Kingett Mitchell Ltd
RESOURCE & ENVIRONMENTAL CONSULTANTS

AQUATIC ECOLOGY AND STREAM MANAGEMENT GROUPS FOR URBAN STREAMS IN THE WAIRARAPA REGION

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AQUATIC ECOLOGY AND STREAM MANAGEMENT GROUPS FOR URBAN STREAMS IN THE WAIRARAPA REGION

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on behalf of

Greater Wellington

prepared by

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Table of Contents

Page

1. Introduction 1

1.1 Background 1
1.2 Scope of Report 1

2. Methods 2

2.1 Urban Stream Selection 2

2.1.1 Masterton 2
2.1.2 Greytown 3
2.1.3 Featherston 4
2.1.4 Abbots Creek (reference site) 4

2.2 Physicochemical Water Quality 5
2.3 Stream Habitat Assessment 5
2.4 Riparian Vegetation 6
2.5 Macroinvertebrates 7
2.6 Fish Communities 8
2.7 Statistical Analysis 8

3. Physicochemical Water Quality 8

4. Stream Habitat 9

4.1 Channel Characteristics 9
4.2 Substrate Characteristics 10
4.3 Periphyton and Aquatic Macrophytes 10

5. Riparian Vegetation 13

6. Macroinvertebrate Community 15

6.1 Diversity and Abundance 15
6.2 Community Composition 16

6.2.1 Masterton 16
6.2.2 Featherston 18
6.2.3 Greytown 19
6.2.4 Reference Stream (Abbots Creek) 20

6.3 Biological Indices 20
6.4 Community Relationships with Habitat and Water Quality 22

7. Fish Communities 24

8. Characteristics of Wairarapa and Wellington Urban and Peri-urban Streams 24

8.1 Introduction 24
8.2 Invertebrates 25
8.3 Instream and Riparian Habitat 25
8.4 Landuse 25
8.5 Stream Classification 26
8.6 Wellington Urban Stream Management Strategy 26

9. Summary 27

10. References 27

Appendix 1 Photographs of Survey Sites.

List of Tables

		Page
2.1	NZMS260 co-ordinates for each sampling location.	2
2.2	Interpretation of MCI and QMCI values from stony riffles.	7
3.1	Physicochemical water quality results measured from Wairarapa urban streams.	9
4.1	Habitat characteristics of Wairarapa urban streams.	10
4.2	Periphyton and aquatic macrophyte cover (%) recorded at Wairarapa urban streams.	12
4.3	Aquatic macrophyte species recorded from Wairarapa urban streams.	12
5.1	Riparian width (m) and stream shade (%) recorded along Wairarapa urban streams.	13
7.1	Fish species recorded from Wairarapa urban streams.	24

List of Figures

2.1	Sampling locations on the Makora Stream, Kuripuni Stream and an unnamed stream draining the Landsdowne Hill area, Masterton.	3
2.2	Sampling locations on the Papawai Stream and Tilsons Stream, Greytown.	4
2.3	Sampling locations on Boat Creek and the reference stream Abbots Creek, Featherston.	5
4.1	Stream sediment composition (%) recorded from Wairarapa urban streams.	11
5.1	Riparian vegetation recorded from Wairarapa urban streams.	14
6.1	The number of taxa recorded per site from Wairarapa urban streams.	15
6.2	Total macroinvertebrate abundances recorded from Wairarapa urban streams.	16
6.3	The proportion (%) of the macroinvertebrate communities made up by the predominant macroinvertebrate groups from Wairarapa urban streams.	17
6.4	MCI values recorded from Wairarapa urban streams.	20
6.5	QMCI values recorded from Wairarapa urban streams.	21
6.6	Number of EPT taxa recorded from Wairarapa urban streams	21
6.7	Proportion of EPT taxa making up the communities recorded from Wairarapa urban streams.	22
6.8	An nMDS ordination of the Wairarapa urban stream community data.	23

Document Quality Assurance

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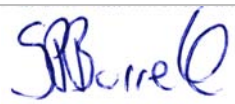
Project Reviewer	**Greg Burrell**	
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1. Introduction

1.1 Background

The Wairarapa region extends north from Palliser Bay to include the South Wairarapa, Carterton and Masterton districts, which have a total population of 38,208 (2001 census). The majority of this population resides within the five main Wairarapa towns of Masterton, Carterton, Greytown, Featherston and Martinborough. The Wairarapa region extends approximately 130 km from north to south, 75 km from east to west, and has an area of 6,010 km^2. This represents almost three-quarters of the Wellington region's land area, but only represents nine per cent of the region's population (423,765).

The major landscape features within the Wairarapa region include the Tararua and Rimutaka Ranges in the west, the central plains on which all the five main towns are located, and the eastern hills. This setting has produced three distinct landscapes which strongly influence the climate and landuse within the region. The climate is cool and dry, with landuse predominantly rural in character (pasture and horticulture). There are many perennial and ephemeral waterways within the region, most of which drain the surrounding ranges into the Ruamahanga River system (including Lake Wairarapa).

As part of a larger project examining the ecological status of urban streams in the Wellington region (Kingett Mitchell 2003, 2005), the urban streams of the Wairarapa region were also examined. The main urban streams in the Wairarapa region include the following:

- Masterton - Makora Stream.
  - Kuripuni Stream.
  - Landsdowne Hill (unnamed stream).
- Greytown - Papawai Stream.
  - Tilsons Stream.
- Featherston - Boat creek.
- Carterton - Mangatarere Stream tributary.[1]

1.2 Scope of Report

This report presents ecological information collected from Wairarapa urban streams for inclusion in an overall analysis of the health of Wellington urban streams. The aims of the project are to answer the following questions:

[1] The entire length of the urban Mangatarere Stream tributary in Carterton had recently been disturbed during the mechanical removal of aquatic plants; hence no sampling was conducted in the Mangatarere Stream tributary.

- What are the significant ecological characteristics of Wairarapa urban streams?
- What waterways require greater protection than other areas?
- How do Wairarapa urban streams compare with those in the Greater Wellington region?
- What are appropriate management objectives for Wairarapa urban streams?

2. Methods

2.1 Urban Stream Selection

2.1.1 Masterton

Three urban streams were sampled in the Masterton Township; they included the Makora Stream, Kuripuni Stream and a small unnamed stream draining the Landsdowne Hill area on the north eastern boundary of Masterton (Fig. 2.1). Photos of each site are presented in Appendix 1, with NZMS260 co-ordinates presented in Table 2.1. The Makora and Kuripuni Streams are tributaries of the Ruamahanga River and the two most significant urban streams in Masterton.

Table 2.1: NZMS260 co-ordinates for each sampling location.

Town	Site	Easting	Northing
Masterton	MK1	2733254	6025859
	MK2	2734137	6023639
	MK3	2735022	6022451
	KP1	2732014	6024758
	KP2	2733068	6024137
	KP3	2733854	6022564
	LH1	2734996	6026574
	LH2	2735071	6025618
Greytown	T1	2717433	6010848
	PW1	2715162	6011686
	PW3	2717255	6009754
	PW2	2716447	6010820
Featherston	B1	2705946	6007022
Reference	A1	2703147	6008725

The upper reaches of the Makora Stream consist of a number of dry ephemeral streams originating on pasture land. A number of springs feed the Makora Stream system as the channels intercept Ngaumutawa Road, which marks the upstream boundary of urbanisation. The Kuripuni Stream originates near an old hatchery on a council reserve adjacent to Hillcrest Street. The reserve has been planted with native vegetation and

contains a series of ponds/springs that feed the headwaters of the Kuripuni Stream. Within the urban zone, both streams flow through open and piped sections, are fed by ephemeral streams, and drain into pasture/lifestyle blocks before entering the Ruamahanga River.

The Landsdowne Hill Stream originates in pasture land as a small naturally meandering stream. It flows through Masterton as modified open and piped sections and drains into an unnamed pond adjacent to the Ruamahanga River.

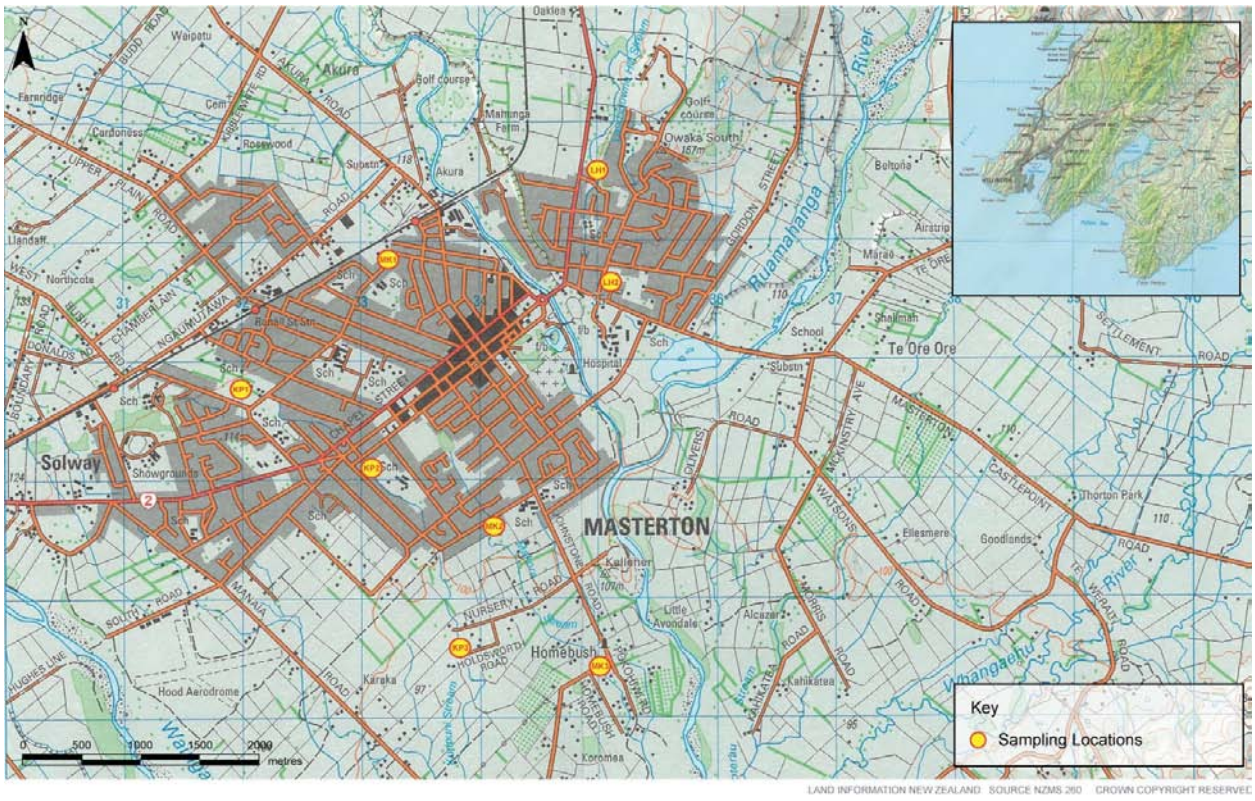

Fig. 2.1: Sampling locations on the Makora Stream, Kuripuni Stream and an unnamed stream draining the Landsdowne Hill area, Masterton.

2.1.2 Greytown

The main waterway flowing through Greytown is the Papawai Stream, a tributary of the Ruamahanga River, originating in pasture land north of Greytown (Fig. 2.2). The stream is piped under the majority of Greytown, emerging in places as an open channel. South of Greytown, the Papawai Stream meanders naturally across pasture land and fed by a number of additional springs before draining into the Ruamahanga River.

Tilsons Stream is a small modified tributary of the Ruamahanga River, originating within the urban limits of Greytown as a roadside drain.

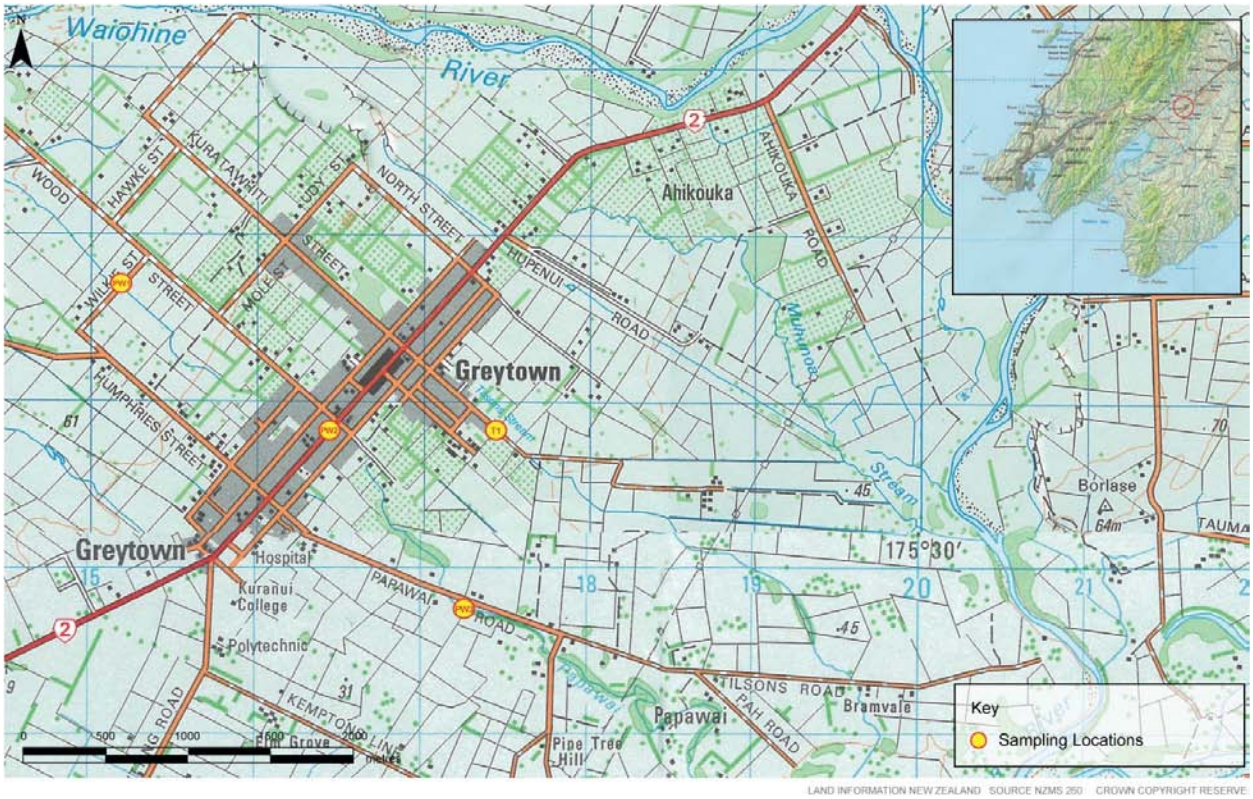

Fig. 2.2: Sampling locations on the Papawai Stream and Tilsons Stream, Greytown.

2.1.3 Featherston

Boat Creek originates from the Tararua Ranges north of Featherston. The waterway is fed by a number of ephemeral streams, which contribute to the high carrying capacity of this waterway (Fig. 2.3). Boat Creek drains the northern and eastern boundaries of Featherston. South of Featherston, Boat Creek drains naturally over pasture land before entering Lake Wairarapa.

2.1.4 Abbots Creek (reference site)

Abbots Creek originates in a steep sided valley within the Rimutaka ranges and flows along the western boundary of Featherston (Fig. 2.3). Abbots Creek in its upper catchment is a high quality stream and thus chosen as a reference site.

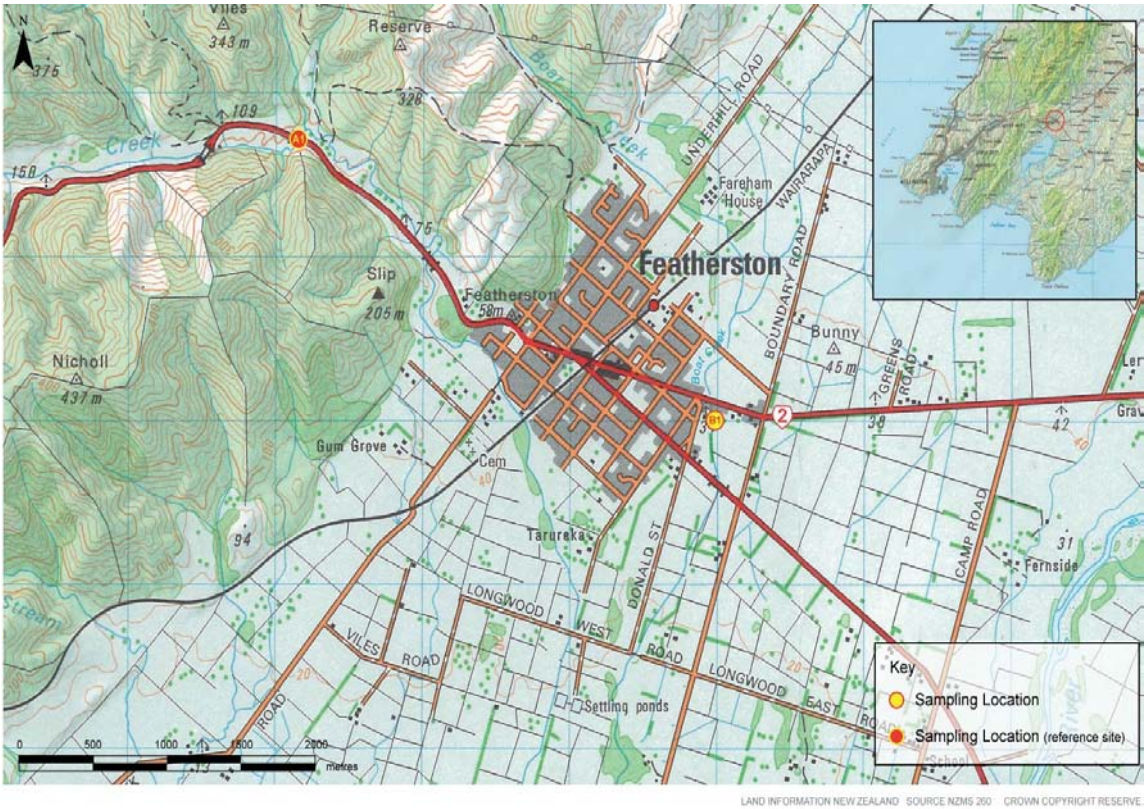

Fig. 2.3: Sampling locations on Boat Creek and the reference stream Abbots Creek, Featherston.

2.2 Physicochemical Water Quality

Urbanisation and the associated impervious surface run-off may affect stream ecosystems by introducing contaminants and sediment created from urban and industrial activities. Catchment imperviousness and the way in which stormwater networks are constructed are the primary determinants of stormwater quality and quantity entering waterways (Duncan 1995). Urban streams are typically degraded, with poor water quality, including depressed dissolved oxygen and elevated temperature, organic compounds, metals and bacteria.

Physicochemical parameters including water temperature (^{o}C), dissolved oxygen (g/m^3 and % saturation), conductivity (µS/cm) and pH were measured mid-stream at each site using YS185 and Winlab Dataline pH field meters calibrated before each day of sampling.

2.3 Stream Habitat Assessment

The channel and habitat condition is an important determinant of the ecology and instream values associated with aquatic habitats. Habitat characteristics were assessed using a modified Auckland Regional Council habitat assessment method (Maxted et al. 2000). This included

an assessment of the following stream habitat characteristics at five equally spaced transects within a 50 m stream reach:

- Channel width and depth (m).
- Velocity (m/s).
- Stream sediment composition (%).
- Streambank characteristics (e.g., form, erosion, slope).
- Periphyton cover (%).
- Aquatic macrophyte cover (%) and species present.

Streambed sediment composition was estimated at each transect as a percentage composition of ten substrate size classes (See Appendix 1 for details). Artificial components of the streambed such as concrete linings and artificially placed boulders were included in this substrate assessment. An assessment of streambank characteristics included measurements of bank height, length and horizontal depth of undercuts, slope, form, erosion and whether they were natural or modified.

2.4 Riparian Vegetation

Riparian vegetation was assessed at five equally spaced transects within the 50 m stream reaches at each site to determine plant species composition and riparian zone widths.

At each transect and on both sides of the stream, riparian vegetation was assessed at 0, 1, 2, 5 and >10 m intervals away from the edge of the streambank using the following vegetation categories:

- NWS: Native woody species.
- EWS: Exotic woody species.
- NNS: Native non-woody species.
- ENS: Exotic non-woody species.
- F: Ferns.
- G: Grasses.
- NV: Non-vascular plants.
- ES: Exposed soil.
- R: Rock.

In addition, vegetation was classified using five height tiers (e.g., 0-0.5, 0.5-1.0, 1.0-2.0, 2.0-5.0 and >5.0 m). Overall, riparian vegetation was recorded as the percent occurrence of each vegetation category across all tiers and distance from the bank. Notes on dominant species were recorded where appropriate. The width of the riparian zone, from the top of the streambank to the edge of the riparian zone or transition to managed landuse, was estimated at each transect.

2.5 Macroinvertebrates

Benthic macroinvertebrates include the diverse assemblage of organisms that live on the surface, under or within the substrates of streams and include insect larvae (e.g., mayflies, stoneflies, caddisflies, beetles), aquatic oligochaetes (worms), snails and crustaceans (e.g., shrimps and crayfish). Because stream macroinvertebrates are such a diverse group and are strongly influenced by aquatic habitat and water quality, they are used widely for monitoring and evaluating water quality and more broadly 'stream health' in New Zealand and overseas (Winterbourn 2004).

Macroinvertebrates were sampled with a kick-net and following the semi-quantitative methods outlined in sampling Protocols C1 and C2 developed by Stark et al. (2001). These methods involve the disturbance of a fixed area of approximately 3 m^2 (10 replicate unit efforts of 0.3 m^2 each), with habitats sampled in proportion to their occurrence within a 50 m reach. Samples were preserved in 70% ethanol solution. Macroinvertebrate samples were processed using protocol PW3 (full count) (Stark et al. 2001).

A benefit of using macroinvertebrates is that they can be indicators of ecosystem health through the calculation and interpretation of biological indices. Biological indices calculated included:

Taxonomic Richness is a measure of the number of macroinvertebrate taxa present in a given area. In general, the greater the numbers of taxa present the higher the quality of the environment.

Abundance measures the total number of macroinvertebrates found in each sample. In extremely degraded environments the total number of macroinvertebrates tends to be lower than in higher quality environments. However, this also depends on the type of species in the community.

The MCI and QMCI (Stark 1985; Stark 1993) were developed for use in stony riffles in New Zealand waterways, and more specifically those subject to organic enrichment. An advantage of the MCI indices is that they provide a simple pollution tolerance score for each taxon ranging from 1 (very pollution tolerant) to 10 (pollution-sensitive), and site scores can be compared to national guideline values (see Table 2.2; Boothroyd and Stark 2000). An important caveat is that the MCI indices are best suited to waterways with depths of 0.1-0.4m, velocities of 0.2-1.2 m/s, and substrate size of 60-140 mm diameter (Stark 1993).

Table 2.2: Interpretation of MCI and QMCI values from stony riffles.

Water Quality	MCI	QMCI
Clean water	> 120	>6.00
Doubtful quality or possible mild pollution	100 - 120	5.00-5.99
Probable moderate pollution	80 – 100	4.00-4.99
Probable severe enrichment	< 80	<4.00

EPT Taxonomic Richness and %EPT provides a measure of the number and proportion of water and habitat sensitive mayfly (Ephemeroptera), stonefly (Plecoptera) and caddisfly (Trichoptera) (EPT) taxa in a sample. A high number of EPT taxa in a sample is indicative of good water and habitat quality. EPT richness and abundance is generally reduced by urbanisation (Suren 2000).

2.6 Fish Communities

Freshwater fisheries information was obtained from surveys undertaken in April 2005 on behalf of Greater Wellington Regional Council and using the New Zealand Freshwater Fisheries Database (NZFFD).

2.7 Statistical Analysis

Patterns in the macroinvertebrate communities were analysed using non-metric multidimensional scaling (MDS) with Bray-Curtis dissimilarity coefficients based on abundance data and using PRIMER v5 software. Spearman rank correlations were used to assess relationships between habitat parameters (e.g., macrophyte cover, water temperature, conductivity etc.), biological indices (taxa richness, MCI, QMCI, EPT and %EPT values) and MDS axis scores using STATISTICA 6.0 software. Only statistically significant correlations ($p<0.05$) are reported in the text.

3. Physicochemical Water Quality

Stream temperatures ranged between a relatively narrow range of 15.1-19.5 ^{o}C, with a median of 16.4 ^{o}C (Table 3.1). Summer stream temperatures within this range are not considered high, but may start to be stressful for some aquatic invertebrates such as Plecopterans (stoneflies). Highest temperatures were recorded at Landsdowne Hill stream, Boat Creek and Tilsons Stream, with lower temperatures recorded in the Makora Stream, the lower Papawai Stream sites and the reference Abbots Creek site. Temperatures were generally lower at the urban sites. Temperatures were not correlated with stream shade, but were negatively correlated with riparian vegetation width ($r_s=-0.546$).

Stream conductivity recorded was moderate-low, ranging between 34.0-154.0 µS/cm (median 72.0 µS/cm). Conductivity within this range indicates that nutrient enrichment is unlikely, with periphyton expected to be in the form of thin films or mats. Highest conductivity was recorded in the Makora Stream. Stream pH ranged between 6.1 and 7.5 (median 7.1), which indicated circum-neutral conditions suitable for aquatic life. With the exception of the dissolved oxygen (DO) concentration recorded at the lowermost Papawai Stream Site PW3 (4.89 g/m^3 and 49% saturation), DO concentrations were moderate-high (>6 g/m^3) with a median of 8.15 g/m^3 and 86% saturation.

Table 3.1: Physicochemical water quality results measured from Wairarapa urban streams.

Town	Site	Temperature (°C)	Conductivity (µS/cm)	pH	Dissolved oxygen (g/m^3)	(%)
Masterton	**MK1**	15.5	145.4	-	6.48	66
	MK2	16.4	154.0	7.3	9.05	92
	MK3	16.1	130.0	6.9	8.47	88
	KP1	16.0	71.0	7.2	11.57	117
	KP2	15.6	82.4	7.1	7.20	73
	KP3	18.1	98.6	7.5	9.80	106
	LH1	19.5	72.0	7.4	8.16	90
	LH2	18.2	55.0	7.4	7.92	84
Featherston	**B1**	18.8	129.0	6.1	7.26	77
Greytown	**T1**	18.4	34.0	7.1	6.99	75
	PW1	17.6	47.0	7.2	8.13	85
	PW2	15.1	45.0	6.8	8.81	87
	PW3	15.1	66.0	6.3	4.89	49
Reference	**A1**	15.1	84.0	7.2	9.50	95
Median[1]		16.4	77.0	7.1	8.13	85
Range		(15.1-19.5)	(34.0-154.0)	(6.1-7.5)	(4.89-11.57)	(49-117)

[1] Data from the reference Site 1 (Abbots Creek) were excluded from the median and range calculations.

A minimum of 5 g/m^3 was recommended for adequate protection of native fish species (Dean & Richardson 1999), thus DO concentrations are not likely to be adversely affecting aquatic life in Wairarapa urban streams. There was no consistent trend in DO concentrations between upstream-downstream sites attributable to urbanisation. Dissolved oxygen concentrations were positively correlated with velocity (rs=0.626) and negatively correlated with macrophyte cover (rs=-0.566).

4. Stream Habitat

4.1 Channel Characteristics

The wetted width of the streams ranged between 0.5-5.0 m, with a median width of 1.8 m (Table 4.1). The streams were generally wider downstream of the urban areas. The channel and wetted widths were similar at each of the urban streams, indicating that erosion had not resulted in significant widening of the channels. In contrast, the reference Abbots Creek Site A1 had a wide flood plain (7 m) in which the actual stream flowed (wetted width of 4.8 m). In general, the streams sampled were moderately shallow, ranging between 0.05-0.4 m deep with a median depth of 0.15 m. Stream depth was positively correlated with channel width ($p<0.05$).

Table 4.1: Habitat characteristics of Wairarapa urban streams.

Town	Site	Wetted width (m)	Channel width (m)	Depth (m)	Velocity (m/s)
Masterton	**MK1**	1.7	1.7	0.31	0.12
	MK2	1.9	2.1	0.40	0.20
	MK3	4.5	4.5	0.15	0.42
	KP1	0.9	0.9	0.05	0.20
	KP2	2.6	2.6	0.25	0.22
	KP3	3.0	3.0	0.27	0.29
	LH1	1.3	1.3	0.19	0.12
	LH2	1.4	1.4	0.13	0.18
Featherston	**B1**	2.7	2.8	0.09	0.03
Greytown	**T1**	0.7	0.7	0.07	0.15
	PW1	0.8	0.8	0.09	0.40
	PW2	0.5	0.5	0.09	0.28
	PW3	5.0	5.0	0.40	0.07
Reference	**A1**	4.8	7.0	0.16	0.56

Stream velocities ranged between 0.0-0.6 m/s, with a median of 0.2 m/s, and were generally greater at downstream sites. This reflects the greater quantities of water flowing at downstream sites. The exception was at Papawai Stream, where stream velocity was greater at the upstream Site PW1 and progressively decreased with distance downstream.

4.2 Substrate Characteristics

Streambed sediments in Wairarapa urban streams were generally dominated by a high proportion of coarse sized particles (>2 mm in size), with gravels being the most common size recorded (Fig. 4.1). The streambed sediments recorded at the upstream and urban sites were generally made up of coarser sediments than the downstream sites, which were generally made up of silt/sand sized particles (<2 mm). An exception was the downstream Kuripuni Stream site (KP3), which also had a high proportion of cobbles and gravels. Small woody debris (SWD) was most common at urban sites.

4.3 Periphyton and Aquatic Macrophytes

Periphyton cover ranged between 0-92% with a median of 40% cover. Periphyton cover increased with distance downstream in the Makora, Kuripuni and Landsdowne Hill streams (Masterton) (Table 4.2). Periphyton was negatively correlated with increased silt/sand (r_s=-0.698) and positively correlated with greater proportions of coarse sediment substrates ($p<0.05$).

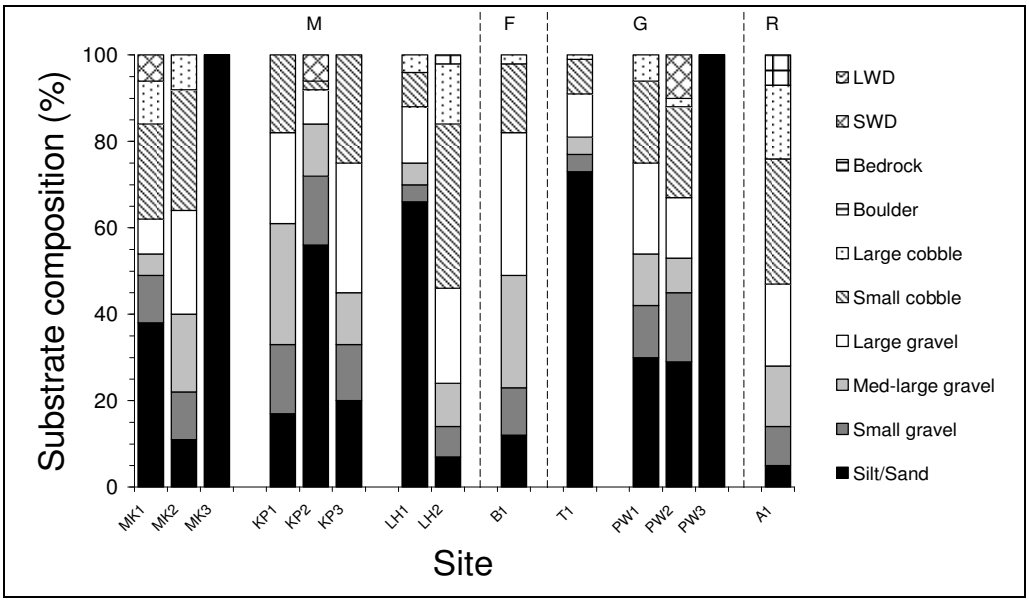

Fig. 4.1: Stream sediment composition (%) recorded from Wairarapa urban streams.

The periphyton recorded from the upstream and urban Makora Stream sites (MK1 and MK2 respectively) was typically thin green/brown films. Periphyton was absent from the downstream Site MK3. The periphyton recorded at the upper Kuripuni Stream Site KP1 was predominantly filamentous green algae, which indicates stable conditions at this site. The periphyton recorded from the urban (Site KP2) and downstream (Site KP2) Kuripuni Stream sites was predominantly thin green/brown films. The periphyton assemblage recorded from the upstream Landsdowne Hill Site LH1 was predominantly thin films, whilst filamentous green algae were more common at the urban Site LH2. The periphyton assemblage recorded at Boat Creek consisted predominantly of thin green films, with filamentous green algae more common at Tilsons Stream. Thin green/brown algae was most common at the upstream and urban Papawai Stream sites (PW1 and PW2), with no periphyton recorded at the downstream site

The number of aquatic macrophyte (aquatic plants) species present and percentage area covered was generally greater upstream and downstream of urban areas (Table 4.2 & 4.3). Macrophyte cover was negatively correlated with medium-large sized gravel (rs=-0.552) and positively correlated with channel width (rs=0.570).

Sprawling emergent species were most represented in Wairarapa urban streams with species recorded including *Ludwigia palustris*, *Apium nodiflorum*, the willow weed species *Persicaria hydropiper* and *Persicaria decipiens, Mimulus guttatus, Callitriche stagnalis* and *Myosotis laxa* (Table 4.3). The charophyte *Nitella hookeri* was abundant at the upstream and downstream Makora Stream sites. Submerged species recorded included the oxygen weeds *Elodea Canadensis* and

Table 4.2: Periphyton and aquatic macrophyte cover (%) recorded at Wairarapa urban streams.

Town	Site	Periphyton Cover (%)	Macrophyte cover (%)
Masterton	**MK1**	40	94
	MK2	92	0
	MK3	0	64
	KP1	24	19
	KP2	10	45
	KP3	62	42
	LH1	38	63
	LH2	66	88
Featherston	**B1**	82	26
Greytown	**T1**	62	14
	PW1	69	3
	PW2	24	0
	PW3	0	94
Reference	**A1**	80	0

Table 4.3: Aquatic macrophyte species recorded from Wairarapa urban streams.

		M[1]								**G**				**F**	**R**
Scientific name	**Common name**	**MK1**	**MK2**	**MK3**	**KP1**	**KP2**	**KP3**	**LH1**	**LH2**	**PW1**	**PW2**	**PW3**	**T1**	**B1**	**A1**
Charophyte															
Nitella hookeri		✓		✓		✓							✓		
Sprawling emergents															
Persicaria hydropiper	Willow weed	✓			✓			✓	✓	✓		✓	✓		
Persicaria decipiens	Willow weed			✓						✓					
Ludwigia palustris	Water purslane	✓						✓							
Apium nodiflorum	Water celery	✓		✓		✓			✓					✓	
Mimulus guttatus	Monkey musk	✓		✓		✓	✓	✓	✓			✓			
Myosotis laxa	Water forget-me-not							✓							
Callitriche stagnalis	Starwort												✓		
Free floating															
Lemna minor	Duckweed	✓						✓	✓	✓				✓	
Azolla rubra	Floating fern									✓					
Submerged															
Elodea canadensis	Canadian pond weed			✓				✓							
Potamogeton crispus	Curled pond weed					✓	✓	✓	✓						
Lagarosiphon major	S.A. oxygen weed				✓	✓	✓								
Myriophyllum aquaticum	Parrot's feather						✓								
Erect emergent															
Carex sp.	Sedge			✓	✓		✓					✓			
Juncus sp.	Rush											✓			
Cyperus eragrostis	Umbrella sedge				✓										
Number of species		**6**	**0**	**6**	**4**	**5**	**5**	**7**	**5**	**4**	**0**	**4**	**3**	**2**	**0**

[1] M = Masterton; G = Greytown; F = Featherston; R = Reference.

Lagarosiphon major (Kuripuni Stream only), *Myriophyllum aquaticum* (lower Kuripuni Stream) and *Potamogeton crispus*. Free floating species recorded included *Lemna minor* and *Azolla rubra* (upper Papawai Stream), with erect emergents recorded including *Carex* sp., *Juncus* sp. and *Cyperus eragrostis*.

No macrophytes were recorded from the reference Abbots Creek site.

5. Riparian Vegetation

Riparian widths recorded along Wairarapa urban streams were variable and did not follow consistent trends between streams (Table 5.1). Riparian widths were strongly correlated with stream shading (rs=0.920). The urban reaches of the Makora Stream, Kuripuni Stream and Papawai Stream had moderate-high stream shading. In comparison, the Landsdowne Hill Stream, Boat Creek and Tilsons Stream were poorly shaded.

Riparian vegetation typically reflected the surrounding landuse. The riparian vegetation at the upstream and downstream pasture dominated sites (MK3, LH1, KP3, PW1 and PW3) contained exotic grasses, exotic woody and exotic non-woody species (Fig. 5.1).

Table 5.1: Riparian width (m) and stream shade (%) recorded along Wairarapa urban streams.

Town	Site	Riparian Width (m)	Riparian shade (%)
Masterton	MK1	3.4	42
	MK2	6.6	46
	MK3	3.8	56
	KP1	30.0	44
	KP2	4.8	48
	KP3	0.0	0
	LH1	0.4	8
	LH2	0.6	6
Featherston	B1	0.0	0
Greytown	T1	2.4	14
	PW1	0.0	0
	PW2	0.9	40
	PW3	0.6	5
Reference	A1	100.0	22

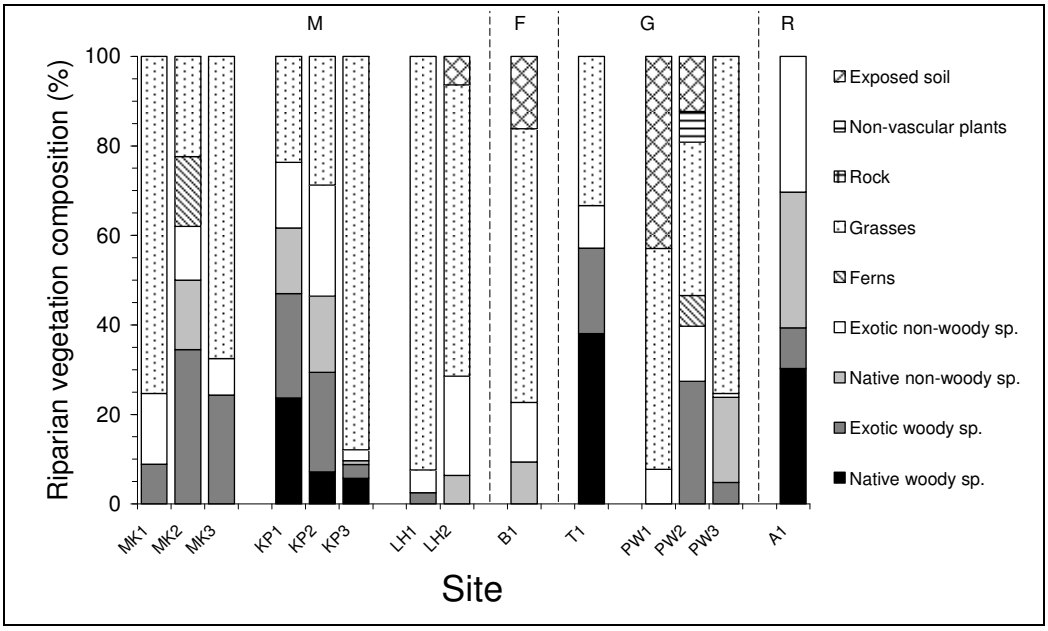

Fig. 5.1: Riparian vegetation recorded from Wairarapa urban streams.

The upper Makora Stream site (MK1) was on the urban boundary of Masterton and pasture land, but also had riparian vegetation dominated by exotic grasses. The riparian vegetation recorded from the upstream Kuripuni site (KP1) was evenly represented by native and exotic woody/non-woody species and exotic grasses. In general, the urban reaches had moderate-good quality riparian vegetation, consisting of a combination of native, exotic woody and non-woody species and exotic grasses, which reflected what property owners had planted in their gardens.

Potentially bad weed species recorded along the Makora Stream included wandering jew (*Tradescantia fluminensis*), crack willow (*Salix fragilis*), tuber ladder fern (*Nephrolepis cordifolia*), arum lily (*Zantedeschia aethiopica*) and monkey musk (*Mimulus guttatus*). There was a particularly bad infestation of monkey musk along the lower reaches of the Kuripuni Stream. Wandering jew was recorded along the Landsdowne Hill Stream, pampas (*Cortaderia selloana*) along Tilsons Stream, and arum lily and monkey musk along Papawai Stream.

The proportion of exotic woody species was positively correlated with riparian width (rs=0.818), stream shade (rs=0.822), and negatively correlated with stream temperature (rs=-0.559). This indicates that exotic trees/shrubs play an important functional role in Wairarapa urban streams by providing favourable temperature conditions for aquatic organisms. The percentage of grass riparian vegetation was positively correlated with macrophyte cover (rs=0.680) and negatively correlated with riparian width (rs=-0.603).

6. Macroinvertebrate Community

6.1 Diversity and Abundance

A total of 62 macroinvertebrate taxa were recorded from the 13 Wairarapa urban stream sites. The number of taxa recorded ranged between 13 taxa at Site T1 (Greytown) and 25 taxa at Site B1 (Featherston) (Fig. 6.1). The median number of taxa recorded was 17 taxa per site. There were 29 taxa recorded from the reference Site A1 on Abbots Creek.

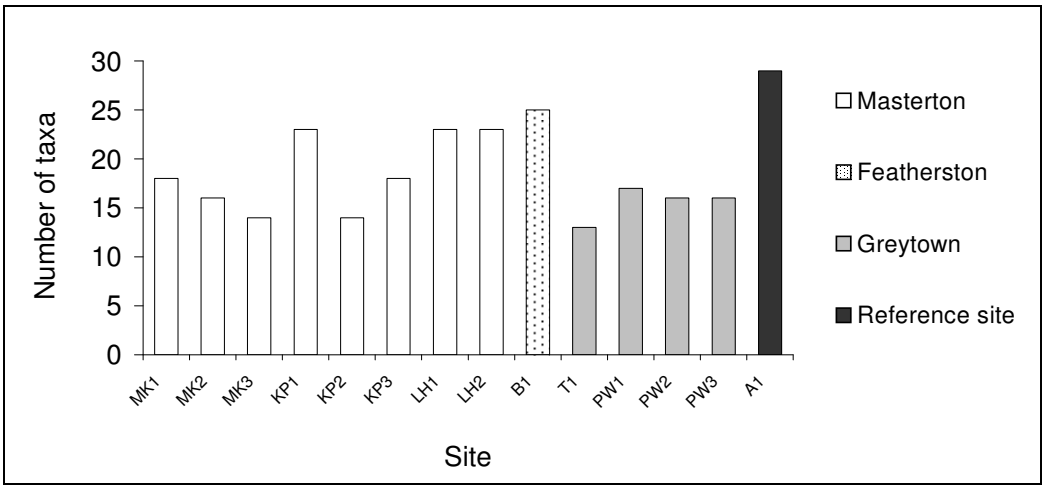

Fig. 6.1: The number of taxa recorded per site from Wairarapa urban streams.

There was a decreasing trend in taxon richness along the Makora Stream. There were fewer taxa recorded from the urban Site KP2 on the Kuripuni Stream. There was no difference in the number of taxa recorded from the upstream (Site LH1) and urban (Site LH2) Landsdowne Hill Stream sites. The number of taxa recorded from the upstream-urban-downstream sites on the Papawai Stream was similar, ranging between 15-17 taxa.

The number of macroinvertebrates recorded per site ranged between 347 individuals at the urban Papawai Stream Site PW2 and 5,112 individuals at the downstream Makora Stream Site MK3 (Masterton) (Fig. 6.2). The median macroinvertebrate abundance was 844 individuals per site, with 609 individuals recorded at the reference Site A1. Sites with high macroinvertebrate abundances were those typically dominated by large numbers (>1,000 individuals) of the amphipod *Paracalliope* and/or *Potamopyrgus* snails. This was evident in the high %dominance values (>75%) recorded for Makora Stream (MK1, MK2 and MK3), Kuripuni Stream (KP1 and KP3) and Papawai Stream (PW3) sites. The median %dominance value for Wairarapa urban streams was 70%, which was much higher than the value recorded from the reference Site A1 (43%).

Macroinvertebrate abundances were greater at the lowermost sites. There was also a decrease in the number of individuals recorded between

the upstream and urban sites sampled from the Makora Stream, Landsdowne Hill Stream and Papawai Stream. The opposite was true for the Kuripuni Stream, with greater abundance recorded from the urban Site KP2 than the upstream Site KP1.

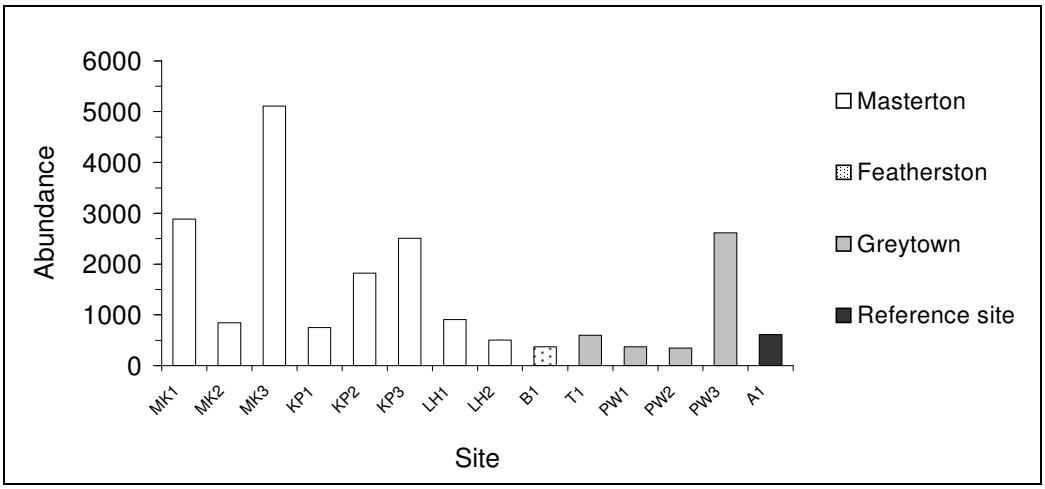

Fig. 6.2: Total macroinvertebrate abundances recorded from Wairarapa urban streams.

6.2 Community Composition

6.2.1 Masterton

Makora Stream

The macroinvertebrate communities recorded from the upstream and urban sites on the Makora Stream (Sites MK1 and MK2) were numerically dominated by large numbers of the mollusc snail *Potamopyrgus* (78% and 85% respectively) (Fig. 6.3).

Molluscs only made up 1% of the downstream MK3 community, with *Physella* snails instead of *Potamopyrgus* being the dominant mollusc recorded. Crustaceans were the next most abundant group, making up between 4% at Site MK2 and 95% at Site MK3. The most common crustacean was the amphipod *Paracalliope*, however other crustaceans recorded included ostracods (all sites), isopods (Site MK1) and the freshwater crayfish *Paranephrops* (koura) (Sites MK2 and MK3).

Dipterans made up between 2-4% of the communities, with *Austrosimulium* (sandflies) the most common dipteran taxa recorded. Tanypodinae chironomids were common at Site MK1 only.

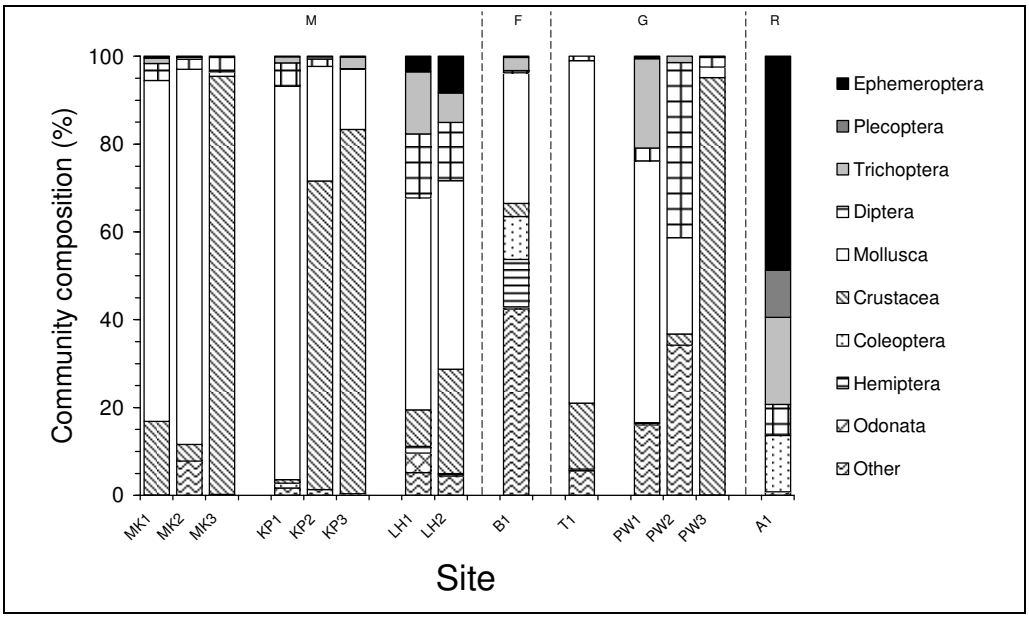

Fig. 6.3: The proportion (%) of the macroinvertebrate communities made up by the predominant macroinvertebrate groups from Wairarapa urban streams.

The greatest proportion of trichopterans (caddisflies) was recorded at Site MK1 (1%) due to moderate numbers of *Polyplectropus* and low numbers of *Pycnocentria*, *Oxyethira* and *Hudsonema*. *Hudsonema* were recorded from all Makora Stream sites. Other caddisflies recorded included *Pycnocentrodes* from Site MK2 and *Hydrobiosis* and *Triplectides* from Site MK3. The stonefly *Megaleptoperla* was recorded from Site MK1 and MK2, the mayfly *Zephlebia* from Site MK1 and the mayfly *Deleatidium* from Site MK2. Other taxa of interest recorded included oligochaetes and leeches from Site MK2 and the damselfly *Xanthocnemis* from Site MK3.

Kuripuni Stream

The macroinvertebrate community recorded from the upstream Site KP1 was dominated by molluscs (90%), with *Potamopyrgus* snails the most dominant mollusc taxon (Fig. 6.3). Site KP1 had a diverse mollusc fauna, with additional taxa recorded including *Physella*, *Gyraulus* and Lymnaeidae snails, the limpet *Ferrissia* and Sphaeriidae bivalves. The proportion of molluscs making up the communities at the urban Site KP2 (26%) and downstream Site KP3 (14%) decreased with distance downstream, which coincided with an increase in the proportion of crustaceans (70% and 83% respectively). In addition, as *Potamopyrgus* numbers decreased between upstream-downstream sites, the number of *Physella* snails progressively increased indicating an increase in organic and nutrient enrichment.

The predominant crustacean recorded was the amphipod *Paracalliope*, with ostracods recorded at Site KP2 and low numbers of the amphipod *Paraleptamphopus* recorded at Site KP1.

The proportion and diversity of dipterans decreased with distance downstream. *Austrosimulium* sandflies were the most commonly recorded dipteran. Chironomids were uncommon in the Kuripuni Stream.

Caddisflies were well represented in the Kuripuni Stream with 9 taxa recorded. The predatory *Psilochorema* and *Triplectides* were recorded across all sites. *Hudsonema* was recorded from the urban Site KP2 and downstream Site KP3 only. The sensitive *Oeconesidae* was recorded at the upstream Site KP1 only, with *Aoteapsyche*, *Pycnocentria* and *Pycnocentrodes* recorded at Site KP3 only. Sensitive mayflies recorded included the generalist mayfly *Deleatidium* at Site KP1 and *Austroclima* at Sites KP2 and KP3.

Landsdowne Hill

Molluscs dominated the Landsdowne Hill Stream Sites LH1 (48%) and LH2 (43%). *Potamopyrgus* snails were most common, with low numbers of *Physella* snails recorded at both sites. *Gyraulus* snails and Sphaeriidae bivalves were recorded at the upstream Site LH1 only. Sites LH1 and LH2 had similar representation by dipterans (15% and 13% respectively), with *Austrosimulium*, and orthoclad and tanypod chironomids the most common dipteran taxa recorded.

Crustaceans were more common at the urban Site LH2, where they represented 24% of the community. Ostracods were the most common crustacean at both sites, with *Paracalliope* amphipods also recorded.

Mayflies represented 8% of the community at Site LH2 and 4% at Site LH1. This was the greatest representation of mayflies at any of the Wairarapa urban sites. The sensitive mayfly *Austroclima* was most common at Site LH1, with *Deleatidium* most common at the urban Site LH2. Caddisflies made up 14% and 7% of the macroinvertebrate communities at Site LH1 and LH2 respectively. The most common caddisflies were *Hudsonema* and *Oxyethira*, with *Pycnocentria* recorded at Site LH1 and *Aoteapsyche*, *Psilochorema* and *Triplectides* recorded at Site LH2.

The damselfly *Xanthocnemis*, water bug *Sigara*, water moth *Hygraula* and oligochaetes were recorded at both sites, but were recorded in higher abundances at Site LH1. Water mites were more common at Site LH2 but also recorded at Site LH1.

6.2.2 Featherston

The macroinvertebrate community recorded from Site B1 on the Boat Creek was diverse in relation to the other Wairarapa urban streams with 25 taxa recorded. The largest proportion of the community was represented by 'other' taxa (42%), especially oligochaetes, but also low numbers of flatworms, nemerteans and leeches (Fig.6.3). The next most common group was molluscs (30%), with *Potamopyrgus* and *Physella* snails recorded in equal numbers.

Hemipterans (water bugs) represented 11% with *Sigara* the most common recorded along with low numbers of *Microvelia* and *Anisops* (backswimmer). Elmid riffle beetles and a single Hydraenidae individual represented 10% of the community.

The caddisfly fauna was diverse, with seven taxa including *Aoteapsyche*, *Hudsonema*, *Olinga*, *Oxyethira*, *Paroxyethira*, *Pycnocentrodes* and *Triplectides*; however in combination they represented only 3% of the community. A single *Coloburiscus* mayfly individual was recorded at this site, which is significant as this mayfly is considered to be sensitive, especially to low dissolved oxygen concentrations and typically found in high velocity, bush streams with stable flow conditions.

Ostracods were the only crustacean recorded, representing 3% of the community. Dipterans were poorly represented, with only single Ephydridae and Stratiomyidae individuals recorded.

6.2.3 Greytown

The mollusc snail *Potamopyrgus* dominated the macroinvertebrate community recorded from the small Tilsons Creek (T1), and along with *Physella* snails and Sphaeriidae bivalves represented 78% of the community (Fig. 6.3). Ostracods made up 15% of the community. Five dipteran taxa made up 1% of the community and included Orthocladiinae chironomids, *Paralimnophila*, Sciomyzidae, Stratiomyidae and *Zelandotipula*. Oligochaetes were the dominant 'other' taxon recorded and representing 5% of the community. No EPT taxa were recorded from Site T1.

The macroinvertebrate community recorded from the upstream Papawai Stream Site PW1 was numerically dominated by *Potamopyrgus* snails, with low numbers of *Physella* snails and Sphaeriidae bivalves also recorded and thus representing 60% of the community. The proportion of molluscs was lower at downstream sites, where they represented 22% of the community at the urban Site PW2 and 2% at Site PW3. Conversely, the proportion of crustaceans increased with distance downstream from 0% at Site PW1, 3% at Site PW2 and 95% at Site PW3. The large proportion of crustaceans at Site PW3 was due to large numbers of *Paracalliope* amphipods. *Paranephrops* (koura) were recorded from the urban Site PW2.

Caddisflies represented 20% of the community at Site PW1 due to a relatively large number of *Hydrobiosis* recorded (60 individuals). Caddisflies were poorly represented at downstream sites (Sites PW2 and PW3), where only low numbers of *Oxyethira* and *Psilochorema* were recorded. Single *Austroclima* and *Deleatidium* mayfly individuals were recorded from Site PW1. No mayflies were recorded from downstream sites. Dipterans had greatest representation at Site PW2 (40%) due to *Austrosimulium* (sandflies) and *Polypedilum* chironomids. Dipterans recorded from the urban Site PW2 and downstream Site PW3 included *Chironomus* chironomids, Hexatomini, *Paralimnophila* and Stratiomyidae.

Oligochaetes were common at Sites PW1 (15%) and PW2 (31%). Flatworms and water mites were recorded from Site PW2 only.

6.2.4 Reference Stream (Abbots Creek)

The macroinvertebrate community recorded from the reference Site A1 on Abbots Creek was of high quality and represented by a large number and proportion of EPT taxa (Fig. 6.3). Mayflies represented the largest proportion of the community with 49%. *Deleatidium* were the most abundant mayfly, representing 43% of the community. Other mayflies recorded included *Nesameletus, Acanthophlebia* and a single *Zephlebia* individual. The community contained a diverse caddisfly fauna, with 10 taxa representing 20% of the community. The most common caddisfly taxon was the sensitive *Olinga* (MCI 9). Other sensitive caddisflies (MCI ≥7) recorded included *Costachorema*, *Orthopsyche*, *Plectrocnemia*, *Psilochorema* and *Pycnocentria*. Other caddisfly taxa recorded included *Aoteapsyche*, *Hydrobiosis*, *Oxyethira* and *Pycnocentrodes*.

6.3 Biological Indices

The MCI values recorded for Wairarapa urban streams ranged between 71 and 92 (median 84), which indicates severe-moderate organic enrichment (Fig. 6.4, refer Table 2.2).

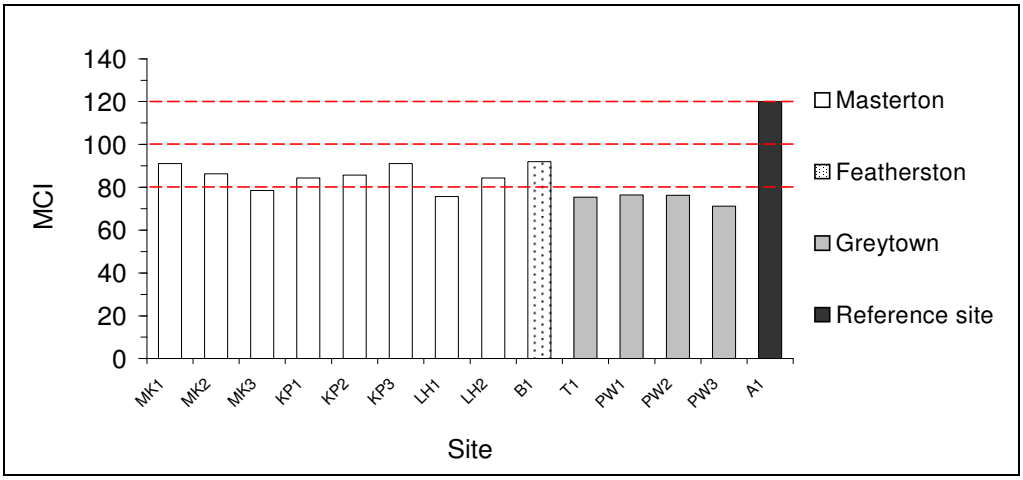

Fig. 6.4: MCI values recorded from Wairarapa urban streams.

The Masterton and Featherston urban streams generally had higher MCI values that the Greytown urban streams. There was a decreasing trend in MCI values recorded between upstream-downstream Makora Stream sites, but an increasing trend for the Kuripuni Stream and Landsdowne Hill Stream with distance downstream. The upstream and urban Papawai Stream sites had similar MCI values.

When comparing MCI and QMCI values, it can be seen that for the urban Makora, Landsdowne Hill, Boat and Papawai Stream sites, the QMCI values indicate poorer water quality than the MCI values (Fig. 6.4 & 6.5). This variance suggests these urban sites contain a greater proportion of lower scoring taxa in relation to higher scoring taxa. In contrast, the lower Makora and Papawai Stream sites had QMCI values that indicated higher water quality than the MCI values. This was due to lower numbers of low scoring *Potamopyrgus* snails (MCI 2) and greater numbers of moderate scoring *Paracalliope* amphipods (MCI 5).

The reference Abbots Creek site had high MCI (120) and QMCI (7.5) values, which indicate this stream has clean water.

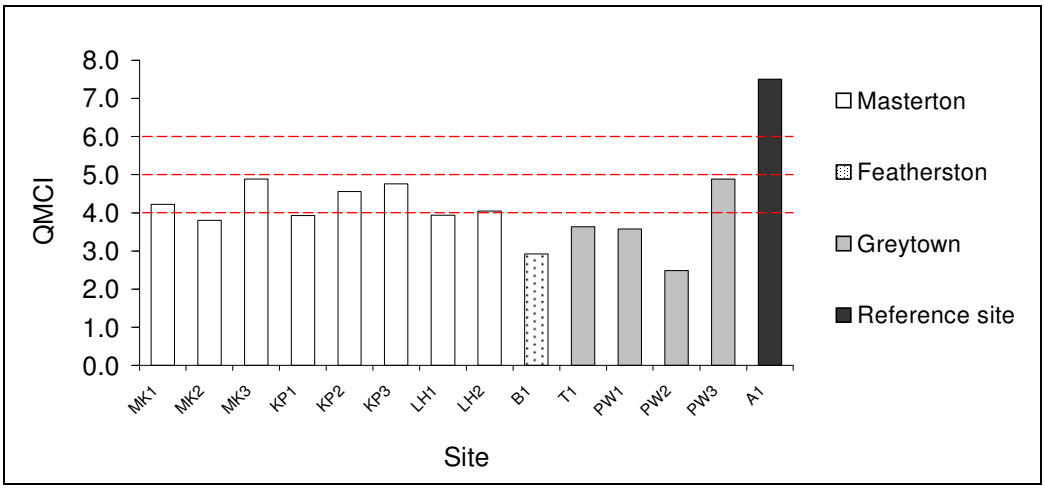

Fig. 6.5: QMCI values recorded from Wairarapa urban streams.

The number of EPT taxa recorded from Wairarapa urban streams ranged between 0-7 taxa (median 4 taxa) (Fig. 6.6). The only site not to have any EPT taxa was the roadside drain section of Tilsons Stream. In contrast, 16 EPT taxa were recorded from the reference Abbots Creek site.

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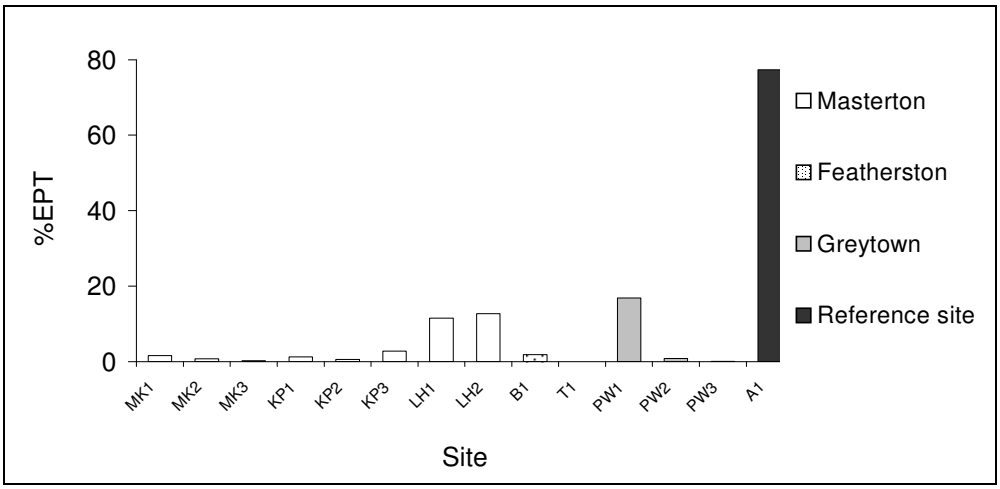

Fig. 6.6: Number of EPT taxa recorded from Wairarapa urban streams

As a percentage of the communities, EPT taxa made up between 0-17% (median 1.2%). The urban streams with the greatest proportion of EPT taxa were the Landsdowne Hill sites (LH1 and LH2) and the upstream Papawai site (Fig. 6.7). EPT taxa made up 77% of the community at the reference Abbots Creek site, with the mayfly *Deleatidium* the most abundant (representing 43%).

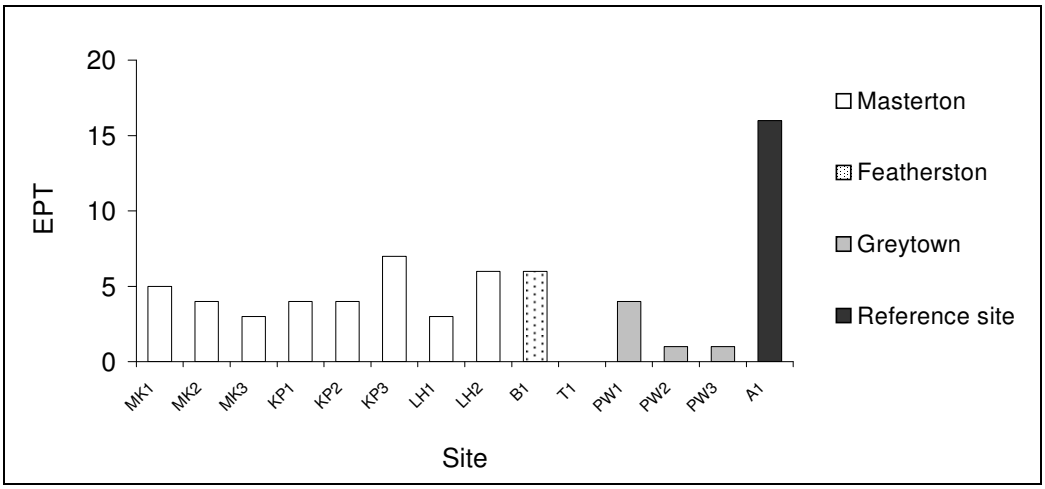

Fig. 6.7: Proportion of EPT taxa making up the communities recorded from Wairarapa urban streams.

6.4 Community Relationships with Habitat and Water Quality

The MDS ordination yielded a two-dimensional solution with a stress value of 0.12, which indicates a useful 2-dimensional picture of the data (Fig. 6.8). Macroinvertebrate and habitat parameters that were significantly correlated ($p<0.05$) with axis scores are shown in Fig. 6.8.

Axis 1 was associated with an upstream-downstream trend, with higher QMCI values ($r_s=0.887$) and greater macroinvertebrate abundances ($r_s=0.799$) (most notably the amphipod *Paracalliope*) correlated with downstream sites that had greater macrophyte cover, channel widths and stream depths. Upstream sites with greater periphyton cover were correlated with snails (predominantly *Potamopyrgus)* and 'other' species such as oligochaetes. Snails and stoneflies were correlated with Axis 2, however it should be noted that stoneflies were only recorded from the Makora Stream.

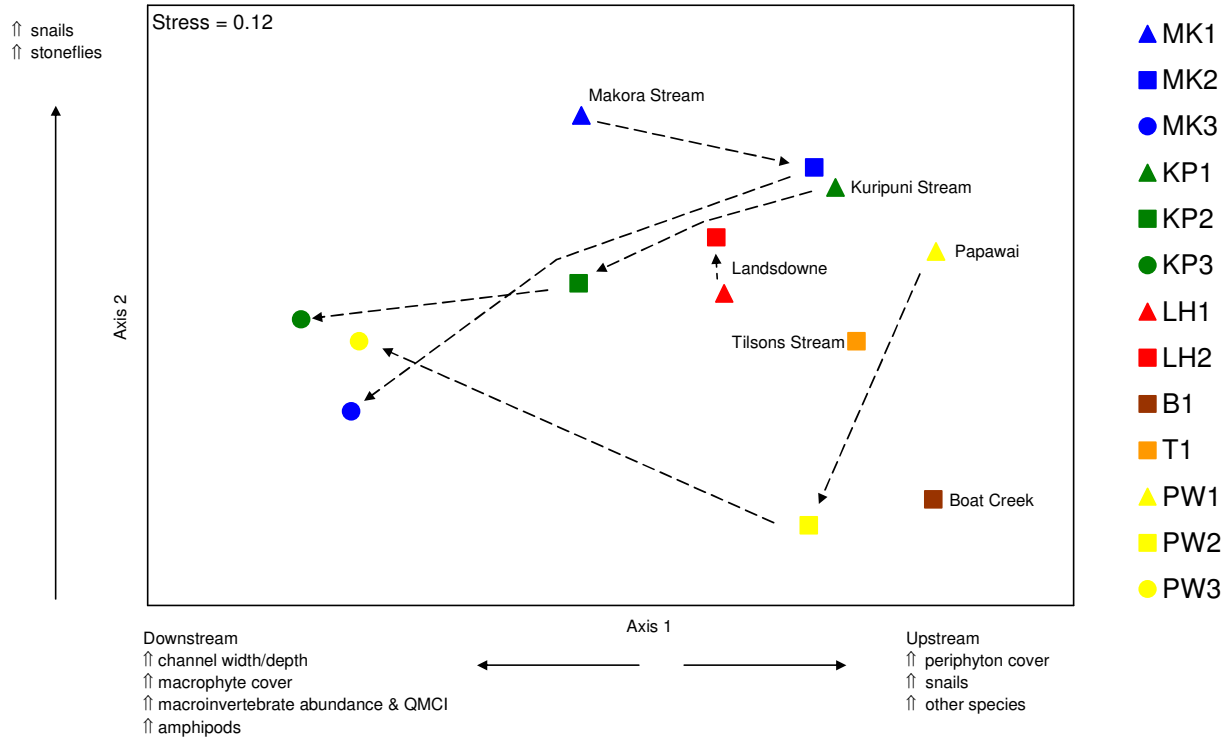

Fig. 6.8: An nMDS ordination of the Wairarapa urban stream community data.

Although not correlated with either MDS axis, the proportion of large gravel was positively correlated with higher biological index values (e.g., taxa richness, MCI, EPT and %EPT (rs>0.550)). Periphyton cover was positively correlated with coarse substrates (e.g., large gravel, small cobble, large cobble) (rs>0.650) and mayflies (rs=0.568). Caddisflies were correlated with large gravel (rs=0.574) and mayflies correlated with large cobbles (rs=0.618). In contrast, fine sand/silt substrates were correlated with lower biological index values (rs<-0.550).

Stream temperature was positively correlated with periphyton cover (rs=0.594), mayfly abundance (rs=0.575), Odonata abundance (rs=0.765) and Hemiptera abundance (rs=0.692). All stream temperatures recorded were within acceptable limits recommended for sustaining aquatic life. Conductivity was positively correlated with macroinvertebrate abundance (rs=0.560), MCI values (rs=0.702) and stoneflies (rs=0.620).

In Wairarapa urban streams, macroinvertebrate communities appeared to be most influenced by habitat conditions such as stream size (channel width and depth), substrate size, macrophyte cover and periphyton cover. Sensitive macroinvertebrate taxa were generally associated with coarse substrates. Fewer taxa were associated with fine silt/sand substrates, however macrophytes where present, provided habitat for large numbers of moderate scoring taxa such as *Paracalliope* amphipods.

7. Fish Communities

The fish fauna recorded from the Makora Stream and Kuripuni Stream (both Masterton) were of low diversity with only longfin eel (*Anguilla dieffenbachii)*, shortfin eel *(Anguilla australis)*, upland bully *(Gobiomorphus breviceps)* and brown trout *(Salmo trutta)* recorded during a survey undertaken in April 2005 on behalf of GWRC (Table 7.1). Fish diversity in the Papawai Stream is similarly of low diversity with longfin eel, shortfin eel and giant kokopu *(Galaxias argenteus)* listed in the New Zealand Freshwater Fish Database (NZFFD). Six fish species including longfin eel, shortfin eel, common bully *(Gobiomorphus cotidianus)*, Crans bully *(Gobiomorphus basalis)*, common smelt *(Retropinna retropinna)* and brown trout have been recorded from the control site (Abbots Creek).

The only fish of national conservation significance recorded from the Wairarapa urban streams were longfin eels, which are considered to be under gradual decline (Hitchmough 2002).

8. Characteristics of Wairarapa and Wellington Urban and Peri-urban Streams

8.1 Introduction

The urban streams surveyed in the present study form a part of a larger study of urban streams of the Wellington region. In this section we compare the Wairarapa urban streams with results from studies on urban streams in Wellington City, Porirua, Kapaiti Coast and Lower Hutt (Kingett Mitchell 2005).

Table 7.1: Fish species recorded from Wairarapa urban streams.

Scientific name	Common name	M[1]					G	R
		MK2	MK3	KP1	KP2	KP3	PW1	A1
Native Species								
Anguilla australis	Shortfin eel	✓	✓	✓	✓	✓	+	+
Anguilla dieffenbachii	Longfin eel	✓	✓		✓		+	+
Galaxias argenteus	Giant kokopu						+	
Gobiomorphus cotidianus	Common bully							+
Gobiomorphus basalis	Crans bully							+
Gobiomorphus breviceps	Upland bully					✓		
Retropinna retropinna	Common smelt							+
Introduced Species								
Salmo trutta	Brown trout	✓	✓		✓			+
		3	3	1	3	2	3	6

[1] M = Masterton; G = Greytown; R = Reference.
✓ = GWRC records (April 2005); + = NZFFD records.

8.2 Invertebrates

Not surprisingly, modified urban and lowland floodplain streams were significantly different in the type and abundance of invertebrates compared to sites elsewhere in the Wellington region. By comparison, stream sites within low-lying peri-urban areas, or with particular characteristics (e.g., Site K5 below the reservoir, Site K2 in Ngaio Gorge, Site KM1 in Khandallah Park, Site PW3 at Papawai Stream; MK3 at Makora Stream) were characterised by a greater relative abundance of amphipods, shrimps or koura.

On average, the benthic fauna of the Wairarapa and Wellington Streams were similar and high in species diversity (total taxa = 111 and 62 (Wellington and Wairarapa streams respectively); mean = 16 and 17 respectively) compared to sites in Auckland (e.g., Waitakere City: total taxa = 82; mean = 13, Kingett Mitchell 2000; North Shore City: total taxa = 57; mean = 10, Kingett Mitchell 2001; Auckland area: total taxa = 78; mean = 10, (Allibone et al. 2001).

As noted above, the macroinvertebrate communities of Wairarapa urban streams were most influenced by habitat conditions such as stream size (channel width and depth), substrate size, macrophyte cover and periphyton cover. In contrast, other Wellington urban streams were related more to shade, native riparian vegetation and larger substrate sizes. Thus the presence and influence of plants and periphyton is important in shaping the streams of the Wairarapa region.

8.3 Instream and Riparian Habitat

Substrate characteristics differed little between Wellington urban streams but differed from Wairarapa urban streams which were typically characterised by a higher proportion of coarse sized particles.

Riparian vegetation and stream bank characteristics varied between streams. For Wairarapa streams, riparian vegetation typically reflected the local landuse amongst sites, while urban streams in Wellington general were characterised by riparian margins of grass and less native vegetation at lower quality stream health (and sites with higher ecological values were characterised by riparian margins with a greater native vegetation component.)

8.4 Landuse

Despite the urban character of the streams sampled in the Wairarapa region, the predominant landuse is pasture; most of the streams sampled arose from springs in pasture (Boat Creek is an exception). The source of flow from springs, the relatively short distance from source of the urban centres (and our sampling sites), and the low-lying nature of the streams with no steep upper catchment eroding and the lack of riparian vegetation

in many cases, means that these streams differ in character from those of the Greater Wellington region.

8.5 Stream Classification

The stream classification for the Wellington urban streams identified 7 stream clusters or groups (Kingett Mitchell 2005). As might be expected, urban catchment characteristics differed between the stream groups. Typically, highly urbanised low-lying streams were characterised by increasing water depth, sand and gravel substrates, increasing macrophyte cover and with riparian margins increasingly grassed and characterised by less native vegetation and with poorer ecological condition.

As outlined above, the urban streams sampled in Wairarapa are characterised by different factors of habitat. The Wairarapa streams are typically placed in the centre of the stream clusters representing Wellington streams.

8.6 Wellington Urban Stream Management Strategy

In the study of urban streams of Greater Wellington, Kingett Mitchell (2005) suggested four management groups for urban stream management in the Wellington region:

- Stream Management 1 (SM1) - Natural or forested.
- Stream Management 2 (SM2) - Natural semi-modified.
- Stream Management 3 (SM3) - Urban and rural modified.
- Stream Management 4 (SM4) - Urban modified.

These were developed from a cluster analysis of 7 groups and modified by an analysis of the stream characteristics. The analysis above suggests that the urban streams of Wairarapa are typically characterised by different factors, in particular the pastoral and low-lying nature of the streams. This might be represented by a category:

- Stream Management 3a (SM3a) – Wairarapa urban and rural modified.

The development of an urban stream management strategy for Wellington will need to incorporate the key characteristics outlined above. Although impacts of urbanisation on stream ecology are apparent in Wellington and an environmental gradient from good quality to highly modified streams is apparent, some elements that characterise the Waiararapa streams will require a different approach.

9. Summary

A total of 14 sites were sampled within urban streams of the Wairarapa region, with assessments of riparian vegetation, instream vegetation, bank stability and macroinvertebrate communities. Overall, streams within the Wairarapa were characterised by predominantly pastoral landuse, a spring source of flow (rather than from ranges) and the overall low-lying nature of the catchments. Highest water and habitat quality sites were present in the upper catchments in most cases (Stream Management Group 1), although moderate quality streams were evident in some mid-catchment sites. In contrast, the lowest water and habitat quality sites were within the lower floodplain sites (Management Group 4), which included the largest number of the sites sampled. The development of an urban stream management strategy for Wellington will need to incorporate the key characteristics Wellington and Wairarapa streams.

10. References

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Appendix 1

Photographs of Survey Sites

Appendix 1: Site Photos

Masterton Streams

MK1 - Upstream Makora Stream at Pownell Road.

MK2 - Urban Makora Stream site at Makora Road

MK3 - Downstream Makora Stream at Highway.

KP1 – Upstream Kuripuni Stream at old hatchery.

KP2 – Urban Kuripuni Stream at Dixon Street.

KP3 – Downstream Kuripuni Stream at Dixon Street.

LH1 - Upstream Landsdowne Hill Stream at council reserve.

LH2 - Urban Landsdowne Hill Stream at Totara Street.

Greytown Streams

PW1 - Upstream Papawai Stream at Wilkie Street.

PW2 - Urban Papawai Stream at SH 2, Greytown.

PW3 - Downstream Papawai Stream at Papawai Road.

T1 – Urban Tilsons Stream at Jellicoe Street.

Featherston and Reference Site

B1 – Urban Boat Creek at SH2, Featherston.

A1 – Reference site on Abbots Creek, SH 2.