BIOTA OF WAIRAKA STREAM

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Contents:

1 Introduction

The Wairaka Stream originates from a culturally significant spring emerging on-campus from ground water percolating through basalt of the Mt Albert lava fields. The stream follows a course across basalt lava prior to combining with Oakley Creek and discharging into the Waitemata Harbour at the Motu Manawa (Pollen Island) Marine Reserve. As a hard-bottomed stream with relatively clear water, it is a rare (and thus valuable) hydrosystem within urban Auckland.

The Wairaka Stream and the catchment is typical of an urban setting with respect to the state of degradation – loss of riparian vegetation, exposure to sunlight, and addition of point and indirect sources of pollutants (especially from hard roadway surfaces). One positive attribute, however, is that much of the stream is open, although there are two piped sections (22m and 128m respectively).

The restoration of ecosystem components and processes is a key element in the sustainable management of any environment. The restoration of the Wairaka Stream is a pivotal step towards sustainable environmental management of the Unitec campus, and an important activity given the cultural significance of the stream.

To measure any improvement in the stream resulting from any restoration activity, the current status of the stream (baseline data) needs to be established – this report represents such information on the plant and macroinvertebrate components of the stream community gathered over 2012. Repeated surveys in future years using the same (standardised) methodologies will allow comparisons in quality indices that can track changes resulting from restoration actions, and thus inform ongoing management of the catchment.

2 Vegetation

Historically, the Wairaka Stream consisted of three branches, with the course of the eastern branch now represented only by two sediment settlement ponds and the western branch presumably piped underground. The central branch is the only significant part of the stream remaining, and within the campus grounds the stream has been heavily modified and channel flow has been piped in sections.

The channel predominantly follows alongside campus buildings and roads. It flows on an old lava flow with some plantings on the bank edges. Storm-water and runoff feed directly into the stream. For the purpose of this survey the existing stream has been split into three zones (see Fig. 1) for classification, cataloguing and description of plant species.

2.1 Methods

An area search was conducted along the stream to identify all species present. Collections were made into voucher specimens for identification in the laboratory, and accessioned into the Unitec Herbarium. Plants identified for this survey were located in the stream itself or along the semi submerged margin. Samples were not taken from the riparian plantings or from the bank above the flood line.

Figure 2: Wairaka Stream showing plant study zones (Blue = Zone 1; yellow = Zone 2; red = Zone 3).

2.2 Results

The results of the aquatics vegetation survey of Wairaka Stream are shown in Table 1. Species lists and abundance are included in Appendix 1.

Table 1: Vegetation totals along Wairaka Stream.

Plant group	*Native*	*Naturalised*	*Totals*
Algae			3
Lichens	13		13
Bryophytes	4	1	6
Ferns	3	2	3
Dicotyledons			26
Monocotyledons	1		8

2.3 Discussion

Amenity plantings present:
At the origin of the stream an area of native garden and riparian species have been established and are managed as an amenity garden (Figs 2.1 & 2.2; Zone 1). Species present in this garden include common native species such as *Ackama rosifolia*, *Arthropodium cirratum*, *Astelia banksii*, *Cordyline australis, Cyathea medullaris*, *Leptospermum* cultivars, and *Veronica* (*Hebe*) cultivars.

Other riparian species that have been planted closer to the stream edge environment include *Apodasmia similis, Carex secta*, *Cortaderia fulvida*, *Machaerina juncea*, *Phormium* spp. and *Syzygium maire.* Further down the stream there are established Crack Willows (*Salix fragilis)* and golden weeping willows (*Salix xchrysocoma)* (Fig. 6, Zone 3), the roots of which grow into the channel and may impact on flow.

Zone One:
This section of stream has established and managed riparian plantings, mostly native species as mentioned above. However there is little management of the weeds that grow on the stream bank or in the channel and they are left to grow and spread freely (Figs. 3 & 4). Species present growing in the channel include *Potamogeton crispus* and *Rorippa nasturtium-aquaticum.*

Fig. 3: Zone 1, stream origin (C. Reynolds 07/08/12).

Fig. 4: Zone 1, weed spread into stream (C. Reynolds 07/08/12).

Zone Two:

This area is mainly surrounded by mown *Pennisetum clandestinum* (Kikuyu grass). Although this year there has been riparian planting along the edges connecting up to zone one (Fig. 5). Species that have been planted into this area include *Carex secta, Cordyline australis, Cortaderia fulvida, Griselinea lucida, Hedycarya arborea, Leptospermum scoparium, Phormium* spp., *Plagianthus regius, Pseudopanax arboreus* and *Sophora microphylla*.

At the end of this zone is where the majority of storm-water enters the stream system, originating from the campus roads, car parks and constructed wetland, (Fig. 6), roughly following the original course of the eastern branch of the stream. This area of stream is also inhabited by many pukeko (*Porphyrio porohyrio*).

Fig. 5: Zone 2, riparian planting (C. Reynolds 07/08/12).

Fig. 6: Zone 2, storm water entering stream (C. Reynolds 07/08/12).

Zone Three:
The final part of the stream that was sampled emerges from a piped section that travels under one of the campus roads (Fig. 6). In this zone, the stream has a narrow channel, moderate flow and approximately 1m high banks (Fig. 7). Here the water is collected in a shallow pond with *Potamogeton crispus* growing in it and *Arthropodium cirratum* and *Clivia miniata* planted around the edges.

The stream then flows over a constructed waterfall (Fig. 8) that has the endemic moss *Fissidens waiensis* growing alongside *F. leptocladus* (Fig. 9) and runs alongside another campus road lined with crack willows (*Salix fragilis*), golden weeping willows (*Salix xchrysocoma*) and the occasional clump of *Agapanthus praecox* subsp. *orientalis* and *Zantedeschia aethiopica*.

Fig. 7: Zone 3, waterfall and crack willows (C. Reynolds 07/08/12).

Fig. 8: Location of *Fissidens waiensis*, Zone 3 (C. Reynolds 07/08/12).

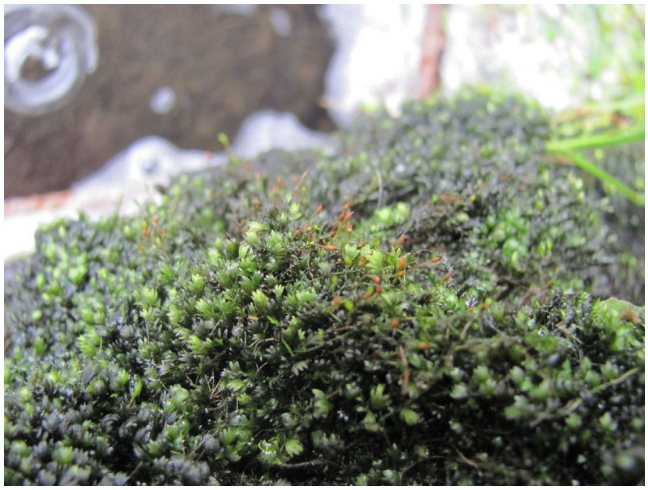

Fig. 9: *Fissidens waiensis* and *F. leptocladus* with capsules (C. Reynolds 07/08/12).

Species of interest:
The endemic moss *Fissidens waiensis* was found and collected. This species has not been collected before in this site and has never been collected with fertile structures. In this survey the Bryophytes have not been systematically studied in detail yet, however there are voucher specimens for four mosses a *Bryum* sp. (UNITEC 005407), *Fissidens waiensis* (UNITEC 005310), *Fissidens leptocladus* (UNITEC 005408) and *Leptdictym riparium* (UNITEC 005295), all identified by Dr Jessica Beever (Landcare Research).

Weeds that need management:
These include *Ehrharta erecta, Tradescantia flumensis, Zantedeschia aethiopica.* These are invasive species and should be considered for management, and should not be allowed to spread further downstream and subsequently into Oakley Creak. Their continued growth will be detrimental for the stream's ecology. Reports of weed-eating taking place along the stream edge will contribute to weed spread further downstream; this management technique could be revised.

2.4 Recommendations

1. Weed control and removal of exotics, with minimisation of weed-eating as a control techniques.

2. Removal of willow roots from stream channel.

3. Continuation of riparian planting within a 5m buffer along stream in exposed areas to provide shade and habitat for native fauna.

3 Macroinvertebrates:

Assessing the assemblage of macroinvertebrates of freshwater streams is a recognised tool for determining water quality worldwide (Boothroyd & Stark 2000). A number of taxonomic indices can be generated from the data gathered. The indices used in this investigation are:

- taxonomic richness (total number of macroinvertebrate taxa);
- number of EPT taxa (Ephemeroptera = mayflies; Plecoptera = stoneflies; Trichoptera = caddisflies);
- %EPT taxa (percentage of the EPT taxa as a proportion of the total taxa);
- MCI score (calculated averaging predetermined taxon sensitivity scores (Boothroyd & Stark 2000).

3.1 Methods

Macroinvertebrate were sampled from the Wairaka Stream at five sites (Fig. 10):
1 – beside newly planted riparian vegetation (close to 180-B001)
2 – beside Te Noho Kotahitanga marae;
3 – within the wetland outlet before the confluence with Wairaka Stream;
4 – Carrington's;
5 – below the outlet of the culvert taking the stream under the road and horticulture buildings.

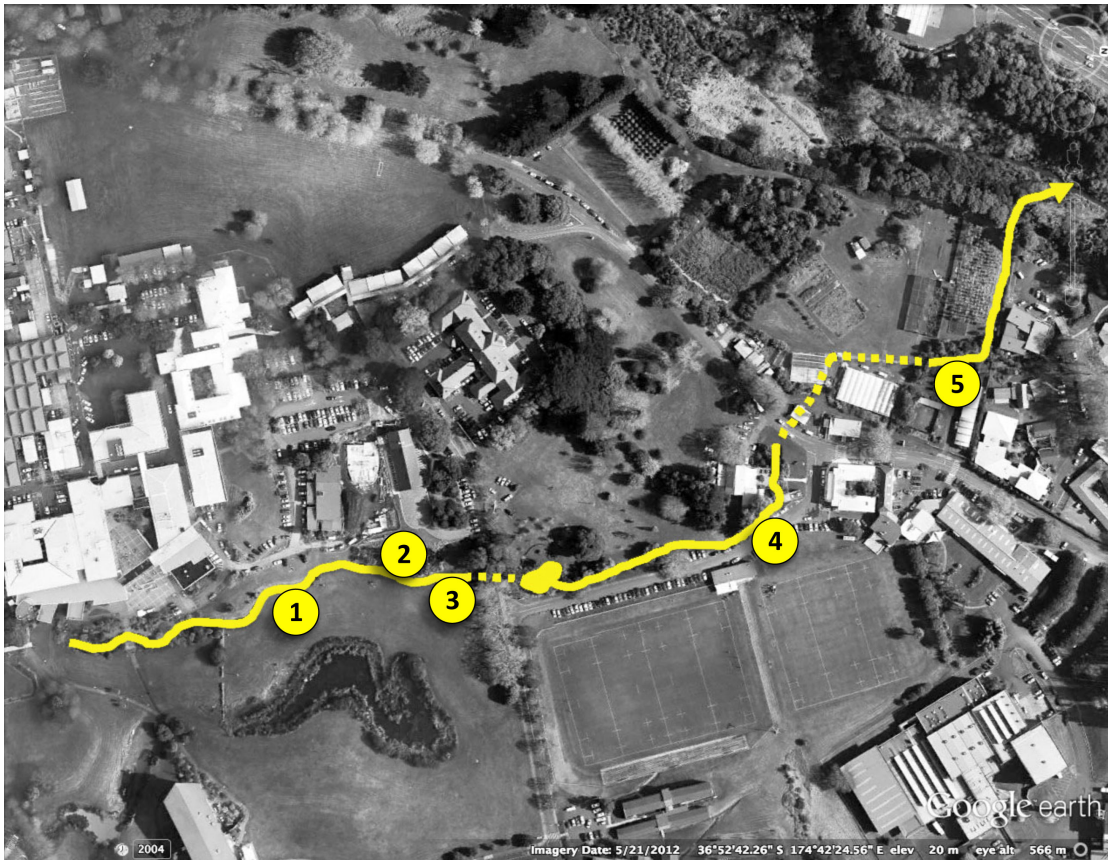

Fig. 10: Location of invertebrate samples points (1 = New planting; 2 = Marae; 3 = wetland outlet; 4 = Carrington's; 5 = culvert outlet)

All samples were collected using the standard New Zealand protocols (Stark et al. 2001; Moore & Neale 2008) for hard-bottom streams. This involved using Protocol C1 (Stark et al. 2001) where a fixed area of stream bed is disturbed upstream of a hand held net. The samples were placed in labelled containers and processed on the same day as collection in the laboratory.

Samples were processed using Protocol P1 (Stark et al. 2001) and invertebrates were identified to an appropriate level for the MCI (primarily genus or family level) using suitable identification keys (e.g. Winterbourn et al. 2006; Gooderham & Tsyrlin 2002). Invertebrate taxa were placed into the semi-quantitative abundance categories:

- rare (R)= 1 to 4 individuals
- common (C) = 5 to 19 individuals
- abundant (A) = 20 to 99 individuals
- very abundant (VA) = 100 to 499 individuals
- very, very abundant (VVA) = 500+ individuals

Macroinvertebrate data were collated in Excel spreadsheet that automatically calculated the range of biotic indices (taxonomic richness, number of EPT taxa, %EPT taxa, MCI score).

3.2 Results

The macroinvertebrate community of Wairaka Stream was sampled in August 2012. The results of this sampling are shown in Tables 2 and 3. Species lists and abundance are included in Appendix 2.

Table 2: Summarised results for macroinvertebrate samples, Wairaka Stream, August 2012.

Biodiversity indicator	Sample site				
	1 New planting	2 Marae	3 Wetland outlet	4 Carrington's	5 Culvert outlet
Number of Taxa	15	14	8	17	15
EPT Value	2	2	1	1	1
% EPT (taxa number)	13.3%	14.3%	12.5%	5.9%	6.7%
MCI Value	62.7	68.6	67.5	74.1	76.0
SQMCI Value	3.59	2.99	3.88	4.25	4.13

Table 3: Interpretation of water quality scores, Wairaka Stream, August 2012.

Biodiversity indicator	Average value	Interpretation (Boothroyd & Stark 2000; Stark & Maxted 2004, 2007)
Number of Taxa	13.8	non-impaired
EPT Value	1.4	poor
% EPT (taxa number)	10.5%	severely impaired
MCI Value	69.8	poor, probable severe pollution
SQMCI Value	3.8	poor, probable severe pollution

3.3 Discussion

The quality of Wairaka Stream is clearly well below that of a high quality reference stream. However, although the biodiversity indicators collectively suggest that the quality of Wairaka Stream is degraded, this does not necessarily suggest that the water is polluted (S. Moore, pers comm.). The addition of the water from the constricted weltand does not appear to degrade the stream.

Water entering the stream originates from groundwater. It is of a temperature that promotes high oxygen levels, and there is a range of habitats along the stream course that should favour a range of macroinvertebrate taxa. There are, however, a number of attributes that are likely to impact negatively on the macroinvertebrate assemblage present and the potential for colonisation of new species:

1. Groundwater is naturally low in the organic matter that is drives a stream ecosystem. Where there is sufficient light and appropriate substrate, aquatic alage plants are present and do contribute organic matter to the system. In addition, organic matter in the form of leaves and woody material does accumulate throughout the stream course. The quantity of organic matter, however, is still relatively low as a result of the short length of the stream and the young riparian planting. It is expected that organic matter will increase over time as the riparian planting grows (this riparian planting will also function to maintain the water at a cooler temperature than if left exposed).

2. Wairaka Stream is geographically isolated from source populations of macroinvertebrates, and is located within a highly fragmented urban landscape. For macroinvertebrates to populate new streams, they need to disperse from source populations against the flow direction, or by air if there is a winged phase of their life-cyle. Where macroinvertebrate species are locally limited, as in the case with most urban habitats, source populations may be too far away, for effective colonisation (Bredervel et al. 2011).

3. Adult flying insects may be most active over the actual stream channel (Smith et al. 2009). Thus culverts along the watercourse will constitute barriers for flighted

adults (Blakely et al. 2006), limiting the degree of upstream colonisation. The Wairaka Stream has two such barriers, one of which is of considerable length (128m).

4. The downstream drift of macroinvertebrates is a major mechanism for population dispersal (Smith et al. 2009). The low productivity of the stream at its groundwater source, coupled with the short length of the stream, limit the potential for repopulation of the macroinvertebrates through downstream drift

Stream size, physical barriers and geographic isolation, therefore, limit the macroinvertebrate assemblage of the Wairaka Stream on both regional and local scales. Existing species may restricted in their dispersal along the water course, and new species may be too far away to colonise. Thus low macroinvertebrate diversity of the Wairaka Stream is likely to be an underestimation of the water quality.

3.4 Recomendations

1. The monitoring of macroinvertebrates of the stream should be carried out regulalrly, possibly on a biennial basis.

2. Further riparian planting is favoured, although it recognised that a compromise between this and any desired ammenity/visual values may need to be explored.

3. A comparison with other urban streams would identify macroinvertebrate species that could be considered for re-introduction to appropriate habitats.

4. *Daylighting of the culverted sections of the stream would be beneficial for macroinvertebrates in the longer-term, although it recognised that would be an very costly exercise.*

5 References

Blakely, T.J., Harding, J.S., McIntosh, A.R. and Winterbourn, M.J. 2006. Barriers to the recovery of aquatic insect communities in urban streams. *Freshwater Biology* 51: 1634–1645.

Boothroyd, I. and J. Stark. 2000. Use of invertebrates in monitoring. In Collier, K.J. and M.J. Winterbourn (eds). *New Zealand stream invertebrates: ecology and implications ofr management.* New Zealand Limnological Society, Christchurch.

Bredervel, R.J., Ja¨ hnig, S.C., Lorenz, A.W., Brunzel, S. and Soons, M.B. 2011. Dispersal as a limiting factor in the colonization of restored mountain streams by plants and macroinvertebrates. *Journal of Applied Ecology* 48: 1241–1250.

Gooderham, J. and E. Tsyrlin. 2002. *The waterbug book*. CSIRO, Collingwood.

Johnson, P. N. and Brooke, P. A. 1998. *Wetland Plants in New Zealand.* Manaaki Whenua Press.

Moore, S. & Neale, M.W. (2008). *Freshwater Invertebrate Monitoring: 2003–2007 analysis and evaluation*. Prepared by Landcare Research and Auckland Regional Council for Auckland Regional Council. Auckland Regional Council Technical Report 2008/010.

Smith, R.F., Alexander, L.C. and Lamp, W.O. 2009. Dispersal by terrestrial stages of stream insects in urban watersheds: a synthesis of current knowledge. *Journal of the North American Benthological Society* 28: 1022–1037.

Stark, J., Boothroyd, I., Harding, J., Maxted, J. and Scarsbrook, M. 2001 . *Protocols for sampling macroinvertebrates in wadeable streams.* New Zealand Macroinvertebrate Working Group Report No. 1. Prepared for the Ministry for the Environment. Sustainable Management Fund Project No. 5103.

Winterbourn, M.J., Gregson, K.L.D. & Dolphin, C.H. 2006. *Guide to the Aquatic Insects of New Zealand*. Bulletin of the Entomological Society of New Zealand 14.

APPENDIX 1:

Plant species collected and identified in the Wairaka Stream

Key to species list

* = native species
a = abundant
c = common
o = occasional
s = sparse

SPECIES	COMMENTS	VOUCHER
Algae		
Algae sp.	a, unidentified, present in all zones	UNITEC 005314
Compsopogon caeruleus	s,	UNITEC 002516
Nitella hookeri	c, present in all zones	UNITEC 001815
Lichens		
Caloplaca sp.*	s, growing over culvert zone 2	UNITEC 005364
Cladonia sp.*	c, growing on rocks zone 1	UNITEC 005366
*Dirinaria applanata**	a, growing on rocks zone 1	UNITEC 005359
*Heterodermia speciosa**	a, growing on rocks zone 1	UNITEC 005357
*Lepraria incana**	o, growing over culvert zone 2	UNITEC 005361
*Leptogium coralloideum**	o, growing on willow zone 3	UNITEC 005367
*Leptogium cyanescens**	o, growing on rocks zone 1	UNITEC 005362
*Parmotrema reticulatum**	a, growing on rocks zone 1	UNITEC 005356
*Phaeophysica orbicularis**	c, growing on rocks zone 1	UNITEC 005360
*Placopsis perrugosa**	c, growing on rocks zone 1	UNITEC 005363
*Usnea rubicunda**	a, growing on rocks zone 1	UNITEC 005358
*Xanthoparmelia scabrosa**	a, growing on rocks zone 1	UNITEC 005368
*Xanthoria ligulata**	a, growing on rocks zone 1	UNITEC 005365
Ferns		
*Adiantum aethiopicum**	s, zone 1, one plant present	UNITEC 005289
*Christella dentata**	o, zone 1, growing in shallows	UNITEC 005288
*Pteris tremula**	o, present around rocks	UNITEC 005278
Bryophytes		
Bryum sp.	a, common in all zones	UNITEC 005407
*Fissidens leptocladus**	o, zone 3 on waterfall and rocks	UNITEC 005408
*Fissidens waiensis**	o, zone 3 on waterfall and rocks	UNITEC 005310
*Leptodictyum riparium**	a, common in all zones	UNITEC 005295
Lunularia cruciata	a, large population in zone 3	UNITEC 005312
*Marchantia berteroana**	o, growing on rocks down to water level	UNITEC 005313

Dicotyledons

Callitriche stagnalis	o, all zones	UNITEC 005282
Cardamine flexuosa	o, zone 3 located on stream bank	UNITEC 005307
Cardamine hirsuta	o, zone 3 located on stream bank	UNITEC 005306
Epilobium ciliatum	a, all zones	UNITEC 005291
Ficus pumila	s, zone 3	UNITEC 005409
Fumaria muralis	a, common in all zones	UNITEC 005410
Galium debile	c, all zones	UNITEC 005281
Geranium gardneri	a, all zones and surrounding gardens	UNITEC 005297
Hydrocotyle moschata var *moschata*	c, zone 1, open areas	UNITEC 005280
Hydrocotyle tripartita	c, mainly zone 2 in stream shallows	UNITEC 005286
Lotus pedunculatus	a, open areas into stream shallows	UNITEC 005304
Ludwigia palustris	c, present in all zones	UNITEC 005279
Myosotis laxa ssp. *Caespitosa*	a, present in all zones	UNITEC 005294
Nasturtium officinale	s, zone 3	UNITEC 001812
Persicaria decipiens	o, zone 3	UNITEC 001809
Persicaria maculosa	c, zone 1, open areas	UNITEC 005276
Persicaria punctata	c, zone 2 in stream shallows	UNITEC 005305
Plantago lanceolata	a, zone 2 open boggy shallows	UNITEC 005302
Ranunculus repens	a, present in all zones	UNITEC 005287
Rorippa nasturtium-aquaticum	a, present in all zones	UNITEC 005290
Rumex obtusifolius	a, present in all zones mainly 2 and 3	UNITEC 005301
Soleirolia solierolii	o, zone 3, potential garden escapee	UNITEC 005308
Stachys arvensis	a, present in all zones	UNITEC 005285
Veronica americana	a, all zones among Rorippa sp	UNITEC 005292
Veronica persica	a, open areas into stream shallows	UNITEC 005298
Veronica serpyllifolia	o, zone 3, stream bank	UNITEC 005309

Monocotyledons

Cyperus involucratus	o, zone 1	UNITEC 005293
Ehrharta erecta	a, in zone 1	UNITEC 005277
Juncus articulatus	a, in all zones, mainly in 2 and 3	UNITEC 005300
*Lemna disperma**	a, in all zones	UNITEC 005411
Landoltia punctata	a, in all zones	UNITEC 005412
Potamogeton crispus	a, in all zones	UNITEC 005283
Tradescantia flumensis	a, all zones mainly zone 3	UNITEC 005299
Zantedeschia aethiopica	o, zone 2 only young plants present	UNITEC 005303

APPENDIX 2:

Macroinvertebrate species identified in the Wairaka Stream

Rare (R)= 1 to 4 individuals
Common (C) = 5 to 19 individuals
Abundant (A) = 20 to 99 individuals
Very abundant (VA) = 100 to 499 individuals
Very, very abundant (VVA) = 500+ individuals

Taxa	MCI score	Sample site				
		New planting	Marae	Wetland outlet	Carringtons	Below Culvert
TRICOPTERA *Oxyethira*	2	A	A	C	C	R
TRICOPTERA *Paroxyethira*	2	C	C			
ODONATA *Xanthocnemis*	5	R	R		C	C
HEMIPTERA *Microvelia*	5		C			R
DIPTERA *Austrosimulium*	3	VA	A	R	VA	A
DIPTERA Culicidae	3	R				
DIPTERA Empididae	3	R				
DIPTERA Hexatomini	5				R	R
DIPTERA Orthocladiinae	2	A	C	A	A	C
COLLEMBOLA	6		R		R	C
CRUSTACEA Copepoda	5			A	C	
CRUSTACEA Ostracoda	3	R	A	VA	C	
CRUSTACEA *Paracalliope*	5	VA	VVA	VA	VVA	VA
CRUSTACEA *Paratya*	5					C
CRUSTACEA Talitridae	5				R	
MITES	5	R	R		R	R
MOLLUSCA *Physa/Physella*	3			R	R	
MOLLUSCA *Potamopyrgus*	4	C		A	VVA	A
OLIGOCHAETA	1	C	VVA		A	A
LEECHES	3	R				
FLATWORMS	3	R	C		C	C
NEMATODES	3		R		R	R
NEMERTEA	3					R
HYDROIDEA (*Hydra viridis*)	3	R	C		R	

Number of Taxa		**15**	**14**	**8**	**17**	**15**
EPT Value		**2**	**2**	**1**	**1**	**1**
% EPT (taxa number)		**13.3%**	**14.3%**	**12.5%**	**5.9%**	**6.7%**
MCI Value		**62.7**	**68.6**	**67.5**	**74.1**	**76.0**
SQMCI Value		**3.59**	**2.99**	**3.88**	**4.25**	**4.13**