Cawthron Report No. 611

The Ecology of Spring Creek - Awarua

Prepared for

MARLBOROUGH DISTRICT COUNCIL

Fish & Game New Zealand

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The Ecology of Spring Creek - Awarua

(Awarua: water from the ground)

Prepared for

Marlborough District Council
and
Fish & Game NZ - Nelson/Marlborough Region

by

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Cover Photo: Spring Creek at Rapaura Road: Roger Young 1999

EXECUTIVE SUMMARY

Spring Creek is a highly valued, picturesque waterway, but in recent years, concerns have been raised over changes in the water quality, water clarity, and flow levels and a perceived decline in the trout fishery. A stakeholders' meeting convened by Marlborough District Council in 1999 identified a number of issues concerning the condition and management of the creek and agreed that a group of agencies should investigate the present condition of the creek and explore solutions to any problems detected. As a result of this the Marlborough District Council, Fish & Game NZ - Nelson Marlborough Region, Department of Conservation, and the Cawthron Institute began a one year collaborative study.

This report presents the results of that study and although it does not attempt to find solutions to all the problems identified during discussions and fieldwork, it does offer information on the present condition of the creek and recommendations for further action.

Spring Creek is primarily spring-fed with direct inputs of groundwater into the mainstem as well as contributions from tributaries. Water levels in the creek are loosely linked with flows in the Wairau River and tend to vary on an annual basis.

Monthly sampling of water quality at 10 sites throughout the catchment revealed:

- Nitrate concentrations were high in the headwaters and tended to decrease downstream. Hollis Creek and Roses Creek also had high concentrations of nitrate. Nitrate concentrations in 1999/2000 generally were higher than those collected during 1994/1998, suggesting perhaps that nitrate concentrations are increasing. However, nitrate concentrations in April 2000 were similar to those measured in April 1985.
- Concentrations of dissolved phosphorus were low in the upper reaches of the creek but increased downstream. High concentrations were also found in Ganes Creek, Dentons Creek and Roses Creek. Aquatic plant growth in Spring Creek is likely to be phosphorus-limited, so it is important that phosphorus loadings do not increase. Fortunately, existing data showed no evidence of an increase in dissolved phosphorus concentrations over time.
- The upper reaches of Spring Creek and Hollis Creek had the clearest water. Water clarity deteriorated downstream in Spring Creek and was moderate to poor in the tributaries. Roses Creek had particularly poor water clarity during August and September 1999 following rain. Limited water clarity data from 1988 also detected the downstream decline in water clarity but there is little to suggest that it has become worse since then.
- Most suspended material was very fine and inorganic. The larger pieces of aquatic plants that can be seen floating down the creek on some occasions have minimal impact on water clarity.
- Concentrations of faecal bacteria generally were low in the upper reaches of the creek, but increased downstream. On some occasions bacterial levels exceeded the Ministry for the Environment's guidelines for safe recreational swimming at Roses Creek, Ganes Creek, O'Dwyers and the Floodgates. Such high levels of bacteria have not been recorded in Spring Creek previously.

Water temperature in the headwaters of Spring Creek was around 14 °C throughout the year reflecting the cool constant temperature of the groundwater. Daily variations in temperature increased down the mainstem of the creek. Larger tributaries, such as Dentons Creek, had similar temperatures to the mainstem of the creek but small ones, like Roses Creek, had large daily and annual variations in temperature.

Daily fluctuations in oxygen concentration were large during December with daily mean concentrations between 80-90 % saturation. In contrast, oxygen fluctuations were lower in May and mean daily values (50 – 60 %) were well below proposed limits (> 80 %) for the protection of aquatic life.

The Spring Creek catchment is highly modified and this is reflected in the aquatic plants and riparian vegetation. Of the 20 species of aquatic plants recorded, 12 were introduced and four of these are considered nuisance species (*Egeria*, *Lagarosiphon*, *Ranunculus* and *Elodea*). *Lagarosiphon* was the most common and dominant species in Spring Creek. At the Floodgates site *Egeria* and *Lagarosiphon* dominated the community accounting for up to 63 % of the plant cover. Stable flows and temperature in Spring Creek allow relatively stable plant communities. There was little change in plant density between the beginning and end of the 1999/2000 summer in Spring Creek's mainstem. At some sites *Lagarosiphon* formed dense surface reaching beds that quite obviously hindered water flow.

Eradication of some aquatic plants, particularly *Lagarosiphon*, is possible in some reaches of Spring Creek and control of other aquatic plants in Spring Creek would be possible with better riparian management. Our survey of shading effects indicated that light intensities of ≤200 µmol/m²/s limit aquatic plant growth, particularly of nuisance species, in Spring Creek. Shade created by large trees on the north bank of Spring Creek achieved levels of light intensity less than 25 µmol/m²/s. This suggests that shading could be an effective way of controlling aquatic plants in some reaches of the creek.

A survey of macroinvertebrate communities undertaken in the Spring Creek catchment on the 20th October 1999 indicated that Ganes, Roses, and, to a lesser extent, Dentons Creeks had macroinvertebrate communities that are reduced in variety and indicative of lower environmental quality than those at sites elsewhere in the catchment. The absence or reduced numbers of amphipods in Ganes and Roses Creeks may be attributable to herbicide toxicity and/or removal of vegetation habitat associated with drain maintenance. Growth and mortality of shrimps did not appear to be directly affected by herbicide applications. However, direct effects on other macroinvertebrate populations cannot be discounted. The removal of vegetation habitat was likely to have impacted shrimp populations and may also have an impact on other species.

Ten species of fish and two large crustaceans have been recorded in Spring Creek. All except two of the fish species are indigenous and require access to the sea. Although Spring Creek does not have as many fish species as the Wairau River it has relatively high species richness when compared with rivers of similar altitude and distance from the sea elsewhere in New Zealand. The entire catchment is accessible for fish, but several species have limited distribution. These were black flounder, common bully and shrimp. The presence and abundance of inanga throughout Spring Creek implies that the floodgates do not limit fish access. The Spring Creek inanga are likely to contribute to the Wairau whitebait fishery.

The stable flow, temperature and high water quality of Spring Creek has supported a popular trout fishery. In recent years, popularity of the Spring Creek trout fishery has declined. Causes of this decline may include loss of spawning and juvenile rearing habitat, passage impaired recruitment of adult trout from the Wairau River, reduction in trout food supply, and/or angler over harvest.

A low level of customary, recreational and commercial eeling takes place in Spring Creek, but the fisheries value of other species is largely unknown.

Trials of various riparian management options on the tributaries of Spring Creek could be undertaken to address the problems related to inputs of nutrients, sediment, and faecal bacteria that have been found. Control of stock access to waterways is probably the best way to control these inputs. Tall riparian vegetation could be used to control nuisance growths of aquatic plants. Plantings for shade-control of aquatic plants should be made on the north bank of streams to maximise effects.

Spring Creek is a relatively small catchment and has not been damaged beyond repair. Its spring-fed nature makes it somewhat resilient to the effects of surrounding land use. On the other hand there are not the flushing flood flows that will remove sediment that enters the creek. There is much potential for small changes in riparian management, by a small number of people and agencies, to result in large improvements to the health of Spring Creek.

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Report reviewed and approved for release by:

Rowan Strickland, Freshwater Group Manager

1. INTRODUCTION

Spring Creek is a picturesque waterway fed by groundwater associated with the Wairau River. The creek is highly valued for its clear, clean water and many people rely on it as a supply of water, food gathering area, and recreational resource. In recent years, however, concerns have been raised over changes in the water quality, and the local community and farmers have noted changes in water clarity and flow levels. Fish & Game New Zealand Nelson-Marlborough region has expressed concerns over a perceived decline in the trout fishery.

In 1999 the Marlborough District Council invited concerned parties to a public meeting to discuss these issues. The meeting was attended by representatives from the Spring Creek Waterways Association, local iwi, South Island Eel Management Committee, Marlborough Freshwater Anglers' Club, Fish & Game Nelson-Marlborough, Department of Conservation, Marlborough District Council and the Cawthron Institute. The meeting identified a number of issues relating to the condition and management of the creek and came to a common agreement on their perception of what the creek should be like in the future (Figure 1.1).

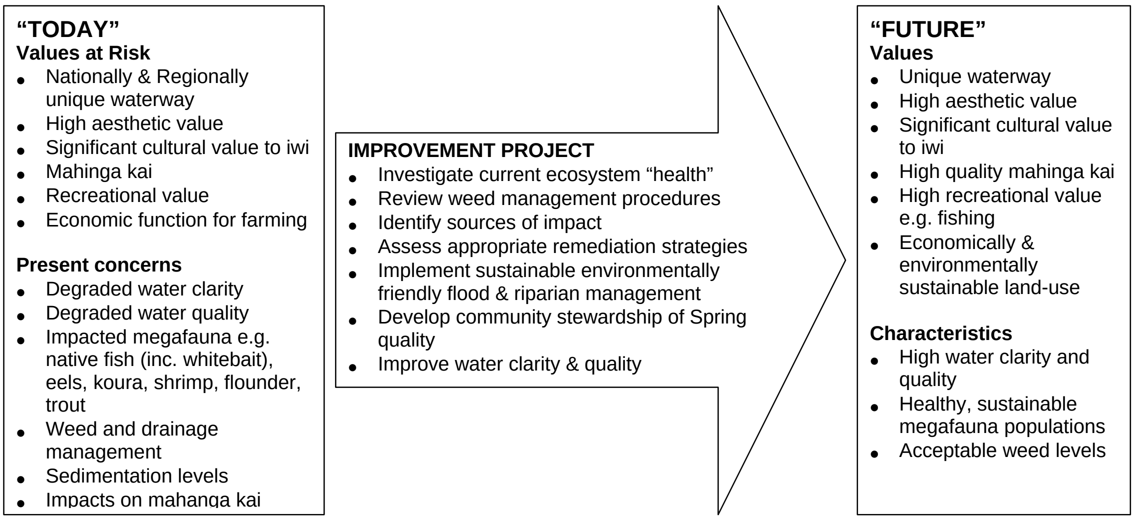

Figure 1.1 Values at risk in Spring Creek today and agreed vision for the creek in the future

The meeting agreed that a group of agencies should investigate the present condition of the creek and seek solutions to any problems detected. As a result of this the Marlborough District Council, Fish & Game NZ - Nelson Marlborough Region, Department of Conservation, and the Cawthron Institute began a one year collaborative study.

A short report was produced after 6 months of data collection (Young & Harding 2000 – see Appendix 7). The present report goes into more detail and describes the results of 12 months of data collection.

Data have been collected and assembled from varying sources. This report does not attempt to find solutions to all the problems identified during discussions and fieldwork, but does offer information on the present condition of the creek and recommendations for further action.

2. THE SPRING CREEK CATCHMENT

Spring Creek flows for approximately 11 km across the lower Wairau Plains before joining the Wairau River 12 km upstream from the ocean (Figure 2.1). The geology surrounding Spring Creek comprises alluvial gravel and sand, initially of glacial origin from the upper Wairau area. In the process of being moved and redeposited in the lower Wairau Plains much of the fine glacial material was removed making it very permeable (Rae 1988). Water from the Wairau River infiltrates into this highly permeable mix of gravels and sand forming the Wairau Aquifer. Spring Creek is the largest and most well known of many outflows from the Wairau Aquifer and has remarkably constant flows. Rainfall is relatively low in the area surrounding Spring Creek (800 - 1000 mm/yr), therefore surface runoff makes only a small contribution to the total flows in the creek (Rae 1988). The Wairau Aquifer covers a large area (11 000 ha) of the Wairau Valley and radioisotope dating has suggested that groundwater in the aquifer takes no more than 30 years to flow from the recharge zone (between Waihopai Confluence and Giffords Road) to the coast (Cunliffe 1988).

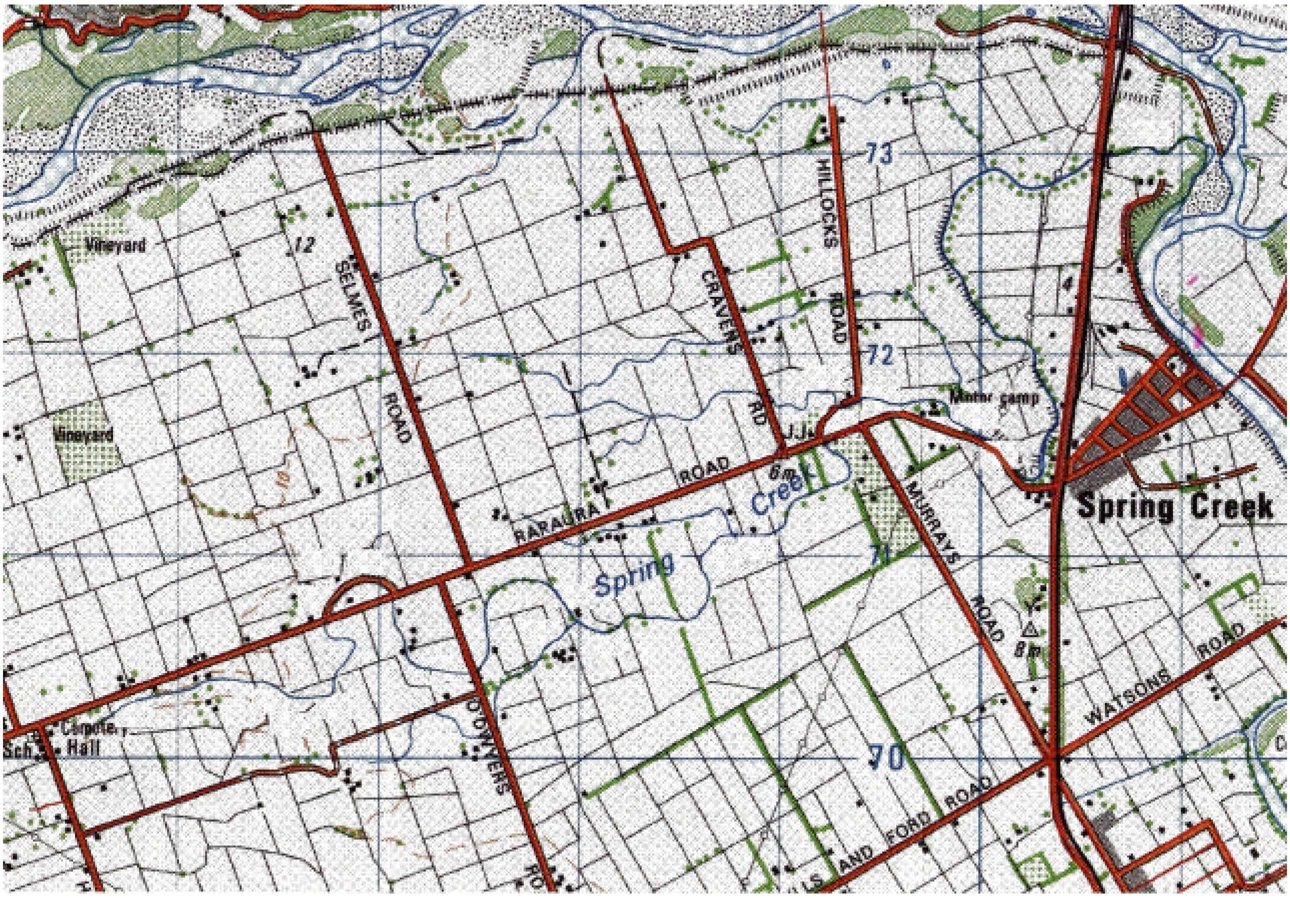

Figure 2.1 Map of the Spring Creek catchment.

Prior to human settlement the area surrounding Spring Creek was mainly swamp, and early maps show flax and swamp vegetation dominating the creek catchment (Rae & Tozer 1990). From the 1850-1860's most of the 70 ha of podocarp-hardwood forest in the area was cleared. By 1990 the only remaining original forest consisted of four kahikatea trees near the SH1 bridge over Spring Creek.

The first flax mill in the region opened in Spring Creek in 1867 and by 1875 eight mills in the area exported flax to Australia and England. These milling activities, in conjunction with land drainage and flood control measures, virtually eliminated freshwater wetlands from the lower Wairau Plains (Rae & Tozer 1990). Early industry within the Spring Creek catchment also included a flourmill, a freezing works, and a butter factory. For the past 125 years farming in the Spring Creek area has concentrated on cash cropping, livestock and horticulture. For some time a salmon farm operated in the upper creek, and a wasabi farm operates in the mid-reaches. Viticulture has become increasingly popular in the last few years.

The low-lying nature of Spring Creek has led to substantial flood protection and drainage schemes. Because of the stable flows within the creek itself flooding is primarily caused by water from the Wairau River rather than from high flows in the creek itself. A floodgate on the lower reaches of Spring Creek was constructed in 1996 to stop water from the Wairau backing up Spring Creek during floods.

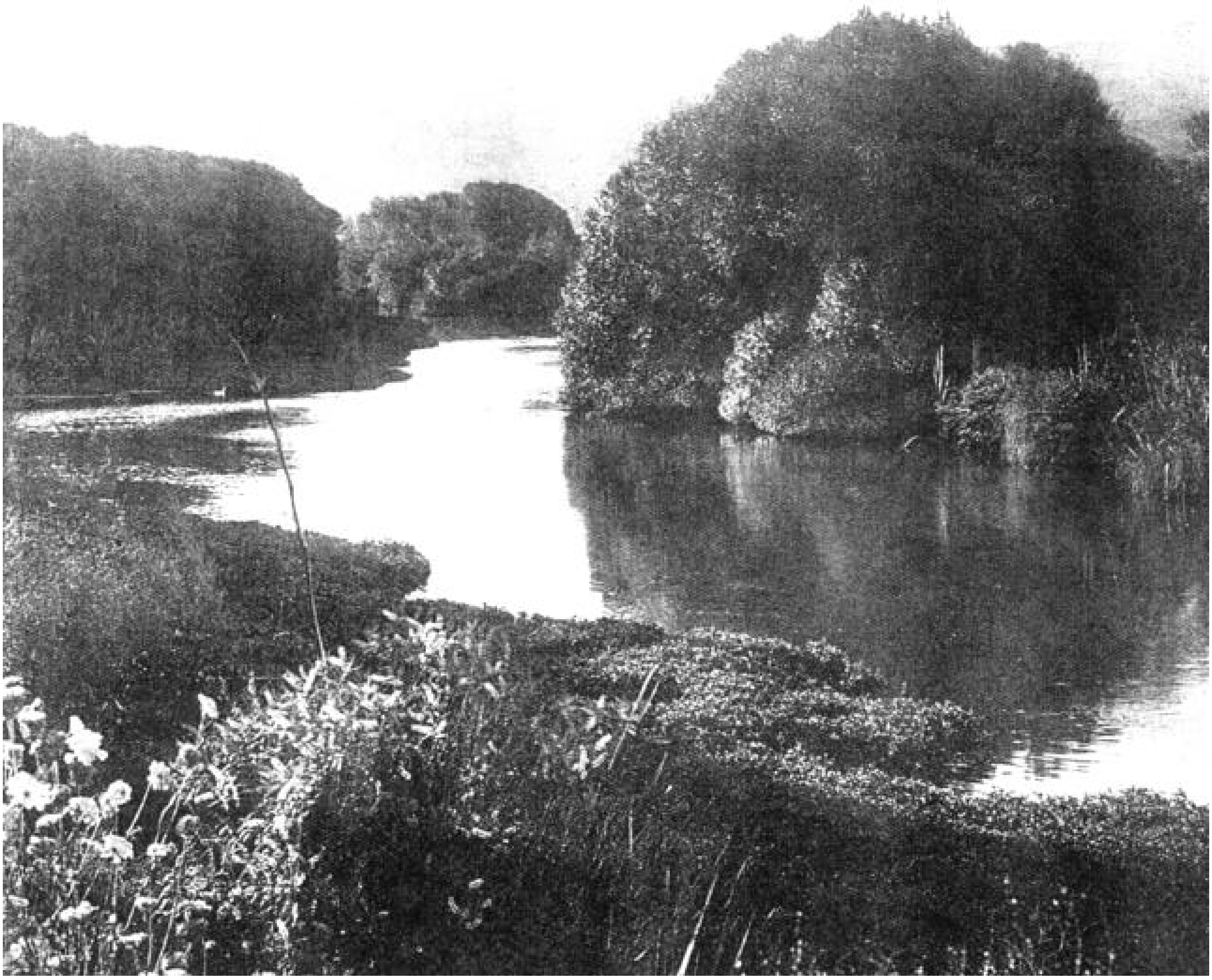

Figure 2.2 Photo from the Auckland Weekly News, Thursday April 22 1909. “A typical southern landscape view – Spring Creek, Marlborough”.

3. FLOWS AND WATER QUALITY

3.1 Flow

Spring Creek is fed by a series of springs throughout the catchment (Figure 3.1). Measurements of flow during July 1991 along the stream and in the tributaries indicated substantial direct inputs of water into the Creek, as well as contributions from tributaries. These direct contributions to flow are largest in the upper reaches between Stump Creek and Hollis Creek (Figure 3.1). The largest tributary in terms of flow is Stump Creek, followed by Dentons Creek, Halls Creek, Hollis Creek, Roses Creek, Ganes Creek and Giffords Creek. It is interesting to note that the headwaters of Spring Creek retreated downstream by several kilometres after the link between the Wairau River and the Opawa River was cut in the 1920's (Rae 1988).

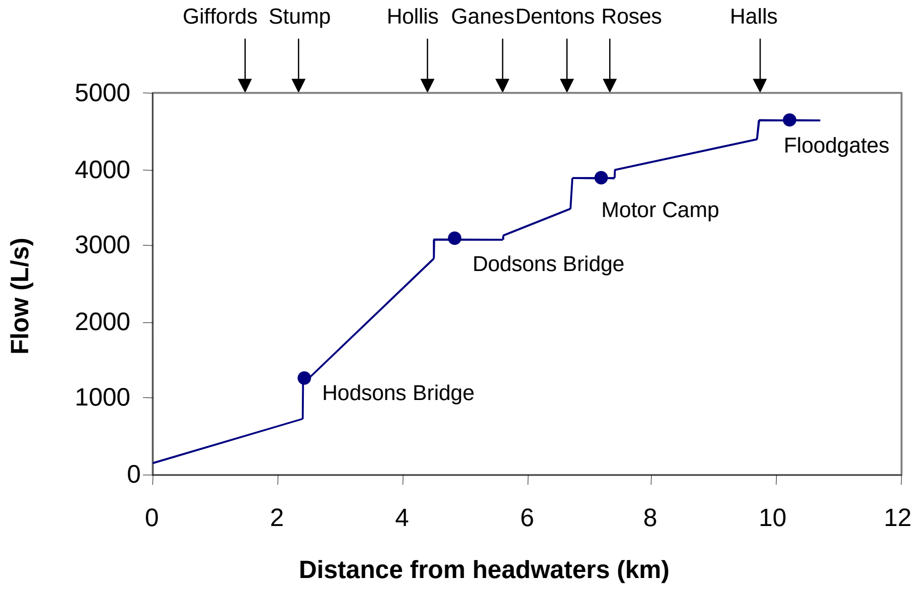

Figure 3.1 An estimate of changes in flow along the length of Spring Creek based on a series of gaugings during July 1991.

A water level recorder at the Motor Camp has been operating since 1996. Water levels change on an annual basis, most likely due to changes in aquatic plant growth downstream (Figure 3.2). Therefore it is not possible to relate water levels directly with flow in the stream. Water demand for irrigation in the catchment may also influence water levels at times. These annual fluctuations seem to have been much larger in the last 3 years (Figure 3.2).

Some sectors of the community believe that willows block the flow and contribute to high water levels in the creek and therefore have petitioned the Council to remove them. Large numbers of willows were removed from the creek in the early 1960's. Further willow removal occurred below Spring Creek township during 1994. Willows were also removed between the SH1 Bridge and the floodgates in 1996 and from the SH1 Bridge almost to Spring Creek township in May 1999. There is some evidence that willow removal temporarily reduced water levels (Figure 3.2), but the loss of the shading that the willows provided has potentially allowed increased growth of aquatic plants in the lower reaches of the creek (Brin Williman, pers. comm.). This is probably the cause of the even higher annual variations in water level that have been observed since the willow clearance (Figure 3.2).

Water level in Spring Creek appears to be linked with flows in the Wairau River to some extent (Figure 3.2). Peaks in Wairau River flow are often matched with peaks in the level of Spring Creek. This relationship is largely driven by increased head pressure driving more water out of the aquifer, rather than from local rainfall in the Spring Creek catchment. The large increase in the level of Spring Creek during June 1998 was probably due to increased flow in Spring Creek and also water backing up from the floodgates during the large flood in the Wairau (Figure 3.2).

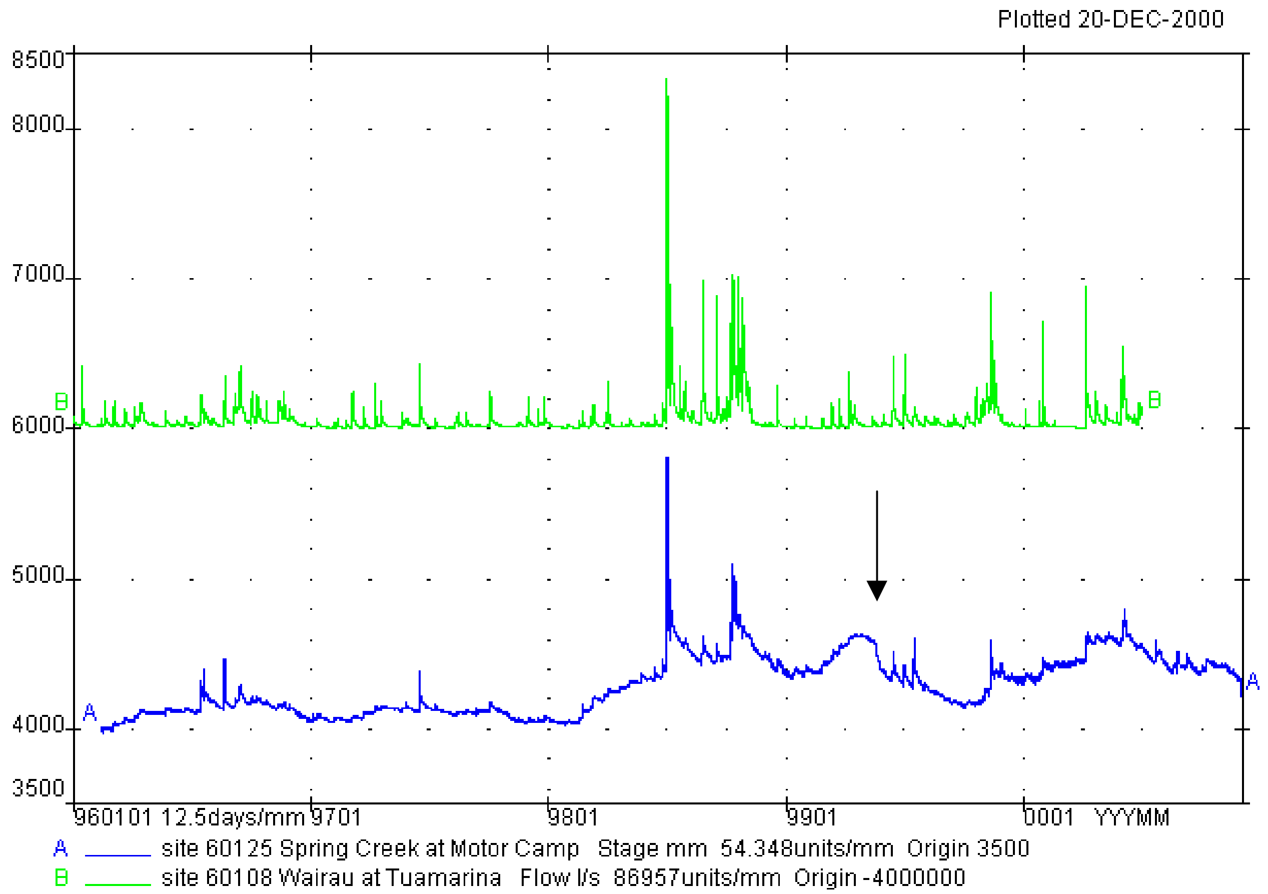

Figure 3.2 Water levels in Spring Creek at the Motor Camp from 1996 to 2000. Flow in the Wairau River at Tuamarina over the same period is also shown. The period when willows were removed from the SH1 bridge to Spring Creek township is shown with an arrow.

3.2 Monthly water quality measurements

3.2.1 Previous water quality studies in Spring Creek

Although concerns have been raised for some time about water quality (specifically high nitrate Robertson 1986), until recently there has been relatively little information available on the water quality of Spring Creek. Shearer (1985) and Rae (1988) reported the results of a survey of 6 sites down the length of the creek over two days in April 1985. Further information was collected in the early 1990's in relation to the operation of the salmon hatchery and wasabi farm. The Marlborough District Council has collected samples from 4 mainstem sites down the catchment 1 – 3 times per year since 1996.

3.2.2 *Study sites and analyses*

As part of the present study the Council sampled water quality monthly at 10 sites in the catchment (including tributaries) from August 1999 to July 2000 (Figure 3.3).

The following water quality parameters were measured:

Water temperature
Conductivity
pH
Turbidity
Total suspended solids (TSS)
Faecal bacteria (*E. coli*)
Nitrate nitrogen (NO_3-N)
Ammoniacal nitrogen (NH_4-N)
Dissolved reactive phosphorus (DRP)
Water clarity (Black disc)
Dissolved oxygen (DO)

Figure 3.3 Map of water quality sites.

Temperature, oxygen, conductivity, pH, turbidity and water clarity were measured in the field using standard meters and/or techniques. All other parameters were measured from samples collected and transferred to the laboratory in chilli bins. Analyses of these samples were undertaken by AgriQuality New Zealand's IANZ registered water testing laboratory using appropriate standard methods.

3.2.3 *Average water quality*

Summaries of the mean water quality measurements at each site are shown in Figure 3.4. The raw data are presented in Appendix 1. Nitrate concentrations were high throughout the catchment but highest at the Tennis Courts, Hollis Creek and Roses Creek (Figure 3.4). Ammoniacal nitrogen concentrations were generally low at all sites, however there were occasional higher measurements in Ganes Creek, Dentons Creek and Roses Creek.

Dissolved reactive phosphorus concentrations also were generally low throughout the catchment but there was a clear increase in DRP concentration down the mainstem of Spring Creek. Higher concentrations of DRP were also found in Ganes, Dentons and Roses creeks (Figure 3.4).

Water clarity was highest at the Tennis Courts and at O'Dwyers Bridge but tended to decrease downstream in the mainstem of the creek (Figure 3.4). In comparison with the other sites, water clarity was low in the tributaries (Ganes, Dentons, Roses), except for Hollis Creek (Figure 3.4). Not surprisingly, turbidity showed a similar pattern with lowest turbidity (clearest water) in the upper reaches of the mainstem, with increasing turbidity downstream. Turbidity in Roses Creek and Ganes Creek was higher than at the other sites.

Total suspended solids concentration tended to mirror the turbidity results. Lowest concentrations were found in the upper reaches of the mainstem at the Tennis Courts, but concentrations increased steadily downstream (Figure 3.4). High concentrations of suspended solids were observed at Ganes Creek and particularly Roses Creek (Figure 3.4). The majority (>80 %) of this suspended material was inorganic (clay and silt). The larger pieces of aquatic plants that can be seen floating down the creek, on some occasions, only make a small contribution to the total amount of suspended material and do not have a major impact on water clarity.

The amount of dissolved oxygen in water can be presented in two ways – the concentration (mg/L) which can vary with temperature and the % Saturation that relates the amount of oxygen in the water with what could potentially be dissolved. The % Saturation measurement is largely independent of water temperature. No major differences in the amount of dissolved oxygen were seen between sites based on the monthly sampling (Figure 3.4). However, oxygen concentrations can fluctuate substantially over a 24-hour period. A more thorough investigation of dissolved oxygen changes among some of the sites is shown in Section 3.5 below.

For freshwater the preferred indicator bacteria is *E. coli* (MfE 1998). Levels of *E. coli* below 126 /100 mL are considered to be safe for contact recreation (MfE 1998). Above this level more frequent sampling is recommended with action to be taken for a single sample above 410 *E. coli* /100 mL (MfE 1998). Concentrations of *E. coli* were generally low in the upper reaches of Spring Creek, except for one very high value at O'Dwyers (Figure 3.4). Concentrations increased downstream and approached the 126 *E. coli* /100 mL alert level (Figure 3.4). Occasional very high concentrations of *E. coli* (>1500 / 100 mL) were found at O'Dwyers, Ganes Creek, Roses Creek and the Floodgates.

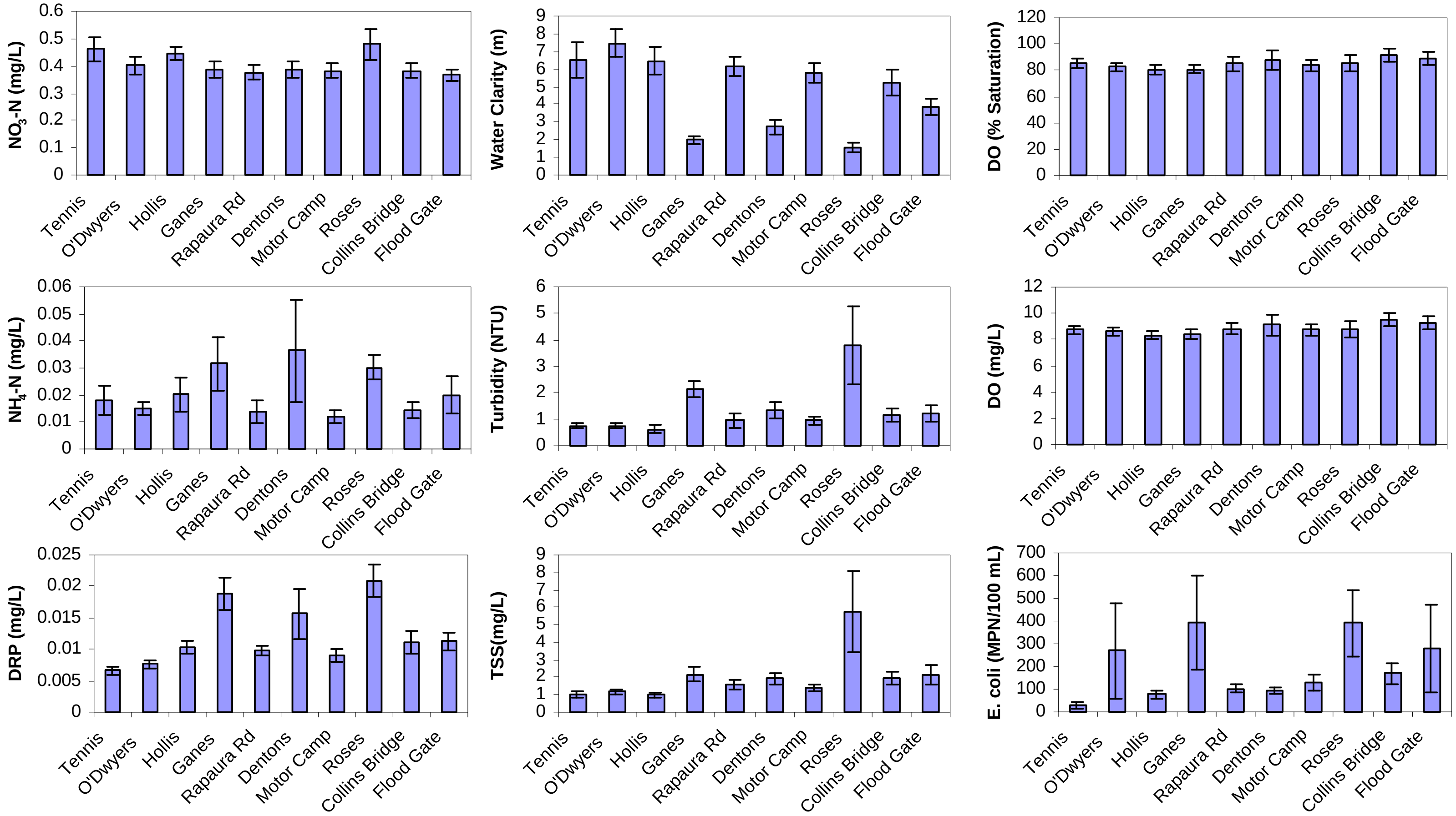

Figure 3.4 Summary of mean water quality parameters (± standard error) for each of the sampling sites.

3.2.4 Annual pattern of water quality

There was considerable variation in the values for some parameters at each site over the 12 months of sampling reported here. For simplicity only six sites are shown which represent the common patterns of annual changes.

On most sampling occasions, nitrate concentrations were highest at the Tennis Courts and decreased down the mainstem of Spring Creek. Nitrate concentrations peaked in winter and early spring at most sites and again in December after rainfall. Concentrations were generally low later in summer and autumn. The pattern was different in Roses Creek, with highest concentrations from March – August 2000 (Figure 3.5).

Dissolved reactive phosphorus concentrations in the mainstem increased downstream and were generally highest in winter. Concentrations of DRP in Ganes Creek and Roses Creek were always higher than in the other sites and also peaked in the winter. There was a large peak in DRP in Ganes Creek during November (Figure 3.5).

Large peaks in the concentration of *E. coli* occurred throughout the year but generally only at one site (Figure 3.5). The large peak in *E. coli* concentration in Ganes Creek occurred at the same time as the peak in DRP concentration, suggesting that there may have been a combined input of nutrients and bacteria to Ganes Creek at that time. There were no similar linkages between DRP and *E. coli* at Roses Creek, which suggests that the types of inputs are not the same for all tributaries.

Total suspended solids concentration and turbidity were very high at Roses Creek during August and September 1999 (Figure 3.5). There were smaller peaks at Ganes and Roses creeks during November and December 1999.

Dissolved oxygen saturation was generally greater than 80 % from August through to February, with one particularly low recording at Hollis Creek. Oxygen saturation at all the sites tended to be low during June and July 2000 (Figure 3.5).

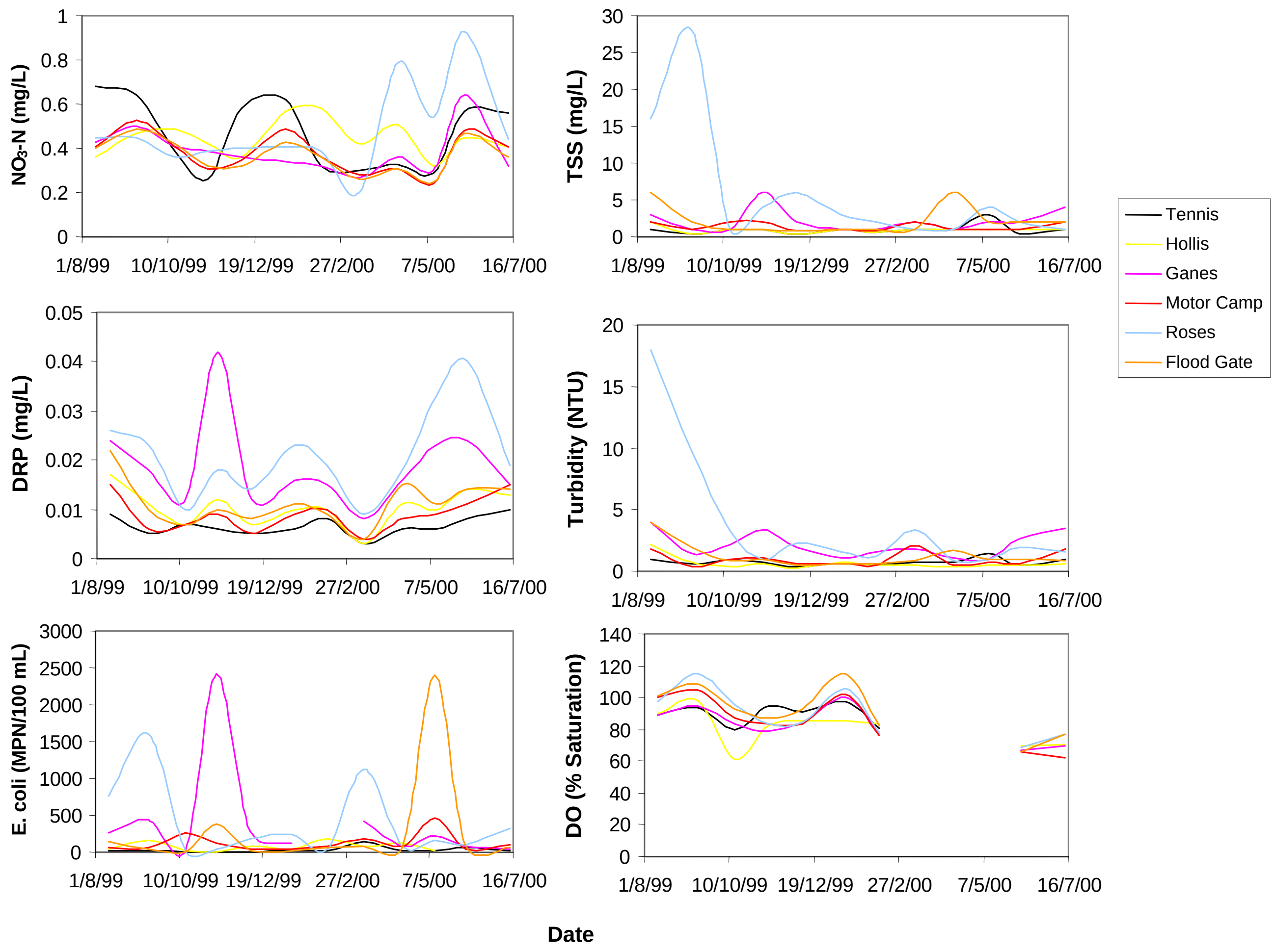

Figure 3.5 Changes in measurements of water quality parameters at six of the sampling sites over the year of sampling.

3.2.5 Comparisons with earlier data

Some water quality measurements have been made at four of the mainstem sites since 1994 and can be compared with data collected more recently (Figure 3.6). There is some evidence that nitrate concentrations have increased over this period of data collection. For example, up until April 1998, none of the nitrate measurements at Rapaura Road was higher than 0.25 g/m^3, whereas from July 1998 onwards almost all samples at the same site were higher than 0.25 g/m^3. Older data on nitrate concentrations at 6 sites down the mainstem of Spring Creek was collected during April 1985 (Rae 1988). While information on the values at particular sites was not presented, the range of values for all 6 sites was 0.24 – 0.33 g/m^3 (Rae 1988). These values were low compared to the majority of samples collected recently, but within the range collected during April 2000.

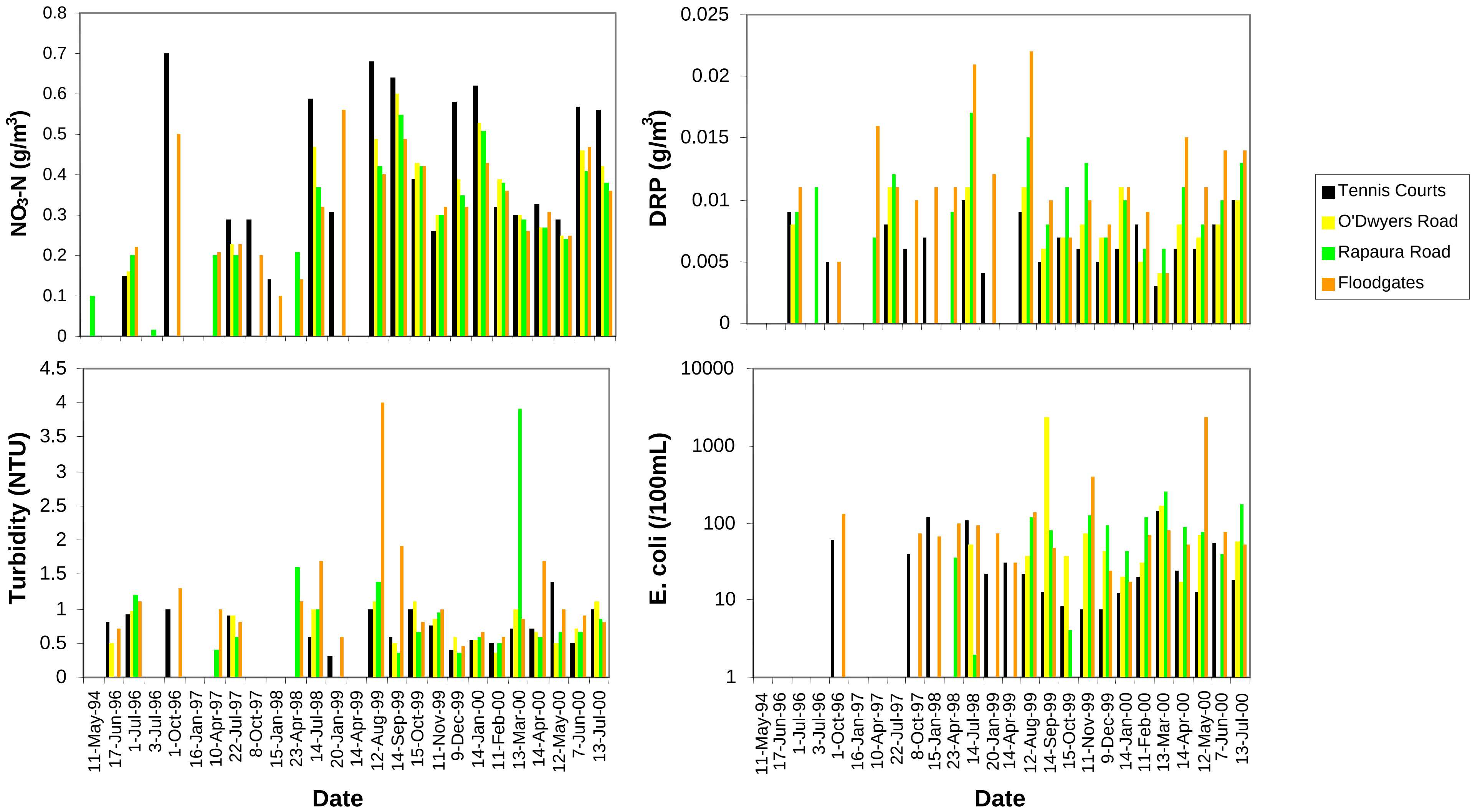

Figure 3.6 Comparison of water quality results from the present study with earlier data at the Tennis Courts, O'Dwyers Road, Rapaura Road and Floodgates sites.

Although nitrate concentrations in Spring Creek are more than sufficient to stimulate prolific growth of algae and other aquatic plants, low dissolved reactive phosphorus levels may be limiting their build-up (MfE 1992). Therefore any increases in dissolved phosphorus concentrations may trigger increased aquatic plant growth. Fortunately, the data indicate that there have been no increase in concentrations of DRP over recent years. Older data (April 1985) on DRP concentrations for six sites down the mainstem range from 0.007 - 0.011 g/m^3 (Rae 1988), which is within the range of values measured more recently (Figure 3.6).

Although there has been no sign of a general increase in turbidity in the mainstem of the creek since 1996, occasional high turbidity measurements have been recorded recently at Rapaura Road and the Floodgates (Figure 3.6). Water clarity was measured at O'Dwyers Road (7 m black disc visibility) and Spring Creek township (5 m black disc visibility) in February 1986 as part of the '100 Rivers' drift dive program. These measurements are very similar to what was measured recently at or near these sites (Figure 3.4). This would suggest that the general downstream decline in water clarity has been apparent for some time and does not appear to have got any worse since 1986.

Concentrations of faecal bacteria do not appear to have changed dramatically in the mainstem of Spring Creek since 1996 (Figure 3.6). However, there have been instances of very high contamination by faecal bacteria at O'Dwyers Road and the Floodgates.

3.3 Continuous water temperature measurements

Water temperature loggers were deployed at the Tennis Courts, Motor Camp, Dentons Creek and Roses Creek on the 12th August 1999 and recorded hourly water temperatures until the 30th August 2000. Water temperature at the Tennis Courts was very stable reflecting the constant temperature of the groundwater (Figure 3.7). The temperature was generally around 14°C, with daily variations <3 °C and an annual variation in mean daily temperature of <2 °C. Further downstream, at the Motor Camp, there were larger daily variations in temperature (up to 5 °C) but annual variation in mean daily temperatures was still only around 2 °C.

In Dentons Creek, one of the largest tributaries, daily variations were similar to that at the Motor Camp (5 °C). Annual variation in mean daily temperature was similar to that in the main-stem, again reflecting the large contribution of groundwater to this stream (Figure 3.7). Much more variation in temperature was apparent at Roses Creek, one of the smaller tributaries (Figure 3.7). Temperature varied by up to 9 °C on a daily basis and mean daily temperatures varied by up to 6 °C over the year. From October to February water temperature in Roses Creek was regularly >19 °C. Although high compared to the other sites, the temperatures in Roses Creek were sufficiently low for most freshwater organisms to survive (Quinn et al. 1994; Cox & Rutherford 2000).

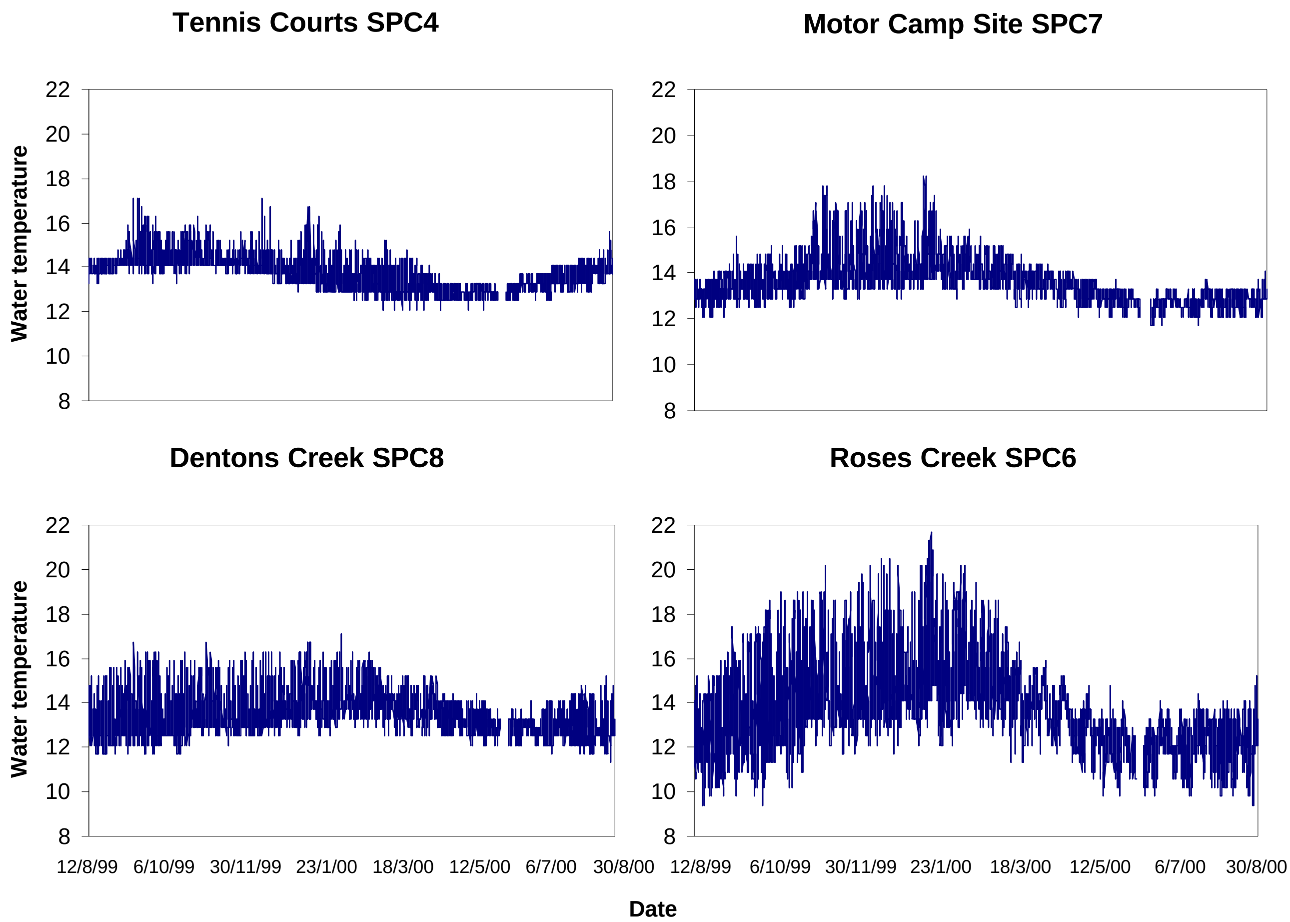

Figure 3.7 Annual pattern of water temperature change at four sites within the catchment.

3.4 Daily oxygen changes

Oxygen concentration in most rivers varies considerably over the course of a day due to the input of oxygen from photosynthesising plants during the day and uptake of oxygen at night. Therefore it is difficult to make conclusions about the amount of oxygen in the water at a variety of sites based on single measurements at varying times of the day. The best way to characterise differences in oxygen concentration between sites is to look at changes in oxygen concentration over the full 24-hour period.

Measurements of oxygen concentrations over 24-hour periods were made at the Tennis Courts, O'Dwyers, Hollis Creek, Dentons Creek, Motor Camp, and Roses Creek during 16-17th December 1999 and 24-25th May 2000. The Floodgates site was also monitored but only during December, while Halls Creek was only monitored during May 2000. Measurements at the Tennis Courts were made every 15-minutes using a Hydrolab DataSonde 3, while measurements at the Floodgates (during December) and Halls Creek (during May) were made using a YSI environmental monitoring system. At all other sites oxygen concentrations were measured every 2-3 hours using a YSI 85 handheld meter. Light intensities over each 24-hour period were also measured every 15 minutes and are shown in Figure 3.8. Light intensities were much higher during the December oxygen sampling period and the day-length was much longer than in May (Figure 3.8).

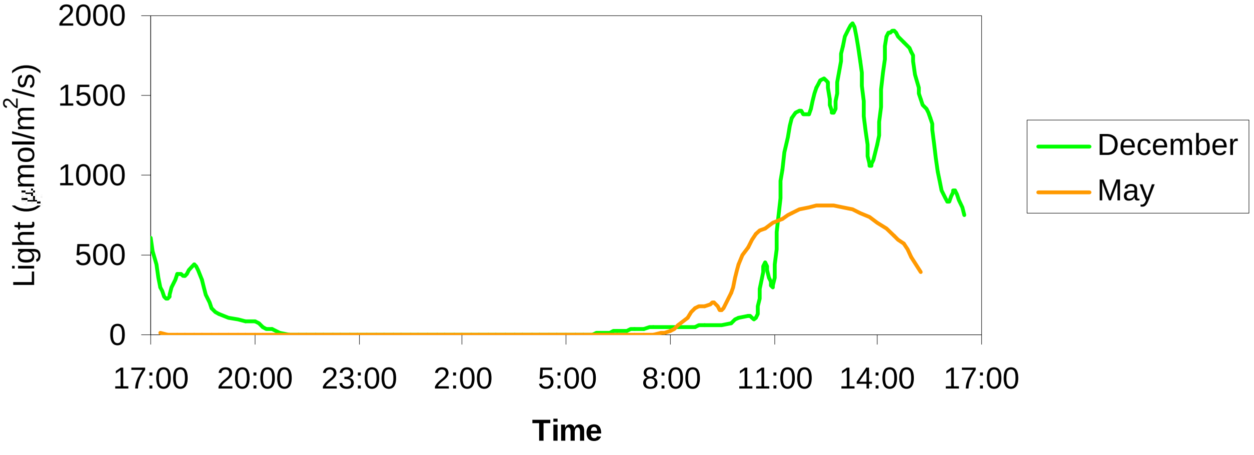

Figure 3.8 Daily changes in light intensity during the 24-hour oxygen measurements.

Daily changes in oxygen saturation closely followed the changes in light intensity during each period. During December, oxygen saturation fluctuated by up to 40 % saturation, while during May daily fluctuations were <15 % saturation (Figure 3.9).

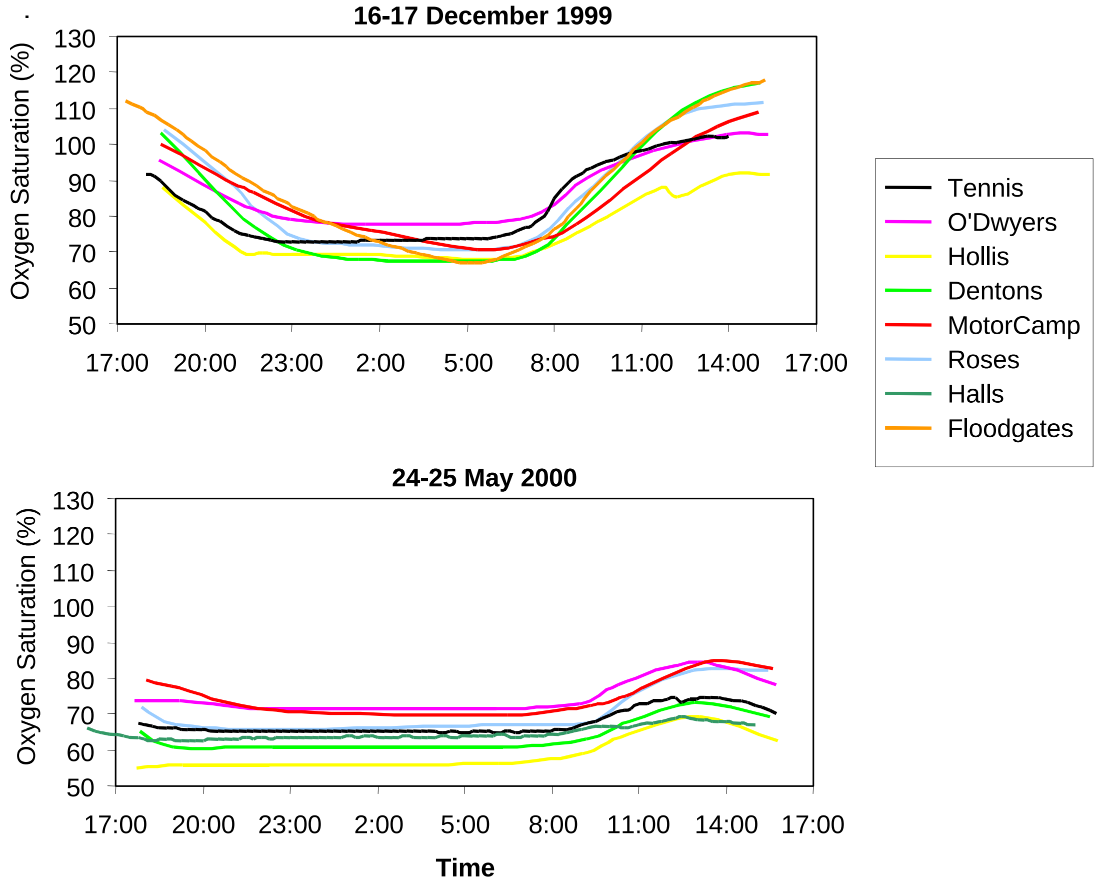

Figure 3.9 Daily changes in oxygen saturation in December and May.

The ANZECC (1992) guidelines propose that mean dissolved oxygen concentration over at least one 24-hour period should be above 80 % saturation for the protection of aquatic ecosystems.

During December the high rates of photosynthesis and subsequent production of oxygen raise oxygen saturation during the day. Mean daily oxygen saturation at the sites was generally above 80 % at all sites during December (Figure 3.9). In contrast, oxygen concentrations were much lower throughout the day during May and mean daily measurements were well below 80 % saturation and as low as 50-60 % at Hollis Creek (Figure 3.9). Sensitive freshwater organisms were likely to have been stressed by these low amounts of oxygen in the water, although mortality of native fish, trout and shrimps was unlikely even at these levels (Dean and Richardson 1999).

Compared with the other sites oxygen saturation tended to be lowest at Hollis Creek during both December and May (Figure 3.9). Hollis Creek was sprayed with a herbicide to control aquatic weeds shortly before both sampling periods (7 days prior to the May recordings), which may have contributed to the low oxygen recordings. Dentons Creek, Roses Creek and Halls Creek were also sprayed before the May oxygen measurements but there was a longer interval between spraying and the oxygen measurements (20-29 days).

3.5 Continuous turbidity measurements

Turbidity was measured continuously at the Tennis Courts, Rapaura Road, Motor Camp, Roses Creek and the Floodgates from October 1999 to July 2000 using Greenspan turbidity loggers. However, there were major problems encountered with unexplained high recordings on occasions at all the sites. It is possible that pieces of aquatic plants were wrapping around the lenses of the recorders affecting the measurements. Fouling of the lenses of the turbidity loggers by algae was also a problem at some of the sites. The lenses were cleaned on a monthly basis during data downloads but recordings were probably only accurate for several days after being cleaned. Due to the uncertainty in the quality of the data from these loggers no further analysis of the results has been attempted.

3.6 Summary

Spring Creek is primarily spring-fed with direct inputs of groundwater into the mainstem as well as contributions from tributaries. Water levels in the creek are loosely linked with flows in the Wairau River and tend to vary on an annual basis.

Monthly sampling of water quality at 10 sites throughout the catchment showed:

- Nitrate concentrations were high in the headwaters and tended to decrease downstream. Hollis Creek and Roses Creek also had high concentrations of nitrate. Nitrate concentrations in samples taken during 1999/2000 were generally higher than those collected during 1994/1998, perhaps suggesting that nitrate concentrations are increasing. However, concentrations of nitrate during April 2000 were similar to those measured in April 1985.
- Concentrations of dissolved phosphorus were low in the upper reaches of the creek but increased downstream. High concentrations were also found in Ganes Creek, Dentons Creek and Roses Creek. Dissolved phosphorus concentrations are low enough to be limiting the growth of aquatic plants, therefore it is important that phosphorus concentrations do not increase. Fortunately, the data showed no evidence of an increase in dissolved phosphorus concentrations over time.
- The upper reaches of the creek have the highest water clarity and the lowest turbidity and amount of suspended sediment. Water clarity deteriorated downstream. Hollis Creek had high water clarity, while water clarity was moderate to poor in the other tributaries. Roses Creek has particularly poor water clarity during August and September 1999. Measurements of water

clarity at 2 sites in 1988 also detected the downstream decline in water clarity but there is no evidence that it has become worse since then.
- Most of the suspended material was very fine and inorganic. The larger pieces of aquatic plants that can be seen floating down the creek on some occasions have minimal impact on water clarity.
- Concentrations of faecal bacteria were generally low in the upper reaches of the creek, but increased downstream. On some occasions bacterial levels exceeded the Ministry for the Environment's guidelines for safe recreational swimming at Roses Creek, Ganes Creek, O'Dwyers and the Floodgates. Such high levels of bacteria have not been recorded in Spring Creek previously.

The cool constant temperature of the groundwater was reflected in the water temperature in the mainstem of the creek. The temperature near the headwaters was close to 14 °C throughout the year. Daily variations in temperature increased down the mainstem of the creek. Larger tributaries, such as Dentons Creek, had similar temperatures to the mainstem of the creek but small ones, like Roses Creek, had large daily and annual variations in temperature.

Daily fluctuations in oxygen concentration were large during December with daily mean concentrations between 80-90 % saturation. In contrast, oxygen fluctuations were lower in May but mean daily values (50-60 % saturation) were well below proposed limits (80 % saturation) for the protection of aquatic life. The reduction in mean oxygen concentrations during May were likely to be due to a combination of lower rates of aquatic plant photosynthesis, thus releasing less oxygen into the water, and increased oxygen uptake caused by decomposition of dead aquatic plant material. Most of the aquatic plants tend to 'die back' to some extent in winter.

4. AQUATIC PLANTS: IMPORTANT HABITAT OR PROBLEM WEEDS?

4.1 Introduction

The pre-human Spring Creek catchment formed part of a vast wetland in what is now the coastal plain of the Wairau River. Vegetation was predominantly flax, raupo, toe toe and cabbage tree, with patches of kahikatea forest. Maori settlement of the area had an impact on the fauna of the wetland, but would have had little other influence than some probable loss of swamp forest. By comparison, European influence included; flax milling, timber milling, clearance and drainage of the wetland for farming, spread of introduced plants and the use of pesticides and herbicides (Rae & Tozer 1990). The riparian vegetation and aquatic plant species in the Spring Creek catchment today are therefore vastly modified.

Aquatic plants (macrophytes) are commonly found in slow flowing waterways throughout New Zealand. With good conditions, such as light, nutrients and stable flow, aquatic plant establishment and growth can be prolific. In such conditions, many of the introduced aquatic plant species can quickly reach nuisance proportions. A number of the introduced species were gazetted as noxious plants under the Noxious Plant Act 1979 (Coffey & Clayton 1988). Aquatic plants are widespread throughout Spring Creek and include several nuisance species.

Ecological benefits of aquatic plants may include:

- Trapping and stabilisation of sediments.
- Uptake and release of nutrients.
- Added surface area for algal production, macroinvertebrates including molluscs.
- Shelter and feeding area for fish.
- Provide and host food sources for waterfowl.

Areas of aquatic plant growth in Spring Creek can therefore be considered biologically productive, the benefits of which must be weighed up when considering control for other benefits.

Marlborough District Council regularly apply herbicide sprays to control aquatic weed growth in drains throughout the Spring Creek catchment. This spray programme is subject to resource consent for herbicide applications, which expires on the 1st August 2001. Details of the Council's spray programme are contained in Williman & Bezar (1999). The Council sprays approximately 160 km of drains in the Lower Wairau Plains, including many of the smaller tributaries of Spring Creek. The mainstem of the creek is presently not subject to any direct drainage management activities. Spraying occurs during spring and autumn annually and is scheduled to avoid native fish spawning periods. In 1998-99 approximately 9 km of drains were sprayed in Spring Creek in autumn and 3.3 km in spring. The primary sprays used were diquat, paraquat and Roundup (Glyphosate). Torpedo gel was also used at some sites. Some of the tributaries of Spring Creek are also mechanically cleared of aquatic plants and sediment (Figure 4.1).

Figure 4.1 Mechanical clearance of Giffords Creek December 1999.

The main tributaries of Spring Creek that are managed for drainage are:

- Giffords Creek
- Hollis Creek
- Ganes Creek
- Rapaura Road Drain
- Dentons Creek
- Roses Creek
- Halls Creek (bottom 250 m)

We assessed the distribution, density and habitat of aquatic plants in Spring Creek by measuring a series of channel cross-sections in the mainstem and tributaries and assessing the abundance and distribution of species in a range of shading regimes

4.2 Cross-sections Survey

Cross-sections to assess the distribution and growth of macrophyte species throughout Spring Creek were measured in October 1999 (six sites) and repeated in March 2000 (eight sites). Cross-section sites were selected that best represented the various reach characteristics of Spring Creek and corresponded with the water quality sampling sites (Figure 3.3).

A tape measure was strung from bank to bank at each cross-section and at metre intervals along cross-sections, depth, plant composition, plant density and plant height were recorded on a field sheet shown in Appendix 2. The last distance interval at each cross-section was corrected to the nearest metre. Species composition and density were determined within a 0.5 m radius of each measurement interval. Plant density was described using a modified Braun-Blanquet scale. This scale converts the percentage of plant cover into a scale from 1 – 6 as follows: 1 = 1 – 5 %; 2 = 6 – 25 %; 3 = 26 – 50 %; 4 = 51 – 75 %; 5 = 76 – 95 %; and 6 = 96 – 100 %. Datum markers were not established at each cross-section, so depths and plant heights were related to water level. Therefore subsequent cross-section depths may not correspond with the original plotted data. Accordingly, plant height differences should be interpreted bearing this in mind.

Cross-section graphs were produced to show the relationship of maximum plant height to water surface (Appendix 3). Each cross-section was plotted so that the true left and true right banks correspond with the left and right side of the graph respectively. Care should be taken interpreting these graphs as they give the impression of continuous plant growth along the cross-section, when in fact there were often gaps of clean substrate. Also they give an exaggerated picture of relative plant height because maximum, rather than average height, was used. Nevertheless the graphs provide a useful baseline from which to make later comparisons and are particularly useful for weed control monitoring. The cross-section graphs are better interpreted in conjunction with the Braun-Blanquet graph and species composition descriptions (Appendix 3).

4.2.1 Results

A total of 20 plant species were recorded from sites throughout Spring Creek and 12 of these were introduced species (Table 4.1). The most common species were willow weed, duckweed, *Nitella*, watercress and *Lagarosiphon*, respectively. Nuisance species such as *Egeria*, *Lagarosiphon*, *Ranunculus* and *Elodea* were present at all sites except the upstream most site (Tennis Courts). *Egeria* began in Dentons Creek (between Raupara Road and the Motor Camp) and was found from there downstream. The largest numbers of nuisance species were found at the Motor Camp site. The least number of species were found at Collins Bridge, where the cross-section was almost entirely dominated by *Egeria* interspersed with *Lagarosiphon*. Species composition remained similar for the remainder of the reaches downstream.

Table 4.1 List of aquatic plant species in Spring Creek and their distribution at sample sites.

Scientific name ***** introduced	**Common Name**	**Tennis courts**	**O'Dwyers**	**Rapaura**	**Motor camp**	**Collins**	**Floodgates**	**Hollis**	**Ganes**	**Dentons**	**Roses**
*Alisma plantago-aquatica**	Water plantain								X		
Azolla filiculoides	Azolla	X	X	X	X		X				X
*Bidens frondosa**	Beggars' tick			X					X	X	X
*Callitriche stagnalis**	Starwort		X								
Carex secta	Niggerhead	X			X			X			
*Egeria densa**	Oxygen weed				X	X	X			X	X
*Elodea canadensis**	Canadian pond weed		X	X	X				X		
*Glyceria fluitans**	Floating sweet grass	X		X							
*Lagarosiphon major**	Oxygen weed			X	X	X	X	X		X	X
Lemna minor	Duckweed	X	X	X	X		X	X	X	X	X
*Mimulus guttatus**	Monkey musk		X								
Myriophyllum propinquum	Water milfoil	X	X								
*Nasturtium officinale**	Watercress	X	X	X			X	X	X		X
Nitella hookeri	Nitella	X	X	X	X		X	X	X		X
Phormium tenax	NZ flax		X	X							
Polygonum decipiens	Swamp willow weed	X	X	X	X	X	X	X		X	X
*Potamogeton crispus**	Curly leaved pondweed			X	X						
*Ranunculus trichophyllus**	Water buttercup		X		X						
*Riccia fluitans**	Liverwort	X									
Typha orientalis	Raupo			X							

Longitudinal differences in aquatic plant species composition were evident in the mainstem of Spring Creek (Figures 4.2 & 4.3). The upper most site (Tennis Courts) was free of nuisance species and changed in composition over the four month sampling period. This would have been mainly due to summer growth of emergent plants such as willow weed. In contrast, the mid-reach site (Motor Camp) and lower reach site (Floodgates) had more consistent community composition, but were dominated by nuisance species. *Lagarosiphon* was the most dominant of the species from the middle reaches downstream. Downstream of the Motor Camp site, *Egeria* was the next most dominant species in the plant community. At the Floodgates site, *Lagarosiphon* and *Egeria* dominated the community accounting for up to 63 % of the plant cover.

Stable flows and temperature in the Spring Creek catchment generally allow relatively stable plant communities. The largest change in the plant community is likely to occur on the margins where emergent growth of some species is subject to winter die back and summer proliferation.

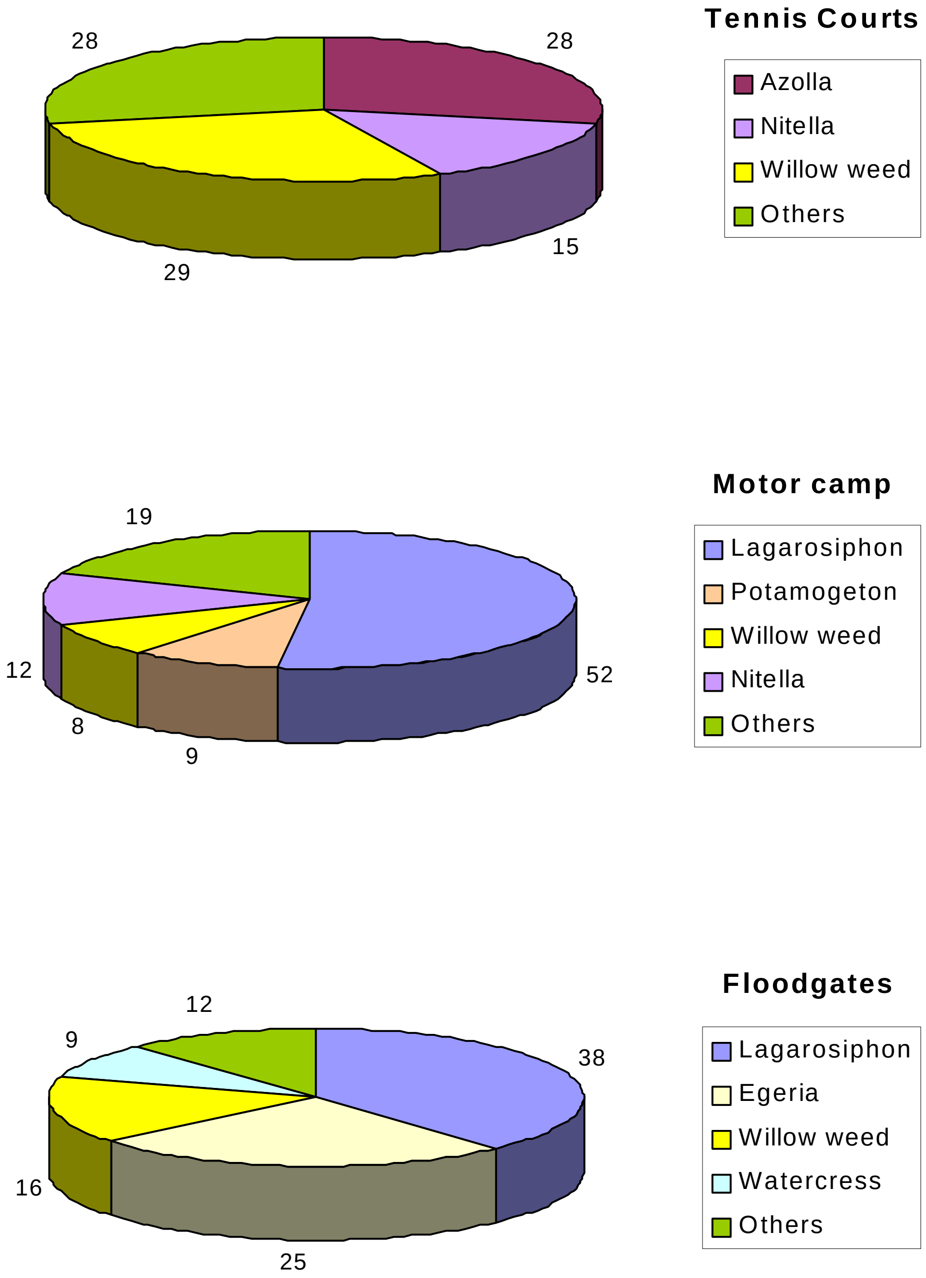

Figure 4.2 October 1999 aquatic plant composition at three sites in the mainstem of Spring Creek

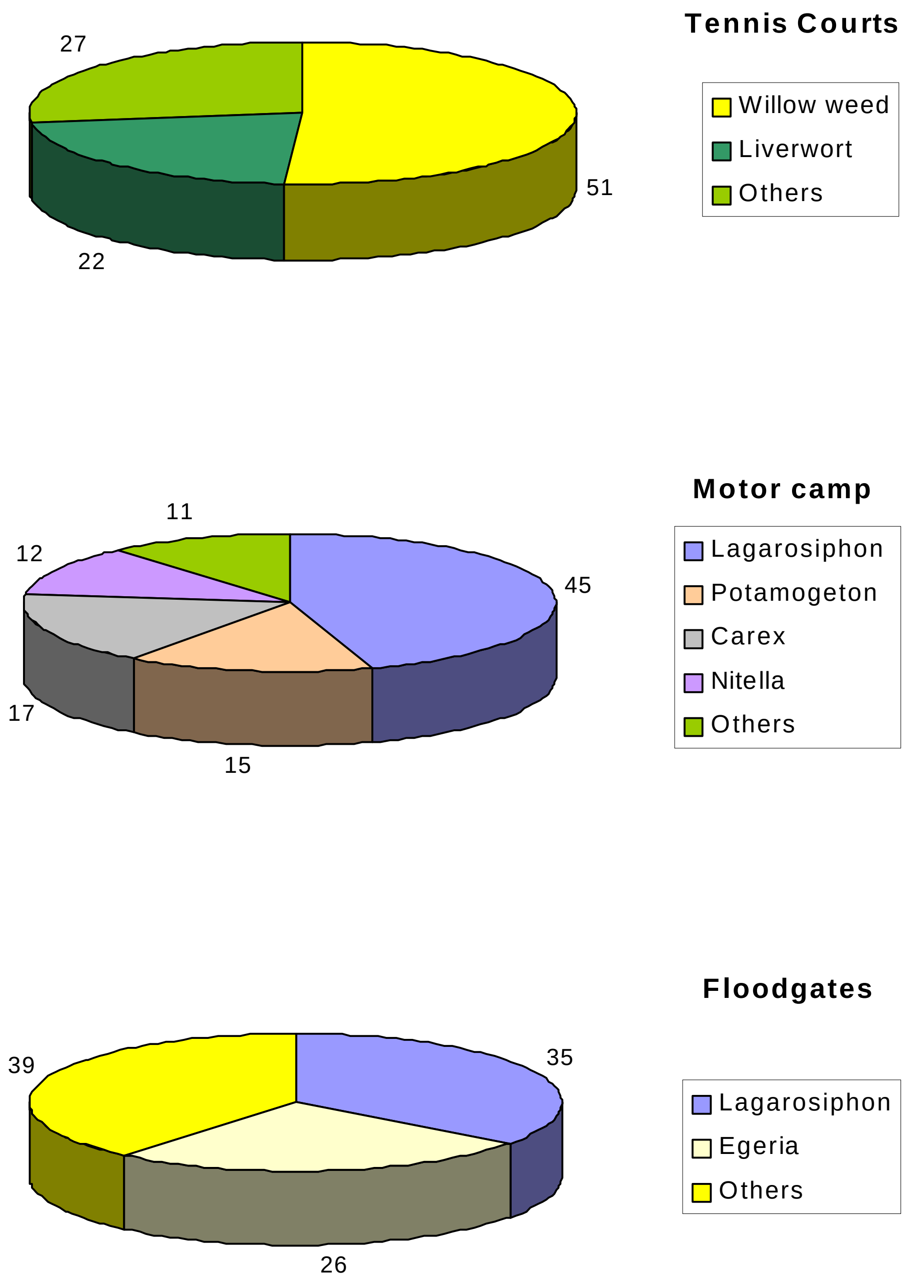

Figure 4.3 March 2000 aquatic plant composition at three sites in the mainstem of Spring Creek

Comparison of the cross-sections between October and March (Appendix 3) shows water levels at all five mainstem sites were higher in March 2000. The cross-sections also indicate an overall increase in plant height at each of these sites, which is no doubt a reflection of summer growth. The increased summer growth of plants may well have influenced water levels. However comparison of Braun-Blanquet values indicate relatively little increase in plant density occurred at the mainstem sites between sampling occasions.

The O'Dwyers site was the most upstream site that we recorded nuisance species and these were *Elodea* and *Ranunculus*, but were not in nuisance proportions. While *Ranunculus* was surface reaching at this site, water velocity appeared to be confining its growth to the margins. *Elodea* was prevented from surface reaching by water velocity but was very dense in patches.

The most upstream site that we recorded *Lagarosiphon* was in Hollis Creek. At this site *Lagarosiphon* was surface reaching and formed a very dense mat over the majority of the cross-section. Its growth obviously hindered water flow and the entire substrate was made up of a deep layer of silt.

We recorded *Egeria* as far upstream as Dentons Creek, but it has been found above the O'Dwyers Road Bridge (S. Bezar pers. comm.). While *Egeria* was the dominant species at the Dentons Creek site, it was never as prolific at the faster flowing sites in the mainstem of Spring Creek.

4.2.2 Discussion

Even though *Egeria* is widespread in the North Island, up until recently Marlborough was the only area in the South Island where *Egeria* had been detected. *Egeria* is an aggressive nuisance species in a number of North Island still-water locations. However *Egeria* does not appear to have established in such nuisance proportions in Spring Creek, possibly because of the reasonably consistent water velocity throughout the mainstem. Pool and slower flowing tributary habitats are an obvious exception.

Aquatic plants can be beneficial in that they enhance oxygen levels through photosynthesis and host algae that strip nutrients from the water. However they also trap sediment. One of the management issues facing Spring Creek is drainage management. Nuisance aquatic plants, such as *Lagarosiphon*, growing in open aspect waterways like Spring Creek require regular control because of their prolific growth and potential to hinder flow with consequent raising of water levels.

Eradication of nuisance plants like *Egeria* and *Lagarosiphon* is possible in Spring Creek. *Lagarosiphon* does not produce seed and can only be spread by vegetative fragments drifting downstream, or by human transfer. Therefore, if the upstream limits of these plants in Spring Creek were determined, a concerted eradication program could be successful in a system of this size.

Riparian planting of Spring Creek and its tributaries has been advocated over many years (Rae & Tozer 1990, Cadenhead 1994) and with strong community interest (O'Brien 1995). Riparian planting is still the most fundamental of options available for managing aquatic plant growth and sedimentation in Spring Creek. The cross-section at O'Dwyers Road demonstrates this point. On the true left bank of this cross-section, the channel is shallow sloping with an open aspect and no overhanging riparian vegetation other than encroaching aquatic plants and then dense *Ranunculus* and *Elodea* beds. The true right bank is steep, has tall poplars and then dense flax and sedges at the water's edge. Because of the shading on the true right bank, aquatic plant growth in the immediate channel has not been as prolific as on the true left. Consequently sediment has not been trapped and the channel has remained relatively clear.

Stream margin protection with long-term rehabilitation of riparian species, such as flax and kahikatea, is also an environmentally sound management option for control of aquatic plants. Well-vegetated stream margins help reduce sediment and nutrient run-off from the land and provide stream shading, all of which influence aquatic plant growth. The following section describes a survey in Spring Creek, which set about to explore the effects of shading on aquatic plant growth.

4.3 Shading survey

The effects of differing shading regimes were tested by surveying 121 quadrats at randomly chosen sites throughout the upper mainstem of Spring Creek, Ganes Creek, Dentons Creek and Roses Creek during May 2000. At each sample site, three 1 m^2 quadrats were positioned evenly across the width of the stream. The plant species in each quadrat were described and percentage of the streambed covered by each species estimated. The type, aspect and quantity of riparian cover were also noted. At each site stream aspect was determined with a compass, and light intensity across the transect was measured with a light meter.

Eight species of plants or plant groups were found in the quadrats (Table 4.2). *Nitella* was the most common species found. The ability of *Nitella* to withstand low light situations allows it to remain present amongst and beneath other plant species, which probably explains its common occurrence.

Plant cover was present in 90 % of the quadrats, although at least some bare substrate was present in 57 % of the quadrats (Table 4.2). There was a positive relationship between light intensity and plant cover. Conversely there was a negative relationship between light intensity and bare substrate. The coverage by willow weed and watercress was positively related with light intensity, while coverage of *Nitella* was negatively related to light intensity.

Table 4.2 The occurrence of plants and their relationship with light intensity in the shading survey.

	% Occurrence	Correlation coefficient with light	Significance of effect
Plant cover	90	0.3783	**
Nitella	59	-0.2435	*
Duck weed	17	0.1757	
Lagarosiphon	18	0.1736	
Willow weed	20	0.3228	**
Elodea	11	0.1355	
Watercress	14	0.3564	**
Grass	26	0.2011	*
Bare substrate	57	-0.3783	**
Other (algae *etc*)	7	-0.2127	*

* indicates a significant relationship (r=>0.1946) ** indicates a highly significant relationship (r=>0.2540),

The strong relationship between the amount of light and percentage of aquatic plant cover is again demonstrated in Figure 4.4. This relationship would be even stronger if it were not for the large coverage of *Nitella* at some of the heavily shaded sites. *Nitella* is able to tolerate low light intensities but does not reach nuisance levels. The group of data points indicating low plant cover but relatively high light intensity were a group of sites that were shaded by large *Eucalyptus* trees. These sites were not only influenced by shade but had a noticeably dense cover of tree leaf litter covering the bed of the stream and possibly further suppressing plant growth. The sparse plant growth recorded at these sites was primarily made up of species along the stream margins, such as willow weed and grasses.

The percentage of cover by nuisance species such as *Lagarosiphon* were all less than 25 % at light readings of ≤200 µmol/m²/s and only achieved higher percentages of cover above 750 µmol/m²/s (Figure 4.5).

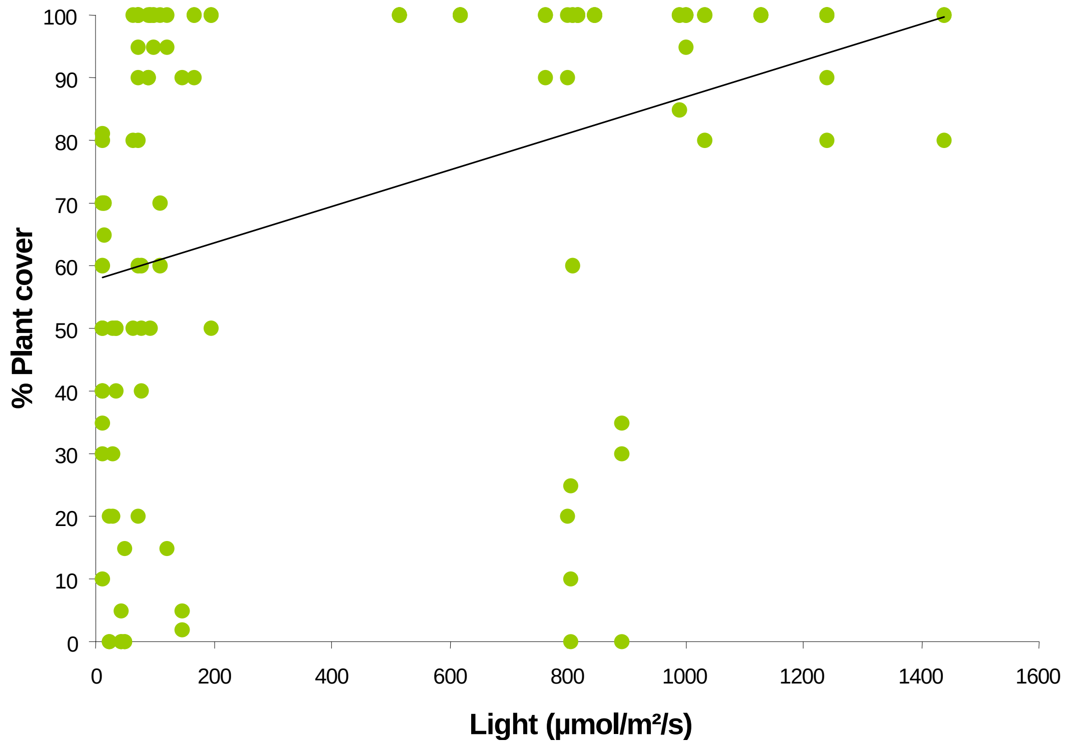

Figure 4.4 The relationship of light and aquatic plant cover in Spring Creek.

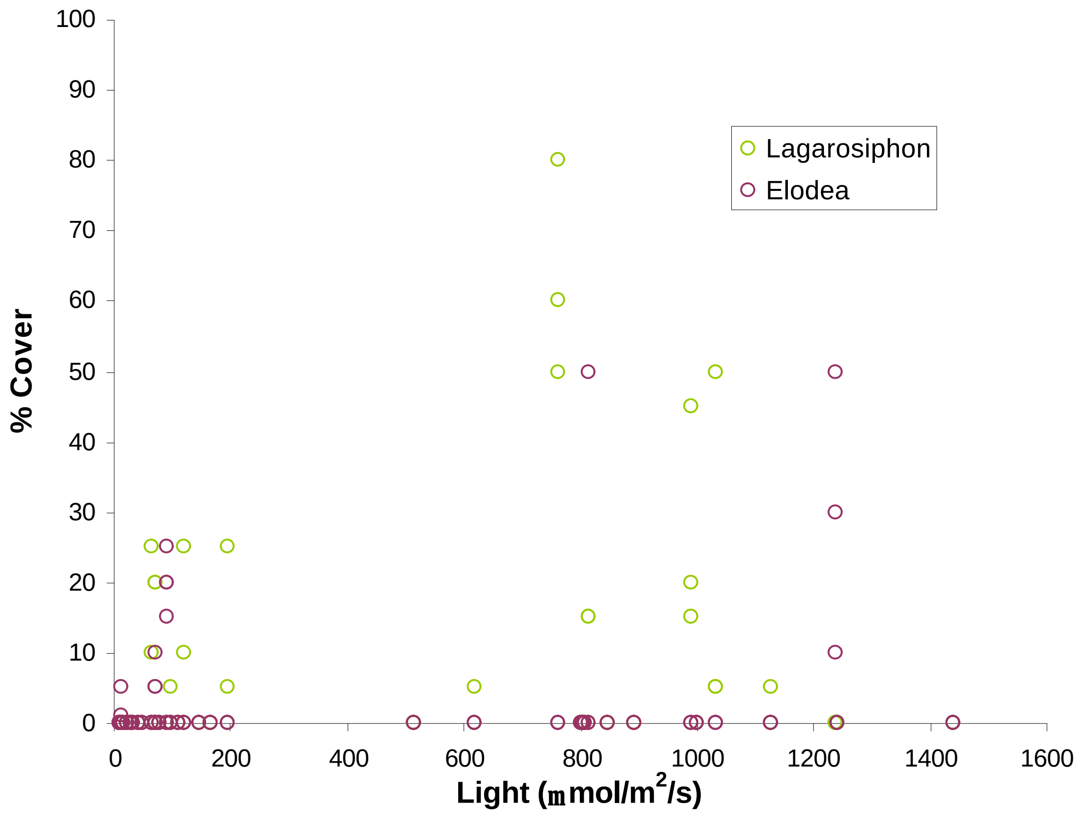

Figure 4.5 The relationship of light and *Lagarosiphon* and *Elodea* cover in Spring Creek.

We did not attempt to analyse the effect of aspect on shading or aquatic plant growth. However, most of Spring Creek and its tributaries flow from west to east. Therefore riparian vegetation on the north banks of these waterways should achieve the best shading. The lowest light levels recorded during this survey were at sites where this was the case. Generally, wherever large trees occurred along northern stream margins, light intensity was less than 25 µmol/m²/s.

4.3.1 Discussion

These results indicate that light intensities of ≤200 µmol/m²/s affect aquatic plant growth, particularly nuisance species, in Spring Creek. Shade created by large trees on the north bank of Spring Creek achieved levels of light intensity less than 25 µmol/m²/s. Shading by riparian vegetation would therefore be a useful option for aquatic plant control. The potential level of shading provided by various plant species relative to their height and distance from the stream margin are worthy of further investigation. Further investigation on the role of aspect and stream orientation on the effectiveness of shading would also be worthwhile.

4.4 Shade Experiment

An experiment was set up on the 24th May 2000 to assess the effect of shade on macrophyte growth in Halls Creek. An eight metre section of one metre high shade cloth was strung vertically across the stream from north to south, while a similar eight metre section was strung vertically across the stream from east to west. Another section was layed down horizontally just above the aquatic plants to provide maximum shade. The shade cloth reduced light intensity by around 60 %.

There was little effect of the shade cloth on aquatic plant growth during the winter. In fact the shade cloth seemed to protect the plants from the frost. The reduction in light intensity resulting from the shade cloth did not appear to be sufficient to restrict the growth of willow weed and water cress, which were the major aquatic plants at the experimental site.

4.5 Summary

Because of the highly modified state of the Spring Creek catchment, both aquatic plants and riparian vegetation have also been vastly modified. Of the 20 species of aquatic plants recorded, 12 were introduced and four of these are considered nuisance species (*Egeria*, *Lagarosiphon*, *Ranunculus* and *Elodea*). *Lagarosiphon* was the most common and dominant species in Spring Creek. At the Floodgates site *Egeria* and *Lagarosiphon* dominated the community accounting for up to 63 % of the plant cover. Generally, stable flows and temperature in Spring Creek allow relatively stable plant communities. We found little change in plant density between the beginning and end of the 1999/2000 summer in Spring Creek's mainstem. Some nuisance species (*Elodea* and *Ranunculus*) appeared to be prevented from reaching the surface and were often confined to the margin of the stream by water velocity. At some sites *Lagarosiphon* formed dense surface reaching beds that quite obviously hindered water flow. The largest annual change in the plant community is likely to occur on the margins where emergent growth of some species is subject to winter die back and summer proliferation.

Eradication of some aquatic plants, particularly *Lagarosiphon*, is possible in some reaches of Spring Creek and control of other aquatic plants in Spring Creek would be possible with better riparian management. Our survey of shading effects indicated that light intensities of ≤200 µmol/m²/s limit aquatic plant growth, particularly of nuisance species, in Spring Creek. Shade created by large trees on the north bank of Spring Creek achieved levels of light intensity less than 25 µmol/m²/s. Shading by riparian vegetation would therefore be a useful option for aquatic plant control.

5. WHAT'S HAPPENING TO THE MACROINVERTEBRATES?

5.1 Introduction

New Zealand's streams, rivers and lakes are inhabited by many species of freshwater insects, worms and snails. These small animals are collectively known as **macroinvertebrates**. Macroinvertebrates live almost their entire lives in the water, although many of the insects have aerial adult stages. Some are tolerant of pollution and others are not. As a result, the presence or absence of some macroinvertebrate species and their relative abundances can often indicate pollution or other problems in a waterway.

As part of our assessment of the condition of Spring Creek we carried out a survey of 10 sites along the main stem of the creek and in the major tributaries.

5.2 Methods

Macroinvertebrate sampling was undertaken on the 20th October 1999 in the vicinity of the 10 water quality sites. At each site a hand-net sample (0.5 mm mesh) was collected. Due to the depth and velocity of the creek at most mainstem sites, samples were taken by sweeping the net through aquatic plants and along the banks of the creek. The net had an extendable handle from 1 m – 4 m in length to facilitate this. Where possible the creek bed was disturbed by dragging the net through the bed or kicking the substrate.

Due to the nature of this sampling we were not able to obtain quantitative (density) data, but are able to compare the relative abundances of one species with another at a site.

Samples were contained in 1 litre plastic jars and preserved in the field using a mixture of 2 % formalin and 70 % ethanol. In the laboratory, samples were sieved, sorted by eye and identified to the lowest taxonomic level possible using standard keys.

Indices used to assist interpretation of macroinvertebrate data included:-

Species richness (or more strictly taxa richness). This is simply the number of different kinds of animals (= taxa) present. Sometimes the different taxa are resolved down to the species level (*e.g. Austroclima sepia*), but may be at the genera level (*e.g. Austroclima* sp.), or even higher taxonomic level (*e.g.* Leptophlebiidae), depending upon the practicality of identification.

EPT taxa. The EPT taxa index is based on the number of kinds of mayflies (**E**phemeroptera), stoneflies (**P**lecoptera), and caddisflies (**T**richoptera) found in a sample. These kinds of freshwater insects are generally intolerant of pollution.

Macroinvertebrate Community Index (MCI) values were calculated according to the method of Stark (1985, 1993, 1998). The MCI relies on prior allocation of scores (between 1 and 10) to different kinds of freshwater macroinvertebrates based upon their tolerance to pollution. Types of macroinvertebrates that are characteristic of unpolluted conditions and/or coarse stony substrates score more highly than those found predominantly in polluted conditions or amongst fine organic sediments. In theory, MCI values can range between 200 (when all taxa present score 10 points each) and 0 (when no taxa are present), but in practice it is rare to find MCI values greater than 150. Only extremely polluted or sandy/muddy sites score under 50.

SQMCI (Semi-Quantitative MCI) values were also calculated. Unlike the MCI, which only uses presence-absence data, the SQMCI incorporates relative abundances into the index calculation. SQMCI values, therefore, reflect the abundance and types of macroinvertebrates found at a site.

Although the MCI and SQMCI were developed to assess organic pollution in stony-bottomed streams, they have proven useful in other stream types for assessing habitat quality or environmental health.

5.3 Results and discussion

Thirty two kinds of invertebrates were collected from the 10 sites surveyed throughout the creek (Appendix 4). Most species were caddisflies (9 kinds), true flies (7), and snails (5). In general the types of benthic macroinvertebrate species recorded throughout the creek were typical of what would be expected in a spring-fed system. The large numbers of mayflies, stoneflies and other insect groups that are commonly found in rain-fed, shallow stony streams generally were not present.

Several indices commonly used to assess pollution in stream systems suggest that some sites in the Spring Creek catchment were in poorer condition than others (Figure 5.1). Species richness was highest at most sites in the mainstem of Spring Creek (16 – 19 kinds per site) and in Hollis Creek (16 kinds). Species richness at the Motor Camp site on Spring Creek (14 kinds) was a little lower than at the other mainstem sites with even fewer types of macroinvertebrates (10 – 13 kinds) recorded from the other tributaries sampled. The poorest variety of macroinvertebrates was recorded in Ganes Creek.

Similarly, the number of mayfly, stonefly and caddisfly (EPT) species was again highest in the headwaters and at several mainstem sites (*i.e*. Tennis Courts, O'Dwyers, and Motor Camp) and in Hollis Creek (Figure 5.1). Low numbers of these sensitive species were found in Dentons and Roses creeks and none was found in Ganes Creek.

MCI values ranged from 98 (O'Dwyers) to 68 (Roses) with the Spring Creek mainstem and Hollis Creek having higher values than the remaining tributaries (Figure 5.1). The SQMCI, through the influence of dominant types of invertebrates, showed more variation between sites and probably provides a more realistic assessment of habitat quality (Figure 5.1). However, both indices ranked the sites in a similar order from highest to lowest quality (Wilcoxon's Signed Ranks test, $Z = -1.876$, $p = 0.169$). As with the MCI, the extreme SQMCI values were recorded in O'Dwyers (5.20) and Roses (1.77) creeks. Based on the SQMCI, Ganes Creek and the Rapaura Road site on Spring Creek had macroinvertebrate communities indicative of moderate impact, whereas in Dentons and Roses creeks conditions were even further degraded.

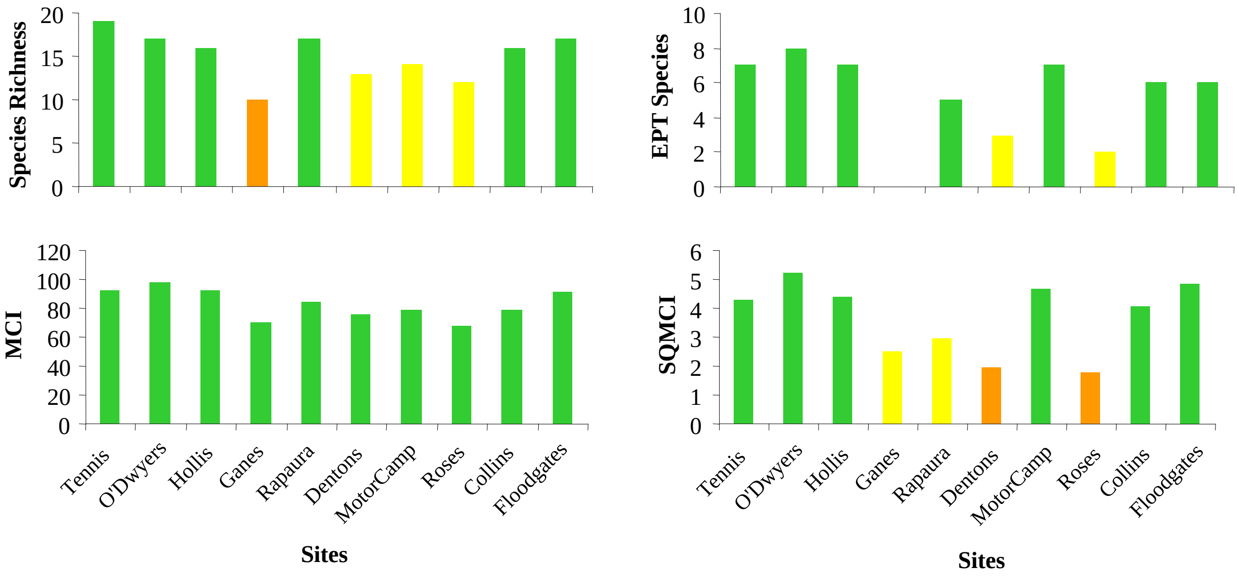

Figure 5.1 Biotic indices values for benthic invertebrates at 10 sites throughout Spring Creek. Green bars indicate sites with "good" macroinvertebrate values, yellow bars "impacted" sites and orange bars sites of "concern".

The most abundant invertebrate at most sites was the common amphipod (*Paracalliope* sp.). This animal was very abundant (100 or more animals per sample) at eight of the 10 sites sampled, and was the most abundant organism at seven of these sites (Tables 5.1 & 5.2; Appendix 4). It was not recorded from Ganes Creek, and was rare (<5 animals per sample) in Roses Creek (Appendix 4). Oligochaete worms, orthocladine midges, or the small black "pond snail" *Potamopyrgus*, were the dominant types of macroinvertebrates at sites where amphipods were not dominant (Tables 5.1 & 5.2).

Given the dominance of amphipods at many sites in the Spring Creek catchment, it is of interest to determine reasons for their absence or reduced abundance at other sites. Amphipods, such as *Paracalliope*, are not robust enough to withstand water turbulence and fast current velocities, so they tend to be found in quieter conditions. Less-swift flowing waters also permit the establishment of dense beds of aquatic plants, which may act directly, or indirectly, as a food source, and as shelter for amphipods. *Paracalliope* is likely to be omnivorous, scavenging for suitable food or browsing on the fine film of periphyton coating plants and other submerged substrates. Massive upstream migrations of *Paracalliope* have been observed in some stream systems. For example, in September and October 1972 large numbers were seen moving upstream along the stream margins in the Leeston Drain (Chapman & Lewis 1976).

Table 5.1 Dominant macroinvertebrates in Spring Creek (20-Oct-99).

Relative abundance	Tennis SPC4	O'Dwyers SPC3	Rapaura SPC2	Motor SPC7	Collins SPC5	Flood SPC1
Very very abundant (>500 animals)	Amphipoda *Potamopyrgus*	Amphipoda		Amphipoda		Amphipoda
Very abundant (100 – 499 animals)		*Pycnocentria*	Amphipoda Worms		Amphipoda	

Table 5.2 Dominant macroinvertebrates in Spring Creek tributaries (20-Oct-99).

Relative abundance	Hollis SPC10	Ganes SPC9	Dentons SPC8	Roses SPC6
Very very abundant (>500 animals)	Amphipoda	Worms *Potamopyrgus*	Orthocladiinae Worms	Worms
Very abundant (100 – 499 animals)	*Pycnocentria* Orthocladiinae Worms		Amphipoda	*Potamopyrgus* Sphaeriidae

During sampling all sites, except Roses Creek, had extensive macrophyte beds that would appear ideal for amphipods. Macroinvertebrate communities at the most upstream (Tennis Court) and downstream (Flood Gates) sites were dominated by amphipods. This, plus the fact that upstream migrations may occur in September – October suggests that amphipods should be present in very high numbers throughout the Spring Creek catchment unless some other factor renders conditions unsuitable. It is possible that herbicide application may be important in explaining the distribution of amphipods.

5.4 Ecological effects of herbicidal applications for weed control

Diquat and paraquat are used for aquatic weed control in tributaries of Spring Creek but not in the mainstem.

The toxicity of a chemical to aquatic organisms is usually expressed as the concentration at which 50 % of the test organisms are killed (LC_{50}) in a given time period (normally 24, 48, or 96 h). The toxicity of a chemical will vary from species to species and on the life-stage and/or size of the individuals. The source of the test organisms, and the softness or hardness of the water may also influence the toxicity results. Not surprisingly, there are differences in toxicity values for particular species quoted by different laboratories.

According to EXTOXNET (1996a,b) diquat dibromide is moderately toxic to practically non-toxic to fish and aquatic invertebrates, while paraquat is slightly toxic to moderately toxic to fish and aquatic invertebrates (Tables 5.3 and 5.4). Draft ANZECC (1999) water quality guidelines state an ECL (environmental concern level) for paraquat of 0.0005 mg/l and an interim guideline of 0.0002 mg/l for diquat. These levels are intended to protect all forms of aquatic life and ecosystem function, although the ECL for paraquat is based on little toxicological data.

Although there are limited data available, it seems that both paraquat and diquat are considerably more toxic to macroinvertebrates than fish (Tables 5.3 and 5.4).

Table 5.3 Toxicity of diquat dibromide to aquatic organisms.

Species	Concentration (mg/l)	LC_{50} duration (h)	Reference
Rainbow trout	12.3	8	EXTOXNET (1996a)
Rainbow trout	90	24	Carter (1968)[1]
Rainbow trout	16	48	Carter (1968)[1]
Rainbow trout	8	96	Carter (1968)[1]
Fingerling trout	20.4	96	EXTOXNET (1996a)
Fish (17 spp.)	0.75 – 300	48 - 96	ANZECC (1999)
Grass carp	1718 - 2092	48 - 96	ANZECC (1999)
Crustaceans (6 spp.)	0.019 – 46.6	48	ANZECC (1999)

[1] cited in Calderbank (1972).

Table 5.4 Toxicity of paraquat to aquatic organisms.

Species	Concentration (mg/l)	LC_{50} duration (h)	Reference
Brown trout	13	96	EXTOXNET (1996b)
Rainbow trout	32	96	EXTOXNET (1996b)
Fish (10 spp.)	5.2 – 156	48 - 96	ANZECC (1999)
Daphnia pulex	1.2 – 4.0	96	Haley (1979)
Paracalliope fluviatilis	1.4	96	Hunt (1974)
Crustaceans (7 spp.)	1.3 – 11	48 - 96	ANZECC (1999)

Amphipods are the most sensitive organisms that are affected by diquat and paraquat. Burnet (1972) found that paraquat at a spray concentration of 2 mg/l (active ingredient) for 30 minutes caused up to an eight-fold increase in amphipod drift numbers during and immediately following treatment. Many of these animals drifting downstream were dead. One month later, amphipod drift numbers were only 5 % of pre-treatment levels, but 11 months later they had returned to pre-treatment levels.

Hunt (1974) investigated paraquat toxicity to the amphipod *Paracalliope fluviatilis* using laboratory experiments and found that they died in concentrations as low as 0.05 mg/l. A delayed toxic effect was also observed with a greater proportion of amphipods dying as exposure time increased. She determined that paraquat adsorbed to sediment and was toxic if ingested and/or even if the amphipods made contact with the sediment when burrowing. This was despite the fact that levels of paraquat in the water were below detection limits. By fitting an exponential regression line to data provided by Hunt (1974), a 96-hour LC50 of approximately 1.4 mg/l was obtained (Table 5.4).

According to a drainage management report submitted by Bezar (1999), Marlborough District Council's applications of diquat and paraquat are to be below 10 and 40 mg/l, respectively. Actual testing of drain waters for active ingredients of dibromide and dichloride salts indicated values between 0.21-1.47 mg/l. At levels such as these in stream water and considering that there will be additional adsorbed active ingredient in sediments (at unknown concentration), it is certain that the weed control programme will be having a direct toxic impact on amphipod populations. It is possible that some other macroinvertebrates, such as freshwater shrimps, may be directly effected as well. The removal of macrophyte beds as a result of herbicide application will also reduce the extent of suitable habitat for amphipods and other macroinvertebrates, even in the absence of a toxic effect.

5.5 Shrimp enclosures

Freshwater shrimps are often found in lowland streams and are usually associated with aquatic plants (Carpenter 1982). Shrimps provide an important food resource for trout in some rivers, however reports from anglers fishing Spring Creek have suggested that shrimp abundance has declined over recent years. As part of the fish survey (see below) large numbers of shrimp were found in the lower reaches of the stream and in Halls Creek during December 1999. However, they appeared to be absent above the Spring Creek township. Shrimp numbers declined from being very abundant, to rare, to absent at sites within just a few hundred metres upstream of one another in both Halls Creek and Spring Creek. The reasons for this abrupt change in shrimp abundance are largely unknown. There were no noticeable changes in habitat through the reaches and there were no obvious physical barriers to shrimp movement.

Photo courtesy of Peter Hamill

Figure 5.2 A freshwater shrimp.

To begin to understand this unusual distribution we placed shrimps in enclosures at sites around the catchment to determine if there was an unknown factor making conditions unsuitable for shrimps at some sites. Shrimps were not naturally present at 5 of these sites (Tennis Courts, Hollis Creek, Ganes Creek, Dentons Creek, and Roses Creek). Shrimps were present at the remaining 2 sites (Halls Creek, Floodgates) which were used as controls to account for any effects of the enclosures.

Three enclosures, each containing 4 shrimps, were tethered at each of the sites on 14th April 2000. Each shrimp was weighed and measured (from the tail to the base of the rostrum). The enclosures were checked on 17th May 2000, 16th June 2000 and finally removed on 30th August 2000. The number of shrimps alive in each enclosure and their weight and length were recorded each time.

Survival of shrimps was generally very high (>90 %) over the 14th April – 17th May period (Figure 5.3). Survival was also high during the other 2 periods with 100 % survival at Ganes and Halls creeks and >50 % survival at the other sites. The low survival rate at the Floodgates site was probably an artefact of the fast current – 2 enclosures were washed away and the remaining one was damaged and shrimps may have escaped. All enclosures were lost at Roses Creek and the Floodgates sites during the period from 16th June to 30th August.

Ganes Creek, and Roses Creek were sprayed with an aqueous diquat/paraquat mix for aquatic plant control during the 14th April – 17th May period. Hollis Creek was sprayed with Torpedo gel during this same period. The upper part of Hollis Creek and Dentons Creek was sprayed with an aqueous diquat/paraquat mix during the 17th May – 16th June period.

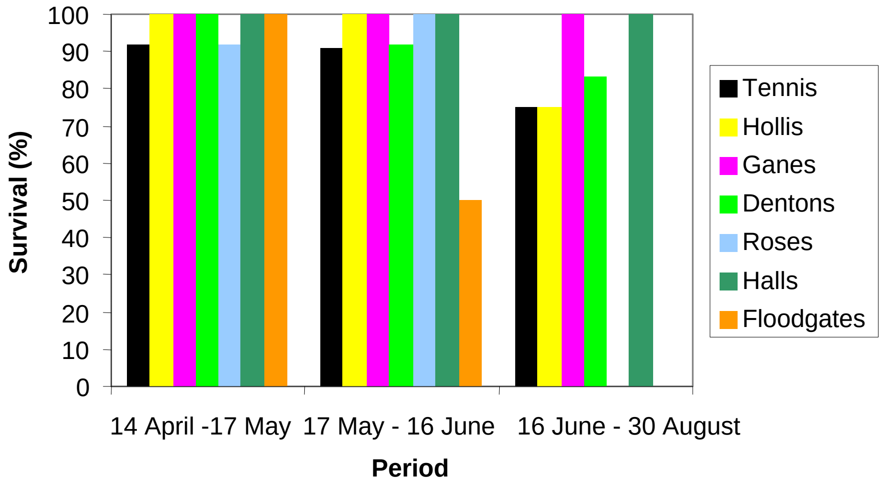

Figure 5.3 Survival of shrimps in enclosures. Shrimps were only found at the Halls and Floodgates sites during the fish survey in December 1999.

The growth data suggest that there was a decline in the average length and weight of shrimps in the enclosures over the period from 14th April to 17th May (Figure 5.4). This decline in size may have been caused by poor feeding conditions within the enclosures, or stress associated with the transfer to the chambers. From 17th May onwards there was a suggestion that the shrimps were growing but there were no clear differences among sites (Figures 5.4).

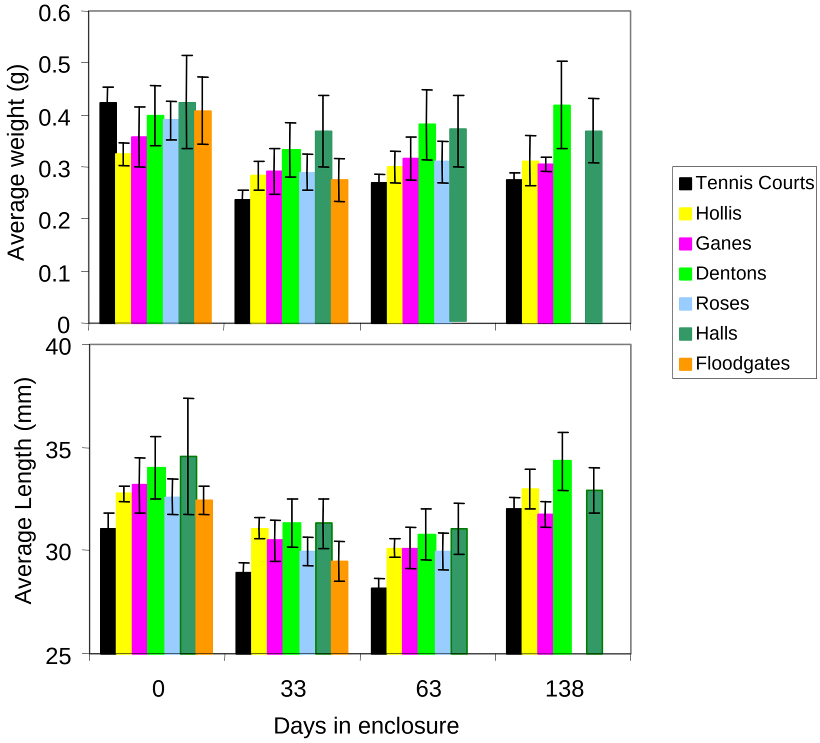

Figure 5.4 Average weight and length of shrimps throughout the transfer experiment.

The results from the shrimp transfer experiment are good news in some respects. There doesn't appear to be a chronic water quality problem in the upper reaches of Spring Creek that is sufficient to kill or change the growth rate of shrimps. The herbicide spraying undertaken during autumn 2000 with either an aqueous diquat/paraquat mix, or Torpedo gel, did not directly cause shrimp mortality. Several of the sites were sprayed while the enclosures were in place and there were no differences in mortality between sites that were sprayed and were not sprayed. We did observe changes in natural shrimp abundance further downstream in Halls Creek after spraying. This was most likely an indirect effect of the spraying caused by the loss of the habitat provided by the aquatic plants. Large numbers of shrimps were seen before the spraying amongst the aquatic plants, but none were seen later after the plants had died back.

Overall, however, the results of the enclosure experiment do not provide any definitive answers to the unusual distribution of shrimps observed in the catchment during our initial survey. There may be intermittent releases of some toxic material into the upper reaches of the stream and which wipe out the shrimp population periodically with insufficient time between these events for recolonisation. However, it is also possible that the distribution we observed was a natural phenomenon and linked with distance from the estuary/coast. Although little is known about the biology of shrimps, it is thought that young shrimp may undergo their early development in brackish water before migrating upstream (Chapman & Lewis 1976). In the future it would be useful to conduct surveys of shrimp distribution at different times of the year to determine if there is significant movement through the catchment.

5.6 Summary

The overall "health" of Spring Creek based upon the survey of macroinvertebrate communities undertaken on 20th October 1999 is shown in Figure 5.5. Ganes Creek, Roses Creek, and, to a lesser extent, Dentons Creek all have macroinvertebrate communities that are reduced in variety (species richness) and indicative of lower environmental quality than those at sites elsewhere in the catchment. The absence or reduced numbers of amphipods in Ganes and Roses Creeks may be attributable to herbicide toxicity and/or removal of vegetation habitat associated with drain maintenance. Growth and mortality of shrimps did not appear to be directly affected by herbicide applications. However, direct effects on other macroinvertebrate populations cannot be discounted. The removal of vegetation habitat was likely to have impacted shrimp populations and may also be an important factor for other species. It is also possible, that fish in Spring Creek could be adversely affected if their food were decimated by drain clearance activities.

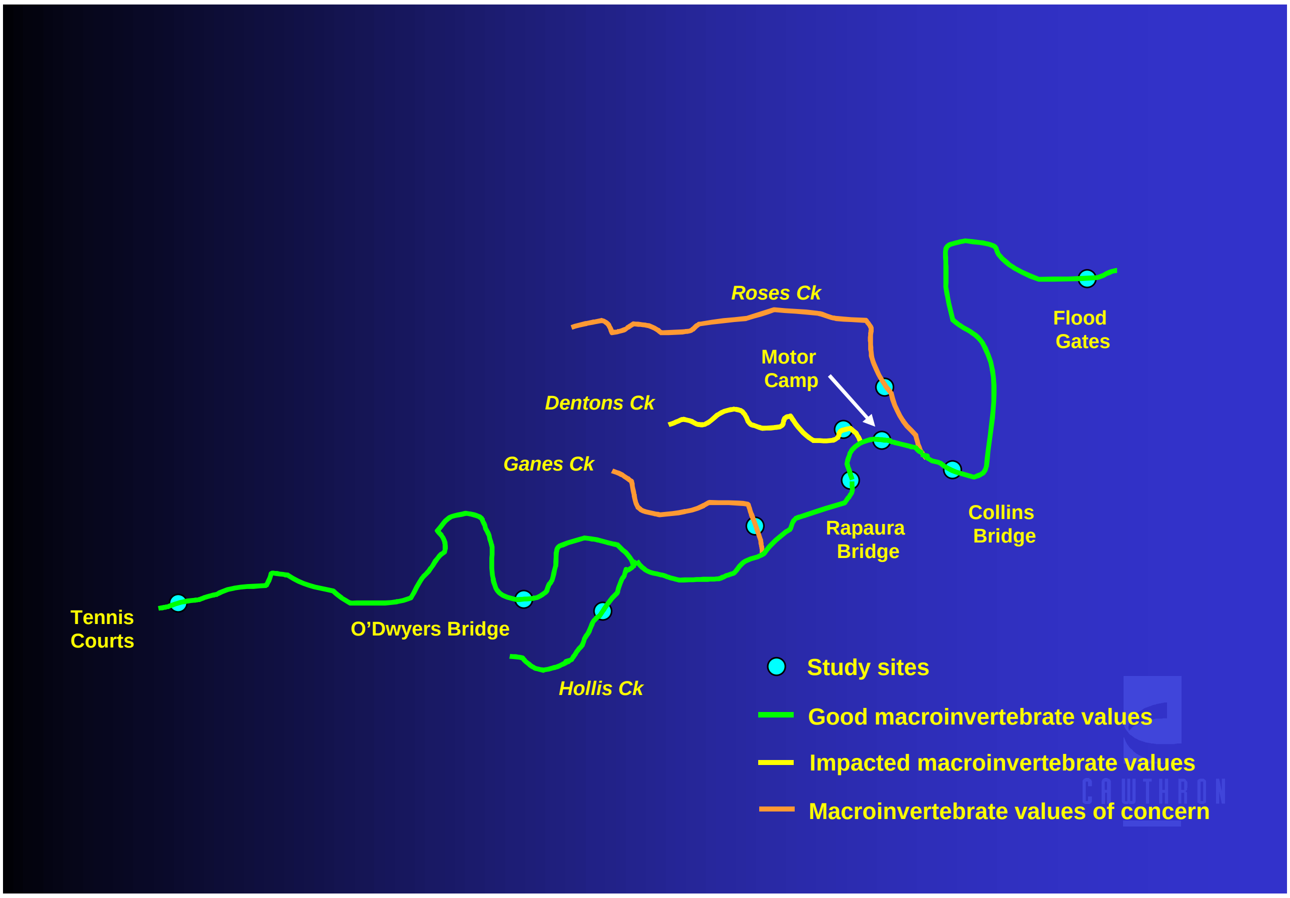

Figure 5.5 Stream health in Spring Creek catchment derived from the macroinvertebrate survey on 20th October 1999.

6. FISH IN SPRING CREEK

Its stable nature, high water quality, close proximity to the sea and relative lack of migratory barriers, makes Spring Creek an ideal habitat for a range of native and introduced species of fish. This section draws on various fish and fisheries values data on Spring Creek from published and unpublished sources ranging from the 1970's through to the present time.

Methods used to determine fish species in Spring Creek have included fyke netting by commercial eel fishers, electric fishing, drift diving, angling and bank-side observation during daylight, but also at night using a spotlight. Despite this varied and relatively intensive sampling, and given the close proximity of the sea, Spring Creek has relatively low fish species richness compared with the Wairau River. The New Zealand freshwater fish database contains records of nine species of fish having been found in Spring Creek, compared with 23 species of fish from the Wairau River system (Table 6.1). Rainbow trout (*Oncorhynchus mykiss*) have also been reported in Spring Creek by anglers. The crustaceans, koura (*Paranephrops planifrons*) and shrimp (*Paratya curvirostris*) have also been recorded in Spring Creek.

Table 6.1 Fish species recorded in Spring Creek (bolded) and the Wairau River (indented).

Common name	Scientific name *(* non-migratory)*
Lamprey	***Geotria australis***
Longfinned eel	***Anguilla dieffenbachii***
Shortfinned eel	***Anguilla australis***
Common smelt	*Retropinna retropinna*
Giant kokopu	***Galaxias argenteus***
Banded kokopu	***Galaxias fasciatus***
Koaro	*Galaxias brevipinnis*
Common river galaxias	**Galaxias vulgaris*
Inanga	***Galaxias maculatus***
Dwarf galaxias	**Galaxias divergens*
Alpine galaxias	**Galaxias paucispondylus*
Rainbow trout	****Oncorhynchus mykiss***
Brown trout	****Salmo trutta***
Quinnat salmon	*Oncorhynchus tshawytscha*
Kahawai	*Arripis trutta*
Yelloweyed mullet	*Aldrichetta forsteri*
Torrentfish	*Cheimarrichthys fosteri*
Redfinned bully	*Gobiomorphus huttoni*
Giant bully	*Gobiomorphus gobioides*
Bluegilled bully	*Gobiomorphus hubbsi*
Common bully	***Gobiomorphus cotidianus***
Upland bully	**Gobiomorphus breviceps*
Black flounder	***Rhombosolea retiaria***

The main attributes of river systems that allow high species richness are a variety of stream habitats and a high proportion of unmodified catchment. Spring Creek has a relatively low variety of different habitat types and the catchment is highly modified which may explain differences in species richness between it and the Wairau River. Despite this, fish species richness in Spring Creek is relatively high on a national basis. In a comparison of 279 records from the New Zealand freshwater fish database, Richardson & Jowett (1996) were able to categorise fish species richness into low, average and high within three different elevation zones. Based on the categories of Richardson & Jowett, species richness in Spring Creek would be considered high (> 5 species).

Distribution of fish species and large crustacea are shown in Table 6.2. Mainstem sites are shaded. Species presence is indicated by solid shading and implied presence by cross-hatching. Implied presence is used for sites that are downstream of any site an anadromous species (migrates to or from the sea during its life cycle) occurs. All species in Spring Creek except for brown trout, rainbow trout and koura are anadromous. However, brown trout could also be considered a migratory species, in that they have access to and from the Wairau River and can migrate to the ocean (Strickland *et al*. 1999).

The low gradient of Spring Creek is highlighted by the fact that inanga were found in abundance at the upstream most site. Inanga are not generally a strong migratory species and in many other river systems only penetrate short distances inland. Migratory obstacles, such as incorrectly placed culverts, are sometimes all it takes to prevent inanga access. Floodgates were installed in Spring Creek in 1996, but since inanga are primarily an annual species (*i.e*. breed and die within one year), their presence now indicates that this construction has had little effect on fish access. However, we have no before and after construction data on inanga abundance to be certain of this. In other river systems, common bully and shrimp often have a similar distribution to that of inanga, but in Spring Creek were only found in the very lower reaches.

Table 6.2 Distribution of fish species and large Crustacea at various locations* in Spring Creek.

Species common name	Tennis Courts	Stump Creek	Giffords Creek	O'Dwyers	Hollis	Ganes	Rapaura	Motor camp	Roses Creek	Halls Creek	Flood gates
Lamprey											■
Longfinned eel	■	■	■	■	■	■	■	■	■	■	▒
Shortfinned eel	■		■	■	■	■	▒	■	■	■	▒
Giant kokopu				■			▒	▒			▒
Banded kokopu	■			▒			▒	▒			▒
Inanga	■		■	▒		■	▒	■		■	■
Rainbow trout	▒	■		■			■	▒			▒
Brown trout	■	■	■	■	■		■	■			■
Common bully										■	■
Black flounder				■			▒	▒		■	■
Koura	■	■	■	■	■		■	■	■	■	■
Shrimp										■	■

* Sites are listed in downstream order from left to right, *i.e*.. Tennis Courts site is the upstream most site.

6.1 Trout habitat features of spring-fed streams

Spring fed streams support some of the most productive trout populations and fisheries in New Zealand and overseas. The reason they do so is because of the stable nature of their flow regimes and the abundant invertebrate life supported by their aquatic plant beds. The stable flow allows aquatic plants to establish and persist. Aquatic plants and stable, often undercut banks with dense riparian vegetation, also provide plenty of cover in which trout of all sizes can hide from predators. The stable flow regimes also provide a favourable environment for trout spawning and fry rearing. Recruitment of trout fry in rain-fed and snowmelt rivers is often limited by the impact of floods scouring eggs from the gravel redds (fish nests) and displacing and killing fry. The cool, buffered, groundwater temperature regimes of spring fed streams also provide a favourable temperature regime for trout survival and growth.

Because of their aquifer origin, spring fed streams can be reasonably resilient to a moderate degree of land development. This is because much of the flow originates from outside of the immediate catchment boundaries. Non-point source pollution arising from land development, such as agriculture, is diluted by the groundwater flow. The aquatic plants also act as natural water purifiers, quickly stripping nutrients from the water. However, spring-fed streams are very susceptible to sediment pollution. Spring-fed streams have a limited capacity to flush and transport sediment owing to their stable flow regimes. For this reason, accelerated erosion arising from land development and disturbance is a serious threat to the hydraulic and ecological functioning of spring-fed streams. Accelerated sedimentation will contribute to in-filling and choking of the channel leading to flooding problems. The smothering of the streambed by sediment kills trout eggs and the invertebrate prey of trout. Sediment pollution lowers the water clarity reducing the ability of trout to see their prey and the ability of anglers to see the trout.

6.2 The trout fishery of Spring Creek

A national angler survey conducted in 1980 found that Spring Creek was the next most frequently visited river by Marlborough anglers after the Wairau River (Richardson *et al.* 1984). The fishery was considered of slightly better than average importance, with close proximity of Spring Creek to anglers' homes the main contributing factor and catch rate the least. At the time of the 1980 survey, the Spring Creek fishery had been improving and for several seasons had produced some very large and well-conditioned trout. Angler opinions on the trout fishery subsequent to the 1980 survey indicated a downturn in numbers of trout and clarity of the water (Appendix 5). A commercial eel fisherman who has fished Spring Creek since 1985 shares these opinions and reports a decrease in his trout by-catch and numbers observed (J. Pacey pers. comm.). In a 1994/1995 angler use survey, Spring Creek had dropped to 12th most important in the Marlborough District (Unwin & Brown 1998).

Length and weight data supplied by four trout anglers who have each fished Spring Creek at different times between 1973 and 2001 (Individual records appear in Appendix 5), are summarised in Figures 6.1 and 6.2. Only those years for which more than four fish were caught were used to calculate annual averages. Years of catch record overlap were amalgamated.

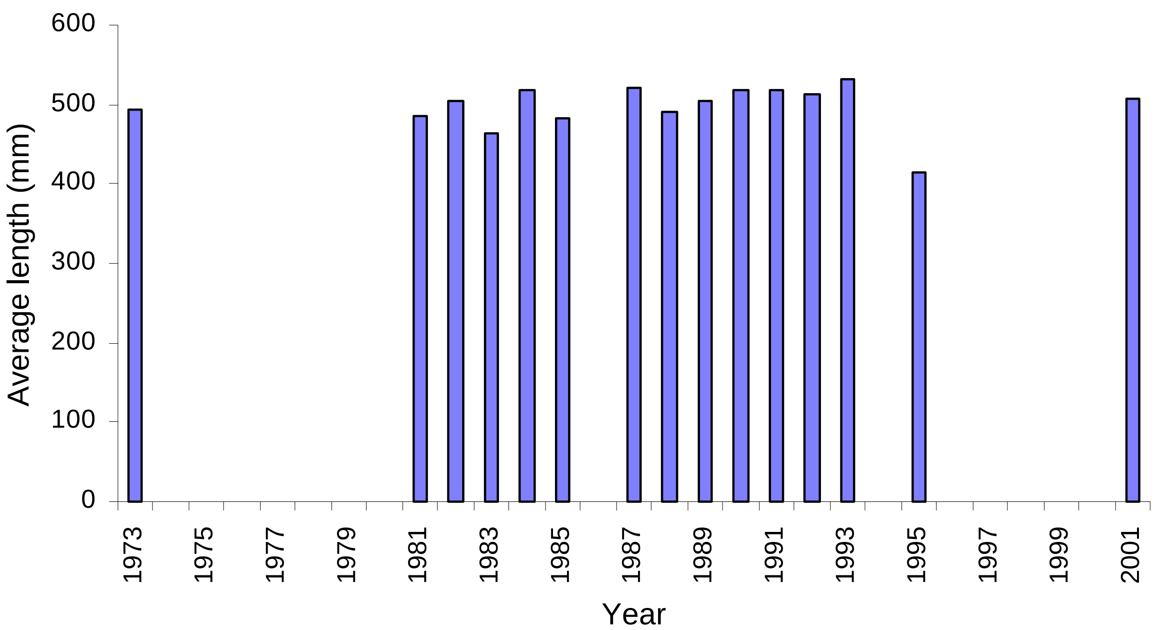

Figure 6.1 Annual average length of brown trout in Spring Creek caught by anglers.

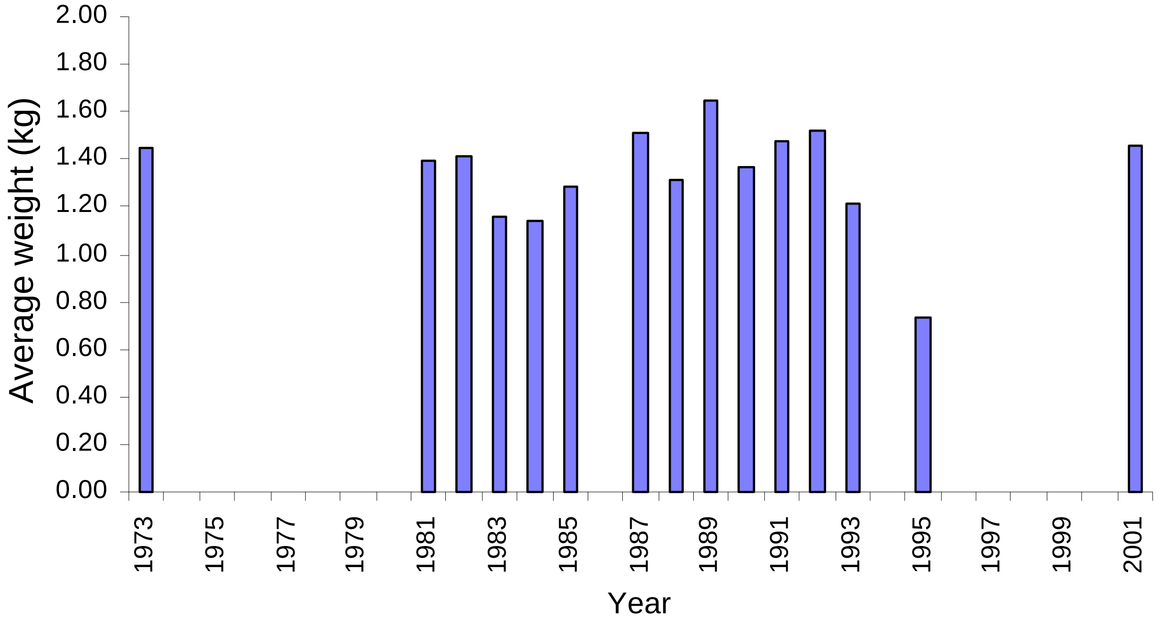

Figure 6.2 Annual average weight of brown trout in Spring Creek caught by anglers.

The average length ranged from 414 mm to 533 mm, while average weight ranged between 0.73 kg and 1.64 kg. There appeared to be a general decline in trout size around 1995, but this appears to have improved in 2001. Overall, angler data did not enable an assessment of declining numbers of trout in Spring Creek, as the anglers did not consistently record catch effort.

Trout were counted in Spring Creek by drift diving in 1986, and regularly since 1995. The dives were undertaken in a 1.1 km reach downstream of O'Dwyers Road (Figure 6.3).

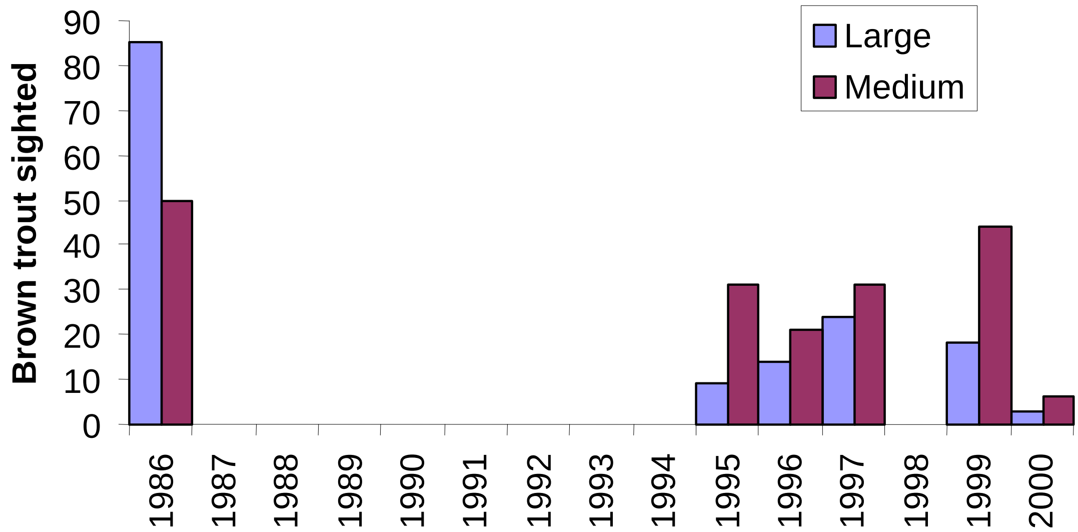

Figure 6.3 Drift dive counts of brown trout in Spring Creek from O'Dwyers Road for 1.1 km downstream.

The drift dive counts since 1995 were lower than in 1986, although it is not possible to attribute statistical significance to this difference because the pre 1995 data are based on only one record. The drift dive count made in 2000 was the lowest on record. Future drift dive counts will be needed to confirm if the low 2000 count signals a declining trend. The low count could otherwise be attributed to any of a number of natural events, such as floods and droughts, both of which occurred at extreme levels in the Wairau catchment in the two years prior to 2000. Drift dive data for a reach below Spring Creek township has shown a similar pattern although water clarity at this site was often too poor for observing trout.

One angler described gut contents of 54 trout caught from Spring Creek over ten seasons. Mayfly and caddisfly nymphs appeared in 50 % of the guts, shrimps in 18 %, brown beetle and other beetles in 13 %, koura in 11 % and all other food items comprised less than 10 %. Some trout ate large numbers of shrimps. For example, 30 shrimps were recorded from the gut of one fish. Anecdotal evidence suggests that shrimp have declined in Spring Creek. Although we have no data to support this assertion, we did detect peculiarities in their distribution (Section 5). Terrestrial invertebrates, such as leaf-hoppers, are also considered to be an important food source for trout in Spring Creek (Richard Abrams, pers. comm.).

The limited amount of available data on trout in Spring Creek tends to support anecdotal evidence suggesting a decline in the trout fishery. The possible causes of this decline however are unclear.

There are several potential causes for the decline of the Spring Creek trout fishery. These include:

- Fry recruitment failure resulting from degraded spawning gravels
- Impaired recruitment of adult trout from the Wairau River resulting from upstream passage difficulties through the outlet culverts. Prior to installation of these culverts and floodgates in 1996, Spring Creek ran through an open channel.
- Impaired fry survival resulting from degraded habitat and food supplies in tributaries
- Impaired trout food supply in Spring Creek and its tributaries (*e.g.*, possible decline in amphipods and shrimps).
- Angler over harvest.

In order to understand what is currently limiting the trout population in Spring Creek a carefully structured research and monitoring programme would need to be implemented. This might take the following form:

1. An inventory of potential trout spawning gravels in the Spring Creek catchment followed by spawning surveys to assess which areas are used by trout (including an assessment of the historical extent and quality of spawning gravels for comparison).

2. Fry abundance monitoring, by electrofishing, in representative spawning areas.

3. Continuation of drift dive surveys to monitor the adult trout population

4. Age and size structure analysis of trout. This complements 3 (above) by allowing tracking of strong and weak year/size classes and identification of critical years affecting trout abundance. These critical years can then be examined for environmental impact or change.

5. Assessment of angler harvest impact. This could be achieved in two ways. The most difficult and expensive approach to this problem is to undertake an annual angler harvest survey. Alternatively, it might be simpler, and certainly more cost effective, to impose a no harvest,

catch and release, regulation on Spring Creek. If harvest has been limiting the trout population then the drift dive surveys, and angler feed-back, should detect an increase in trout abundance over 3 – 5 years.

6.3 The eel fishery of Spring Creek

Based on anecdotal information, we assume at least a low level of recreational eeling takes place in Spring Creek, but this has been difficult to ascertain because a club or other organisation does not represent this group of fishers. Te Tau Ihu Mahi (EMC6) is a statutory body that provides advice to the Minister of Fisheries on recreational, customary and commercial eeling in the Nelson/Marlborough area. The EMC6 eel management plan identifies Spring Creek as a customary eel fishery but gives no detail of the level of use (Anon. 1996).

Commercial eeling has taken place in Spring Creek since the 1970's and at one stage there was even a collection depot set up there. Approximately two or three commercial fishers utilise Spring Creek from time to time, but the most active of these is Jim Pacey, who has fished the catchment since 1985, and from whose comments the remainder of this section on eels is based.

Spring Creek is not a highly valued commercial eel fishery because its low temperature limits the amount of eel activity and it is not easy to set nets because of channel shape and the amount of aquatic plants. Jim Pacey's fishing records provide some indication of the commercial catch from Spring Creek since 1991 (Figure 6.4). Excluding the year 2000, which only included catches until April, the annual catch ranged from 810 kg to 2340 kg. In the last few years fishing effort has been purposely reduced in the hope that harvest can be sustained at this level. Figure 6.4 suggests that this level of catch is sustainable. In April 2000 approximately 300 eels died while in holding nets in Roses Creek and a further 1300 were lost after they reached the processors. While some internal bleeding was observed amongst the affected fish, the reasons for these mortalities are unknown. Samples from the dead eels were tested for some potential contaminants, but nothing was found (Noni Pacey, pers. comm.).

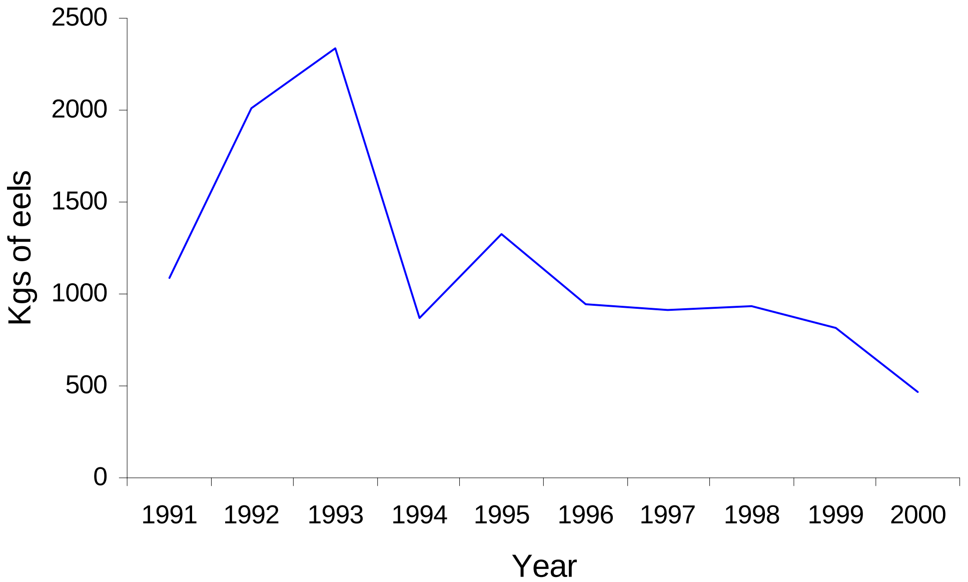

Figure 6.4 Annual eel harvest from Spring Creek by Jim Pacey

6.4 Other fisheries values

In an inventory of whitebaiting rivers in the South Island, the Wairau River was described as a major recreational fishery with a small commercial component (Kelly 1988). Most whitebaiting was done in the lower 10 km of the Wairau River and up to 140 whitebaiters would fish the river on a good day. Spring Creek was not singled out as a whitebait fishery, though its confluence with the Wairau is within the Wairau's lower 12 km. Department of Conservation staff in Blenheim have no record of whitebaiting in Spring Creek, or even in the vicinity of its confluence with the Wairau River. This is surprising given the abundant numbers of inanga (whitebait adults) we recorded throughout tributaries of Spring Creek. Despite the lack of a whitebait fishery in Spring Creek, it no doubt contributes to the Wairau whitebait (inanga) population

Although not always considered to be freshwater fish, flounder, and in particular, black flounder (*Rhombosolea retiaria*) can penetrate many miles inland in some rivers systems. The low gradient of Spring Creek allows black flounder to penetrate into most of its lower reaches but it is unknown whether recreational fishers exploit them.

Other than providing commercial and recreational fisheries, the presence of fish in any freshwater system is an attraction for an ever-increasing number of people who just enjoy observing aquatic life. Spring Creek is no exception *e.g.* tame eels and trout have been encouraged by several landowners that have tributaries of Spring Creek running through their property. The thrill an experienced angler enjoyed in discovering a giant kokopu in Spring Creek is apparent in Appendix 5.

6.5 Summary

Nine species of fish and two large crustaceans have been recorded in Spring Creek. All except one of the fish species are indigenous and require access to the sea. Although Spring Creek does not have as many fish species as the Wairau River it has relatively high species richness when compared with rivers of similar altitude and distance from the sea elsewhere in New Zealand. The entire catchment is accessible for fish, but several species appeared to have limited distribution. These were black flounder, common bully and shrimp. The presence and abundance of inanga throughout Spring Creek imply that the floodgates do not limit fish access. The Spring Creek inanga no doubt contribute to the Wairau whitebait fishery.

The stable flow, temperature and high water quality of Spring Creek has supported a popular trout fishery. In recent years, the popularity of the Spring Creek trout fishery has declined. Potential causes for this decline may include:

- Loss of spawning and juvenile rearing habitat.
- Passage impaired recruitment of adult trout from the Wairau River.
- Possible declines in trout food supply.
- Angler over harvest.

A carefully planned research programme to understand what is currently limiting the trout population in Spring Creek might include:

- An inventory of potential trout spawning areas and a spawning survey.
- Juvenile trout abundance in representative spawning areas.
- Continued monitoring of the adult trout population.
- Age and size structure analysis.
- Assessment of angler harvest impact.

A low level of customary, recreational and commercial eeling takes place in Spring Creek, but the fisheries value of other species is largely unknown.

7. RIPARIAN MANAGEMENT

Throughout New Zealand there are major problems with non-point source pollution of rivers and streams from agricultural and other land use activities (MfE 2000). Improved riparian management practices are increasingly being seen as the best way to maintain or improve the condition of degraded aquatic ecosystems.

Riparian vegetation can shade streams reducing water temperature and limiting the growth of nuisance aquatic plants. Vegetation can also help to control the amount of nutrients and sediment passing from the land to the stream.

The concept of riparian management is not something new for Spring Creek. The potential benefits have been outlined previously (Boffa Miskell 1994) and ways of enhancing the riparian margins of Spring Creek have been proposed by Cadenhead (1994). However, the implementation of such programs has been limited. Problems and conflict related to the issues of public access and the economic consequences of riparian retirement have been difficult to overcome. There are also trade-offs between the potential long-term improvements of riparian plantings versus the loss of easy access for drain clearance activities.

Spring Creek is a relatively small catchment and has not been damaged beyond repair. Its spring-fed nature makes it somewhat resilient to the effects of surrounding land use. On the other hand there are not the flushing flood flows that will remove any sediment that enters the creek. There is much potential for small changes in riparian management, by a small number of people and agencies, to result in large improvements to the health of Spring Creek (Figures 7.1, 7.2, 7.3 & 7.4).

This report has identified that there are concerns in some of the tributaries that could be addressed with improvements in riparian management. Elevated levels of nutrients, sediment and bacteria are a clear indication that things could be better. There is also evidence that the aquatic community is under stress in some tributaries. Problems with the implementation of improved riparian management need to be overcome.

Figure 7.1 Land disturbance very close to the mainstem of Spring Creek

Figure 7.2 A Spring Creek tributary lacking adequate stream margin vegetation and shading resulting in sediment and nutrient input. With the addition of unrestricted sunlight aquatic plants are able to flourish.

Figure 7.3 Trees on the south side only shade the portion of streambed immediately under the canopy. At most angles the sun is able to penetrate through the water column beneath the tree canopy. Consequently, at this site aquatic plants flourish on the south side but where the bank provides some shade on the north side, growth is not quite so prolific.

Figure 7.4 Good protection of stream margin vegetation but there is no shade to suppress aquatic plant growth**.**

8. RECOMMENDATIONS

The next steps are very important for achieving the goals set for Spring Creek at the initial stakeholders' meeting (Figure 1.1). In this section of the report we highlight some efforts that could be made in the catchment with the aim of achieving these goals.

8.1 Riparian management trials

The report has shown that there are conditions of concern in several Spring Creek tributaries. Trials of different riparian management options could be conducted on several of these tributaries. It is important in each case to determine the goals of any changes in riparian management. The constant temperatures of the groundwater feeding the creek moderate temperature fluctuations. Therefore, riparian planting of trees to lower stream temperatures is not necessarily a high priority. However, shading from tall riparian vegetation also has the potential to control the growth of nuisance aquatic plants. Therefore in areas where nuisance aquatic plants are a problem it would be useful to plant vegetation that would shade the stream. This should be done on the north bank of streams to maximise the shading effect. If only one bank of a stream is planted then problems with access for drainage activities can be minimised.

Cadenhead (1994) has suggested various native species that could be planted in the riparian zone of Spring Creek and would achieve weed control objectives. Other species, such as *Eucalyptus nitens*, appeared to be very successful in limiting aquatic plant growth in the upper reaches of Roses Creek during our shading survey. These trees supply a large amount of leaf litter and debris that are potentially an important food resource for koura and other aquatic organisms.

Input of sediment, nutrients and faecal bacteria were also identified as being problems in some of the tributaries of Spring Creek. Limiting the access of stock to these streams and ensuring that there is at least some gap between land disturbance and adjacent waterways is probably the best way to control these inputs. Out-of-stream watering for stock is already being used in some tributaries and should have immediate benefits.

8.2 Options for drainage management

The tributaries of Spring Creek are actively managed for drainage purposes, with twice yearly herbicide applications for aquatic plant control and occasional mechanical clearance of plants and sediment. Results from the invertebrate survey suggest that some types of organisms may be directly affected by the toxic effects of the sprays, while others are influenced indirectly by the loss of the aquatic plants, which form an important habitat.

It might be useful to trial alternative methods of aquatic plant clearance *e.g.* shading by riparian vegetation (see above), and hand weeding. The costs and potential benefits of alternative methods would have to be compared with existing techniques. Further studies looking at the aquatic community before and after spraying may be required to fully assess the costs and benefits of any technique.

It would also be worth trying to assess the potential of eradicating some of the nuisance aquatic plants from the creek. *Lagarosiphon* does not produce seed and can only be spread by vegetative fragments drifting downstream, or by human transfer. Therefore, if the upstream limits of these plants in Spring Creek were determined, a concerted eradication program, using hand weeding and/or weed control mats, could be successful in a system of this size.

8.3 Further work on the trout population

There is some evidence to suggest that the trout population has declined in Spring Creek. Several factors could be responsible for the decline. As mentioned earlier, in order to understand what is currently limiting the trout population in Spring Creek a carefully structured research and monitoring programme would need to be implemented. This might take the following form:

- An inventory of potential trout spawning gravels in the Spring Creek catchment followed by spawning surveys to assess which areas are used by trout (including an assessment of the historical extent and quality of spawning gravels for comparison).

- Fry abundance monitoring, by electrofishing, in representative spawning areas.

- Continuation of drift dive surveys to monitor the adult trout population

- Age and size structure analysis of trout. This complements 3 (above) by allowing tracking of strong and weak year/size classes and identification of critical years affecting trout abundance. These critical years can then be examined for environmental impact or change.

- Assessment of angler harvest impact. This could be achieved in two ways. The most difficult and expensive approach to this problem is to undertake an annual angler harvest survey. Alternatively, it might be simpler, and certainly more cost effective, to impose a no harvest, catch and release, regulation on Spring Creek. If harvest has been limiting the trout population then the drift dive surveys, and angler feed-back, should detect an increase in trout abundance over 3 – 5 years.

8.4 More shrimp surveys

Our shrimp survey in December 1999 found that the distribution of shrimps was limited to the lower reaches of Spring Creek and Halls Creek. As shrimps are important in the diet of trout in Spring Creek, it would be interesting to know if this distribution is permanent or whether we observed something unusual. The presence of shrimps is easily detected with an electric fishing machine so further surveys would not require a large amount of effort.

8.5 Have the floodgates had any effect on the fishery?

Our fish survey showed that poor migrants such as inanga and shrimps were found upstream of the floodgates. This would suggest that the floodgates do not act as a barrier for the migration of aquatic life. It would be interesting, however, to measure flow velocities through the floodgates culvert to compare them with natural stream velocities upstream. To test that the floodgates do not impair trout migration into Spring Creek from the Wairau, the numbers of adults entering the system and exiting the upstream end of the floodgate culvert would need to be investigated.

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Appendix 1

Water Quality Data

Appendix 1. Water quality data from each of the sampling sites on each date.

Site	**12/8/99**	**14/9/99**	**15/10/99**	**11/11/99**	**9/12/99**	**14/1/00**	**11/2/00**	**13/3/00**	**14/4/00**	**12/5/00**	**7/6/00**	**13/7/00**
Nitrate nitrogen (g/m^3)												
Tennis	0.68	0.64	0.39	0.26	0.58	0.62	0.32	0.3	0.33	0.29	0.57	0.56
O'Dwyers	0.49	0.6	0.43	0.3	0.39	0.53	0.39	0.3	0.27	0.25	0.46	0.42
Hollis	0.36	0.47	0.49	0.42	0.36	0.57	0.58	0.42	0.51	0.32	0.45	0.41
Ganes	0.43	0.5	0.41	0.39	0.36	0.34	0.32	0.27	0.36	0.3	0.64	0.32
Rapaura Rd	0.42	0.55	0.42	0.3	0.35	0.51	0.38	0.29	0.27	0.24	0.41	0.38
Dentons	0.42	0.46	0.35	0.4	0.34	0.35	0.29	0.22	0.5	0.33	0.63	0.35
Motor Camp	0.41	0.53	0.41	0.31	0.35	0.49	0.36	0.28	0.31	0.24	0.48	0.41
Roses	0.45	0.45	0.36	0.39	0.4	0.41	0.39	0.2	0.79	0.54	0.93	0.44
Collins Bridge	0.4	0.53	0.4	0.31	0.34	0.49	0.36	0.28	0.33	0.25	0.51	0.38
Flood Gate	0.4	0.49	0.42	0.32	0.32	0.43	0.36	0.26	0.31	0.25	0.47	0.36
Ammonical nitrogen (g/m^3)												
Tennis	0.026	<0.005	0.012	0.021	0.006	0.008	0.008	0.009	0.01	<0.005	0.032	0.073
O'Dwyers	0.029	0.025	0.014	0.025	0.01	<0.005	0.026	0.009	0.011	0.009	0.009	0.01
Hollis	0.082	0.023	0.006	0.015	0.014	0.007	0.007	0.01	0.041	<0.005	0.02	0.014
Ganes	0.005	0.02	0.012	0.12	0.014	0.041	0.019	0.018	0.014	0.017	0.076	0.022
Rapaura Rd	0.055	0.018	0.018	0.011	0.006	<0.005	<0.005	0.009	0.023	<0.005	0.0006	0.008
Dentons	0.05	0.024	0.007	0.012	<0.005	<0.005	0.24	0.013	0.008	0.016	0.029	0.03
Motor Camp	0.016	0.009	0.01	0.008	0.007	<0.005	<0.005	0.01	0.014	<0.005	0.021	0.034
Roses	0.055	0.019	0.026	0.054	0.023	0.016	0.012	0.016	0.02	0.045	0.041	0.035
Collins Bridge	0.033	0.017	0.019	0.009	0.006	<0.005	<0.005	0.007	0.034	0.009	0.01	0.019
Flood Gate	0.093	0.007	0.019	0.01	0.01	<0.005	0.01	0.014	0.023	0.014	0.029	<0.005

Appendix 1 continued

	12/8/99	14/9/99	15/10/99	11/11/99	9/12/99	14/1/00	11/2/00	13/3/00	14/4/00	12/5/00	7/6/00	13/7/00
DRP (g/m^3)												
Tennis	0.009	0.005	0.007	0.006	0.005	0.006	0.008	0.003	0.006	0.006	0.008	0.01
O'Dwyers	0.011	0.006	0.007	0.008	0.007	0.011	0.005	0.004	0.008	0.007	0.008	0.01
Hollis	0.017	0.011	0.007	0.012	0.007	0.01	0.01	0.003	0.011	0.01	0.014	0.013
Ganes	0.024	0.018	0.012	0.042	0.012	0.016	0.015	0.008	0.016	0.023	0.024	0.015
Rapaura Rd	0.015	0.008	0.011	0.013	0.007	0.01	0.006	0.006	0.011	0.008	0.01	0.013
Dentons	0.019	0.014	0.055	0.009	0.005	0.005	0.007	0.004	0.017	0.019	0.017	0.017
Motor Camp	0.015	0.006	0.007	0.009	0.005	0.009	0.01	0.004	0.008	0.009	0.011	0.015
Roses	0.026	0.023	0.01	0.018	0.014	0.023	0.019	0.009	0.018	0.033	0.04	0.019
Collins Bridge	0.029	0.008	0.008	0.01	0.006	0.009	0.014	0.004	0.01	0.011	0.012	0.012
Flood Gate	0.022	0.01	0.007	0.01	0.008	0.011	0.009	0.004	0.015	0.011	0.014	0.014
Total Phosphorus (g/m^3)												
Tennis	0.008	0.005	0.008	0.008	0.006	0.01	0.008	0.015	0.01	0.015	0.09	0.029
O'Dwyers	0.01	0.008	0.008	0.012	0.009	0.018	0.01	0.019	0.011	0.012	0.033	0.03
Hollis	0.017											
Ganes	0.024											
Rapaura Rd	0.015	0.009	0.011	0.029	0.017	0.017	0.012	0.032	0.016	0.017	0.039	0.033
Dentons	0.019											
Motor Camp	0.015	0.008	0.012	0.017	0.012	0.011	0.012	0.022	0.011	0.017	0.036	0.033
Roses	0.026											
Collins Bridge	0.029											
Flood Gate	0.025	0.015	0.017	0.018	0.014	0.022	0.013	0.019	0.03	0.021	0.048	0.033

Appendix 1 continued

	12/8/99	14/9/99	15/10/99	11/11/99	9/12/99	14/1/00	11/2/00	13/3/00	14/4/00	12/5/00	7/6/00	13/7/00
***E.coli* (MPN/100 mL)**												
Tennis	22	13	8.4	7.4	7.4	12	19.9	146.7	24.3	13	56	18
O'Dwyers	38	2400	37	73	42.8	20.3	30.1	162.4	17.3	71		58
Hollis	40	160	15	7.4	79.8	44.1	190	88.4	111.2	27		82
Ganes	260	440	15	2419	275.5	111.9		410.6	81.6	230	82	31
Rapaura Rd	120	80	4.1	126	93.3	42.6	118.7	261.3	90.6	75	40	170
Dentons	230	110	91	86	86	44.3	110	90.6	45.5	99	86	29
Motor Camp	64	55	260	114	45.7	47.2	86.5	172.3	71.7	460	48	110
Roses	770	1600	23	34	178.9	250	35.4	1119.85	86.2	170	110	330
Collins Bridge	160	61	31	197	62.7	47.2		172.3	248.1	610	140	130
Flood Gate	140	47	1	387	24	17.5	69.7	82	52	2400	75	51
Water clarity (m)												
Tennis	7.6	12.6	4.4	8.6			5.3	2	4.45		8	5.8
O'Dwyers	5	9.6	10.9				9.2	6.5	7.4		6.25	4.8
Hollis	4.2	6	5	6.9			5.9	5.1	12.5		5.65	7
Ganes	0.7	2.2	1.9	1.3			2.25	2.1	3.1		2.85	1.4
Rapaura Rd	4	6.3	6.1	5.8			6	3.6	9.3		6.6	7.6
Dentons	1.4	3.3	1.6	2.8			4.65	4.2			1.85	1.95
Motor Camp	2.5	5.4	5.2	6.1			7.45	7.6	7.1		6	4.6
Roses	0.35	0.65	1.1	1.8			1.45	2	2.9		2.2	1.5
Collins Bridge	2.15	4.75	4.1	2.7			8.5	7.3	4.6		7.75	5.05
Flood Gate	1.8	4.6		2.6			5	4.2	2.7		4.3	5.45

Appendix 1 continued

	12/8/99	14/9/99	15/10/99	11/11/99	9/12/99	14/1/00	11/2/00	13/3/00	14/4/00	12/5/00	7/6/00	13/7/00
Turbidity (NTU)												
Tennis	1	0.6	1	0.75	0.4	0.55	0.5	0.7	0.7	1.4	0.5	1
O'Dwyers	1.1	0.5	1.1	0.85	0.6	0.55	0.35	1	0.65	0.5	0.7	1.1
Hollis	2.1	0.7	0.3	0.55	0.25	0.75	0.5	0.45	0.3	0.5	0.5	0.6
Ganes	4	1.4	2.2	3.4	1.9	1.1	1.5	1.8	1.1	1	2.6	3.5
Rapaura Rd	1.4	0.35	0.65	0.95	0.35	0.6	0.5	3.9	0.6	0.65	0.65	0.85
Dentons	3.8	0.5	1	1.4	0.6	1.2	0.5	1	0.5	0.5	3.3	2
Motor Camp	1.8	0.4	0.9	1.1	0.6	0.6	0.45	2	0.45	0.7	0.6	1.8
Roses	18	9.7	3.2	1	2.3	1.6	1.2	3.4	0.8	0.9	1.9	1.6
Collins Bridge	3.1	0.8	0.7	1	0.6	0.6	0.7	2.5	0.65	0.7	0.85	1.7
Flood Gate	4	1.9	0.8	1	0.45	0.65	0.6	0.85	1.7	1	0.9	0.8
Total suspended solids (g/m^3)												
Tennis	1	0.5	1	1	0.5	1	0.7	1	1	3	0.5	1
O'Dwyers	2	0.8	2	1	0.6	1	1	1	1	1	2	1
Hollis	2	0.5	1	1	0.5	1	0.7	1	1	1	1	1
Ganes	3	1	1	6	2	1	1	2	1	2	2	4
Rapaura Rd	2	1	1	3	0.9	1	1	4	1	2	1	1
Dentons	3	2	1	3	0.5	1	0.6	4	2	1	2	3
Motor Camp	2	1	2	2	0.8	1	0.8	2	1	1	1	2
Roses	16	28	1	4	6	3	2	1	1	4	2	1
Collins Bridge	3	1	1	3	1	1	0.6	5	1	3	2	2
Flood Gate	6	2	1	1	0.9	1	1	1	6	2	2	2

Appendix 1 continued

	12/8/99	14/9/99	15/10/99	11/11/99	9/12/99	14/1/00	11/2/00	13/3/00	14/4/00	12/5/00	7/6/00	13/7/00
Dissolved oxygen (% Saturation)												
Tennis	89.4	94.1	79.5	94.4	91	97.4	80.6		72.3		70.8	
O'Dwyers	88.7	99.4	73.6	90.3	90	91	83		66.9		73.5	67.1
Hollis	89.6	98.2	61.5	82.7	85	85	83		76.5		69.3	70.6
Ganes	89.2	94.5	83.3	79	84	100	77.6		65.3		67.2	69.7
Rapaura Rd	93.4	98.3	87.3	85.5	86.5	106			53.6		72.2	81
Dentons	101.3	118.4	119.3	86.8	97.1	105	68		52.3		63.3	69
Motor Camp	99.7	105.1	87.2	83.1	83.2	102	76		72.3		66	62.4
Roses	97.1	114.8	95.1	83.5	84	106	78		46		68.6	77
Collins Bridge	102.5	118.7	95.8	84.2	93.8	113	82		79.7		71.3	78.6
Flood Gate	100.8	108.4	93	86.8	92.9	115	82.2		70.4		66.2	76.5
Dissolved oxygen (mg/L)												
Tennis	9.2	9.61	8.32	9.63	9.3	9.9	8.1		7.7		7.51	8.15
O'Dwyers	9.2	10.32	7.79	9.2	9.2	9.35	8.3		7.6		7.76	7.27
Hollis	9.3	10.22	6.4	8.6	9.02	8.7	8.6		8		7.27	7.37
Ganes	9.4	10.01	8.27	8.01	8.6	9.9	7.9		6.75		7.25	7.66
Rapaura Rd	9.7	10.28	9.12	8.49	8.9	10.75	8.6		5.7		7.87	8.65
Dentons	10.4	12.23	12.38	8.9	10	10.7	7		5.4		6.67	7.35
Motor Camp	10.3	10.95	9	8.69	8.63	10.3	7.8		8.3		7.01	6.55
Roses	10.1	11.9	9.78	8.61	8.4	10.4	7.95		4.7		7.42	8.2
Collins Bridge	10.6	12.18	9.9	8.52	9.62	11.6	8.4		8.27		7.63	8.47
Flood Gate	10.4	11.28	9.69	8.9	9.55	11.7	8.34		7.16		7.12	8.38

Appendix 1 continued

	12/8/99	14/9/99	15/10/99	11/11/99	9/12/99	14/1/00	11/2/00	13/3/00	14/4/00	12/5/00	7/6/00	13/7/00
pH												
Tennis	6.8	6.9	6.8		6.8	6.9	6.8	6.8	6.8	6.8	6.8	7
O'Dwyers	7	6.9	7		7	7	7	6.9	6.9	6.9	6.9	7
Hollis	7	7	7		7	7	6.9	7	6.9	6.9	6.9	7
Ganes	7.1	7	7		7.2	7	6.9	7	7	7	7	7
Rapaura Rd	7.1	7	7		7	7.1	7	7	6.9	7	7	7.1
Dentons	7.2	7.5	7.7		7.1	7.1	6.9	6.8	6.8	6.9	7	7
Motor Camp	7.2	7.1	7.1		7.1	7.2	7.1	7	7	7	7	7.1
Roses	7.2	7.7	7.5		7.2	7.2	7.1	7	6.9	7	7.1	7.3
Colling Bridge	7.2	7.2	7.2		7.1	7.2	7	7	7	7	7	7.1
Flood Gate	7.2	7.2	7.2		7.1	7.3	7.1	7	7.1	7.1	7	7.1
Specific Conductivity (μS/cm)												
Tennis	57.5	63.1	60.6	60.1	62.5	62	63.7		61.9		68	64.9
O'Dwyers	60.7	62.5	61.5	60.1	61	63.7	63.8		62.6			65
Hollis	69.1	67.7	69.8	67	67.3	68	68		67.5		78.1	71.2
Ganes	69.6	69	66.8	66.7	67	66	66.2		70.1		79	69.4
Rapaura Rd	61.9	63.2	62.5	61.3	62	63.5	63.7		64.5			65.6
Dentons	62.5	65	63.1	64.3	63.8	63	63.8		69.7			67
Motor Camp	62.8	63.5	63.5	61.6	62.2	64	63.7		65			65.7
Roses	74.1	66.4	64.3	65.5	70	65.3	67		81.3			71.7
Collins Bridge	62.8	63.4	62.5	61.8	62.2	64	63.7		65.2			65.9
Flood Gate	64.8	66	64.2	63.2	63.5	64.2	64.6		66.8			66.9

Appendix 2

Aquatic plant survey form

Appendix 2 Aquatic plants survey form

Location……………………………………………………………**Date**………………

Landmarks…………………………………………………………………………………

U/W Secchi…………………**m** **Distance measured from true**……**bank**

Braun-Blanquet scale: 1 = 1-5% 2 = 6-25% 3 = 26-50% 4 = 51-75% 5 = 76-95% 6 = 96-100%

Dist.	Depth	Max. plant ht.	B. B.	Species + % composition

Comments (other species observed)

Appendix 3

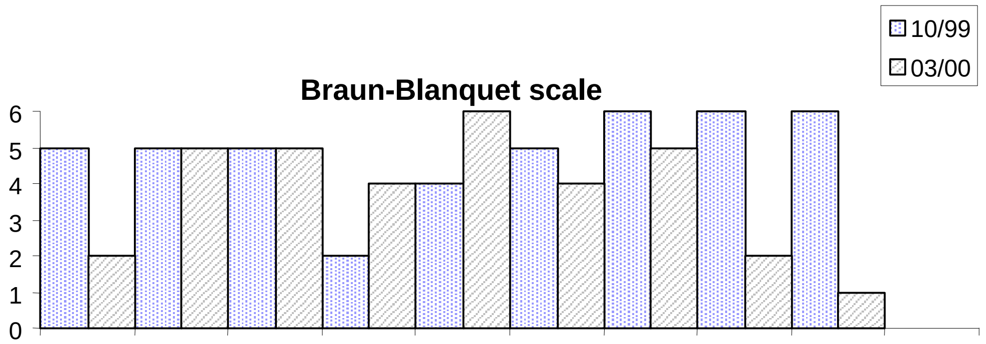
Aquatic plant cross sections

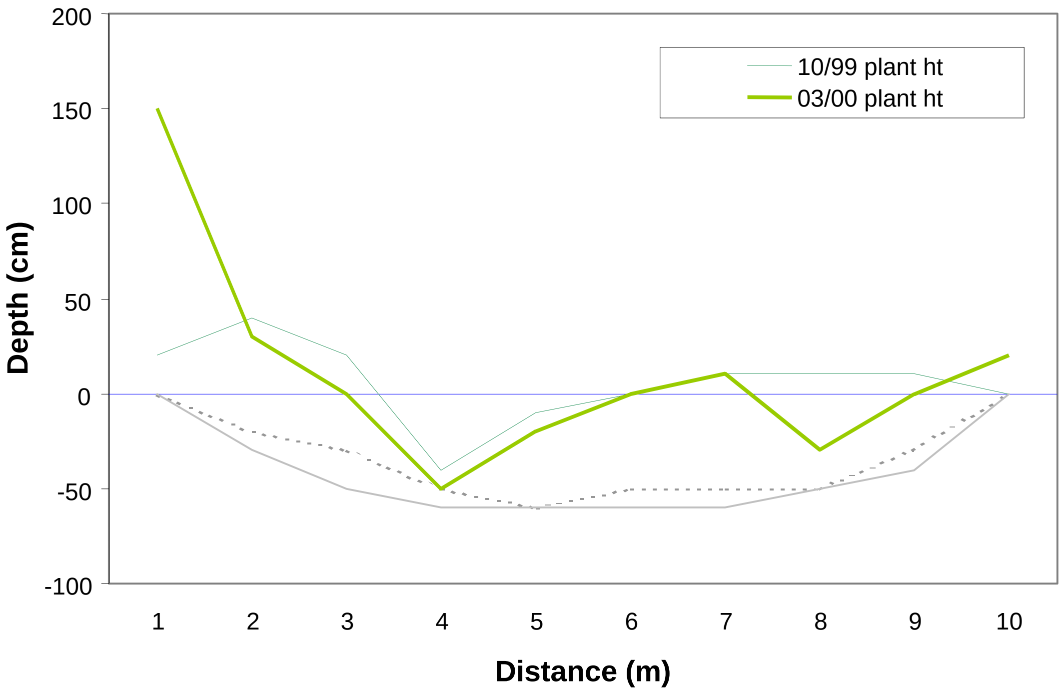
Appendix 3 Aquatic plants cross-sections as at March 2000

TENNIS COURTS

Dist	Plant	%	Plant	%	Plant	%	Plant	%	Plant	%
0	*Polygonum decipiens*	100								
1	*Polygonum decipiens*	100								
2	*Polygonum decipiens*	99	*Lemna minor*	1						
3	*Riccia fluitans*	75	*Glyceria fluitans*	20	*Nitella hookeri*	5				
4	*Riccia fluitans*	70	*Nasturtium officinale*	10	*Glyceria fluitans*	10	*Nitella hookeri*	5	*Polygonum decipiens*	5
5	*Riccia fluitans*	60	Detritus	25	*Nasturtium officinale*	10	*Nitella hookeri*	5		
6	*Polygonum decipiens*	80	*Nasturtium officinale*	5	*Nitella hookeri*	5	*Riccia fluitans*	5	*Lemna minor*	5
7	*Myriophyllum propinquum*	50	*Nasturtium officinale*	45	*Nitella hookeri*	5				
8	Terrestrial veg	30	*Polygonum decipiens*	30	*Myriophyllum propinquum*	10	*Nitella hookeri*	5	Detritus	25
9	*Polygonum decipiens*	70	Terrestrial veg	25	*Lemna minor*	5				

Lawn and some stream margin grasses on TR bank. Some evidence of weed spraying on TR margin.
O/hanging willows and other trees shading TL bank.

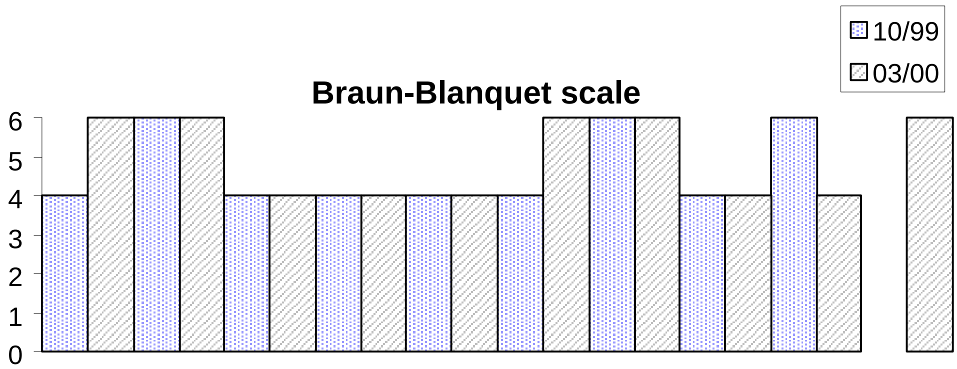


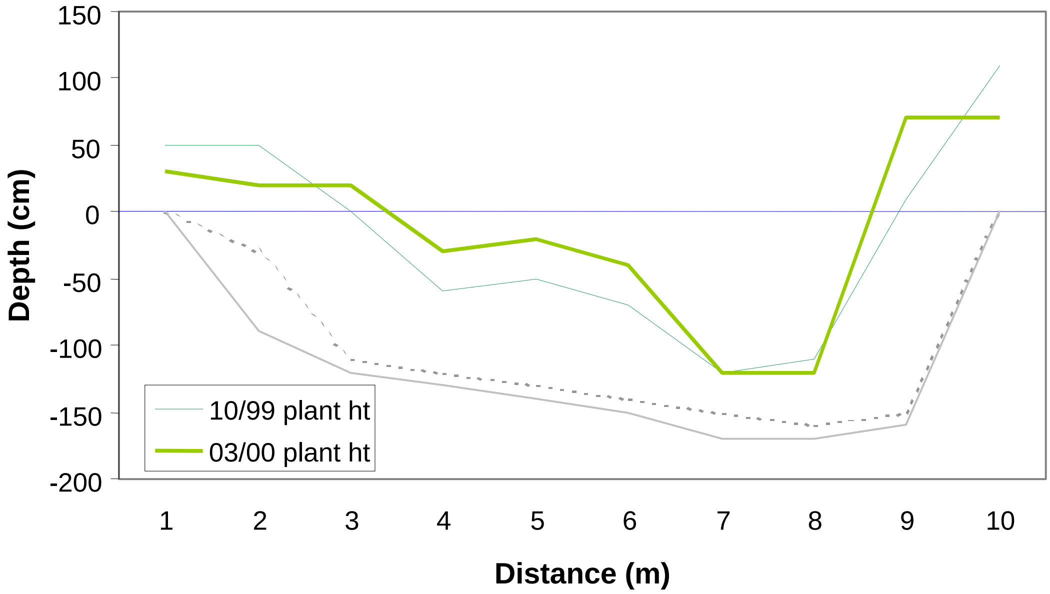


O'DWYERS ROAD

Dist	Plant	%	Plant	%	Plant	%	Plant	%	Plant	%
0	*Mimulus guttatus*	70	*Polygonum decipiens*	20	*Lemna minor*	10				
1	*Polygonum decipiens*	45	*Mimulus guttatus*	45	*Lemna minor*	10				
2	*Polygonum decipiens*	50	*Elodea canadensis*	30	*Nasturtium officinale*	10	*Ranunculus trichophyllus*	10		
3	*Ranunculus trichophyllus*	80	*Nitella hookeri*	10	*Elodea canadensis*	5	*Nasturtium officinale*	5		
4	*Ranunculus trichophyllus*	80	*Nitella hookeri*	10	*Elodea canadensis*	5	*Nasturtium officinale*	5		
5	*Elodea canadensis*	50	*Ranunculus trichophyllus*	45	*Myriophyllum propinquum*	5				
6	*Elodea canadensis*	80	*Myriophyllum propinquum*	20						
7	*Elodea canadensis*	60	*Myriophyllum propinquum*	40						
8	*Ranunculus trichophyllus*	45	*Nasturtium officinale*	40	*Elodea canadensis*	5	*Lemna minor*	5	Terrestrial veg	5
9	Terrestrial veg. & detritus	100								

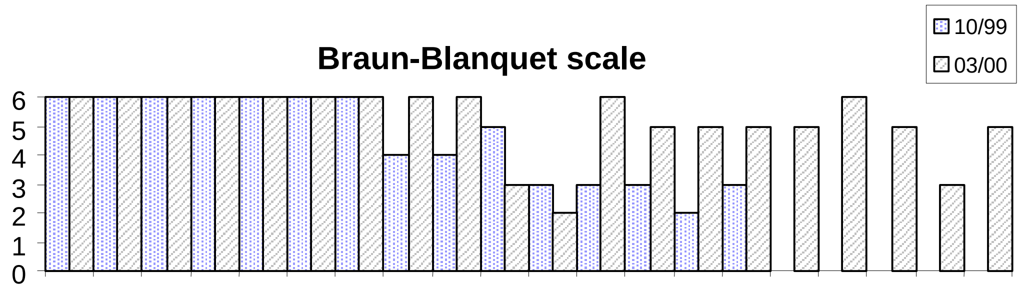
Open but with lush wetland and terrestrial bankside vegetation

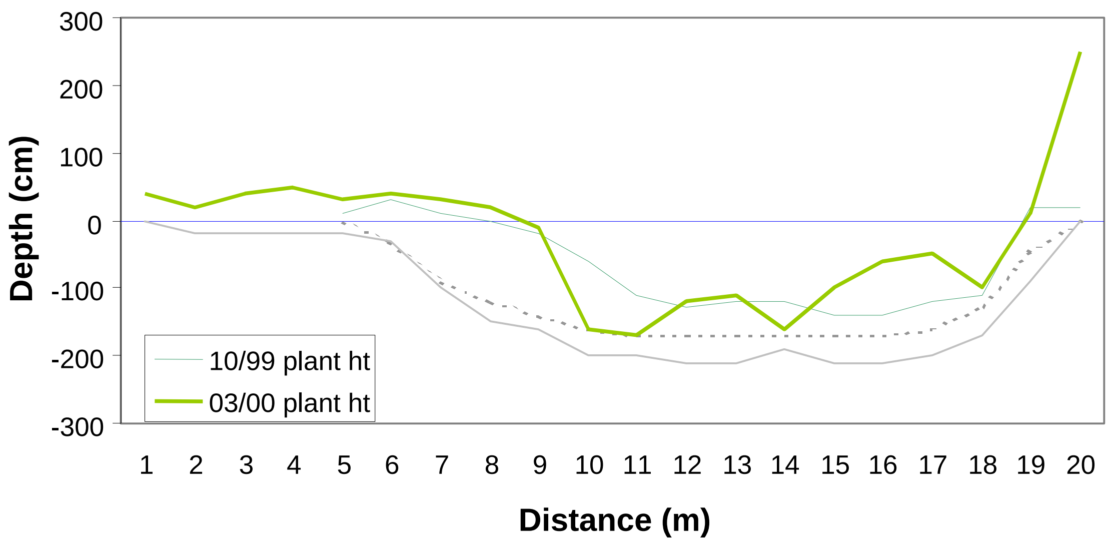




RAPAURA ROAD

Dist	Plant	%	Plant	%	Plant	%	Plant	%
0	Terrestrial veg	50	*Nasturtium officinale*	50				
1	*Polygonum decipiens*	50	*Nasturtium officinale*	45	*Lemna minor*	5		
2	*Polygonum decipiens*	50	*Nasturtium officinale*	45	*Lemna minor*	5		
3	*Polygonum decipiens*	50	*Nasturtium officinale*	45	*Lemna minor*	5		
4	*Nasturtium officinale*	59	*Polygonum decipiens*	40	*Lemna minor*	1		
5	*Nasturtium officinale*	80	*Polygonum decipiens*	19	*Lemna minor*	1		
6	*Nasturtium officinale*	80	*Polygonum decipiens*	19	*Lemna minor*	1		
7	*Nasturtium officinale*	95	*Lemna minor*	5				
8	*Lagarosiphon major*	50	*Nasturtium officinale*	45	*Lemna minor* & *Azolla rubra*	5		
9	*Lagarosiphon major*	50	*Elodea canadensis*	50				
10	*Lagarosiphon major*	50	*Elodea canadensis*	50				
11	*Elodea canadensis*	100						
12	*Elodea canadensis*	100						
13	*Elodea canadensis*	100						
14	*Elodea canadensis*	50	*Lagarosiphon major*	50				
15	*Lagarosiphon major*	70	*Elodea canadensis*	30				
16	*Lagarosiphon major*	60	*Elodea canadensis*	40				
17	*Lagarosiphon major*	80	*Elodea canadensis*	20				
18	*Elodea canadensis*	50	*Lagarosiphon major*	30	*Nasturtium officinale*	15	*Lemna minor* & *Azolla rubra*	5
19	*Phormium tenax*	70	Sedges	20	*Polygonum decipiens*	10		

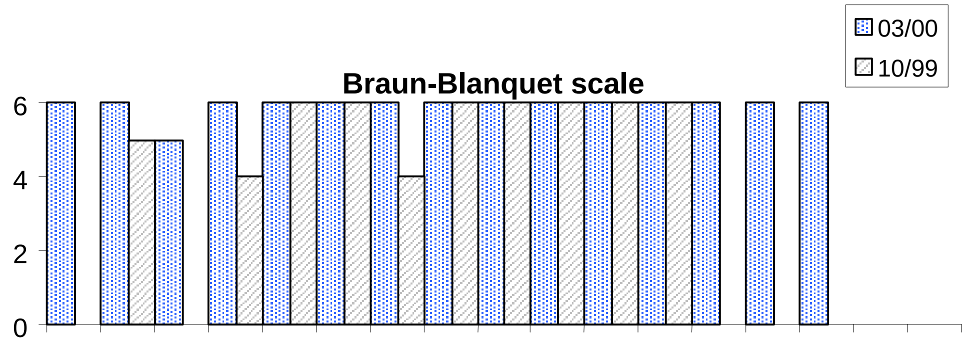


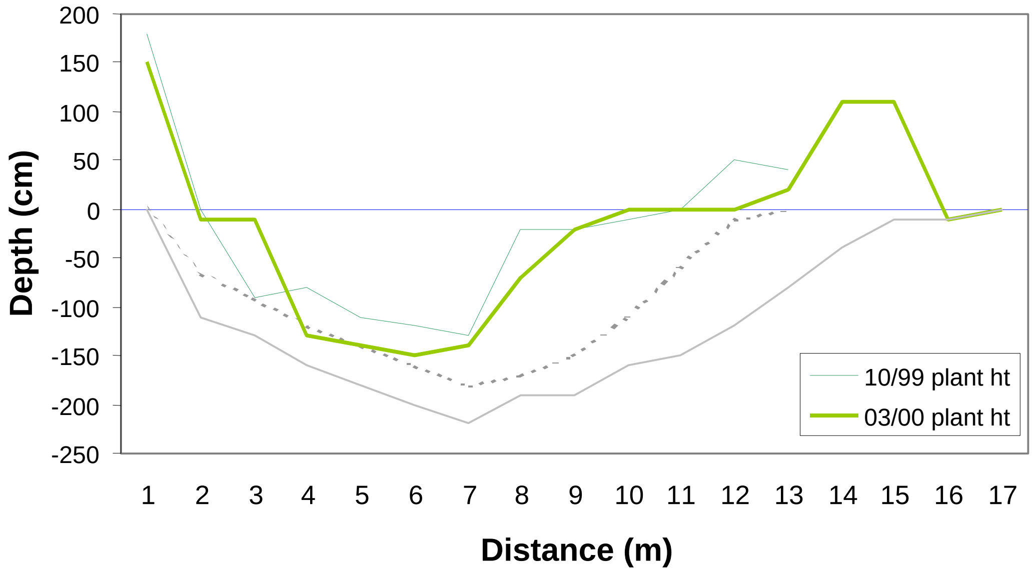


MOTOR CAMP

Dist	Plant	%	Plant	%	Plant	%	Plant	%
0	Sedges & Terrestrial veg	100						
1	*Lagarosiphon major*	100						
2	*Lagarosiphon major*	35	*Egeria densa*	35	*Potamogeton crispus*	25	*Potamogeton cheesmanii*	5
3	*Potamogeton crispus*	90	*Elodea canadensis*	10				
4	*Potamogeton crispus*	80	*Nitella hookeri*	20				
5	*Nitella hookeri*	60	*Potamogeton crispus*	30	*Egeria densa*	10		
6	*Nitella hookeri*	80	*Lagarosiphon major*	15	*Egeria densa*	5		
7	*Lagarosiphon major*	80	*Nitella hookeri*	20				
8	*Lagarosiphon major*	100						
9	*Lagarosiphon major*	100						
10	*Lagarosiphon major*	100						
11	*Lagarosiphon major*	100						
12	*Polygonum decipiens*	50	*Lagarosiphon major*	50				
	Polygonum decipiens	50	*Carex secta*	49	*Lemna minor*	1		
	Carex secta	100						
	Mud	100						
	Mud	100						

Mostly open site with some willows bordering true right bank

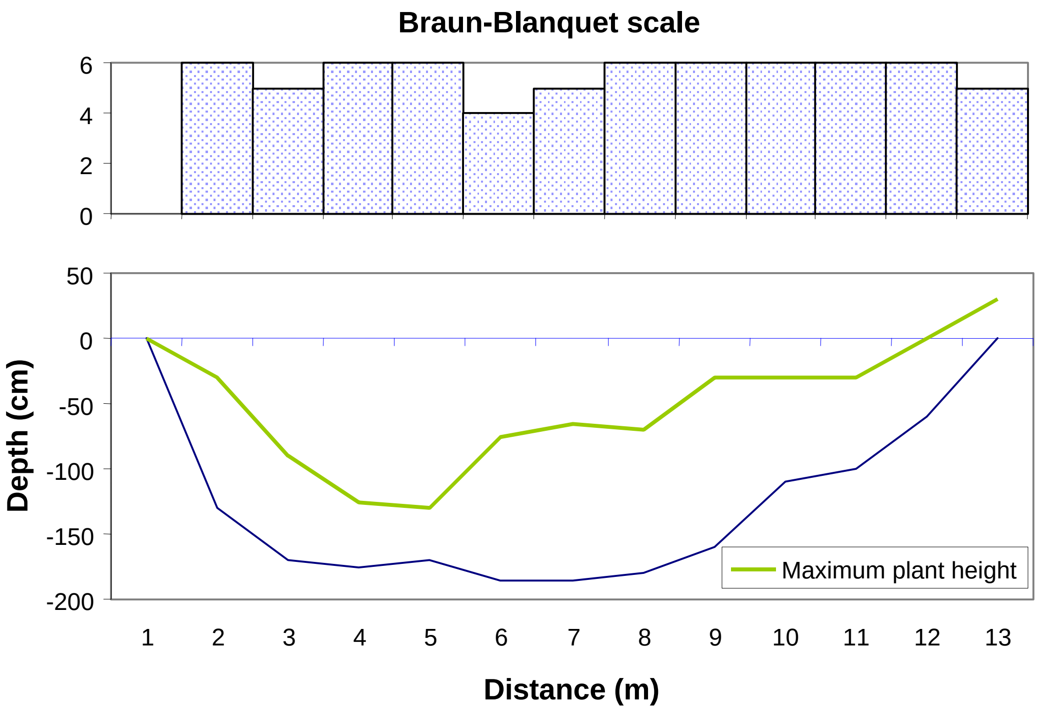




COLLINS BRIDGE (surveyed in October 1999 only)

Distance	Plant	%	Plant	%	Plant	%
0	Mud					
1	*Lagarosiphon major*	50	*Egeria densa*	50		
2	*Egeria densa*	100				
3	*Lagarosiphon major*	80	*Egeria densa*	20		
4	*Lagarosiphon major*	40	*Egeria densa*	60		
5	*Egeria densa*	100				
6	*Egeria densa*	100				
7	*Egeria densa*	100				
8	*Egeria densa*	100				
9	*Egeria densa*	100				
10	*Lagarosiphon major*	70	*Egeria densa*	30		
11	*Lagarosiphon major*	80	*Egeria densa*	15	*Polygonum decipiens*	5
12	*Polygonum decipiens &* terrestrial veg					

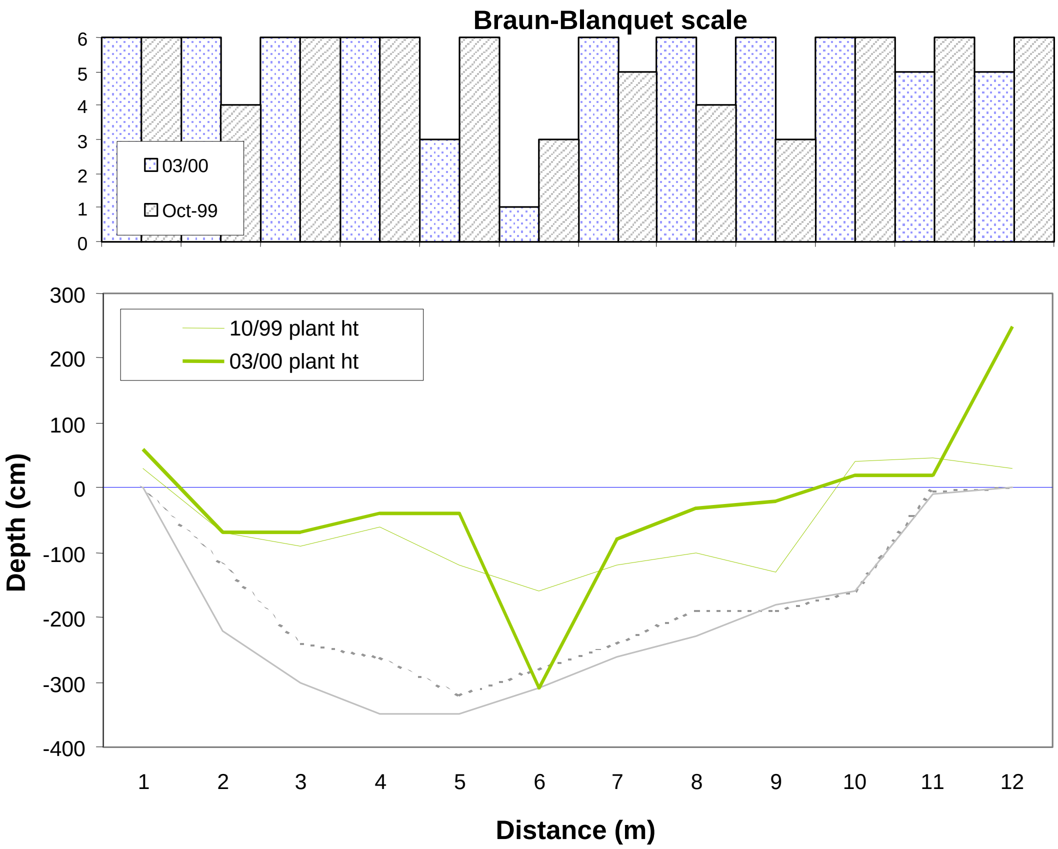
Heavily shaded by willows on south side (true right bank)



FLOODGATES

Distance	Plant	%	Plant	%	Plant	%	Plant	%
0	Terrestrial veg	100						
1	*Lagarosiphon major*	50	*Egeria densa*	50				
2	*Lagarosiphon major*	40	*Egeria densa*	40	*Nitella hookeri*	15	*Nasturtium officinale*	5
3	*Lagarosiphon major*	70	*Egeria densa*	30				
4	*Lagarosiphon major*	90	*Egeria densa*	10				
5	Mud	100						
6	*Egeria densa*	80	*Lagarosiphon major*	20				
7	*Lagarosiphon major*	70	*Egeria densa*	30				
8	*Egeria densa*	50	*Lagarosiphon major*	50				
9	*Nasturtium officinale*	90	*Polygonum decipiens*	5	*Lemna minor*	5		
10	*Polygonum decipiens*	50	Terrestrial veg	50				
11	Terrestrial veg	100						

Evidence of spraying amongst TR bank vegetation



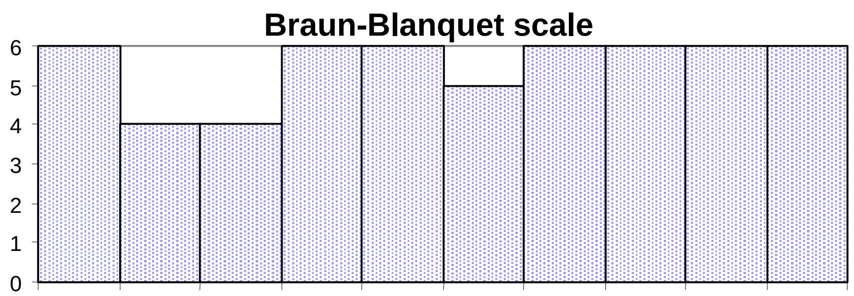
HOLLIS CREEK

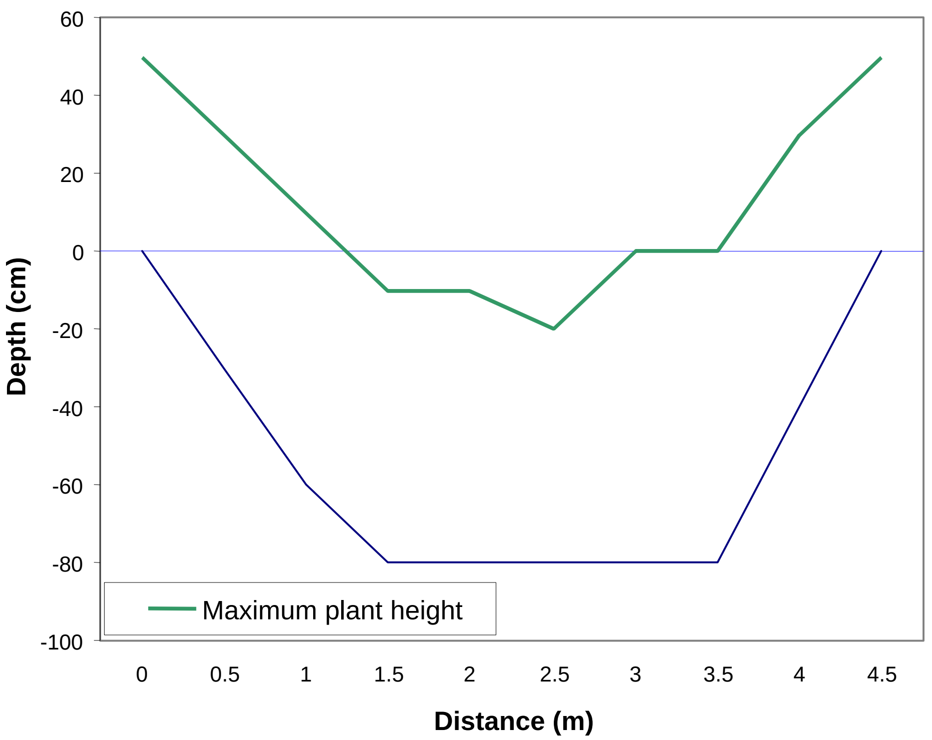
Dist	Plant	%	Plant	%	Plant	%	Plant	%	Plant	%
0	Sedges	100								
0.5	*Polygonum decipiens*	50	*Lagarosiphon major*	25	Sedges	20	*Lemna minor*	5		
1	*Lagarosiphon major*	40	*Polygonum decipiens*	25	*Nasturtium officinale*	20	*Nitella hookeri*	10	*Lemna minor*	5
1.5	*Lagarosiphon major*	50	*Nasturtium officinale*	30	*Nitella hookeri*	20				
2	*Lagarosiphon major*	90	*Nitella hookeri*	10						
2.5	*Lagarosiphon major*	90	*Nitella hookeri*	10						
3	*Lagarosiphon major*	100								
3.5	*Lagarosiphon major*	100								
4	*Lagarosiphon major*	50	*Polygonum decipiens*	40	*Nasturtium officinale*	5	*Lemna minor*	5		
4.5	Terrestrial veg	50	*Polygonum decipiens*	50						

30/03/2000

This site destined to have application of Torpedo in several weeks time.

Previously sprayed 2 years ago. Anecdotal evidence of koura and eels having dissappeared.



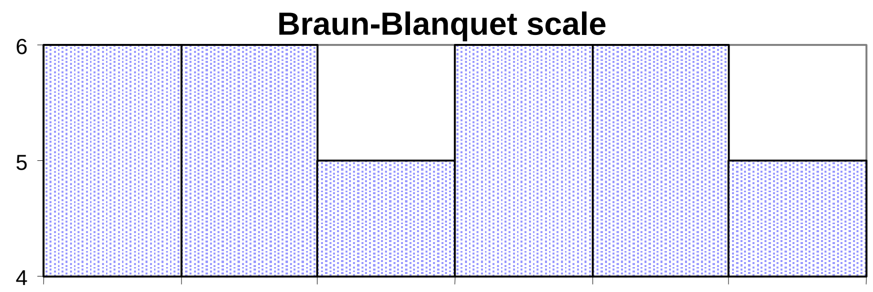


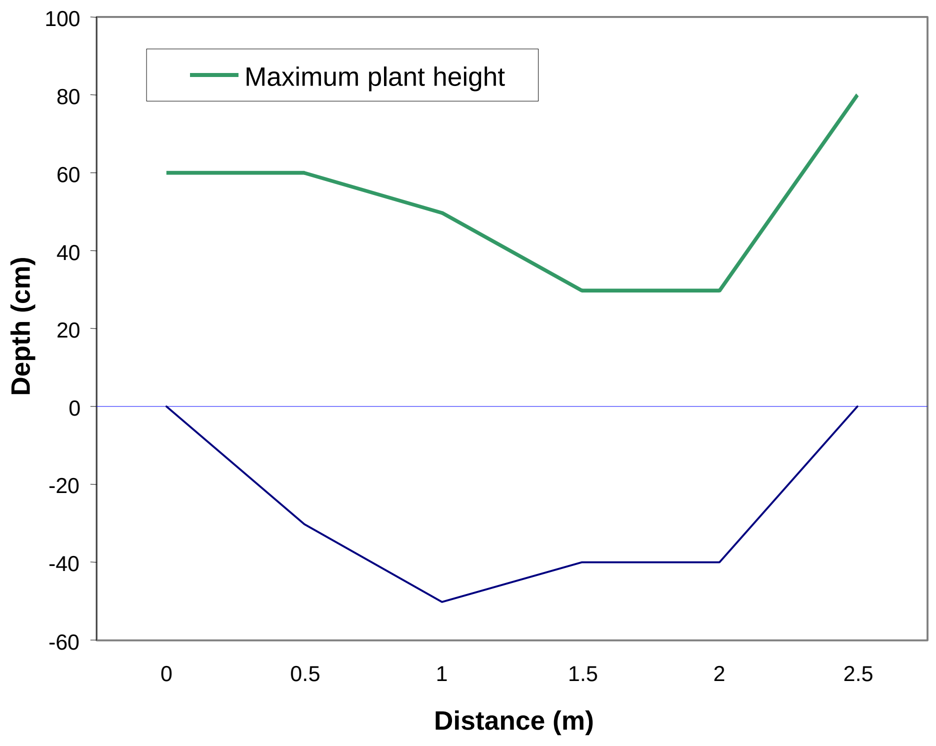
GANES CREEK

Dist	Plant	%	Plant	%	Plant	%	Plant	%
0	*Nasturtium officinale*	90	Terrestrial veg	5	*Lemna minor*	5		
0.5	*Nasturtium officinale*	95	*Lemna minor*	5				
1	*Nasturtium officinale*	95	*Lemna minor*	5				
1.5	*Nasturtium officinale*	70	*Nitella hookeri*	10	*Alisma plantago-aquatica*	10	*Elodea canadensis*	10
2	*Nasturtium officinale*	70	*Nitella hookeri*	10	*Alisma plantago-aquatica*	10	*Elodea canadensis*	10
2.5	*Nasturtium officinale*	70	Terrestrial veg	30				

30-Mar-00

At half fence near house, 50 m upstream of dirt track

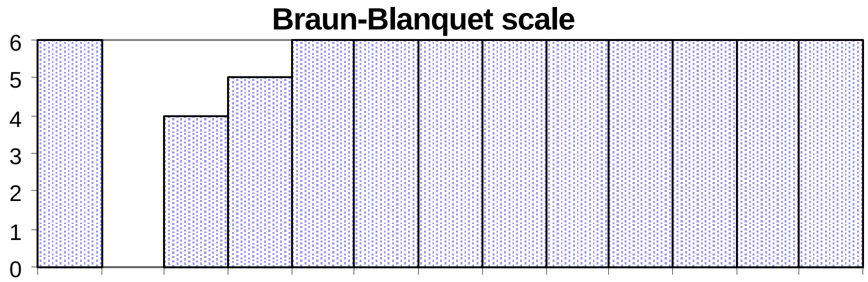


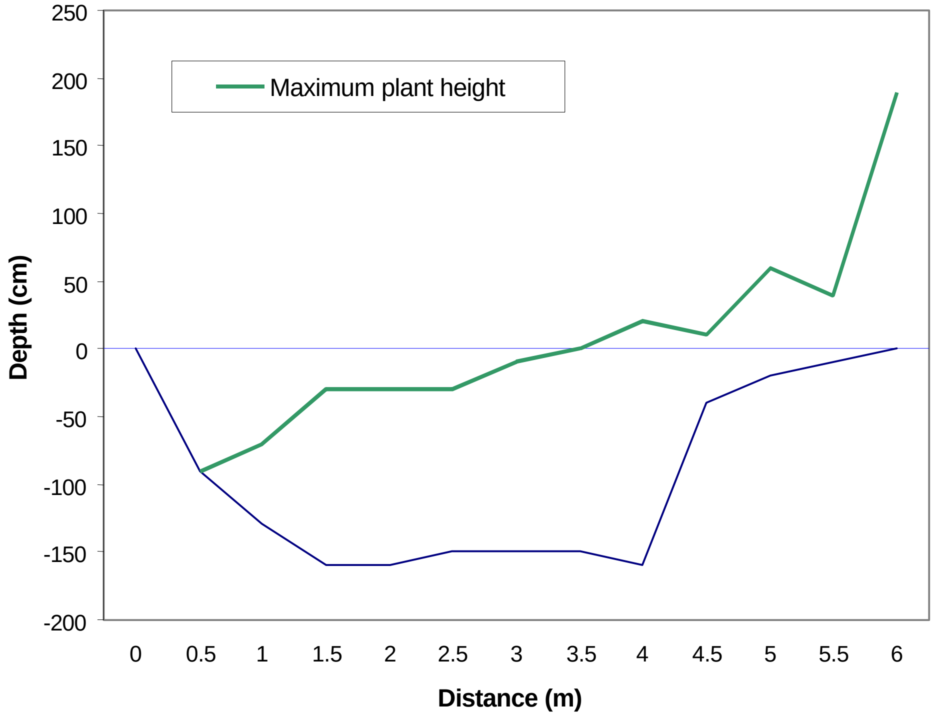


DENTONS CREEK

Dist	Plant	%	Plant	%	Plant	%
0	Terrestrial veg	95	*Lemna minor*	5		
0.5	Mud	100				
1	*Egeria densa*	100				
1.5	*Egeria densa*	100				
2	*Egeria densa*	100				
2.5	*Egeria densa*	100				
3	*Egeria densa*	85	*Lagarosiphon major*	15		
3.5	*Egeria densa*	70	*Lagarosiphon major*	30		
4	*Polygonum decipiens*	70	*Lagarosiphon major*	20	*Egeria densa*	10
4.5	*Polygonum decipiens*	100				
5	*Polygonum decipiens*	50	Detritus	45	*Lemna minor*	5
5.5	*Polygonum decipiens*	60	Detritus	40		
6	*Polygonum decipiens*	50	Terrestrial veg., sedges & rushes	50		

30-Mar-00
Located 1 m downstream from willow and 1 m upstream from temperature logger
Polygonum and terrestrial plants on TR bank recently poisoned



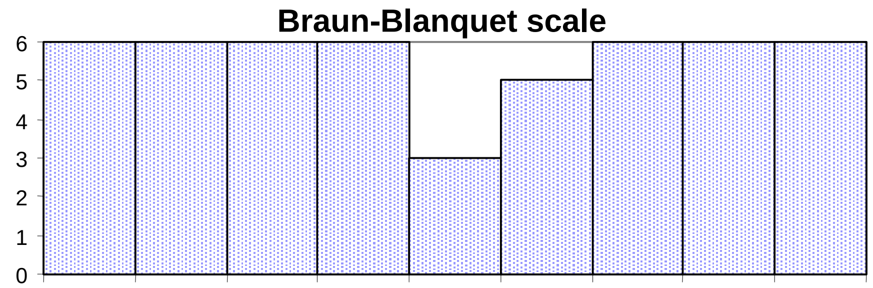


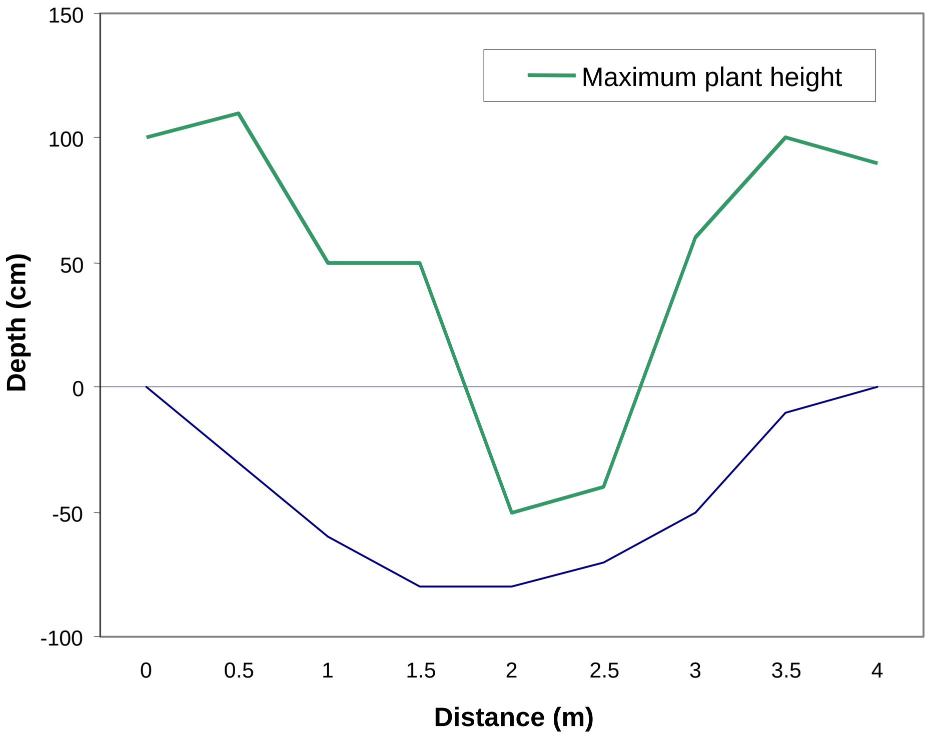
ROSES CREEK

Dist	Plant	%	Plant	%	Plant	%
0	Terrestrial veg	100				
0.5	Terrestrial veg	80	*Polygonum decipiens*	15	*Lemna minor*	5
1	*Polygonum decipiens*	75	Terrestrial veg	20	*Lemna minor*	5
1.5	*Polygonum decipiens*	50	*Nitella hookeri*	50		
2	*Elodea canadensis*	50	*Nitella hookeri*	50		
2.5	*Lagarosiphon major*	50	*Elodea canadensis*	50		
3	*Polygonum decipiens*	95	*Lemna minor*	5		
3.5	*Polygonum decipiens*	95	*Lemna minor*	5		
4	*Polygonum decipiens*	80	Terrestrial veg	20		

30-Mar-00

Located by temperature logger at half fence





Appendix 4

Macroinvertebrates

Appendix 4 Macroinvertebrate kick-net (0.5 mm mesh) samples taken on 20th October 1999.
Abundance categories used were R = 1-4 organisms; C = 5-19; A = 20-99; VA = 100-499; VVA = >500

	Tennis	O'Dwyers	Hollis	Ganes	Rapaura	Dentons	Motor	Roses	Collins	Flood
Taxon	**SPC4**	**SPC3**	**SPC10**	**SPC9**	**SPC2**	**SPC8**	**SPC7**	**SPC6**	**SPC5**	**SPC1**
Mayflies										
Austroclima sepia	R	C	R		R					R
Zephlebia versicolor	R	A	R		R	C	C	R	R	C
Dragonflies										
Xanthocnemis zelandica	C		R	R	R			R	C	
Water bugs										
Microvelia macgregori		R							C	
Sigara sp.	C	C								R
True flies										
Austrosimulium spp.		A		R	R	R	A	R	R	A
Chironomus sp. A					A				R	
Orthocladiinae	A	A	VA	C	A	VVA	A	R	A	A
Paralimnophila skusei				R						
Polypedilum sp.			R		R	R	R			
Tanypodinae	R	R	R	R	R					
Tanytarsus vespertinus					R					
Caddisflies										
Hudsonema aliena		R								
Hudsonema amabilis		C								
Hydrobiosis budgei							R		R	
Hydrobiosis sp.	R						R			R
Oxyethira albiceps	A	C	C			C	C	R	C	A
Paroxyethira hendersoni			R		R		R		R	
Polyplectropus puerilis	R	C	A		C	C	R		C	
Psilochorema nemorale	R	R	C							R
Pycnocentria evecta	C	VA	VA		R		C		C	A
Worms	A	C	VA	VVA	VA	VVA	A	VVA	A	R
Flatworms								R		
Snails										
Ferrissia neozelandica	R							R	R	R
Gyraulus sp.	A									
Physa sp.	A	R		R	R	R			A	R
Potamopyrgus antipodarum	VVA	C	A	VVA		A	A	VA	R	R
Sphaeriidae	A		A	C		R	C	VA		R
Crustaceans										
Amphipoda	VVA	VVA	VVA		VA	VA	VVA	R	VA	VVA
Ostracoda	C	R	A	C	A	C	R	A		
Paranephrops zelandicus					R	R				R
Paratya curvirostris										C
Taxa richness	19	17	16	10	17	13	14	12	16	17
MCI	93	98	93	70	85	75	79	68	79	91
SQMCI	4.29	5.20	4.40	2.51	2.94	1.92	4.66	1.77	4.06	4.81
EPT	7	8	7	0	5	3	7	2	6	6

Appendix 5

Angler opinions and Angling records

Appendix 5 Angler opinions and records from Spring Creek. The first eight pages of this appendix are reports and records from Roger Winter. The remaining material is from Dick Abrams.

9A Totara Place
BLENHEIM

Ph: 03-578 3473
Fax: 03-577 9258
Email: roger@theoldtrout.com
Email: roglizwinter&xtra.co.nz

18 August 2000

Dear Roger

Read your "Spring Creek Study" article in Fish and Game News No. 21 and your request for catch information in that waterway over the last 10 or more years.

I have attached a copy from my diary records commencing 07/10/81 concluding 23/01/92, showing fish I have landed in Spring Creek from the mouth up to Dodson's farm, over that period. NOTE the giant kokopu on 02/11/85. Didn't know what it was at that time so took it home and had Rex Frost identify it, before I released it still alive, in the drain on Alabama Road in Blenheim.

The reason for no entries after 23/01/92 is because that was the time that Wayne King's sub-divisions took place and it was to much of a hassle getting access to that part of the creek which I had been accessing up till then.

This data may be of interest to you.

I have also attached some documents prepared by Dick Abrams who, as you can see from the local newspaper article prepared by Tony Orman, has been coming out from the USA pretty regularly over the years and fishing our local rivers during late January-early March. He has kept a diary (attached) in which he has recorded his catches. He is an expert angler and has fished all over the world. He is coming out again next February. I keep in touch with him during the year.

Regards

Roger Winter

SPRING CREEK-FISH CAUGHT BY R.G.E. WINTER FROM 07/10/81 to 23/01/92

DATE	TIME	WEATHER	FLY	SPECIES/SEX		WEIGHT	LENGTH	C/F	STOMACH
7/10/81	1830	Fine 1/4 moon	Mrs Simpson	Brown	NR	1lb 8oz	NR		Released
17/10/81	1045	Southerly,O/cast	Black/Gold Spin	Brown	NR	1lb 8oz	40cm	38	Caddis
17/10/81	1600	" "	" " "	Brown	NR	1lb 13oz	44cm	36	Cockabulli
9/11/81	2050	Fine 1/4 moon	Mrs Simpson	Brown	NR	2lb 3oz	45cm	38	Released
14/11/81	845	Showers,O/cast	Creedons Creeper	Brown	F	2lb 2oz	46cm	31	Small caddis/mush
22/11/81	2050	Fine	Mrs Simpson	Brown	NR	1lb 10oz	44cm	NR	Empty
25/11/81	1015	Fine	Hare & Copper	Brown	F	5lb 7oz	58cm	45	Koura,eel, brown beetles
27/11/81	2005	Fine	Spinner	Brown	F	1lb 12oz	35cm	NR	Released
29/11/81	1905	Rain	Spinner	Brown	NR	8lb 14oz	71cm	NR	Brown beetles
4/12/81	2020	Fine	Brown Beetle	Brown	M	5lb 6oz	60cm	41	Koura,brown beetles
4/12/81	2110	Fine	Brown Beetle	Brown	F	1lb 10oz	42cm	36	Caddis.mush
1/01/82	2000	Fine 1/4 moon	Brown Beetle	Brown	F	2lb	44cm	38	Caddis,10 beetles
9/01/82	2200	Fine,full moon	Yellow Hairy Dog	Brown	F	3lb 7oz	51cm	42	Caddis,crawler
10/01/82	2140	Fine,full moon	Yellow Hairy Dog	Brown	M	4lb 6oz	56cm	41	Spider,crawler,caddis
11/01/82	1925	Fine,full moon	Small dry	Brown	F	2lb 6oz	45cm	41	Numerous dry flys
1/02/82	2035	Fine,gusty,1/3 moon	#16 dry fly	Brown	F	6lb	59cm	47	1lb of roe, vine hoppers
2/02/82	1930	Fine,gusty,cloudy	#16 dry fly	Brown	NR	1lb 10oz	40cm	40	Released
3/04/82	1800	Fine,breeze	Pheasant Tail	Brown	M	5lb	25 inches	35	Released
2/11/82	2035	Fine,clear	Pheasant Tail	Brown	F	NR	45cm	NR	NR
2/11/82	2100	Fine,clear	Rabbit lure	Brown	M	4lb 6oz	22in	37	NR
7/11/82	2055	Fine,windy	Mrs Simpson	Brown	F	2lb 13oz	20in	33	Released
13/11/82	1525	Fine,sunny	Horned Caddis	Brown	F	2lb 3oz	NR	NR	Drys
13/11/82	1625	" "	Hare & Copper	Brown	F	NR	NR	NR	Released
17/11/82	1935	Fine, windy	Pheasant Tail	Brown	F	NR	44cm	NR	Released
26/11/82	2115	Rain,no wind	Mrs Simpson	Brown	NR	2lb	NR	NR	Released
28/11/82	1930	Windy,full moon	Black Pete	Brown	NR	2lb	NR	NR	Released
10/12/82	1635	Fine	Ginger dry	Brown	M	3lb 8oz	20.5in	NR	Released
23/12/82	2110	Fine	Brown Beetle	Brown	F	1lb 12oz	NR	NR	Released
10/01/83	2140	Fine,warm wind	Creedons Creeper	Brown	F	2lb	NR	NR	Released
30/01/83	2055	Fine	Small dry fly	Brown	F	2lb 4oz	18in	NR	Released
7/03/83	1930	Fine,windy	Spent Spinner	Brown	F	3lb 2oz	20.5in	36	Horned caddis
12/03/83	705	Cloudy,no wind	Spent Spinner	Brown	F	2lb 8oz	NR	NR	Variety sub & surface flies

26/10/83	1830	Fine,no wind	Ginger dry fly	Brown	F	2lb 2oz	45cm	NR	Homed caddis
30/11/83	1940	Fine, no wind	Mrs Simpson	Brown	M	2lb 6oz	NR	NR	Homed caddis
16/12/83	1950	Fine	Pheasant Tail	Brown	M	3lb 8oz	NR	NR	Brown beetles
20/12/83	2045	Fine	Pheasant Tail	Brown	F	NR	16in	NR	Nymphs
20/12/83	2055	Fine	Mrs Simpson	Brown	M	NR	19in	NR	Willow grubs, nymphs
7/01/84	2200	Fine, new moon	Mrs Simpson	Brown	M	2lb 6oz	19in	NR	Drys
9/01/84	2035	Fine, very windy	Possum	Brown	F	1lb 8oz	NR	NR	Released
28/01/84	2040	Fine, no wind	Mole Fly	Brown	F	2lb 4oz	44cm	NR	Released
28/01/84	2105	" " "	Mole Fly	Brown	M	5lb 8oz	65cm	32	Released
27/02/84	2020	Fine, no wind	Mole Fly	Brown	M	4lb 4oz	NR	NR	Released
7/03/84	1910	Cloudy, 1/4 moon	Mole Fly	Brown	F	1lb 8oz	NR	NR	Released
22/04/84	1705	Fine, no wind	Small dry fly	Brown	M	3lb 8oz	21in	NR	Drys
22/10/84	1515	Sunny, some wind	Creedons Creeper	Brown	F	1lb 4oz	NR	NR	Released
1/11/84	1930	Fine, no wind	NR	Brown	F	1lb 4oz	NR	NR	Released
16/11/84	1945	O/cast,windy	Hare & Copper	Brown	F	1lb 4oz	NR	NR	Released
16/11/84	2020	Heavy rain,wind	Hare & Copper	Brown	F	3lb 2oz	19.5in	NR	Released
17/11/84	1515	Fine,hot,sunny	#8 brown nymph	Brown	M	3lb 12oz	21.5in	NR	Released
20/11/84	2020	Fine,warm	NR	Brown	F	2lb 12oz	NR	NR	Nymphs, no brown beetle
20/11/84	2045	" "	NR	Brown	M	1lb 8oz	NR	NR	Nymphs, no brown beetle
22/11/84	2025	Fine,no wind	Pheasant Tail	Brown	F	1lb 4oz	NR	NR	Released
24/12/84	2025	Fine,new moon	Hare & Copper	Brown	F	2lb 4oz	NR	NR	Nymphs, caddis
28/12/84	2040	O/cast, no wind	Pheasant Tail	Brown	F	3lb 8oz	19"	51	Nymphs, koura
11/01/85	2005	Creek up 2' Clear	Pheasant Tail-Dry	Brown	F	2lb	NR	NR	Dry flies, caddis
11/01/85	2140	" " " "	Pheasant Tail	Brown	F	1lb 8oz	NR	NR	Caddis
12/01/85	2120	Fine, light wind	Spent Spinner	Brown	F	2lb	40cm	50	Small caddis
12/01/85	2130	" " "	Spent Spinner	Brown	M	4lb 2oz	NR	NR	Koura,shrimp, willowgrub,bb
26/01/85	2135	Cloudy, new moon	Yellow Rabbit lure	Brown	M	4lb	22"	37	Nil
26/01/85	2155	" " "	Yellow Rabbit lure	Brown	F	2lb 12oz	18"	NR	Homed caddis
10/02/85	2110	Fine,cloudy,wind	Hare & Copper	Brown	M	2lb 12oz	17"	45	Caddis, small nymphs
12/02/85	2120	Fine,cloudy,no wind	Brown Rabbit lure	Brown	M	4lb 8oz	21"	46	Slime,weed,caddis
15/02/85	2110	Fine,no wind	Yellow Rabbit lure	Brown	H	2lb 12oz	21"	29	Few nymphs
13/10/85	1900	Fine, no wind	Ginger hackle dry	Brown	M	1lb 4oz	NR	NR	Released
2/11/85	2045	Fine, breezy	#6 Green Hairy Dog	GIANTKOKOPU			9"	NR	
23/03/86	2045	Full moon,fine	Yellow Rabbit lure	Brown	M	4lb	53cm	43	NR
5/10/86	1500	Showers,no wind	Shrimp	Brown	F	1lb 4oz	NR	NR	Released
27/01/87	1025	O/cast, windy	Tube Fly	Brown	F	3lb 12oz	NR	NR	Homed caddis

13/02/87	1300	Fine, breezy	Possum & Copper	Brown	F	2lb 8oz	NR	NR	Wil grub, small grubs
25/10/87	2200	Fine, no wind	Pig hair lure	Brown	M	5lb	NR	NR	Released
12/12/87	2225	O/cast, no wind	Black lure	Brown	F	2lb	NR	NR	1 cockabulli,beetles
12/12/87	30	" " "	Black lure	Brown	F	3lb 12oz	20.5"	NR	30 shrimps
30/12/87	2020	O/cast, breezy	Possum & Copper	Brown	F	2lb	NR	NR	Released
30/12/87	2220	" "	Pig hair lure	Brown	F	2lb 8oz	NR	NR	Nil (Sea run)
7/11/88	2345	Fine, no wind,clear	Red Hairy Dog	Brown	F	2lb 8oz	NR	NR	9 shrimps
8/11/88	2240	Fine	Green Hairy Dog	Brown	F	2lb 12oz	NR	NR	Numerous nymphs/shrimps
27/11/88	2300	Fine	Tube Fly	Brown	F	3lb 4oz	NR	NR	Shrimps
27/11/88	2330	"	Tube Fly	Brown	M	1lb 8oz	NR	NR	Released
30/11/87	2145	Fine,cloudy,no wind	Tube Fly	Brown	F	1lb 12oz	NR	NR	Few brown beetle
3/11/88	2210	Full cloud,no wind	Tube Fly	Brown	F	4lb 4oz	NR	NR	Released
28/12/88	2225	Cloud, no wind	Tube Fly	Brown	M	2lb 12oz	NR	NR	Released
28/12/88	2240	" " "	Tube Fly	Brown	M	3lb 12oz	NR	NR	Koura
18/01/89	2330	Fine,o/cast,no wind	Tube Fly	Brown	M	5lb 8oz	NR	NR	Released
25/03/89	2040	Full moon, cloudy	Tube Fly	Brown	M	5lb 8 oz	NR	NR	Released
7/04/89	2105	Clear sky, windy	Tube Fly	Brown	F	5lb	55cm	48	Empty
17/11/89	2120	Moon, clear	Coch-y-bondhu	Brown	F	3lb 12oz	NR	NR	Released
17/11/89	2320	" "	Tube Fly	Brown	F	4lb	NR	NR	Shrimps, koura
18/11/89	15	" "	Green Hairy Dog	Brown	M	2lb 4oz	NR	NR	Released
14/03/90	2040	O/cast, no wind	Tube Fly	Brown	F	2lb	NR	NR	Released
7/10/90	2145	Cloudy	Tube Fly	Brown	M	3lb	NR	NR	Shrimps
8/10/90	2030	Cloudy	Tube Fly	Brown	M	2lb	NR	NR	Shrimps
24/10/90	2110	1/4 moon,o/cast	Tube Fly	Brown	M	4lb 8oz	NR	NR	Koura
26/01/91	2440	1/2 moon, no wind	Red Hairy Dog	Brown	M	2lb	NR	NR	Released
12/12/91	1145	Sun. No wind	Possum & Copper	Brown	M	3lb4oz	NR	NR	Few nymphs
3/03/91	2130	Cloudy, no wind	Red Hairy Dog	Brown	F	2lb	NR	NR	Empty
3/03/91	2300	" " "	Red Hairy Dog	Brown	F	3lb 12oz	NR	NR	Shrimps
4/12/91	2150	No wind, clear sky	Big ugly lure	Brown	M	4lb 8oz	NR	NR	2 shrimps, small sticks
23/01/92	2130	3/4 moon	Tube Fly	Brown	M	3lb 8 oz	NR	NR	Few nymphs

SPRING CREEK

AN OVER VIEW FROM AN EXPERIENCED ANGLER

1984
The first occasion that I met Spring Creek was with Jock Tod (ex Marlborough Acclimatisation Society Councillor) and the memory is still with me. We fished in the afternoon from State Highway 1 up the true left bank (TLB) in to A Campbells property. The stream was clear and you could see the bottom in all pools even the very deeps still ones. I did not catch a fish neither did Jock but the impression of good numbers of large fish (4lbs plus) remains.

1985
I shifted out to live in Spring Creek, one of the factors influencing the shift was Spring Creek fishing. My main area of fishing was the TLB from Hillocks Rd to State Highway 1 and the TRB from State Highway 1 tot he confluence of the Wairau. I did most of my fishing from behind the camping ground to A Campbell's boundary as this was all owned by one person. The stream edge was grazed by sheep mainly and then not over grazed, enough to keep the weeds down. You could see the bottom in most places on an average day i.e. sunshine, partly cloudy, light breeze. There was no apparent bloom in the water. Fish were apparent everywhere mostly feeding on nymphs in the daytime but it was not unusual to get a rise for mayflies etc. At times you would have 6 or more fish rising regularly in a 50m stretch. Stomach contents of fish were not examined in detail but large numbers of horned caddis were typical. At times of the year the adult vinehopper moths would be the only food apparently taken.

1989
I began night fishing as a change to daylight and as I had less opportunity to fish during the day. There seemed to be fish everywhere some nights you could hear them splashing all over the place taking moths, shrimps and koura. Invariably if you kept a large fish the stomach would contain 1 or 2 koura some of quite large proportion say 100mm body length. Some nights there were thousands of shrimps in the water - you would see in the torch-light shoals of them that would go about a foot out from the edge and as far as you could see up and down the creek form where you were standing.
Day time fishing was still good clarity okay.

1995
The Creek water clarity at times is abysmal. For example November 1995 I took an American fishing in the Creek. We started at the Wairau confluence and fished up the TRB to State Highway 1 in the morning. Any fish at a depth of a metre or more was very hard to see, the overhead conditions were bright and there was no wind. We caught 3 fish between us which was good, size around 2 to 3lb. Several fish were rising but it was almost impossible to see those fish unless they were over a light bottom.
In the afternoon we fished from A Campbell's boundary up to the camping ground on the

TLB. The water looked as though milk had been poured in it and had a bloom to it. The visibility was poor so that fish spotting was not an option.

There seems to be other changes too. Very rare to spot a flounder in the Creek now, these were pretty common (say 2 a day) in the earlier years. At night time the fish are not splashing around. During this last season it was rare to hear a fish. The two I kept from right fishing one was empty the other had a small koura. The shoals of shrimps have gone, shrimps are still there but only in small groups of a dozen or so. Koura still seem plentiful as they are easy to find in the torch-light. There is little activity of rising fish during daylight hours in comparison to what was happening 10 years ago.

General Conclusions.

1. The large fish numbers are down - when you fish the Creek you don't look for one pounder's
2. The clarity of the water has diminished especially in the last 3 or 4 years. Clarity of the water is the special attraction of the Creek allowing spotting of large fish and the opportunity to catch them.
3. There has been a change in the make up of the fauna of the Creek which has resulted in the feeling pattern of trout changing.
4. Access is more difficult as there are more landowners to ask.

CHANGES TO THE CREEK

Since I began fishing in the Creek there have been some significant changes.

1. The introduction of the Salmon hatchery which on the surface may seem to be a benign operation. It is significant that the water clarity has deteriorated so much in the last 12 years.
2. The camping ground owners have renewed all the grasses on the Creeks edge by spraying. This is an esplanade reserve and that practice must be illegal.
3. The dairy farm that took up most of the land from O'Dwyers Rd to the hatchery house has been subdivided and now is mostly in grapes or intensive cropping with the paddocks worked up within a metre of the Creek edge.
4. Urban housing on the edge of the Creek. A typical example is on the TRB immediately downstream from Hillocks Rd corner. What used to be paddocks with a line of poplars along the edge of the Creek is now in the main mown grass, concrete, houses, garages with subsequent run off. With the increasing subdivision and no marginal reserves land owners tend to develop to the edge of the Creek and landscape it accordingly. Stormwater from roofs and driveways is channelled directly into the Creek.
5. More grazing to the edge by heavy animals, cattle, especially on the TLB from the camping ground to A Campbell's boundary and on the area owned by the MDC.
6. Willow growth.

   1983: I believe the Creek edges were cleared of willow along the MDC (old Catchment Board) lease hold land on the TLB from State Highway 1 upstream to Fern's Creek. In 1994/95 a lot of willow was removed from the camping ground downstream on the TLB.

   However rampant willow growth interferes with the following water course and sets up dams which change the flow of the main stem of the Creek. In places large willows are right in the Creek and the growth goes right across this has changed the water levels in several places.
7. Weed growth.

   This is hard to quantify but one pool in particular some 100 metres upstream of SH1 is a lot narrower than it was in 1984. It was almost impossible to cast right across this pool with a fly line - now it is easy. Large clumps of weed used to be regularly flowing down the Creek apparently broken off by the currents this doesn't happen as much now. What does break off gets caught in the willow coffer dams.
8. Creek tributaries.

   The urban sprawl has had effect on the side streams with some of them denuded of side growth by people intent on tidying up their backyards.
9. Channel structure.

   Kids used to float canoe or tube from the camping ground to SHWY 1 via a clear channel. You cannot do it now

ID	DATE	SEX	WEIGHT LB
1	8.10.89	BH	5.0
2	18.10.89	BJ	2.25
3	29.10.89	BH	2.5
4	30.10.89	BH	3
5	30.10.89	BJ	5.5
6	6.1.90	BH	2
7	6.1.90	BJ	6
8	11.1.90	B?	1.5
9	12.1.90	B	1
10	12.1.90	B	1.5
11	12.1.90	B	2
12	8.3.90	B	1
13	9.3.90	B	1.5
14	9.3.90	B	2.75
15	9.3.90	J	2
16	9.3.90	H	2
17	9.3.90	J	3.5
18	11.3.90	BJ	4
19	11.3.90	BJ	4
20	11.3.90	B?	1.5
21	16.3.90	BJ	2.5
22	18.3.90	BH	2.25
23	29.3.90	B?	2
24	29.3.90	BH	4
25			

ID	DATE	SEX	WEIGHT LB
1	10.11.91	BH	2
2	10.11.91	BJ	3.5
3	26.1.92	BJ	7.25
4	26.1.92	BH	6
5	30.1.92	BJ	3
6	31.1.92	BH	2
7	25.2.92	BH	3
8	25.2.92	BJ	4
9	30.3.92	BJ	7.25
10	11.4.92	BJ	2.5
11	11.4.92	B?	1.5
12	11.4.92	B?	1
13			

ID	DATE	SEX	WEIGHT LB
1	20.10.92	B?	0.5
2	20.10.92	BH	1.5
3	1.11.92	BH	4
4	8.1.93	B?	1
5	8.1.93	BH	2
6	26.4.93	BH	4
7			

Save the Spring Creek trout, urges US angler

by Tony Orman

Trout fishing in Marlborough's renowned Spring Creek is declining says an overseas angler.

Dick Abrams, a professor of psychiatry at Chicago Medical School, USA, and an avid trout angler, has visited Marlborough for 11 of the past 12 summers, primarily because of the quality of Spring Creek's trout fishing. However, in recent seasons, the creek's fishing had declined, he said.

"Trout fishing in Spring Creek has deteriorated significantly over the past six years," said Dr Abrams.

He said he had kept details of his fishing days over the dozen years, recording the size of every trout caught before releasing it, using a tape measure and a scale with calibrated accuracy of plus or minus one ounce.

This year, Dr Abrams fished a favourite section of Spring Creek where he had caught some of his largest trout. He carefully inspected every single piece of likely water and saw no trout. Puzzled he examined his records of earlier years and found that several years ago he had caught numerous trout in that section up to 3kg, but since 1993 had caught none.

Dr Abrams said he noticed a well-worn streamside path running beside the creek. In conversation with a farmer, he learnt local anglers were fishing the creek at night, using a bully lure, carved from bone and festooned with treble hooks.

Dr Dick Abrams . . . concerned about Marlborough's classic Spring Creek.

"Using a stout baitcasting or spinning rod and line, this lure is dragged across large pools at night in order to arouse the largest of trout into striking," Dr Abrams said.

It was virtually impossible to lose such a fish once hooked on stout tackle, and all fish so caught were killed.

"The killing is the sole point of bully fishing. This is meat fishing, plain and simple, and can in no way be considered sport," Dr Abrams.

He said discussion in recent years at district council and landowner level focused on beautification of the area, stream access, flood control and water quality but never on the need to fund research to ascertain the causes of the serious and progressive decline in Spring Creek's trout population.

While there was a need for research, there were several steps that should be taken to save and restore the trout fishing in Spring Creek, Dr Abrams said.

These included:

* Banning night fishing. "This is the equivalent to banning use of the bully lure and other treble-hooked casting plugs, because any self-respecting trout would laugh himself silly at seeing such a contraption in broad daylight."

* Introduce fly fishing only sections requiring use of a fly, fly rod and fly reel.

"Spinning with a water-filled plastic bubble and a fly attached should clearly not be considered to be fly fishing."

* Introduce "fishing for fun" sections by catch-and-release stretches, "or better still, designate all of Spring Creek catch-and-release. There are more than enough rivers nearby for bait and spin fishermen."

Dr Abrams said the introduction of no-kill rules on several top US trout rivers had restored fishing to a standard not seen since the early part of the 20th century.

* Commercial eeling should be strictly controlled in Spring Creek.

"Although some believe eeling improved trout fishing by removing a potential source of trout predation, the fact is during Spring Creek's heyday 25 to 50 years ago, when trout were in the 5lb to 20lb class and often caught, eels, and very large ones, were abundant, far more so than they are today, when trout populations are low and large trout few and far between."

Dr Abrams said some might see his suggestions as draconian in an egalitarian society such as New Zealand's, but in the case of Spring Creek there was a considerable economic benefit from maintaining such a top trout stream at its highest standard.

He said visiting overseas tourists such as himself, brought tourist revenue into the region in fishing any world-class river. He had stayed on his visits to Marlborough for about 30 days each time, spending on domestic airfares, motel, car rental, supermarket, restaurant, food, petrol, fishing tackle and fishing licence.

"I'm only one fisherman. Multiply that by the numbers who as I do, visit Blenheim, mainly to fish Spring Creek and nearby waters and the economic value of the resource becomes apparent and well worth maintaining and enhancing to restore its former quality," Dr Abrams said.

As an example, because of the noticeable decline in Spring Creek's trout fishing, he did not return to New Zealand and Marlborough last year, and instead fished in Argentina, where he enjoyed good fishing.

However, this season on returning, he did notice a slight improvement in Spring Creek's trout fishing. Dr Abrams said it might be coincidence, but a possible factor was the temporary closure of the Spring Creek salmon hatchery at Rapaura. Although the hatchery had a clean bill of health following water tests, a possible factor could be that odours from the hatchery discernible only to trout could inhibit trout entering and ascending Spring Creek from the lower Wairau River.

"The Wairau is probably where most larger Spring Creek trout come from. Salmonids such as trout have a uniquely keen sense of smell, keen enough to detect odours in the concentration of one part per tens or hundreds of millions," Dr Abrams said.

This sensitive sense of smell enabled fish such as salmon to travel vast distances across the ocean from feeding grounds to the headwaters of rivers of their birth.

Dr Abrams said he had no evidence of the effects one way or the other, of a fish hatchery on Spring Creek.

"It is a pure hunch or gut feeling, and I don't know how to test it but I think it's a possibility worth considering," he said.

Dr Abrams said much public discussion had centred on creating streamside esplanade reserves under the Resource Management Act. It was doubtful if creating such esplanades would have a beneficial effect on the trout fishery.

"The opposite result seems to me more likely to occur with further reduction in trout populations due to easier streamside access and the resultant increased fishing pressure," he said.

"Esplanade reserves were not essential for trout angling access, as most New Zealand landowners were agreeable to any request for permission to fish on their land."

Dr Abrams said he had returned to Marlborough this summer after going to Argentina last year, because of fond memories of Blenheim, it's people and the very good friends he had made on previous visits.

Yes, this summer he caught a very good Marlborough brown trout on a dry fly. It was more than 4kg (9lb) and was carefully released.

And he didn't catch it in Spring Creek, where 10 years ago he might have!

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SPRING CREEK: Catch records 1985-1995 prepared by R. Abrams

When comparing this catch record with others, remember that these are actual recorded measurements, not estimations. Each fish was measured by tape-measure and weighed with an 8-lb. Salter balance (16 gradations to the pound), calibrated annually against known weights. All fish caught on #14-16 barbless flies and released unharmed.

Almost every part of Spring Creek is represented, from its mouth at the Wairau to Stump Creek Road. In addition to Spring Creek, I regularly spent a number of days each trip fishing several other local rivers, and there were often several days each trip made unfishable by bad weather. This accounts for most of the gaps in the record, although in recent years I have fished Spring Creek relatively less and less as the number and size of the fish have declined..

From 1985 through 1990 my trips lasted 4 weeks each; from 1991 onwards, only 2 weeks each.

Beginning in 1991 the numbers of fish I saw began to drop steadily, with lies that were always occupied in past years remaining empty throughout my stay. By 1994, whole sections of the creek that used to regularly hold numbers of large fish now appeared virtually fishless except for the occasional 12-15 incher. The Campbell property is a good example: where once a walk from their bridge to the beginning of Dodson's property would routinely reveal at least 5-7 good fish in the 2.5 to 4 lb. class, last year and this year I saw none. Considering the record of past years, it is really remarkable that last year I only caught a total of 2 fish in Spring Creek.

Now, in 1995, a sharp drop has occurred in the average fish size, with a 20% reduction in length and a corresponding 50% reduction in weight. The number of fish seems to have increased, although this may just be a function of the fact that I'm now forced to seek out and actively fish for much smaller fish than I would have bothered with in the past (during the 1980s I would never have even cast to most of the 15" fish that I'm glad to catch now).

I have also noticed the almost complete absence of leaf-hoppers (sometimes erroneously called "lace-wing moths") along the banks of Spring Creek--in earlier years these appeared in profusion and constituted a major food source for the trout. There was a time when a leaf-hopper imitation could always be counted on to take a surface-feeding trout, but this has not been the case for several years now. The deleatidium mayfly (#16, mahogany-colored) that used to hatch around 9-11AM also seems to have virtually disappeared

TABLE- The dates are given American style (month-year). The three parenthetical numbers at the bottom of each column represent (1) the total number of fish caught that trip, (2) their mean length, and (3) their mean weight in pounds.

1985

	in.	lb-oz
3-2	10	2-14
3-16	18	2-14
	20	3-3
	19.5	2-10
3-18	18	2-5
	17	2-3

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1985		
	21	3-0
3-20	18	2-5
	17	2-6
	21	3-4
3-21	19.5	3-0
3-23	18	2-8
3-24	20	3-8
3-25	19	3-3
	23.5	3-10
3-26	22	4-4
(16)	(19.3)	(2.7)
1986		
2-18	18.5	2-2
2-22	22.5	4-12
2-24	19	2-12
2-26	19	2-11
	22	3-10
2-27	22	4-0
	18.5	2-10
2-28	18	2-3
3-1	20	3-0
3-4	18	2-2
	17	1-14
	21	3-11
3-7	19	2-14
3-8	21.5	4-7
3-9	20	2-13
3-10	21	3-9
3-11	23	5-4
3-12	26.5	4-10
3-14	19.5	2-12
(19)	(20.3)	(3.0)
1987		
2-17	16	1-8
	18	2-6
2-19	18	2-12
	23	5-9
2-20	18	2-4
	20	3-7
	23	5-9
2-21	22	4-12
2-22	19	2-14
3-1	22	4-8
	22	5-0
	22	4-8
3-5	19.5	2-9
	21	3-8
	19.5	2-4
3-6	18.5	2-6
3-7	19	2-8
	19	2-14
	23	4-2
	20.5	3-3
3-8	23	4-2
	19.5	3-3
3-11	25	6-8
3-15	18	2-9
	25	5-6

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(25)	(20.5)	(3.5)
1988		
2-19	21	3-8
	17	1-11
	18	2-0
	19	2-8
2-24	19.5	2-3 (slab)
2-26	17	2-5
	16	1-10
2-28	16	1-11
	16	1-11
3-2	24	4-13
	17.5	2-8
3-3	22	3-14
3-4	22	4-2
	17.5	2-1
3-5	22	3-14
	19.5	3-5
3-6	24	4-12
	18	2-1
3-8	18	2-6
3-11	21	3-8
3-12	23	5-15
3-13	18	2-7
	18	2-10
3-14	21	3-9
(24)	(19.4)	(2.7)
1989		
2-18	18	2-4
	18	2-4
2-20	19	2-4
	19	2-7
	19	2-7
2-21	17	1-12
	19.5	2-6
	19.5	2-5
	18	2-4
	19	2-12
2-23	22.5	4-1
	19	2-11
	20	2-11
	19	1-13 (slab)
	19	2-10
	18	2-2
2-27	19	2-6
2-28	22	4-2
3-2	17.5	2-4
	22.5	4-2
	21.5	3-12
3-4	24	4-12
3-6	19.5	2-14
3-11	23	4-10
3-12	24	5-1
3-13	19	2-12
3-14	21	3-4
(27)	(19.9)	(2.8)
~~1990~~		

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1990		
2-22	18.5	2-12
2-24	18.5	2-8
2-25	18	2-2
	16	1-11
	21	2-15
	24	4-14
	17.5	2-3
	22	3-13
2-27	22.5	5-5
	22	4-8
2-28	24	5-1
	17	2-3
	21	3-6
	20	2-8
	23	4-12
3-2	24	4-7
3-3	24	5-1
	18	2-9
	20	2-11
3-5	18.5	2-8
3-7	19	3-0
3-8	18	2-2
3-10	24	5-2
	17	2-2
3-15	19.5	2-14
3-16	23	4-15
	21	3-4
	17	2-0
	23	5-3
(29)	(20.4)	(3.3)
1991		
3-4	17	1-12
3-11	21	3-0
	21.5	3-8
	20	3-0
3-12	21	3-6
	22	4-6
(6)	(20.4)	(2.8)
1992		
2-27	17.5	1-14
3-2	22	4-0
3-4	21.5	3-15
3-5	21.5	3-15
	20	2-11
3-9	21	3-10
3-10	18	1-12
(7)	(20.2)	(2.8)
1993		
2-25	22	2-13
2-28	22	3-11
	18	2-1
3-1	22	4-2
(4)	(21)	(2.2)
1994		
2-26	20	2-14
3-5	20	2-14 (cnk)

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~~[illegible]~~		
1995		
2-25	17	1-14
	16.5	1-9
2-26	20.5	2-6 (slab)
	15	1-4
	15.5	1-6
	15.5	1-7
	14	1-1
	15	1-3
3-2	16.5	1-12
	18.5	2-5
	15.5	1-7
(11)	(16.3)	(1.4)

2001

23.5"	4 3/4 lb
18"	2 1/4 lb
19.5"	2 3/4 lb
20"	2 3/4 lb
18"	2 1/4 lb
19"	3 1/4 lb
20"	3 1/4 lb
17"	2 lb
20"	3 lb
25"	6 1/2 lb
18"	2 3/4 lb
20"	2 1/2 lb
24"	5 1/4 lb
19"	2 1/2 lb
18"	2 lb
19.5"	3 lb
22"	4 1/4 lb
19.5"	3 1/4 lb
20"	3 lb

Comments on angling in Spring Creek during 2001 – Dick Abrams

The mean size of 20" (50.8 cm) and 3.2 lb (1.44 kg) remain similar to the years 1985-1990, and substantially better than the years 1991-1998. The total fishing effort for 2001 was 17 days at about 3 hrs/day, or 51 hours. Of course, I hooked about 25% more fish that escaped, and fished over another 25% that just weren't interested. This adds up to pretty good fishing, in my view. I covered almost all of the Creek from the weir to just below the site of the old salmon hatchery. One area in particular, which has essentially not held any fish since being overdeveloped some years ago, provided more fish than any other section--this was extremely gratifying to me as it was once prime trout water. Another favorite area that appeared fishless 2 years ago, provided the next largest number of trout.

I have heard the comment that the apparent increase in trout numbers compared to, say, 2 years ago simply represents trout coming up from the Wairau to escape the warm, low water. Well, the Wairau was almost as warm and low 2 years ago, but trout were extremely scarce in the Creek, to the extent that I did not return last year for fear of a repeat disaster.

Not included in the list--unfortunately--is the big one that got away--worth mentioning nevertheless because my estimate of his size should be reasonably valid as I actually had him in my net, partly lifted out of the water, before he flipped out while I was struggling with him. He was certainly not less than 8 lb and probably closer to 9. I have only caught one larger trout in Spring Creek.

I noticed a definite improvement in water quality this year compared with the past few years, the single exception being one day in which a milky sediment partially obscured things. I fish only to trout that I can see (or see evidence of), and it was much easier to see them this year than several years ago. The real difference, though, is that they were there this year, compared, say, to 2 years ago where during several days in a row, up and down the creek, I saw no sign of fish.

Appendix 6

Impressions of Roses Creek

Appendix 6 Impressions of Roses Creek from a long-term local resident - Mr Edgar Wratt

Rose's Creek. 19-6-2000.

Where is it? Rose's Creek with water begins on Farm No. 88, Selmes Road. The first permanent artesan water is a small flow from the irrigation well in the middle of the farm. However, the Back Paddock behind the House at No. 130 drains in a south-easterly direction into Rose's Creek about half a mile away. Part of the way is via a drain of covered oil drums.

What has Rose's Creek necessarily got to do with the health of the Spring Creek stream? The answer is nothing except in time of flood. It will never be anything more than a Swamp because of its small amount of fall.

Originally, Rose's Creek did not open into the Spring Creek stream. The Catchment Board when it used to operate from the County Sheds, Rapaura, deepened the access when it first took over the cleaning of the Swamps. Previously, the overflow entered the Spring Creek stream only in time of flood. I can remember the dirty seepage pond between Ian Woolley and Morrison's farms as long ago as 1935. Morrison's farm is basically the beginning of a sandhill which spreads out just below there and, hence, the draining by seepage. Is it practical still to have a grassed spillway for its entry to the Spring Creek stream?

The fall of the northern part of the

2

lower Wairau Plain is towards the Bluff and, hence, so is that of all the Swamps. The Spring Creek stream itself intercepts these Swamps. It could quite well follow an earthquake fault line.

The elevation of the House at No. 130, Selmes Road, is 43 feet above sea level. This is 516 inches. No. 130 is roughly 10 miles from the sea. This is 800 chains at 80 chains to the mile. So, the fall is only $\frac{516}{800}$ or $\frac{5}{8}$ inch per chain. By comparison the Canterbury Plains have a fall to the sea of 2 inches per chain over 40 miles. Thus, Rose's Creek is a Swamper. The other present-day creeks are end results too.

The first piece of the ditch (Creek) at the bottom end of Rose's Creek in No. 88 was dug by Sam Adams in about 1911 by hand when Charles Tombs, my grandfather, used to own the property. My father and, later myself have cleaned this piece of Rose's Creek by hand many times before the Catchment Board took over the maintenance with heavy machinery and spraying. We had to begin about 200 yards below the boundary fence to get enough fall through the raupo, blackberry and water.

Later, my father insisted that the ditch was not widened but only deepened by the heavy machinery. Now, the sheep do not try to drink out of the ditch and so get drowned but have a water trough which fills from a windmill and tank via 200 mm. black polythene piping at no cost.

The Catchment Board firstly cleared the willows, flax and honeysuckle from one side of the ditch to allow access by their ditching machine. It was a big job to cut the firewood out of the willow trees towed out into the paddock and then to burn the trimmings and other rubbish afterwards.

Then the Council changed to employing contractors to do the work. I can remember Holly, Brownie MacDonald and Simcox. Holly deepened the ditch. He struck big native timber buried in the swamp beneath. Some of it across the ditch is still making a waterfall. In two other places there are big vertical stumps 30 inches across that are now visible.

Since then the plant growth has been sprayed annually with weedkillers which have either poisonned the creek's fauna or starved them to death. The freshwater crayfish, frogs and eels have disappeared. This is the state now.

In the first place, the purpose of the willow trees planted along Roses Swamp was for firewood. Volunteer willow trees from trimmings soon thickened up the stands of them. The old cut stumps eventually die from silver blight decay.

4

Willows are farmed for firewood but only on one side of the ditch otherwise the roots soon block the ditch from side to side and no machine can handle them. The House at No. 130 is still equipped with a wood range (a Centennial Orion) which is used in winter time for heating the otherwise electric hotwater cylinder. The electric water heating is turned off and power to the Nightstor heater for the house is turned on at no extra cost.

Flax is the best shelter from wind for livestock along the Swamp bordering the ditch (Creek). Misplaced bushes can be pushed to one side with the tractor and shovel. Ditching machines handle flax and blackberry well and the cleanings can be loaded on to a truck at the same time

Great expense and amount of work has gone into improving the drainage of surrounding farms by deepening Rose's Creek. However, there has been a considerable increase in the current of any water, that may drain down it, and the transfer of soil in flood time after heavy rain. This has always gone on but now it goes further faster.

Recently, the erosion of good soil by run off of water in flooding, otherwise dry, ditches has been partly offset by the subsoiler.

5

Local farmers have found that the subsoiler with 21-inch spaced 4 tynes worked to 15 inches depth after ploughing to, say, 10 inches improves drainage downwards considerably and reduces run-off. Dry ditches around paddocks and leading to Rose's Creek are now needed only after heavy rain when the soil becomes saturated. Four farmers bordering Rose's Creek have gone into partnership to buy such a subsoiler. They are: Murray Gane, Graeme Gane, Quentin Wratt and Ian Woolley. The Subsoiler is now in Ian's yard and an 80 h.p. tractor pulls it quite well.

Another problem is showing up now that the Swamps have been deepened to Creeks. Where the sides are at all steep, the sides appear to be creeping inwards over a greasy subsoil. Thus, the level of the bottom is tending to go back to where it started. The movement seems to begin from a distance after the passage of heavy machinery. This problem is in addition to sediment that may settle on the bottom.

E. C. Wratt

Appendix 7

Interim Spring Creek report

Cawthron Research News

"...a natural spring treasured by the local community ..."

March 2000

How healthy is Spring Creek?

Roger Young
&
Jon Harding

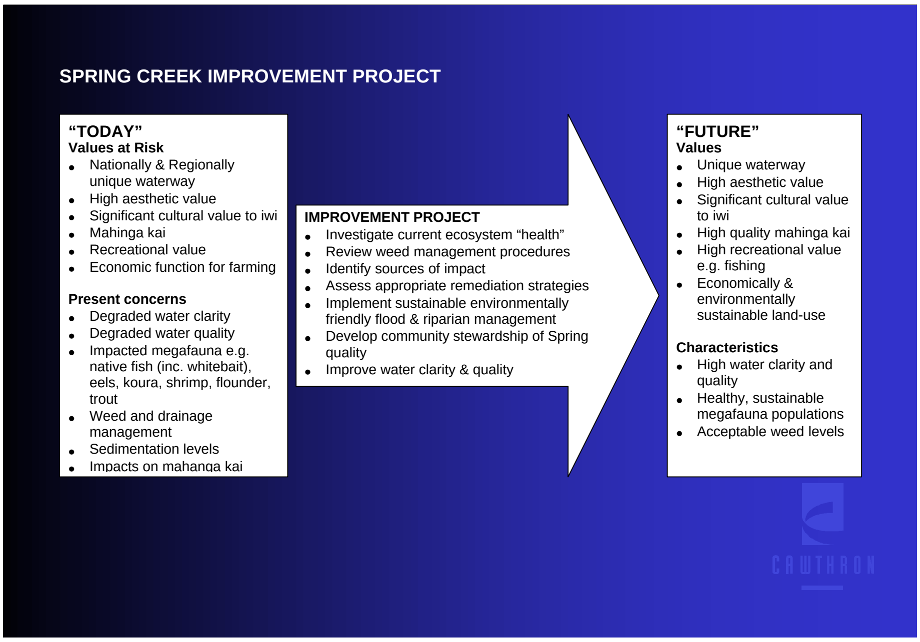
Spring Creek, near Blenheim is a natural spring treasured by the local community. For decades the spring has been valued for its clear, clean water. Many people rely on this unique stream – local farmers depend on it for a continuous supply of water, anglers travel from around the world to fish it, local Maori take watercress from the spring, and whitebait and eels are regularly harvested.

But all is not well in Spring Creek. Over the last few years there has been increasing concern over the condition of the creek. The clarity of the water seems to be getting worse, and there has been a general decline in its popularity for trout fishing.

Last year the Marlborough District Council called a meeting of representatives of the local community to discuss concerns over Spring Creek. Members of the Spring Creek Waterways Association, local residents, iwi, Eel Management Committee and other interested groups all attended. As a result of this meeting staff of the District Council, Nelson-Marlborough Fish & Game, Department of Conservation and the Cawthron Institute are pooling their efforts in a one-year study to collect baseline information on the condition of the creek. Data gathered from this study will help us find practical solutions to the problems facing the creek.

In this article we present some of the results after six months of the study. So far, our efforts have concentrated on an assessing water quality, and the health of plants and animals living in the creek.

Spring Creek – a natural scenic spring with high water quality and clarity



An overview of present concerns identified by the local community, and a vision of what the spring could be in the future

CAWTHRON

On occasions bacteria levels exceeded the Ministry for the Environment's guidelines for safe recreational swimming.

Where does Spring Creek water come from?

The groundwater that feeds Spring Creek comes from the Wairau Aquifer. This water has the same water chemistry as the Wairau River, and so differences in the water quality between the spring and the river will be caused by activities occurring on the land between the river and the spring.

How hot is too hot?

One of the most important features affecting the health of stream systems is the water temperature. High water temperatures can stress stream life and reduce oxygen levels in the water.

The water that comes out of the ground at the Tennis Courts is at a constant temperature around 14°C, with only very small daily variations in temperature. Further downstream, at the Motor Camp, there were slightly larger daily variations and a seasonal increase in temperature from August to December. Temperatures in two of the tributaries – Dentons Creek and Roses Creek – were much higher than in the mainstream of Spring Creek reflecting the smaller amount of water in these systems and perhaps a lack of shading.

Daily maximum temperatures regularly approached 18 - 20°C in Roses Creek. Such high temperatures make this stream unsuitable for some freshwater animals. This tributary has very variable temperatures.

Bad Bacteria

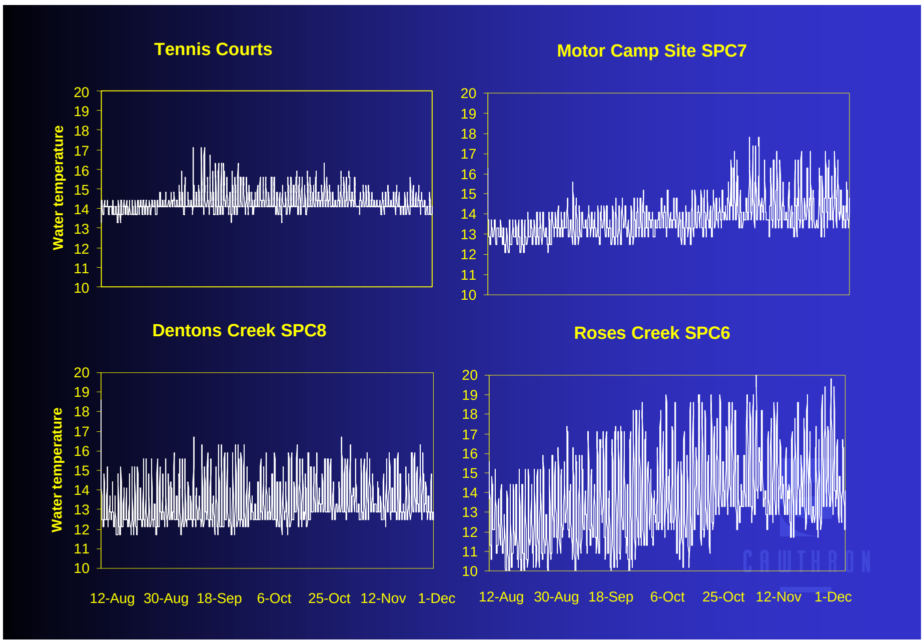
Faecal bacteria are often used as a measure pollution from livestock wastes, and high counts of bacteria may effect the health of humans swimming in or drinking the water.

Bacteria levels have been measured monthly at several sites throughout the creek. Low levels were usually found in the upper parts of Spring Creek, except for one very high measurement at O'Dwyers Bridge. However, higher bacterial counts were found in Ganes Creek and in Roses Creek during early spring. On occasions these levels exceeded the Ministry for the Environment's guidelines for safe recreational contact. However, bacterial levels were generally below these limits in the middle and lower reaches of Spring Creek.

Nutrients: essential for weed growth

Frequently, nutrients can enter a stream from run-off from fertilized pasture or be added by livestock. These nutrients, particularly nitrogen and phosphorus, can trigger the growth of algae and nuisance weeds in the creek.

Nitrogen levels in the spring were relatively high (0.3 – 0.7mg/L), but tended to decrease downstream. This nitrogen is probably used by the large number of aquatic plants and weeds that grow along the creek.



Water temperatures at two sites on the creek and in two tributaries

CAWTHRON

Phosphorus followed the opposite pattern with very low concentrations in the upper reaches of Spring Creek and higher levels downstream and in some of the tributaries (Ganes, Dentons, Roses).

Although levels of nitrogen were more than sufficient to stimulate prolific growth of algae and other aquatic plants (>0.04 – 0.1mg/L), low phosphorus levels (≤0.03mg/L) may be limiting their buildup. Therefore any increases in dissolved phosphorus concentrations in the future may trigger increased aquatic plant growth.

How clear is the water?

Water clarity has been measured by five continuous recorders over the last six months. Water clarity is often measured in NTUs. Low NTUs i.e. close to or less than 1 indicate very clear water, while the higher the NTUs the dirtier the water.

Generally, water clarity slowly deteriorates down the main stem of Spring Creek. At the headwater of the spring (near the tennis courts), the water is extremely clear (<1 NTU for 93% of the time). Underwater visibility can reach 12 m. However, at the lower end of the creek (at the floodgates) it was never this clear.

Some tributaries, such as Roses Creek, are probably adding dirty water to the main river, worsening water clarity

Some tributaries, such as Roses Creek, are probably adding dirty water to the main river, worsening water clarity. The water in Roses Creek was often discoloured (>5NTU for 94% of the time).

Water clarity is usually a good indicator of the amount of material suspended in the water. There was very little suspended material at the headwaters, but higher amounts downstream. Tributaries such as Ganes, Dentons and particularly Roses creeks have periods of high suspended sediment levels. The majority of this suspended material is very fine, silt and sand.

The larger pieces of aquatic plants that can be seen floating down the creek on some occasions do not appear to be having a major impact on water clarity.

Marlborough District Council, Cawthron Institute and Fish & Game staff measuring water clarity in the

What about oxygen: the currency of life?

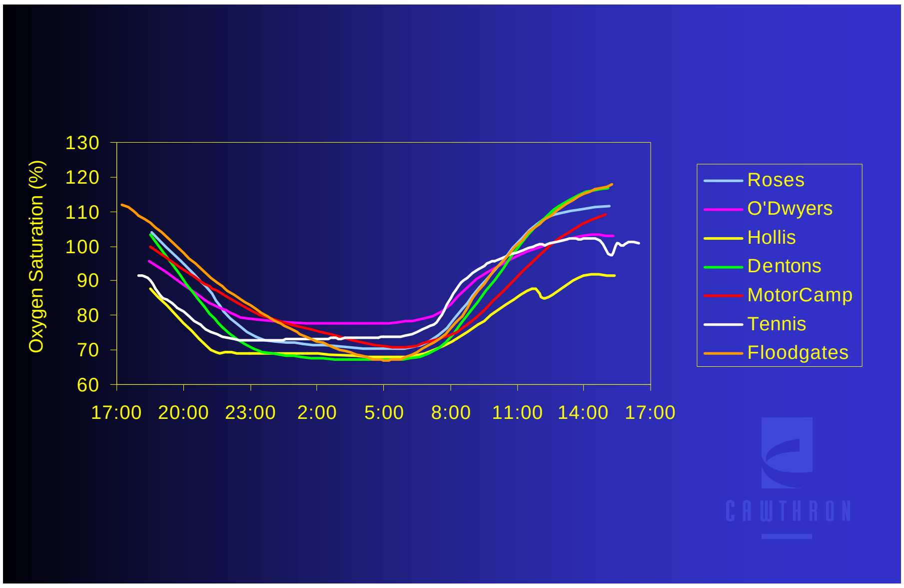
The amount of oxygen in the water is another fundamental factor controlling what can live in streams and rivers.

Oxygen concentrations can vary widely over the length of a day because aquatic plants will release oxygen into the water during the day when they are photosynthesizing and use it up at night.

Turbidity

NTU	<1	1-2	2-5	>5
Tennis Courts	93%	5%	1%	0.5%
Rapaura Road	38%	54%	5%	2.7%
Motor Camp	8%	49%	35%	8%
Roses Creek	0%	0%	6%	94%
Floodgates	0%	22%	64%	14%

The spring has very clear water at its headwaters (the Tennis Courts) but gets more turbid downriver. In contrast, Roses Creek is discoloured most of the time



Dissolved oxygen levels are lower in some tributaries than others, but at all sites oxygen is used up at night and increases during the day

The largest daily variations in oxygen occurred at the floodgates and in Dentons Creek. Both of these sites have dense mats of aquatic plants. Oxygen concentrations were below 80% at all sites for several hours during the night which may have been stressful for some species of fish and other organisms in the stream.

Consistently low oxygen saturation was seen in Hollis Creek. It is possible that decaying aquatic weeds, which had been sprayed shortly before sampling, caused this.

Aquatic plants may provide important habitat for organisms living in the stream but some of these weeds can cause drainage problems by clogging the channel. A survey of aquatic plants and weeds down Spring Creek showed a strong change in the distribution of the plant community. In the upper reaches there was a wide variety of aquatic plants including some native species, whereas the lower reaches were dominated by two nuisance aquatic weeds - *Lagarosiphon* which is found from at least Rapaura Road downstream, and *Egeria* which is present from Dentons Creek downstream.

At present, Marlborough is the only region in the South Island where this pest weed *Egeria* is found, and so it is important that pieces of these weeds are not transported upstream on diggers or other equipment.

Check list of species found in Spring Creek 20.10.99

Scientific name	Common Name	I	II	III	IV	V	VI
*Alisma plantago-aquatica**	Water plantain						
Azolla filiculoides	Azolla	x	x	x	x		x
Callitriche stagnalis	Starwort		x				
Carex secta	Niggerhead	x			x		
Egeria densa	Oxygen weed				x	x	x
Elodea canadensis	Canadian pond weed		x	x	x		
Glyceria fluitans	Floating sweet grass	x		x			
Lagarosiphon major	Oxygen weed			x	x	x	x
Lemna minor	Duckweed	x	x	x	x		
Mimulus guttatus	Monkey musk		x				
Myriophyllum propinquum	Water milfoil	x	x				
Nasturtium officinale	Watercress	x	x	x			x
Nitella hookeri	Nitella	x	x	x	x		x
Phormium tenax	NZ flax		x				
Polygonum decipiens	Swamp willow weed	x	x	x	x	x	x
Potamogeton crispus	Curly leaved pondweed			x	x		
Ranunculus trichophyllus	Water buttercup		x		x		
Typha orientalis	Raupo			x			

* *Alisma plantago-aquatica* was observed only at Ganes Creek site

Locations referred to in the above table

I. Tennis Courts
II. O'Dwyers Road Bridge
III. Rapaura Road Bridge
IV. Motor Camp
V. Collins Bridge
IV. Floodgates

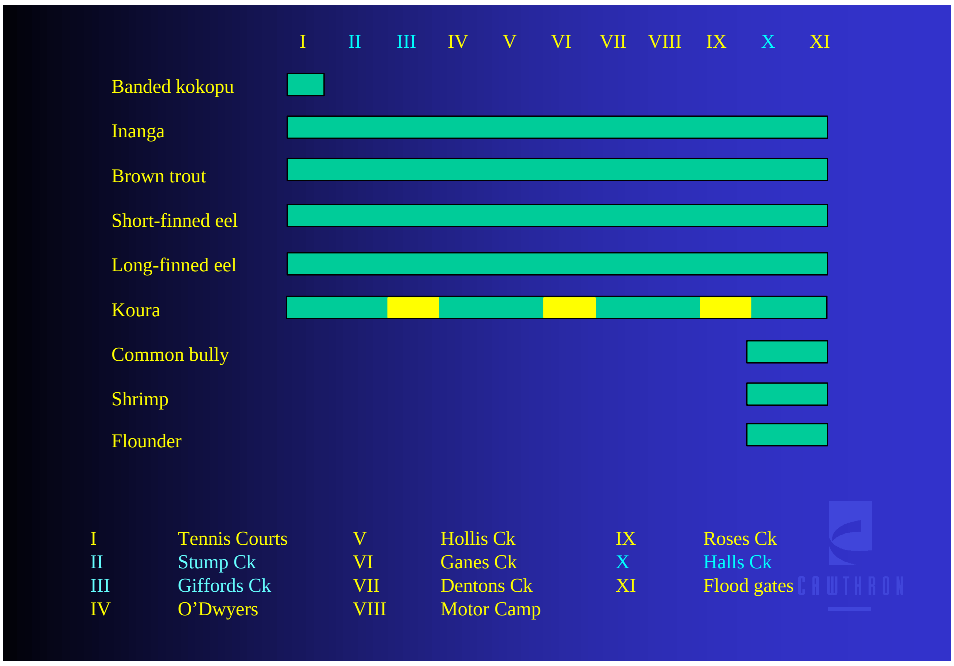
Stream life – what can it tell us?

Most New Zealand streams and rivers are teeming with animal life - insects, worms snails, crayfish, eels and fish. Among these the smaller animals, the benthic or "bottom-dwelling" invertebrates e.g. insects, worms and snails are good indicators of the "health" of a stream.

In Spring Creek, the headwaters had the highest number of benthic invertebrate species with slightly less downstream. Of

The headwaters (at the Tennis Courts) are rich in aquatic plant species while the lower reaches (e.g. the Floodgates) have few species, mainly nuisance weeds the tributaries, Ganes Creek, Dentons Creek and Roses Creek had particularly low numbers of species while Hollis Creek was similar to the mainstem of Spring Creek.

Some species of benthic invertebrates are very sensitive to pollution while others are tolerant. Examples of sensitive groups are the mayflies, stoneflies, and caddisflies. The number of these sensitive species in the mainstem of Spring Creek ranged from 6 to 8, but dropped to 3 in Dentons Creek, 2 in Roses Creek and 0 in Ganes Creek. The low numbers of sensitive species in these tributaries is of some concern.



Several fish and larger invertebrate species are found throughout the creek, however shrimp and bullies seem to be quite limited. The yellow bar indicates that koura are rare.

What fish are present?

A fish survey found seven different species of fish in the Spring Creek and its tributaries. Brown trout, short-finned eels, long-finned eels and one of the adult whitebait species (the inanga) were found throughout the catchment. One banded kokopu (another adult whitebait species) was seen at the top of Spring Creek, while common bullies and flounders were only found in the lower reaches (including Halls Creek). Koura (freshwater crayfish) were seen in the upper and lower reaches of Spring Creek and present in some tributaries (Stump, Hollis, Dentons, Halls), but absent or very rare in others (Giffords, Ganes, Roses).

Another animal that may be declining in numbers in Spring Creek is the shrimp. Several locals have commented on the lack of shrimps in recent years and although our survey still shows large numbers in the lower reaches and in Halls Creek, they do seem to be absent above Spring Creek township. Shrimp numbers declined from being very abundant, to rare, to absent within just a few hundred metres as you move upstream in both Halls Creek and Spring Creek. The reasons for this sudden change in shrimp abundance are unknown. Further studies will be needed to give us a better indication of the reasons for this unusual distribution.

Spring Creek tributary with a riparian buffer protecting the stream boundary

What's the next step?

At present we are only half way through our preliminary study, and yet it is clear that the concerns of the local community about the condition of the creek are justified.

So far we have identified that water clarity does decrease down the length of Spring Creek, and that some of the tributaries may be a source of this poorer water. The biological community within the Spring Creek (particularly benthic invertebrates, shrimps, and

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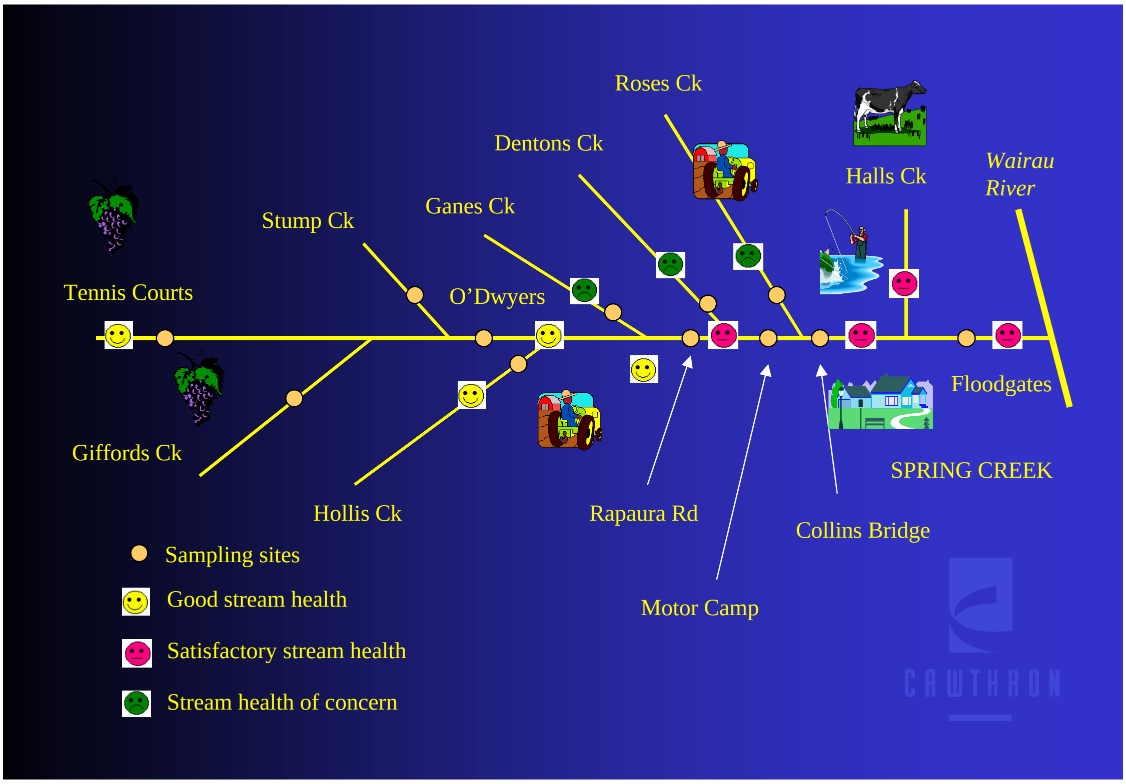

Overall stream health seems to be declining down Spring Creek, with better water quality and biological communities upstream than in the lower reaches. Conditions in several of the tributaries are of concern

koura) show that some parts of the creek and its tributaries are degraded, and no longer capable of supporting these species. Currently, low phosphorus levels are probably limiting the growth of algae and other aquatic plants, but any future increase in phosphorus inputs could have significant impacts.

Now that we have some information on the condition of Spring Creek, the next steps of the project will be very important. We still don't know the answers to many questions, but our work so far can help us target the right questions to answer. For example, can we reduce the amount of sediment getting into some of the tributaries? What is limiting the distribution of some animals within the creek? Can careful riparian planting help to reduce sediment and nutrient inputs? Could this also help reduce temperature changes and aquatic plant growth? Are there practical, cost effective changes in management that could be made which could have large benefits to the health of Spring Creek?

Over the next six months we will be gathering more information and with the continuing support of the local community begin to find answers and solutions to some of these questions.

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