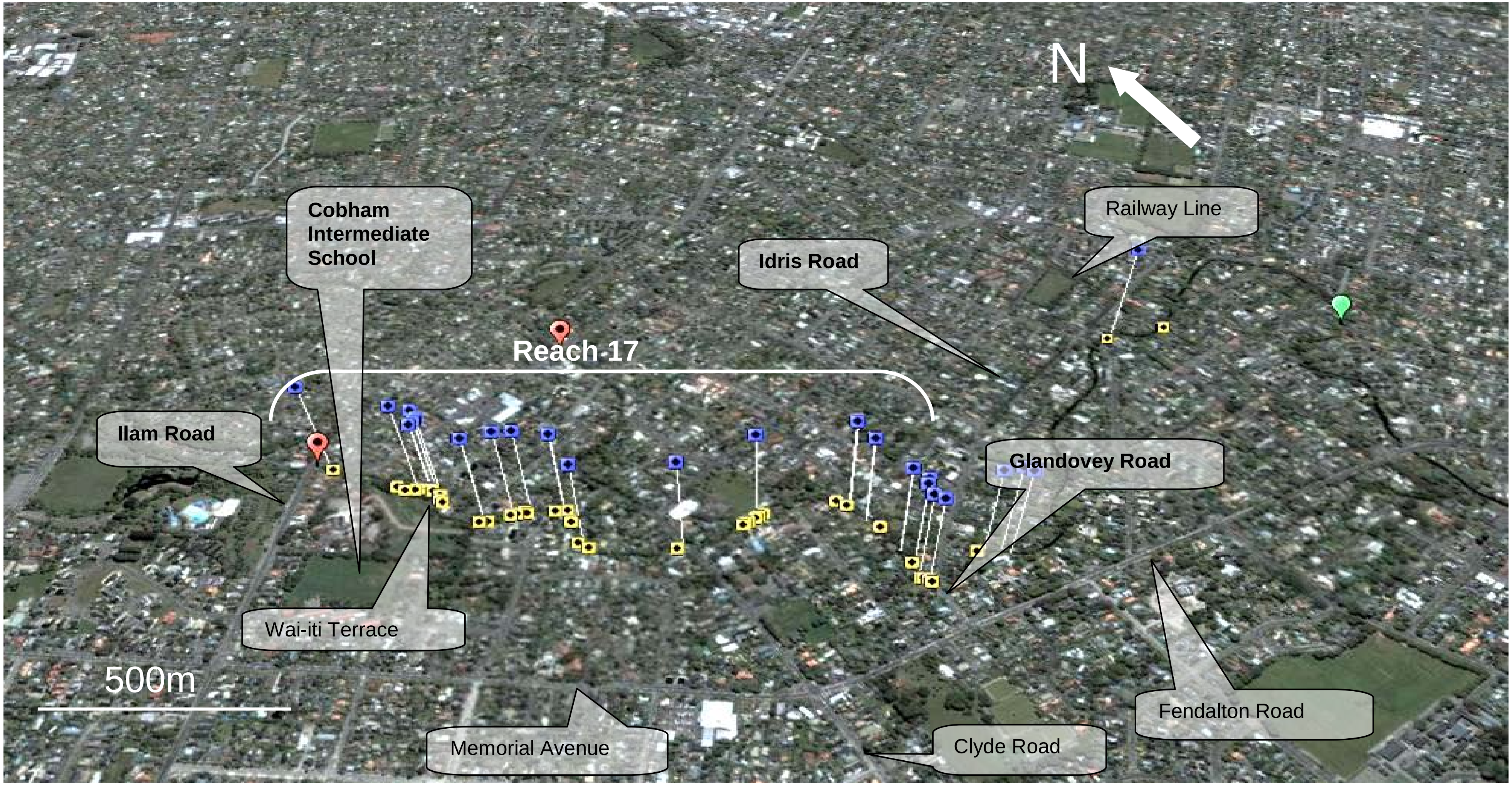


Figure c. Wairarapa stream showing redd sites (GPS coordinates) from the 2002 survey, and redds from the 2008 survey. The 2002 sites have been elevated above the stream to allow greater visual clarity. Start of survey and end of survey markers are also indicated.