Styx River Annual Monitoring of Aquatic Ecology

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Prepared for:
Christchurch City Council

Instream Consulting Limited
PO Box 28 173
Christchurch 8242

instream CONSULTING LTD

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EXECUTIVE SUMMARY

This report describes results from the 2019 round of annual macroinvertebrate monitoring of the Styx River at Styx Mill Reserve, in relation to Environment Canterbury stormwater discharge consent CRC131249. Aquatic habitat and macroinvertebrate communities in 2019 were comparable to previous years. The macroinvertebrate community included a moderate number of pollution-sensitive taxa and community composition was indicative of fair quality. Most parameters complied with stormwater consent surface water objectives, with the exception of fine sediment cover (<2 mm diameter). There were no significant increasing or decreasing trends that are indicative of declining ecosystem health. Thus, there is no indication of an increasing or reducing impact of stormwater discharges on aquatic ecosystems at the Styx River monitoring site.

1. INTRODUCTION

This report presents the latest results of annual aquatic ecology monitoring of the Styx River at Styx Mill Conservation Reserve. Monitoring at this site is a requirement of the Styx Stormwater Management Plan (SMP) and Environment Canterbury discharge consent CRC131249. Annual invertebrate monitoring has been undertaken at this site on seven occasions from 2013 to 2019. The primary purpose of the annual monitoring site is to pick up any trends in aquatic habitat and invertebrate community health that might otherwise be missed by the 5-yearly ecology monitoring programme at this site of relatively high ecological value. Ecology monitoring results for the wider Styx catchment are reported by Instream (2018).

The purpose of this report is to summarise monitoring results to date, assess compliance against surface water objectives of the stormwater consent, and to determine whether there are any trends over time that could be associated with stormwater discharges.

2. METHODS

2.1. Monitoring Site

The monitoring site is located within Styx Mill Conservation Reserve Figure 1). The annual monitoring site is referred to as Site 14 in the 5-yearly monitoring programme (Instream 2018). Coordinates for the site are: Easting 1568256, Northing 5187756 (NZTM projection). Fieldwork was undertaken on 14 March 2019 under baseflow conditions.

2.2. Sampling

Field methods were identical to those used in previous years (Instream 2018), with one exception. Macroinvertebrate laboratory processing was done using the 200 fixed count, plus scan for rare taxa method (Protocol P2 from Stark et al 2001), rather than full counts, which were done in previous years. This is based on recommendations from Stark (2018) that Protocol P2 provides similar results to full counts for kicknet samples, with much less laboratory processing time.

Monitoring includes measurements of water quality, habitat, macrophyte and periphyton cover, and sampling of benthic macroinvertebrates. The sampling site comprises a 20 m long sampling reach. Water quality sampling entailed measurement of dissolved oxygen (DO), temperature, pH, and conductivity in the field, using a recently-calibrated Hannah Instruments water quality meter (model HI9829). Results of monthly water quality monitoring throughout the city are reported elsewhere (Margetts & Marshall 2018).

Habitat sampling was undertaken either at the reach scale (e.g., neighbouring landuse) or at each of three transects, located at 10 m spaces along the reach. Some habitat parameters were measured at multiple points across each reach (e.g., water depth), while other parameters were taken at the transect scale (e.g., macrophyte cover). Water velocity was measured at one location per transect, mid-channel, using a Seba Mini velocity meter.

Figure 1: Location of the Styx River annual ecology monitoring site.

Macroinvertebrate sampling entailed collection of a single kicknet (500 µm mesh) per site, covering a total area of approximately 1.5 m² and sampling all available habitats. Macroinvertebrates were preserved in denatured ethanol and sent to Biolive Consultants for sorting and identification, using Protocol P2 (fixed count, plus scan for rare taxa) of Stark et al. 2001).

2.3. Data Analyses

2.3.1. Data Management and Habitat Data

Data from 2019 were added to data from all previous years of monitoring in a single Microsoft Excel spreadsheet. The combined spreadsheet was provided to CCC in electronic form at the time this report was submitted, and the data is available from CCC on request.

Statistical analyses were conducted on the following parameters: bed cover with fine sediment (<2 mm diameter); emergent and total macrophyte cover; and cover with long filamentous algae (>2 cm long). These parameters were chosen because they can all impact macroinvertebrate communities and they all have associated Styx SMP water quality

objectives or Canterbury Land and Water Regional Plan (LWRP) freshwater outcomes. SMP water quality objectives are as follows: maximum 40% cover with fine sediment; maximum 50% cover for total macrophytes; and maximum 30% cover for long filamentous algae. In addition, the LWRP freshwater outcome for spring-fed plains streams is a maximum of 30% cover for emergent macrophytes.

Data were averaged for each transect (where relevant), plotted, compared with water quality objectives, and inspected for evidence of any patterns over time or amongst sites. Trends over time were examined statistically using the Mann-Kendall trend test on annual median data for each site in Time Trends statistical software (version 6.30. build 11).

2.3.2. Macroinvertebrate Analyses

The following biological indices were calculated from the raw invertebrate data:

Taxa Richness: The number of different invertebrate taxa (families, genera, species) at a site. Richness may be reduced at impacted sites, but is not a strong indicator of pollution.

%EPT: The percentage of all individuals collected made up of pollution-sensitive Ephemeroptera (mayfly), Plecoptera (stonefly), and Trichoptera (caddisfly) taxa. %EPT is typically reduced at polluted sites, and is particularly sensitive to sedimentation. This metric is calculated without pollution-tolerant hydroptilid caddisflies, which can skew %EPT results at sites where they are abundant.

EPT Taxa Richness: The number of different EPT taxa at a site. It is reduced at polluted sites. Calculated with hydroptilid caddisflies excluded.

MCI and QMCI: The Macroinvertebrate Community Index and the Quantitative MCI (Stark 1985). Invertebrate taxa are assigned scores from 1 to 10 based on their tolerance to organic pollution. Highest scoring taxa (e.g., many EPT taxa) are the least tolerant to organic pollution. The MCI is based on presence-absence data: scores are summed for each taxon in a sample, divided by the total number of taxa collected, then multiplied by a scaling factor of 20. The QMCI requires abundance data: MCI scores are multiplied by abundance for each taxon, summed for each sample, then divided by total invertebrate abundance for each sample. We calculated site MCI and QMCI scores using the tolerance scores for hard-bottomed streams, to reflect the dominant substrate present (Stark & Maxted 2007). MCI and QMCI scores can be interpreted as per the quality classes of Stark & Maxted (2007), as summarised in Table 1.

Table 1: Interpretation of MCI and QMCI scores (from Stark & Maxted 2007).

Quality Class	MCI	QMCI
Excellent	>119	>5.99
Good	100-119	5.00-5.90
Fair	80-99	4.00-4.99
Poor	<80	<4.00

Macroinvertebrate data were analysed statistically using the Mann-Kendall trend test. QMCI scores were compared with the water quality objective of a minimum QMCI of 4.5 for consent CRC131249.

3. RESULTS AND DISCUSSION

3.1. Water quality

On the day of sampling, water temperatures were cool, dissolved oxygen concentrations were high, and pH levels were near-neutral (Table 2). All water quality parameters measured were at typical levels for a spring-fed Canterbury stream and were adequate for sustaining aquatic life. However, all of the parameters measured can fluctuate on a daily and seasonal basis, so the data are indicative only. For more detailed water quality data, the reader is referred to the annual water quality monitoring report of Margetts & Marshall (2018), which summarises results of monthly sampling at multiple locations throughout the Styx catchment.

Table 2: Water quality data collected during ecology sampling.

Parameter	Value
Dissolved oxygen (%)	86
Temperature (°C)	13.8
pH	6.5
Conductivity (µS/cm)	113

3.2. Habitat

The sampling site is bordered by a mix of native grasses, shrubs and trees, as well as some exotic weeds (blackberry and convolvulus) and willows, which provide a moderate amount of shading to the river (mean = 52% shade). Overhanging vegetation and stable bank undercuts provide reasonable fish cover, and the predominantly stony bed is good habitat for pollution-sensitive invertebrates. Representative site photographs from 2019 are attached as Appendix 1.

Mean bed cover with fine sediment (<2 mm diameter) was 59% in 2019, which exceeded the SMP water quality objective of 40% (Figure 2). There was zero bed cover with long filamentous algae (>2 cm) in 2019, which complied with the SMP objective of 30% (Figure 2). Emergent macrophyte cover was 13%, which complied with the LWRP freshwater outcome of 30% cover, while total macrophyte cover was 48%, which fell just within the SMP objective of 50% (Figure 3).

No significant increasing or decreasing trend was detected for any of the four habitat variables tested (P>0.05; Appendix 2). There was a weak, but not statistically significant, increasing trend for fine sediment cover (P=0.068); however, there is considerable variation in the data and they do not suggest a meaningful pattern over time (Figure 2).

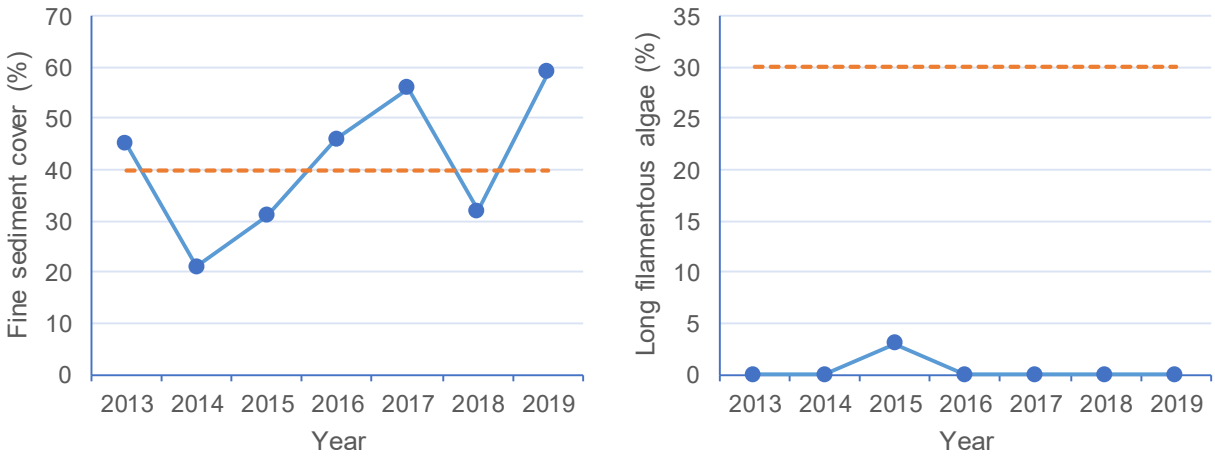

Figure 2: Bed cover with fine sediment (left) and long filamentous algae (right). Dashed lines indicate the SMP objectives of 40% fine sediment cover and 30% long filamentous algae cover.

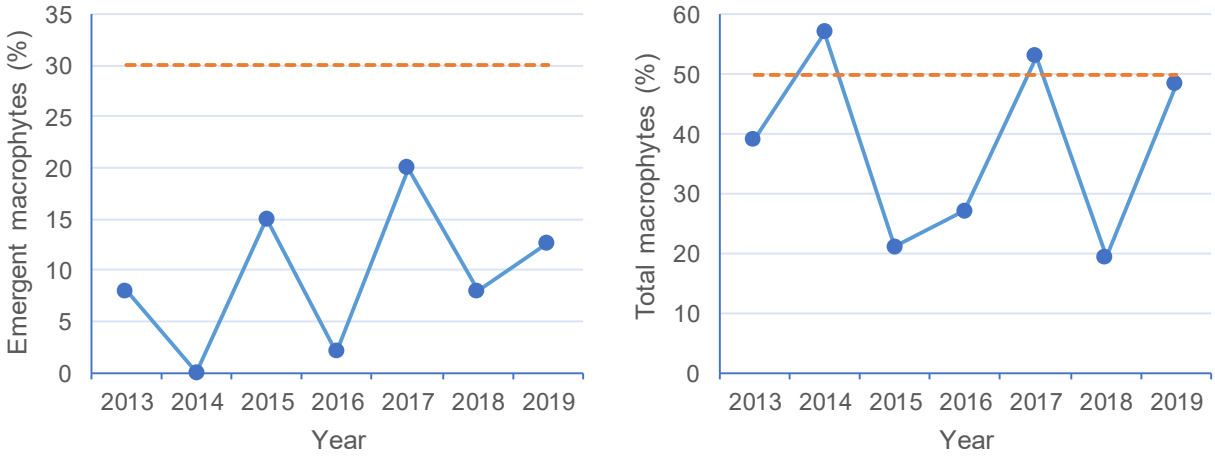

Figure 3: Bed cover with emergent macrophytes (left) and total macrophytes (right). Dashed lines indicate the LWRP outcome of 30% cover for emergent macrophytes and the SMP objective of 50% cover for total macrophytes.

3.3. Macroinvertebrates

A total of 36 taxa, including 9 EPT taxa, were collected from the annual monitoring site in 2019, which is intermediate to values recorded in previous years (Figure 4). EPT abundance was 36% in 2019, which was also within the range of values recorded previously (Figure 4). In 2019, the annual monitoring site recorded a QMCI score of 4.6, which is just above (i.e., complies with) the SMP water quality objective of 4.5, and it is within the range of values recorded in previous years (Figure 4). Over the last seven years, QMCI scores have remained in the range of 4 to 5, which is indicative of "fair" quality (Stark & Maxted 2007; Table 1).

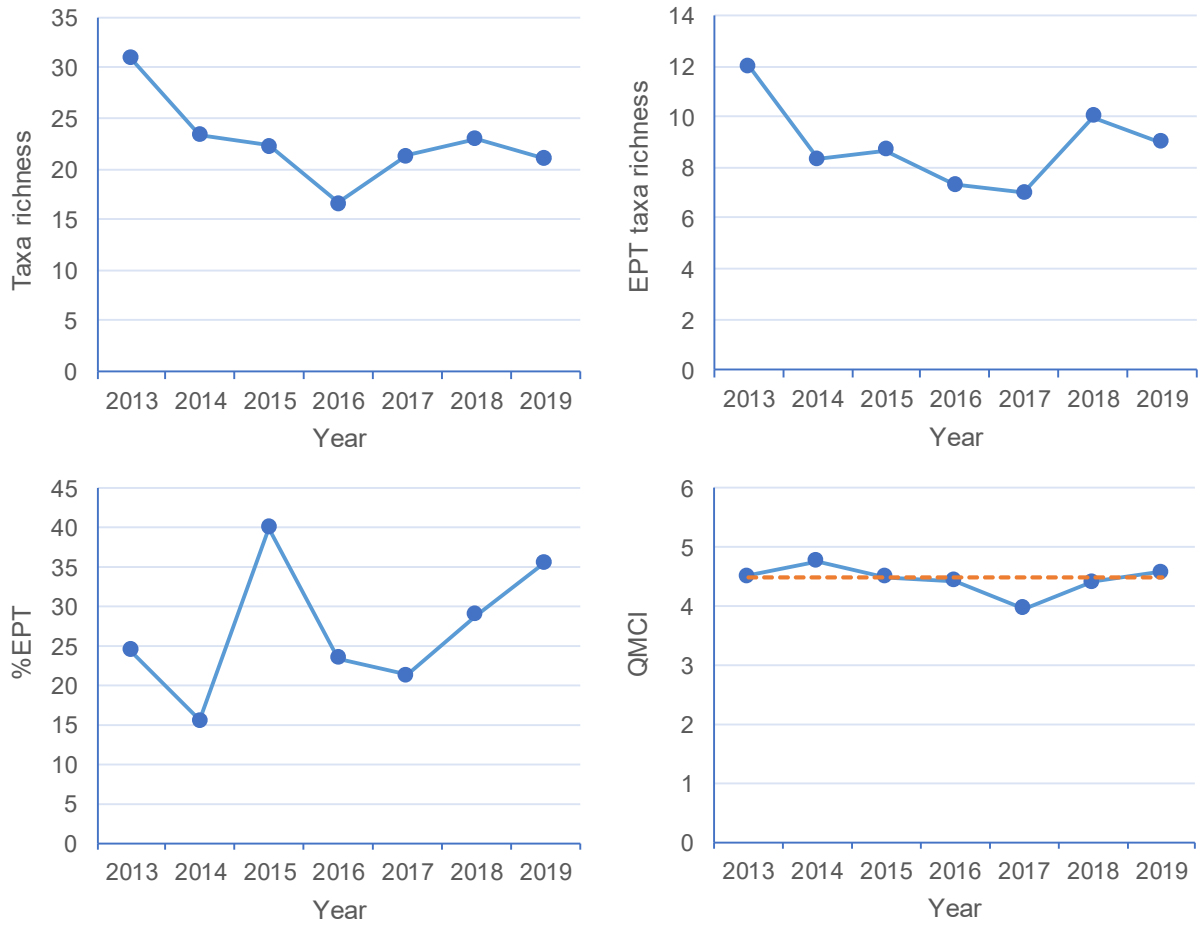

Figure 4: Macroinvertebrate taxa richness, EPT taxa richness, percent EPT abundance, and QMCI scores. The dashed orange line on the QMCI plot indicates the SMP objective, which is a minimum of 4.5.

None of the invertebrate community indices had a significant increasing or decreasing trend over the seven year monitoring period (P>0.05; Appendix 2). Taxa richness showed a weak, but not statistically significant, declining trend (P=0.068); this was primarily influenced by a single high value in 2013, so is unlikely to be a meaningful pattern (Figure 4).

4. CONCLUSIONS

Aquatic habitat and macroinvertebrate communities at the Styx River annual monitoring site in 2019 were comparable to previous years. The macroinvertebrate community includes a moderate number of pollution-sensitive taxa and community composition was indicative of fair quality. Most parameters complied with stormwater consent surface water objectives, with the exception of fine sediment cover. There were no significant increasing or decreasing trends that are indicative of declining ecosystem health that could be attributed to stormwater discharges.

5. REFERENCES

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Stark, J. D., and Maxted, J. R. (2007). A user guide for the Macroinvertebrate Community Index. Report prepared for the Ministry of the Environment. Cawthron Report No. 1166.

APPENDIX 1: SITE PHOTOGRAPHS FROM 2019

Figure 1: Upstream end of the monitoring reach, looking downstream.

Figure 2: Downstream end of the monitoring reach, looking upstream.

APPENDIX 2: SUMMARY RESULTS OF STASTICAL TESTS

Mann-Kendall trend test results for habitat and invertebrate variables. These results statistically test trends over time and use data for all seven monitoring years (2013-2019) at each individual monitoring site. No significant trends were detected (P>0.05).

Variable	Median value	Kendall statistic	Z	P-Value	Percent annual change
Fine sediment cover	45	11	1.502	0.068	6.1
Long filamentous algae cover	0	-2	-0.25	0.443	0.0
Emergent macrophyte cover	8	6	0.76	0.236	25.0
Total macrophyte cover	39	-3	-0.3	0.386	-3.4
Taxa richness	22	-11	-1.502	0.068	-3.0
EPT taxa richness	9	-3	-0.3	0.386	-4.6
Percent EPT	24	5	0.601	0.281	8.0
QMCI	4.5	-7	-0.901	0.191	-0.7