

Study Our Streams
Aquatic Benthic Macroinvertebrate Communities in Streams on the North Shore of Lake Superior, 2009

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December 2010

Introduction

Benthic macroinvertebrates respond to ecosystem changes faster than other members of the aquatic community and therefore are commonly used as indicator species to assess the health of aquatic ecosystems. Trends and changes in aquatic macroinvertebrate populations and in their community structure can serve as indicators of short-term stresses that may ultimately influence the aquatic community of Lake Superior. EcoSuperior Environmental Programs has been acquiring baseline data about the macroinvertebrate communities in unimpaired streams on the north shore of Lake Superior and investigating the benthic community structure in possibly impaired sites.

The goals of the current study were fivefold: to assess seven minimally-impacted streams on the north shore of Lake Superior for their suitability as reference condition sites, to reassess the biological health of two streams considered possibly impaired in an earlier study (Deacon & Lavoie 2008), to resample benthic macroinvertebrates at one site that had previously been sampled during June of 2009 to determine the effect of season on the composition of the benthic macroinvertebrate community, to re-evaluate two reference condition sites that had previously been sampled to determine the year-to-year effect on the composition of the benthic macroinvertebrate communities, and to assess three urban test sites that were possibly impaired.

Procedure

We examined all watersheds draining into Lake Superior between Thunder Bay and Sault Ste. Marie to find rivers and streams that were minimally- impacted and of variable size, stream order, substrate and other physiographic features (Deacon & Lavoie 2008). The criteria used to determine whether or not a stream was minimally- impacted are outlined by the Ontario Benthos Biomonitoring Network (Jones *et al.*, 2005).

The aquatic benthic macroinvertebrate communities were sampled at seven minimally-impacted candidate reference condition sites (Wesley Creek, Little Cypress River, Dublin Creek,

Wolf River, Cedar Creek, Whitewood Creek and Pitch Creek, Fig. 1) during September and October 2009. The Wolf River site, which was sampled in June 2009 by Lakehead Region Conservation Authority personnel, was resampled by EcoSuperior in late September 2009 to determine the effect of season on the composition of the benthic macroinvertebrate community.

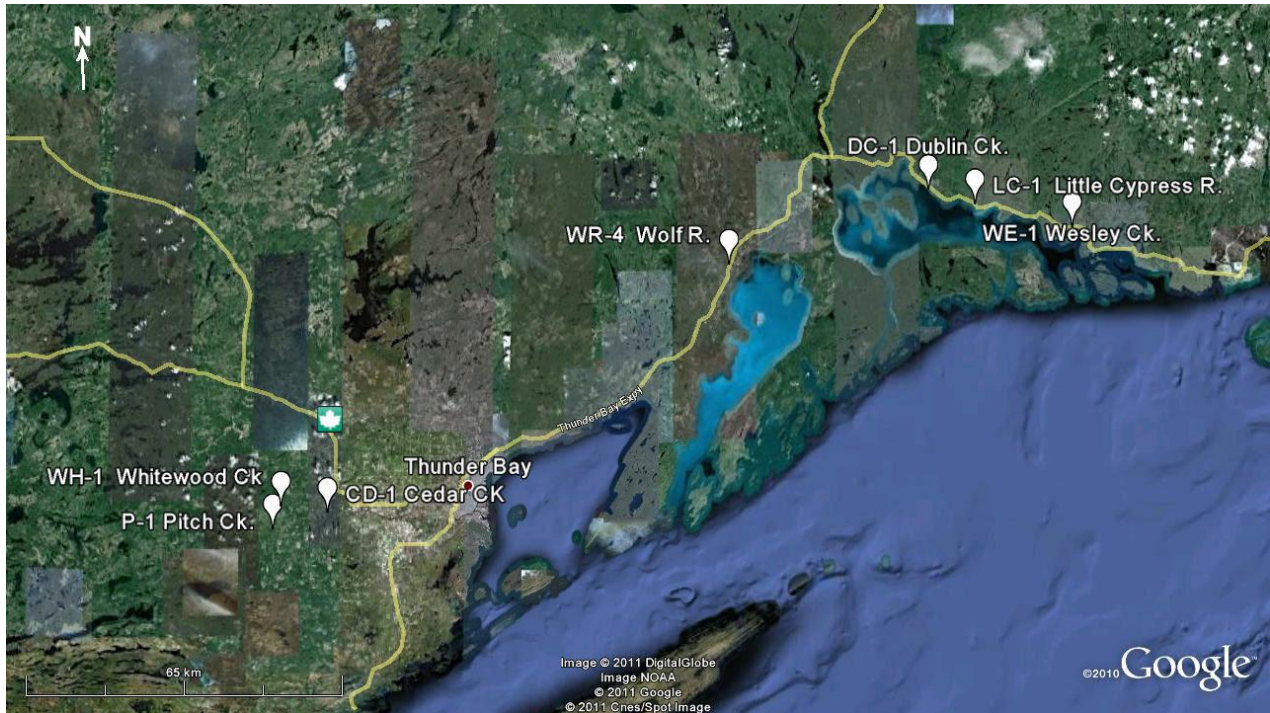


Figure 1. Minimally-impacted candidate reference condition aquatic benthic macroinvertebrate sampling sites, 2008.

Barrett River and Coldwater River sites were sampled in early October 2009. The macroinvertebrate communities were considered possibly impaired when surveyed in 2007, and a reassessment of the benthic communities was recommended.

The Current River site (CU-14) was sampled during late September 2009. This site had been sampled in mid-October of 2004, the end of June 2005 and late September 2008; therefore, we hoped to determine if any changes had occurred in community structure due to seasonal variation and/or annual variation. We also sampled the Jackpine River during late September 2009. This site had been sampled in mid-September of 2005, 2007 and 2008; therefore, we wanted to determine if any changes had occurred in community structure from year to year.

Two streams within the city limits of Thunder Bay were sampled in mid-September as urban test sites (Fig. 2). One site on McVicar Creek (MVU-2) and two sites on the McIntyre River (MIU-1 & MIU-2) were sampled.

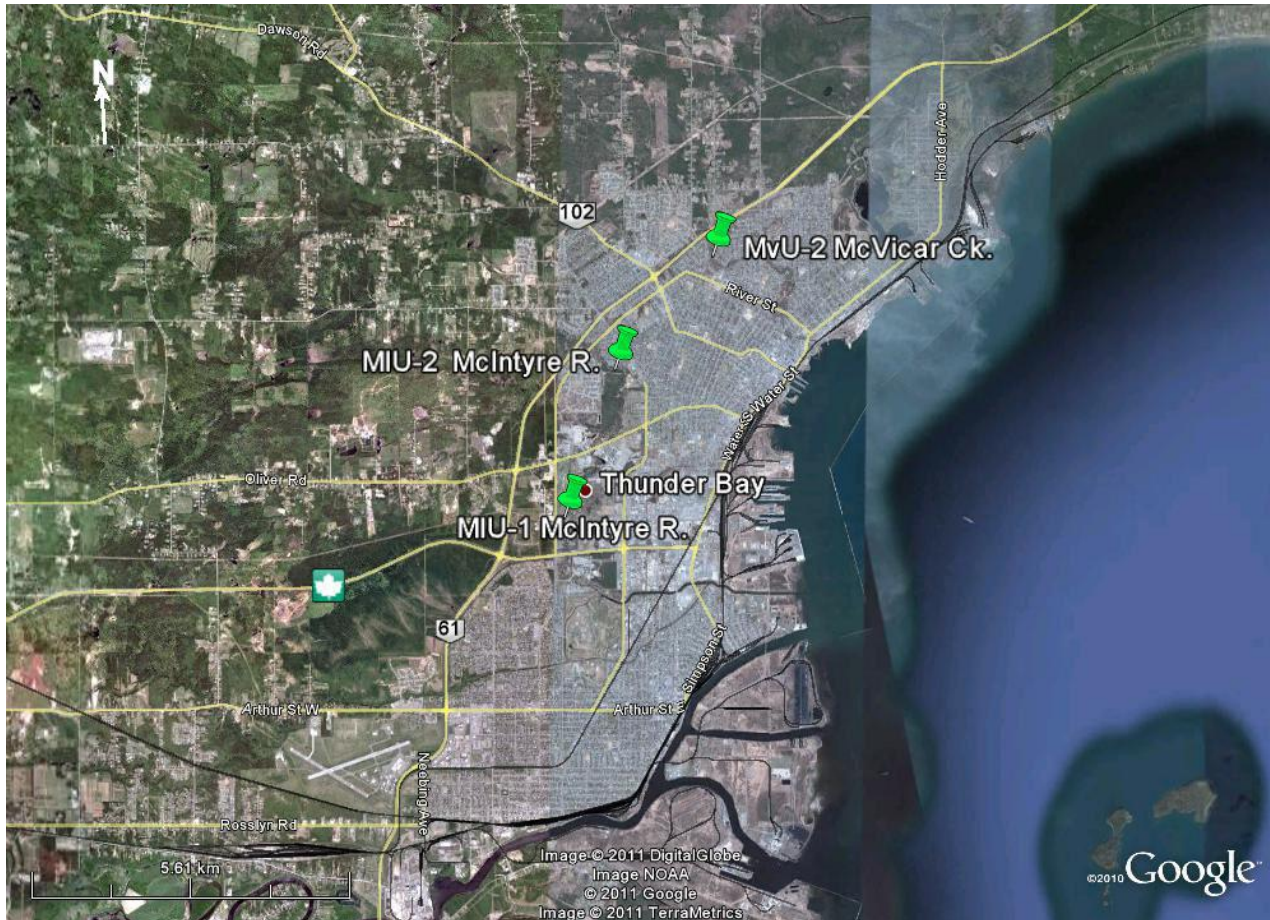


Figure 2. Urban aquatic benthic macroinvertebrate sampling test sites, Thunder Bay, 2008.

Benthic macroinvertebrates were sampled at all sites according to OBBN protocol (Jones *et al.*, 2005), using a traveling kick-and-sweep with a 500-micron D-net. Three sub-samples were collected at each of the sites and each sub-sample was preserved in the field in 96% ethanol. The sub-samples were then sorted in the laboratory. A minimum of 100 benthic macroinvertebrates were randomly picked from each of the sub-samples using a Nikon SMZ1500 at 10X magnification. The macroinvertebrates were identified using taxonomic keys by Clarke (1981), Peckarsky *et al.* (1990), Merritt *et al.* (2008), and Wiggins (1996). Most organisms were identified to Order or Family level to facilitate the determination of various biotic indices. Orders such as Ephemeroptera, Plecoptera, and Trichoptera are particularly sensitive to impaired water quality, and were therefore identified to the Genus level when possible (Appendix 1 - Appendix 15).

The aquatic benthic macroinvertebrate community was assessed according to the 27-taxa Reference Condition Approach (RCA) as outlined in the Ontario Benthos Biomonitoring Network Protocol Manual (Jones *et al.* 2005). The OBBN is a partnership led by the Ontario Ministry of the Environment and Environment Canada's Ecological Monitoring and Assessment Network

(EMAN). The 27-Taxa include: Amphipoda, Anisoptera, Bivalvia, Ceratopogonidae, Chironomidae, Coelenterata, Coleoptera, Culicidae, Decapoda, Ephemeroptera, Gastropoda, Hemiptera, Hirudinea, Isopoda, Lepidoptera, Megaloptera, Miscellaneous Diptera, Nematoda, Oligochaeta, Plecoptera, Simuliidae, Tabanidae, Tipulidae, Trichoptera, Trombidiformes, Turbellaria, and Zygotera. The biotic indices used to characterize the benthic communities include: Total Abundance, Richness, Dipteran Richness, Insect Richness, Simpson's Index, Shannon's Diversity Index, Hilsenhoff Biotic Index (HBI), % Dominants, % Ephemeroptera Odonata Trichoptera (EOT), % Ephemeroptera Plecoptera Trichoptera (EPT), % Chironomids, % Crustacea, % Dipterans, % Gastropods, % Mollusca, % Non-Dipteran Insects, % Odonates, % Pelecypods, and % Oligochaetes (Worms).

The OBBN biotic indices (Table 1) (Jones et al., 2005) used to analyse the 27-taxa identified from the candidate sites provide an insight into present and past conditions experienced by the aquatic macroinvertebrate communities. Some of the biotic indices (high % Worms, high % Chironomids) are useful for identifying sites that are heavily impacted by nutrient enrichment. Nutrient enrichment will cause premature eutrophication resulting in low dissolved oxygen in the water, with consequent degradation of the habitat. Both worms and chironomids are tolerant of low-oxygen concentrations and become the dominant organisms in eutrophic ecosystems. Chironomids are also highly tolerant of toxic chemicals; therefore, they can survive and become dominant in conditions that kill other organisms, including worms. Other biotic indices (high % EPT, low Hilsenhoff Biotic Index) help to confirm high water quality at the site. Ephemeroptera, Plecoptera and Trichoptera (EPT) are intolerant of toxins and require oxygen concentrations that are close to saturation. The Hilsenhoff Biotic Index (HBI) is calculated using tolerance values assigned to the various macroinvertebrate taxa (Tables 1 & 2). EPT have low HBI values, whereas worms and chironomids have high HBI values. HBI values above 6.0 are considered indicative of an impaired system, usually because of organic enrichment which can cause eutrophication. Each biotic index provides a separate insight into the quality of the habitat. The combination of several indices makes it possible to evaluate the relative, long-term health of the site. However, not all biotic indices are necessary to determine whether a site is impaired, or whether it should be considered a suitable reference condition site.

The selected biotic indices used to evaluate all the sites were: Richness, Shannon's H' Diversity, Hilsenhoff Biotic Index, % Dominant, % EPT, % Chironomids, and % Worms (Table 1). These biotic indices were compared with data from streams on the north shore of Lake Superior (Deacon & Lavoie, 2005; Deacon & Lavoie 2008; Deacon & Lavoie 2009) to determine whether the values obtained were high or low in relation to other regional reference condition sites. General physiographic features (Table 3) combined with biotic indices (Tables 4-7) provided

Table 1. Biotic Indices: calculations and descriptions.

Subcategory	Index	How to Calculate:	Indication
Richness/Diveristy	ABUNDANCE	Sum of Organisms	possibly impaired if extremely low or high value
	RICHNESS	Count of taxa found in a sample	the greater the number of taxa the higher the quality of the habitat
	INSECT RICHNESS	Count of Chironomidae+Culicidae +Ceratopogonidae +Tipulidae +Tabanidae +Simuliidae+Odonates(Zygoptera and Anisoptera) + Coleoptera + Ephemeroptera + Hemiptera + Lepidoptera + Megaloptera + Plecoptera + Trichoptera + misc Dipterans	the greater the number of taxa the higher the quality of the habitat
	DIPTERIAN RICHNESS	Count of Chironomidae+Culicidae +Ceratopogonidae+Tipulidae+Tabanidae+ Simuliidae	the greater the number of taxa the higher the quality of the habitat
	SIMPSON'S INDEX	Proportion of species i relative to the total number of species (p_i), squared Squared proportions for all the species summed, and the reciprocal is taken	probability that two individuals will belong to the same taxon
	SHANNON'S H' DIVERSITY	$H' = -\sum(p_i * \ln(p_i))$ where p_i =proportion of the count of each taxa	high values indicate increased evenness of the counts among the taxa and higher quality habitat
Composition	%AMPHIPODA	Sum of amphipoda /abundance *100	associated with eutrophic conditions
	%CHIRONOMIDAE	Sum of Chironomidae / Abundance*100	extremely abundant in highly eutrophic situations, but present in all habitats
	%CRUSTACEANS and MOLLUSCA	(Sum of Amphipoda+Decapoda+Isopoda +Gastropoda + Pelecypoda) /Abundance*100	associated with eutrophic conditions, but present in many habitats
	%CRUSTACEANS	(Sum of Amphipoda+Decapoda+Isopoda) /abundance*100	associated with eutrophic conditions, but present in many habitats
	%EPHEMEROPTERA	Sum of Ephemeroptera /abundance*100	the greater the value the higher the quality of the habitat
	%GASTROPODS	Sum of Gastropoda /abundance*100	associated with eutrophic conditions, but present in many habitats
	%HIRUDINEA	Sum of Hirudinea /abundance*100	associated with eutrophic conditions, but present in many habitats
	%ISOPODA	Sum of Isopoda /abundance*100	associated with eutrophic conditions
	%MOLLUSCA	(Sum of Gastropoda + Pelcypoda) /abundance*100	associated with eutrophic conditions, but present in many habitats
	%ODONATES	(Sum of Anisoptera and Zygoptera) /abundance*100	the greater the value the higher the quality of the habitat
	%OLIGOCHAETES	Sum of Oligochaetes /abundance*100	abundant in highly eutrophic situations, but present in many habitats
	%PELECYPODA	Sum of Pelecypoda /abundance*100	the greater the value the healthier the habitat
	%TIPULIDAE	Sum of Tipulidae /abundance*100	possibly impaired if extremely high value, but present in many habitats
	%TABANIDAE	Sum of Tabanidae /abundance*100	possibly impaired if extremely high value, but present in many habitats
	%SIMULIDAE	Sum of Simuliidae /abundance*100	possibly impaired if extremely high value, but present in many habitats
	%DIPTERA	(Sum of Chironomidae+Culicidae +Ceratopogonidae +Tipulidae+Tabanidae+Simuliidae +misc Dipterans) / Total Abundance* 100	possibly impaired if extremely low or high value
	%INSECTS	(Sum of abundance of Chironomidae+Culicidae +Ceratopogonidae +Tipulidae+Tabanidae+Simuliidae+Odonates (Zygoptera and Anisoptera) + Coleoptera + Ephemeroptera + Hemiptera + Lepidoptera + Megaloptera + Plecoptera + Trichoptera + misc Dipterans)/ Total Abundance* 100%	possibly impaired if extremely low or high value
	%NON-DIPTERIAN INSECTS	(Sum of Zygoptera + Anisoptera + Coleoptera + Ephemeroptera + Hemiptera + Lepidoptera + Megaloptera + Plecoptera + Trichoptera)/Total Abundance* 100	a high value indicates higher water quality than a lower value
	%EPT	(Sum of Ephemeroptera + Plecoptera + Trichoptera) / Abundance * 100	a high value indicates higher water quality than a lower value
	%EOT	(Sum of Ephemeroptera + Anisoptera + Zygoptera + Trichoptera) / Total Abundance * 100	a high value indicates higher water quality than a lower value
Tolerance	%DOMINANT	Abundance of the Most Common Taxon / abundance * 100	the dominance of a pollution tolerant group indicates an impaired site
	HILSENHOFF'S BIOTIC INDEX	$=\sum(x_i \cdot t_i) / \text{Total abundance}$ where x_i =abundance of each taxa and t_i = tolerance value for each taxa.	a low value implies low nutrient conditons. Values above 6.0 are of concern

Table 2. Tolerance Values (Hilsenhoff 1988) used in the calculation of the Hilsenhoff Biotic Index.

Family	Tolerance	Family	Tolerance
PLECOPTERA			
Capniidae	1	Perlidae	1
Chloroperlidae	1	Perlodidae	2
Leuctridae	0	Pteronarcyidae	0
Nemouridae	2	Taeniopterygidae	2
Peltoperlidae	?		
EPHEMEROPTERA			
Baetidae	4	Metretopodidae	2
Baetiscidae	3	Oligoneuriidae	2
Capnidae	7	Polymitarcyidae	2
Ephemerellidae	1	Potomanthidae	4
Ephemeridae	4	Siphonuridae	7
Heptageniidae	4	Trycorythidae	4
Leptophlebiidae	2		
ODONATA			
Aeshnidae	3	Gomphidae	1
Calopterygidae	5	Lestidae	9
Coenagrionidae	9	Libellulidae	9
Cordulegastridae	3	Macromiidae	3
Corduliidae	5		
TRICHOPTERA			
Brachycentridae	1	Molannidae	6
Glossosomatidae	0	Odontoceridae	0
Helicopsychidae	1	Philopotamidae	3
Hydropsychidae	4	Phryganeidae	4
Hydroptilidae	4	Polycentropodidae	6
Lepidostomatidae	1	Psychomyiidae	2
Leptoceridae	4	Rhyacophiliidae	0
Limnephilidae	4	Sericostomatidae	3
MEGALOPTERA			
Corydalidae	0	Sialidae	4
LEPIDOPTERA			
Pyralidae	5		
COLEOPTERA			
Dryopidae	5	Psephenidae	4
Elmidae	4		
DIPTERA			
Athericidae	2	Psychodidae	10
Blephariceridae	0	Simuliidae	6
Ceratopogonidae	6	Muscidae	6
Blood-red Chironomidae	8	Syrphidae	10
Other (including pink) Chironomidae	6	Tabanidae	6
Dolichopodidae	4	Tipulidae	3
Empididae	6		
Ephydriidae	6		
AMPHIPODA			
Gammaridae	4	Talitridae	8
ISOPODA			
Asellidae	8		

Table 3. Physiographic features of the streams sampled in Thunder Bay, Sept-Oct, 2009.

Site Name	Site Code	Category	Hydraulic Head (mm)	Dissolved Oxygen (ppm)	Substrate	Cover (%)	Algae	Woody Debris	Detritus
Barrett River	B-1-1	Riffle	75	10.2	boulder, cobble	25-49	slimes/crusts	abundant	present
	B-1-2	Pool	33		sand, cobble		slimes/crusts	present	present
	B-1-3	Riffle	30		boulder, cobble		attached	abundant	present
Coldwater River	CW-1-1	Pool	8	10.2	sand, cobble	0-24	absent	abundant	present
	CW-1-2	Riffle	23		cobble, gravel		slimes/crusts	abundant	present
	CW-1-3	Riffle	23		boulder, cobble		slimes/crusts	abundant	present
Wesley Creek	WE-1-1	Riffle	10	8.0	boulder, sand	75-100	attached/slimes/crusts	present	abundant
	WE-1-2	Pool	1		cobble, sand		slimes/crusts	present	abundant
	WE-1-3	Riffle	6		cobble, sand		slimes/crusts	present	abundant
Little Cypress	LC-1-1	Riffle	4	7.9	gravel, silt	75-100	absent	abundant	abundant
	LC-1-2	Pool	1		cobble, silt		absent	abundant	abundant
	LC-1-3	Riffle	7		gravel, silt		absent	abundant	abundant
Dublin Creek	DC-1-1	Riffle	9	10.6	cobble, sand	25-49	fimaments/attached/slimes/crusts	present	present
	DC-1-2	Pool	1		sand, gravel		fimaments/attached/slimes/crusts	present	abundant
	DC-1-3	Riffle	7		cobble, gravel		fimaments/attached/slimes/crusts	present	abundant
Jackpine River	JP-1-1	Riffle	40	9.6	cobble, gravel	0-24	attached/slimes/crusts	abundant	abundant
	JP-1-2	Pool	1		sand, gravel		attached/slimes/crusts	present	present
	JP-1-3	Riffle	25		boulder, cobble		attached/slimes/crusts	present	present
Wolf River (June)	WR-4-1	Riffle	60	10.8	cobble, gravel	0-24	absent	abundant	abundant
	WR-4-2	Pool	5		sand, silt		absent	present	present
	WR-4-3	Riffle	55		cobble, gravel		absent	abundant	abundant
Wolf River (Sept)	WR-4-1	Riffle	40	11.1	cobble, gravel	0-24	slimes/crusts	present	present
	WR-4-2	Pool	5		silt, gravel		absent	present	abundant
	WR-4-3	Riffle	80		cobble, gravel		slimes/crusts	present	present
Current River	CU-14-1	Riffle	8	11.1	cobble, sand	0-24	fimaments/attached/slimes/crusts	present	abundant
	CU-14-2	Pool	1		boulder, cobble		attached/slimes/crusts	present	abundant
	CU-14-3	Riffle	25		cobble, boulder		fimaments/attached/slimes/crusts	present	abundant
Cedar Creek	CD-1-1	Riffle	35	12.5	boulder, cobble	0-24	filaments/attached/slimes/crusts	present	present
	CD-1-2	Pool	15		gravel, silt		slimes/crusts	abundant	present
	CD-1-3	Riffle	23		boulder, cobble		slimes/crusts	abundant	present
Whitewood Creek	WH-1-1	Riffle	25	8.9	cobble, sand	75-100	slimes/crusts	present	abundant
	WH-1-2	Pool	4		sand, gravel		absent	present	abundant
	WH-1-3	Riffle	13		gravel, boulder		slimes/crusts	present	abundant
Pitch Creek	P-1-1	Riffle	27	9.6	cobble, sand	50-74	absent	abundant	abundant
	P-1-2	Pool	7		cobble, boulder		absent	present	abundant
	P-1-3	Riffle	20		cobble, boulder		absent	present	abundant
McVicar Creek	MVU-2-1	Riffle	10	10.4	cobble, boulder	50-74	attached/slimes/crusts	present	abundant
	MVU-2-2	Pool	2		sand, boulder		slimes/crusts	present	abundant
	MVU-2-3	Riffle	6		boulder, sand		attached/slimes/crusts	present	abundant
McIntyre River	MIU-2-1	Riffle	7	9.9	cobble, boulder	0-24	attached/slimes/crusts	present	abundant
	MIU-2-2	Pool	2		cobble, sand		attached/slimes/crusts	present	abundant
	MIU-2-3	Riffle	5		cobble, sand		attached/slimes/crusts	present	abundant
McIntyre River	MIU-1-1	Riffle	15	9.6	gravel, cobble	0-24	attached/slimes/crusts	present	present
	MIU-1-2	Pool	0		cobble, sand		attached/slimes/crusts	present	present
	MIU-1-3	Riffle	9		cobble, sand		attached/slimes/crusts	present	abundant

sufficient means to evaluate whether the site was impaired or should be included in the OBBN Reference Condition database.

Observations

2009 Candidate Reference Condition Sites

The Wesley Creek site (WE-1) (Table 4) had a moderate Richness (9.3), moderately low Shannon's H' Diversity (1.35), very low Hilsenhoff Biotic Index (4.15), moderately high % Dominants (53.7), moderately low % Chironomids (36.7), and moderately low % Worms (3.2). The % EPT (50.2) was moderate, and combined with the low HBI, is considered indicative of a healthy ecosystem. Site WE-1 should be included in the OBBN Reference Condition database.

The Little Cypress River site (LC-1) (Table 4) had a moderate Richness (9.3), a high Shannon's H' Diversity (1.72), a low Hilsenhoff Biotic Index (4.58), a moderately low % Dominants (30.8), an extremely low % Chironomids (19.6), and a high % Worms (16.1). The % EPT (59.2) was high. The high % Worms could indicate impairment because worms are tolerant of nutrient enrichment and eutrophic conditions; however, the low HBI and the high % EPT are considered indicative of a healthy ecosystem. Worms may have responded to the abundance of alder and willow leaves in the stream which probably provided habitat and food for the worms. Site LC-1 should be included in the OBBN Reference Condition database as a naturally-occurring nutrient-rich stream.

The Dublin Creek site (DC-1) (Table 4) had a moderately low Richness (7.3) and a low Shannon's H' Diversity (1.00). Low Richness and Diversity are considered indicative of an impaired aquatic environment which allows only specialized taxa to survive and thrive. The Hilsenhoff Biotic Index (6.69) was extremely high. A Hilsenhoff Biotic Index value above 6.0 is considered indicative of an impaired community, usually by organic enrichment as mentioned earlier. The % Dominants (64.9) was high as was the % Chironomids (64.9). The % EPT (12.5) was very low, and % Worms (18.3) was high; therefore, site DC-1 was considered impaired. Dublin Creek is neither eutrophic nor is the creek contaminated by toxic chemicals; therefore, worms and chironomids were not abundant because of differential mortality. The substrate in the sample sites consisted of cobble, gravel and sand, as well as large areas of bedrock and boulders which were covered in algae (Table 3). Worms thrive in algal-rich habitats because the algae provide shelter as well as food for the worms. Site DC-1 should not be included in the OBBN Reference Condition database; however, the stream should be reassessed to confirm its impairment.

Table 4. Selected mean biotic indices of the macroinvertebrate communities from candidate reference condition sites, 2009.

Site Name	Site Code	Sampling Date	Richness	H' Diversity	Hilsenhoff's Biotic Index	% Dominants	% EPT	% Chironomids	% Worms
Wesley Creek	WE-1	26-Sep-09	9.3	1.35	4.15	53.7	50.2	36.7	3.2
Little Cypress River	LC-1	27-Sep-09	9.3	1.72	4.58	30.8	59.2	19.6	16.1
Dublin Creeek	DC-1	09-Oct-09	7.3	1.00	6.69	64.9	12.5	64.9	18.3
Wolf River	WR-4	22-Jun-09	7.7	0.98	6.09	72.6	12.9	28.3	0.6
Wolf River	WR-4	30-Sep-09	8.3	1.35	5.81	52.5	41.8	45.7	6.5
Cedar Creek	CD-1	19-Oct-09	8.7	1.57	5.38	43.5	61.7	23.5	8.3
Whitewood Creek	WH-1	29-Sep_09	8.7	1.77	5.22	30.1	57.2	19.9	14.5
Pitch Creek	P-1	06-Oct-09	11.0	1.59	5.10	46.8	71.5	13.8	4.8

The Wolf River site (WR-4) sampled on 22 June 2009 (Table 4) had a moderately low Richness (7.7), a very low Shannon's H' Diversity (0.98), a high Hilsenhoff Biotic Index (6.09), a very high % Dominants (72.6), but a moderately low % Chironomids (28.3). The % EPT (12.9) was very low, as was the % Worms (0.6). The combination of low richness and diversity coupled with high HBI and very high % Dominants would normally indicate that Site WR-4 is impaired. However, this site was dominated by black flies (55.8%, Appendix 4) at the time of sampling. Most black flies are highly seasonal (late spring/early summer) and found in streams with high water quality, although some black fly species are tolerant of low oxygen concentrations associated with high nutrient inputs and associated eutrophic conditions. The abundance of black flies in the June sample increased the % Dominants, thereby decreasing diversity and increasing HBI. Site WR-4 was re-examined during the autumn when black flies were not abundant (see below) to determine seasonal effects and whether the site should be included in the OBBN Reference Condition database.

The Cedar Creek site (CD-1) (Table 4) had a moderate Richness (8.7) and Shannon's H' Diversity (1.57). The Hilsenhoff Biotic Index (5.38) was moderately low, as was the % Dominants (43.5). The % Chironomids (23.5) was low. The % EPT (61.7) was very high and the % Worms (8.3) was high. The high % Worms possibly indicates a community from a nutrient-rich habitat; however, the substrate at Cedar Creek is dominated by boulders and cobble (Table 3) which support a rich algal community, similar to Dublin Creek. Apparently worms thrive in an algal-rich habitat. The low HBI and the high % EPT indicate that site CD-1 is unimpaired and should be included in the OBBN Reference Condition database.

The Whitewood Creek site (WH-1) (Table 4) had a moderate Richness (8.7) and a high Shannon's H' Diversity (1.77). The Hilsenhoff Biotic Index (5.22) was moderately low, as was

the % Dominants (30.1). The % Chironomids (19.9) was low. The % EPT (57.2) was high, as was the % Worms (14.5). The substrate at Whitewood Creek was dominated by boulders and cobble (Table 3) which support an algal community of slimes and crusts as seen at Dublin Creek and Cedar Creek. Worms were abundant probably because of the presence of the algae. The low HBI and the high % EPT indicate that site WH-1 is unimpaired and should be included in the OBBN Reference Condition database.

The Pitch Creek site (P-1) (Table 4) had a high Richness (11.0) and a moderate Shannon's H' Diversity (1.59). The Hilsenhoff Biotic Index (5.10) and the % Dominants (46.8) were moderately low. The % Chironomids (13.8) was extremely low. The % EPT (71.5) was extremely high, whereas the % Worms (4.8) was moderate. The low HBI and the high % EPT indicate an unimpaired community. Site P-1 should be included in the OBBN Reference Condition database.

Re-assessment of Possibly Impaired Sites

Barrett River and Coldwater River, located in Lake Superior Provincial Park, were first assessed in 2007 during a survey of rivers located on the northeastern shore of Lake Superior. Both rivers contained benthic macroinvertebrate communities with a high HBI and moderately low % EPT which indicated possible impairment. Barrett River and Coldwater River warranted subsequent reassessment (Deacon & Lavoie 2008).

In 2009 the Barrett River site (B-1) (Table 5) had a moderately low Richness (7.0) and Shannon's H' Diversity (1.30), a high Hilsenhoff Biotic Index (6.08), % Dominants (56.4), % Chironomids (56.4) and % Worms (9.3). The % EPT (31.4) was moderately low. These biotic indices are similar to those obtained during the first survey at site B-1 in 2007 (Table 5) when the community was considered possibly impaired and warranted re-assessment. The similarity of the results between 2007 and 2009 indicates that the composition of the communities is relatively stable probably because conditions have remained constant in the stream. No evidence of watershed alteration or of toxic input was noted in 2007 or 2009. Apparently, the biotic indices provide a reasonable reflection of the macroinvertebrate communities at site B-1. The community at site B-1 is unusual with a high HBI and moderately low % EPT which usually indicates a community from a nutrient-enriched environment. Barrett River is isolated in Lake Superior Provincial Park, receives no anthropogenic inputs except for airborne pollutants and no watershed disturbance has occurred; therefore, the biotic indices probably reflect a healthy ecosystem. The high HBI and low % EPT may be related to the low flow conditions that were experienced during 2009 which increased the filamentous, attached, slime and crust algae at the sampling site (Table 3). The algae provide different habitat and support different

Table 5. Selected mean biotic indices of the macroinvertebrate communities from Barrett and Coldwater Rivers, Ontario, 2007 & 2009.

Site Name	Site Code	Sampling Date	Richness	H' Diversity	Hilsenhoff's Biotic Index	% Dominants	% EPT	% Chironomids	% Worms
Barrett River *	B-1	31-May-07	8.0	1.19	6.20	62.0	29.2	62.0	0.6
Barrett River	B-1	08-Oct-09	7.0	1.30	6.08	56.4	31.4	56.4	9.3
Coldwater River *	CW-1	31-May-07	9.0	1.31	6.23	58.5	28.3	58.5	5.0
Coldwater River	CW-1	20-Sep-05	7.3	1.22	5.95	59.6	29.9	59.6	5.9

* Deaon & Lavoie 2008

communities, particularly chironomids and worms as noted above for Dublin Creek (DC-1) and below for Current River (CU-14) and Jackpine River (JP-1). Barrett River (B-1) should be included in the OBBN Reference Condition database; however, an additional survey should be completed to confirm the health of the community when more is known about the relationship between algae and the benthic macroinvertebrates in the streams of northwestern Ontario.

In 2009, the Coldwater River site (CW-1) (Table 5) had a moderately low Richness (7.3) and Shannon's H' Diversity (1.22). The Hilsenhoff Biotic Index (5.95), the % Dominants (59.6) and the % Chironomids (59.6) were high. The % EPT (29.9) was moderately low and the % Worms (5.9) was moderate. These indices are similar to those determined during 2007 (Table 5); however, the HBI was below 6 in 2009 whereas the HBI was 6.23 in 2007. Possibly some "improvement" in the macroinvertebrate community occurred between 2007 and 2009, or more likely the change was related to normal variation within a healthy community. The indices for Coldwater River are also very similar to those obtained for Barrett River. Coldwater River (CW-1) is located in Lake Superior Provincial Park as is Barrett River (B-1). The physiographic features of Coldwater River are similar to those of Barrett River, except that Coldwater River has a lower hydraulic head than Barrett River (Table 3). Even the taxa in the communities of these two rivers are similar (Appendices 9 & 10). Again, no evidence of disturbance or toxic input was noted in the Coldwater River watershed. The community at site CW-1 is unusual as seen in Barrett River, but probably reflects a healthy ecosystem. Stream flow was low during 2009 which increased the filamentous, attached, slime and crust algae at the sampling site (Table 3). Coldwater River (CW-1) should be included in the OBBN Reference Condition database; however, an additional survey should be completed at some time in the future, as suggested for Barrett Creek.

Two other rivers located within Lake Superior Provincial Park (LSPP), Specked Trout Creek and Old Woman River, were surveyed in 2007 (Deacon & Lavoie 2008). Both streams were included in the OBBN Reference Condition database, but both streams are similar to Barrett River and

Coldwater River. All four streams have low values for % EPT and somewhat elevated HBI values. Because both Speckled Trout Creek and Old Woman River had moderate HBI values below 6, the streams were included in the OBBN database in 2007. Some aspect other than nutrient enrichment and/or toxic inputs must be affecting the macroinvertebrate communities to cause the decrease in % EPT and increase in HBI in these streams.

A study of streams in Lake Superior Provincial Park to determine the cause(s) of the unusual composition of the macroinvertebrate communities should be considered.

Season-to-Season Effects

The Wolf River site (WR-4) (Table 4) was sampled 22 June and re-sampled 30 September 2009 to determine the effect of season on the composition of the benthic macroinvertebrate community. The 30 September community (Table 4) had a moderate Richness (8.3), a moderately low Shannon's H' Diversity (1.35), a moderately high Hilsenhoff Biotic Index (5.81) and % Dominants (52.5). Heptageniidae (flat-headed mayflies) and Hydropsychidae (net-spinning caddisflies) were abundant in the September sample, whereas Simuliidae (black flies) were dominant in the June sample (Appendices 4 & 5). The % Chironomids (45.7), the % EPT (41.8) and the % Worms (6.5) were all moderate. The above indices indicate that the macroinvertebrate community at Site WR-4 was unimpaired on 30 September; however, this site was evaluated as possibly impaired when sampled on 22 June at a time when black flies dominated the macroinvertebrate community. Apparently certain taxa such as black flies, which are seasonally abundant in certain northwestern Ontario streams, can affect the biotic indices. Sampling for analysis using the OBBN Reference Condition Approach should be avoided during black fly season. Site WR-4 should be included in the OBBN Reference Condition database based on the results from the 30 September survey when black flies were not abundant.

Year-to-Year

The Current River site (CU-14) (Table 6) was sampled 30 September 2009. This site had been sampled in mid-October of 2004, the end of June 2005 and late September 2008; therefore, we hoped to determine if any changes had occurred in community structure due to season and/or year-to-year fluctuations.

The 30 September 2009 macroinvertebrate community at CU-14 (Table 6) had a moderate Richness (9.7), a moderately low Shannon's H' Diversity (1.24) and a moderately high Hilsenhoff

Table 6. Selected mean biotic indices of the macroinvertebrate communities from year-to-year reference condition sites, 2004 to 2009.

Site Name	Site Code	Sampling Date	Richness	H' Diversity	Hilsenhoff's Biotic Index	% Dominants	% EPT	% Chironomids	% Worms
Current River	CU-14	14-Oct-04	10.7	1.85	5.43	32.1	48.6	29.5	5.4
Current River	CU-14	29-Jun-05	12.3	1.93	6.22	30.5	30.2	29.1	4.8
Current River	CU-14	18-Sep-08	11.7	1.86	6.03	36.3	31.5	35.4	2.4
Current River	CU-14	30-Sep-09	9.7	1.24	6.41	65.3	18.7	65.3	4.1
Jackpine River	JP-1	20-Sep-05	8.0	1.52	5.76	40.9	49.7	34.1	9.3
Jackpine River	JP-1	15-Sep-07	8.7	1.38	5.85	53.4	47.6	34.2	11.6
Jackpine River	JP-1	21-Sep-08	11.7	1.86	6.03	36.3	31.5	35.4	2.4
Jackpine River	JP-1	26-Sep-09	8.0	1.60	5.67	36.5	41.5	36.5	9.9

Biotic Index (6.41). The % Dominants (65.3) and % Chironomids (65.3) were very high. The % EPT (18.7) was between moderately low and low, and the % Worms (4.1) was moderate. The reference condition site CU-14 is possibly becoming impaired as indicated by the high HBI and the low % EPT. CU-14 was in good condition in 2004 with a moderate HBI (5.43) and a moderate % EPT (48.6) (Table 4), then deteriorated slightly in 2005 as indicated by a higher HBI (6.22) and lower % EPT (30.2) (Table 4). The HBI was also high (6.03) and the % EPT (31.5) moderately low in 2008 (Table 4), which was similar to 2005. The moderately high HBI (6.41) and the moderately low % EPT (18.7) in 2009 could indicate that the site is deteriorating. However, the change in the macroinvertebrate community structure could also be related to the low flow conditions that were experienced during 2009 which increased the filamentous, attached, slime and crust algae at the sampling site (Table 3). The algae provides different habitat and supports different communities, particularly chironomids and worms. There was no evidence of watershed alteration or of toxic input which could cause differential mortality and contribute to the increase in chironomids and decrease in % EPT as observed in 2009. Annual sampling should continue at site CU-14 to identify the causes of these changes and observe further variation.

The Jackpine River site (Table 6) was sampled 26 September 2009. This site had been sampled in mid-September of 2005, 2007 and 2008; therefore, we hoped to determine if any changes had occurred in community structure due to year-to-year fluctuations.

The 26 September 2009 macroinvertebrate community at JP-1 (Table 6) had a moderate Richness (8.0), a moderately high Shannon's H' Diversity (1.60) and a moderate Hilsenhoff Biotic Index (5.67). The % Dominants (36.5) and % Chironomids (36.5) was moderately low. The %

EPT (41.5) was moderate, whereas the % Worms (9.9) was high. Apparently JP-1 was unimpaired as indicated by the moderate values for HBI and % EPT, although the % Worms was high. The substrate at the Jackpine River is dominated by gravel, cobble and boulders which supports a community of slime and crust algae (Table 3). Apparently the % Worms increases when slimes and crusts are present in streams on the north shore of Lake Superior.

In 2005 Site JP-1 was considered unimpaired, but unusual because of a high % Worms (Table 6). This site had a similar community in 2007, but the % Worms was even higher (Table 6). The % Worms decreased in 2008 (Table 6); however, the HBI exceeded 6.0 which is considered an indication of possible impairment. In 2009 Site JP-1 returned to a community structure very similar to that first observed in 2005 (unimpaired, but high % Worms). No evidence of watershed alteration or toxic input was noted during the period from 2005 to 2009; therefore, the observed changes may be related to normal variation within a healthy ecosystem with algae. Annual sampling should continue at site JP-1 to follow any further variation.

Urban Test Sites 2009

The McVicar Creek Urban site (MVU-2) had a moderate Richness (8.7), moderately low Shannon's H' Diversity (1.26), and a very high Hilsenhoff Biotic Index (6.69) (Table 7). The % Dominants (53.2) was moderately high; however, the % Chironomids (27.7) was moderately low and % EPT (19.3) was low. The % Worms (43.7) was extremely high, higher than found in any of the other 40 Lake Superior streams sampled to 2009. The low Diversity, the high HBI and the extremely high % Worms indicate that site MVU-2 is impaired, probably related to nutrient input and algae.

The biotic indices of the test and urban sites of McVicar Creek have consistently indicated a possibly-impaired benthic community. A high HBI, a high to very high % Worms and low to very low % EPT (Table 7) could be related to nutrient input. The substrate at McVicar Creek is dominated by boulders and cobble which supports a thriving community of slime and crust algae (Table 3). Possible sources of nutrient input include runoff from properties adjacent to the creek (either residential or commercial) or stormwater discharge into the creek. The macroinvertebrate communities in McVicar Creek should be assessed at several locations within the urban portion of the stream and compared with the communities at the reference condition sites that were identified in 2004 (Table 7) to determine whether differences in the taxa composition and/or biotic indices exist. If differences do exist, then identification of causes may be possible.

Table 7. Selected mean Biotic Indices of urban macroinvertebrate communities, Thunder Bay, Ontario, 2004-2009.

Site Name	Site Code	Sampling Date	Richness	H' Diversity	Hilsenhoff's Biotic Index	% Dominants	% EPT	% Chironomids	% Worms
McVicar Creek	MV-I	07-Oct-04	8.0	1.40	5.92	54.0	26.7	54.0	3.3
McVicar Creek	MV-V	07-Oct-04	9.7	1.40	5.58	46.1	49.9	41.1	2.9
McVicar Test	MV-T1	13-Jun-07	6.0	1.22	6.96	52.8	11.4	28.0	36.2
McVicar Test	MVT-1	15-Sep-08	11.3	1.81	6.57	40.3	15.8	17.0	30.2
McVicar Urban	MVU-1	15-Sep-08	10.3	1.67	6.51	43.3	24.1	17.4	43.3
McVicar Urban	MVU-2	24-Sep-09	8.7	1.26	6.69	53.2	19.3	27.7	43.7
McIntyre River	MI-1	8-Oct-04	11.7	1.92	4.75	29.0	63.8	16.1	5.7
McIntyre River	MI-5b	8-Oct-04	10.0	1.55	5.67	37.6	48.6	37.6	3.1
McIntyre River	MI-6	8-Oct-04	8.7	1.10	6.19	64.8	27.9	64.8	3.1
McIntyre River	MIU-2	24-Sep-09	9.7	1.44	5.97	53.5	30.7	51.6	8.8
McIntyre River	MIU-1	22-Sep-09	10.0	1.44	6.35	50.0	24.3	50.0	15.5

The McIntyre River Urban site (MIU-2) located near George Burke Park (Fig. 2) upstream from MIU-1 had a moderate Richness (9.7) and Shannon's H' Diversity (1.44) (Table 7). The Hilsenhoff Biotic Index (5.97) and the % Dominants (53.5) were high. The % Chironomids was moderately high (51.6) and the % EPT (30.7) was moderately low. The % Worms was moderately high (8.8). Site MIU-2 is unimpaired and should be included in the OBBN Reference Condition database; however, the high HBI and moderately low % EPT indicate that this site may be deteriorating, possibly because of nutrient input as indicated by abundant algae and the high % Worms.

The McIntyre River Urban site (MIU-1) located near the Thunder Bay Country Club at Central Avenue (Fig. 2) had a high Richness (10.0) and a moderate Shannon's H' Diversity (1.44) (Table 7). The Hilsenhoff Biotic Index was high (6.35), whereas was the % Dominants (50.0) and the % Chironomids (50.0) was moderate. The % EPT (24.3) was moderately low. The % Worms was high (15.5). Site MIU-1 is impaired as indicated by the high HBI, the moderately low % EPT and the high % Worms. Nutrient input must reach a critical level at some point between George Burke Park (MIU-2) and the Thunder Bay Country Club (MIU-1), promoting algal growth on the substrate and consequent changes in the taxa, especially the high % Worms. The macroinvertebrate communities should be assessed at several locations within the urban portion of the McIntyre River and compared with macroinvertebrate communities from reference condition sites identified during in 2004 (Table 7) to determine whether consistent differences in the taxa composition and/or biotic indices exist between urban sites and a

reference condition site. If differences do exist, then identification of causes may be possible. If the source of the nutrient enrichment can be found and eliminated, the aquatic benthic macroinvertebrate community should recover relatively quickly.

Conclusion

The first goal of this project was to locate reference condition sites for minimally -impacted streams along the north shore of Lake Superior. Wesley Creek (WE-1), Little Cypress River, Wolf River (WR-4), Cedar Creek (CD-1), Whitewood Creek (WH-1) and Pitch Creek sites warrant inclusion in the OBBN Reference Condition database. As well, McIntyre River (MIU-2), an urban test site, should be included in the OBBN Reference Condition database as a site against which to compare other urban streams.

The second goal of this project was to re-assess the macroinvertebrate communities at two sites that had previously been considered possibly impaired. Both Barrett River (B-1) and Coldwater River (CW-1) had communities that were remarkably similar in structure (high HBI, moderately low % EPT) to those found in 2007 (Table 5). Watershed disturbance and toxic inputs were not evident at either site. An abundance of slimes and crust algae on the substrate may be affecting the macroinvertebrate communities, causing a decrease in % EPT and increase in HBI in these streams. Sites B-1 and CW-1 should be included in the OBBN Reference Condition database; however, an additional study of streams in Lake Superior Provincial Park to confirm the health of the macroinvertebrate communities should be considered.

The third goal of this project was the evaluation of the Wolf River (WR-4) benthic macroinvertebrate communities during early summer and late fall to determine the extent of changes between seasons. Seasonal abundance of taxa, especially black flies which are common in certain northwestern Ontario streams, can affect the results of the biotic indices. Sampling for analysis using the OBBN Reference Condition Approach should be avoided, if possible, during back fly season.

The fourth goal of this project was to sample benthic macroinvertebrates at two sites that had previously been sampled in an attempt to determine the effect of season and/or year on the composition of the benthic macroinvertebrate community. Current River (CU-14) is probably undergoing a directional change towards impairment, possibly related to low flow and an increase in algae. Jackpine River (JP-1) is displaying variability, but the macroinvertebrate community returned to a structure very similar to that first observed in 2005 (unimpaired, but high % Worms). Sampling should continue on an annual basis at both CU-14 and JP-1.

The fifth goal of this project was to assess macroinvertebrate communities in urban sites that were possibly impacted. The McVicar Creek Urban site (MVU-2) is impaired as indicated by the low Diversity, the high HBI and the extremely high % Worms which are probably related to nutrient input and algae. The macroinvertebrate communities in McVicar Creek should be assessed at several locations within the urban portion of the stream and compared with the communities at reference condition sites to determine whether differences in the taxa composition and/or biotic indices exist. McIntyre River (MIU-2) is unimpaired; however, the high HBI and moderately low % EPT indicate that this site could potentially become impaired. McIntyre River MIU-1 is impaired, possibly because of eutrophication related to nutrient input as indicated by the high HBI, moderate % EPT and the high % Worms. A study as outlined for McVicar Creek (above) should be undertaken on the McIntyre River to identify the source(s) of nutrient input. If the source(s) of nutrient enrichment can be found and eliminated, the aquatic benthic macroinvertebrate communities in both McVicar Creek and the McIntyre River should recover relatively quickly.

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Appendix 1a. Benthic macroinvertebrates from Wesley Creek, Ontario, 2009.

		Wesley Creek	Wesley Creek	Wesley Creek
		WE-1-1	WE-1-2	WE-1-3
		Riffle	Pool	Riffle
		26-Sep	26-Sep	26-Sep
PLATYHELMINTHES				
NEMATODA		2		2
MOLLUSCA				
Gastropoda				
Ancylidae				
Lymnaeidae				
Physidae				
Planorbidae				
Bivalvia				
Sphaeriidae				
ANNELIDA				
Oligochaeta		7		4
Hirudinea				
ARTHROPODA				
Hydracarina		1	1	5
Decapoda				
Cambaridae	<i>Orconectes</i>			
Isopoda				
Asellidae	<i>Caecidotea</i>	1	4	
Insecta				
Ephemeroptera				
Amelitidae	Juvenile <i>Ameletus</i>			
Siphonuridae	<i>Parameletus</i>			
Baetidae	Juvenile/damaged <i>Acentrella</i>			
	<i>Baetis</i>	1		
	<i>Plauditus</i>	1		
Isonychiidae	<i>Isonychia</i>			
Heptageniidae	Juvenile/damaged <i>Epeorus (Iron)</i>			
	<i>Heptagenia</i>			
	<i>Leucrocuta</i>			
	<i>Maccaffertium</i>			
	<i>Rhithrogena</i>			
	<i>Stenacron</i>			
	<i>Stenonema</i>			
Ephemerellidae	Juvenile/damaged <i>Attenella</i>	1	1	
	<i>Ephemerella</i>			1
	<i>Eurylophella</i> (s str.)			
	<i>Serratella</i>			
Caenidae	<i>Caenis</i>			
Baetiscidae	<i>Baetisca</i>			
Leptophlebiidae	Juvenile/damaged <i>Habrophlebia</i>			
	<i>Leptophlebia</i>			
	<i>Paraleptophlebia</i>			
Odonata				
Gomphidae	Juvenile/damaged <i>Dromogomphus</i>			
	<i>Ophiogomphus</i>			
Aeschnidae	<i>Basiaeschna</i>			
	<i>Boyeria</i>			
Cordulegastridae	<i>Cordulegaster</i>			
Corduliidae	Juvenile			
Plecoptera	Juvenile/damaged	1		
Taeniopterygidae	Juvenile/damaged <i>Oemopteryx</i>			1
	<i>Taeniopteryx</i>			
Nemouridae	Juvenile/damaged <i>Nemoura</i>	43	19	53

Appendix 1b. Benthic macroinvertebrates from Wesley Creek, Ontario, 2009.

		Wesley Creek	Wesley Creek	Wesley Creek
		WE-1-1	WE-1-2	WE-1-3
		Riffle	Pool	Riffle
		26-Sep	26-Sep	26-Sep
Leuctridae	Juvenile/damaged			
	<i>Leuctra</i>			
	<i>Paraleuctra</i>	10	7	3
Capniidae	Juvenile/damaged			
	<i>Allocapnia</i>			
	<i>Paracapnia</i>		5	2
Perlidae	Juvenile/damaged			
	<i>Acroneuria</i>			
	<i>Claassenia</i>			
	<i>Paragnetina</i>			
Perlodidae	Juvenile/damaged			
Chloroperlidae				1
Coleoptera				
Dryopidae	<i>Helichus</i>			
Elmidae	Juvenile/damaged			
	<i>Dubiraphia</i>			
	<i>Optioservus</i>			
Trichoptera	Juvenile/damaged/ Pupa			
Philopotamidae	<i>Dolophilodes</i>	3		6
	<i>Chimarra</i>			
Polycentropodidae	Juvenile/damaged			
	<i>Polycentropus</i>			
Hydropsychidae	Juvenile			
	<i>Cheumatopsyche</i>			
	<i>Hydropsyche</i>	1		
	<i>Parapsyche</i>	1		1
Rhyacophilidae	<i>Rhyacophila</i>			
Glossosomatidae	<i>Glossosoma</i>	4	1	
	<i>Protoptila</i>			
Hydroptilidae	<i>Hydroptila</i>			
	<i>Oxyethira</i>			
Lepidostomatidae	<i>Lepidostoma</i>			
Limnephilidae	Juvenile/damaged		1	
	<i>Hydatophylax</i>			
Goeridae	<i>Goera</i>			
Leptoceridae	<i>Mystacides</i>			
	<i>Oecetis</i>			
Diptera	Damaged/pupa			
Ceratopogonidae	<i>Bezzia/Palpomyia</i>			
	<i>Ceratopogon</i>			
	<i>Dasyhelea</i>			
	<i>Mallacohelea</i>			
	<i>Probezzia</i>	2	2	1
	<i>Stilobezzia</i>			
Chironomidae		35	63	22
Psychodidae	<i>Psychoda</i>			
Simuliidae	<i>Cnephia/Ectemnia</i>			
	<i>Simulium</i>	4		5
Tipulidae	Juvenile/damaged			
	<i>Antocha</i>			
	<i>Dicronata</i>	2		1
	<i>Hexatoma</i>			
Athericidae	<i>Atherix</i>			
Empididae	<i>Chelifera/Metachela</i>			
	<i>Hemerodromia</i>			
Total number of individuals		120	104	108
% Sorted		10.0	7.5	11.3

Appendix 2a. Benthic macroinvertebrates from Little Cypress River, Ontario, 2009.

		Little Cypress	Little Cypress	Little Cypress
		LC-1-1	LC-1-2	LC-1-3
		Riffle	Pool	Riffle
		27-Sep	27-Sep	27-Sep
PLATYHELMINTHES				
NEMATODA				
MOLLUSCA				
Gastropoda				
Ancylidae				
Lymnaeidae				
Physidae			1	
Planorbidae				
Bivalvia				
Sphaeriidae				
ANNELIDA				
Oligochaeta		26	18	7
Hirudinea		1	1	1
ARTHROPODA				
Hydracarina				
Decapoda				
Cambaridae	<i>Orconectes</i>			
Isopoda				
Asellidae	<i>Caecidotea</i>			
Insecta				
Ephemeroptera	Juvenile			
Amelitidae	<i>Ameletus</i>			
Siphonuridae	<i>Parameletus</i>			
Baetidae	Juvenile/damaged	2	1	7
	<i>Acentrella</i>			
	<i>Baetis</i>	10	4	8
	<i>Plauditus</i>			4
Isonychiidae	<i>Isonychia</i>			
Heptageniidae	Juvenile/damaged			
	<i>Epeorus (Iron)</i>			
	<i>Heptagenia</i>	1		1
	<i>Leucrocuta</i>			
	<i>Maccaffertium</i>	1		1
	<i>Rhithrogena</i>			
	<i>Stenacron</i>			
	<i>Stenonema</i>			
Ephemerellidae	Juvenile/damaged			
	<i>Attenella</i>			
	<i>Ephemerella</i>			
	<i>Eurylophella</i> (s str.)	1	2	
	<i>Serratella</i>			
Caenidae	<i>Caenis</i>			
Baetiscidae	<i>Baetisca</i>			
Leptophlebiidae	Juvenile/damaged			
	<i>Habrophlebia</i>			
	<i>Leptophlebia</i>			
	<i>Paraleptophlebia</i>			
Odonata				
Gomphidae	Juvenile/damaged			
	<i>Dromogomphus</i>			
	<i>Ophiogomphus</i>			
Aeschnidae	<i>Basiaeschna</i>			
	<i>Boyeria</i>			
Cordulegastridae	<i>Cordulegaster</i>			1
Corduliidae	Juvenile			
Plecoptera	Juvenile/damaged	1	1	
Taeniopterygidae	Juvenile/damaged	1	1	
	<i>Oemopteryx</i>			
	<i>Taeniopteryx</i>			
Nemouridae	Juvenile/damaged			
	<i>Nemoura</i>	28	7	30

Appendix 2b. Benthic macroinvertebrates from Little Cypress River, Ontario, 2009.

		Little Cypress	Little Cypress	Little Cypress
		LC-1-1	LC-1-2	LC-1-3
		Riffle	Pool	Riffle
		27-Sep	27-Sep	27-Sep
Leuctridae	Juvenile/damaged			
	<i>Leuctra</i>			
	<i>Paraleuctra</i>	6	13	1
Capniidae	Juvenile/damaged			
	<i>Allocapnia</i>			
	<i>Paracapnia</i>			
Perlidae	Juvenile/damaged			
	<i>Acroneuria</i>			
	<i>Claassenia</i>			
	<i>Paragnetina</i>			
Perlodidae	Juvenile/damaged			
Chloroperlidae				
Coleoptera				
Dryopidae	<i>Helichus</i>			
Elmidae	Juvenile/damaged			1
	<i>Dubiraphia</i>			
	<i>Optioservus</i>		1	
Trichoptera	Juvenile/damaged/ Pupa			
Philopotamidae	<i>Dolophilodes</i>			
	<i>Chimarra</i>			
Polycentropodidae	Juvenile/damaged			
	<i>Polycentropus</i>		1	
Hydropsychidae	Juvenile			2
	<i>Cheumatopsyche</i>	1		2
	<i>Hydropsyche</i>			
	<i>Parapsyche</i>			
Rhyacophilidae	<i>Rhyacophila</i>	2		1
Glossosomatidae	<i>Glossosoma</i>	1		1
	<i>Protoptila</i>			
Hydroptilidae	<i>Hydroptila</i>			
	<i>Oxyethira</i>			
Lepidostomatidae	<i>Lepidostoma</i>	12	16	14
Limnephilidae	Juvenile/damaged			1
	<i>Hydatophylax</i>		1	
Goeridae	<i>Goera</i>			
Leptoceridae	<i>Mystacides</i>			
	<i>Oecetis</i>			
Diptera	Damaged/pupa			
Ceratopogonidae	<i>Bezzia/Palpomyia</i>			
	<i>Ceratopogon</i>			
	<i>Dasyhelea</i>			
	<i>Mallacohelea</i>			
	<i>Probezzia</i>	1	2	
	<i>Stilobezia</i>			
Chironomidae		12	30	19
Psychodidae	<i>Psychoda</i>			
Simuliidae	<i>Cnephia/Ectemnia</i>			
	<i>Simulium</i>	1		
Tipulidae	Juvenile/damaged			1
	<i>Antocha</i>			
	<i>Dicronata</i>	1		2
	<i>Hexatoma</i>			
Athericidae	<i>Atherix</i>			
Empididae	<i>Chelifera/Metachel</i>		1	
	<i>Hemerodromia</i>			
Total number of individuals		109	101	105
% Sorted		6.3	7.5	11.3

Appendix 3a. Benthic macroinvertebrates from Dublin Creek, Ontario, 2009.

		Dublin Creek	Dublin Creek	Dublin Creek
		DC-1-1	DC-1-2	DC-1-3
		Riffle	Pool	Riffle
		09-Oct	09-Oct	09-Oct
PLATYHELMINTHES				4
NEMATODA				
MOLLUSCA				
Gastropoda				
Ancylidae				
Lymnaeidae				
Physidae				
Planorbidae				
Bivalvia				
Sphaeriidae				
ANNELIDA				
Oligochaeta		18	5	41
Hirudinea				
ARTHROPODA				
Hydracarina		2		
Decapoda				
Cambaridae	<i>Orconectes</i>			
Isopoda				
Asellidae	<i>Caecidotea</i>			
Insecta				
Ephemeroptera	Juvenile			
Amelitidae	<i>Ameletus</i>			
Siphonuridae	<i>Parameletus</i>			
Baetidae	Juvenile/damaged			1
	<i>Acentrella</i>			
	<i>Baetis</i>	3		
	<i>Plauditus</i>	1		6
Isonychiidae	<i>Isonychia</i>			
Heptageniidae	Juvenile/damaged	1		
	<i>Epeorus (Iron)</i>			1
	<i>Heptagenia</i>			
	<i>Leucrocuta</i>			
	<i>Maccaffertium</i>			2
	<i>Rhithrogena</i>			
	<i>Stenacron</i>			
	<i>Stenonema</i>			
Ephemerellidae	Juvenile/damaged			
	<i>Attenella</i>			
	<i>Ephemerella</i>			
	<i>Eurylophella</i> (s str.)			
	<i>Serratella</i>			
Caenidae	<i>Caenis</i>			
Baetiscidae	<i>Baetisca</i>			
Leptophlebiidae	Juvenile/damaged	1	1	2
	<i>Habrophlebia</i>			
	<i>Leptophlebia</i>	2	1	6
	<i>Paraleptophlebia</i>			
Odonata				
Gomphidae	Juvenile/damaged			
	<i>Dromogomphus</i>			
	<i>Ophiogomphus</i>			
Aeschnidae	<i>Basiaeschna</i>			
	<i>Boyeria</i>			
Cordulegastridae	<i>Cordulegaster</i>			
Corduliidae	Juvenile			
Plecoptera	Juvenile/damaged		1	2
Taeniopterygidae	Juvenile/damaged			
	<i>Oemopteryx</i>			
	<i>Taeniopteryx</i>			
Nemouridae	Juvenile/damaged			
	<i>Nemoura</i>	6		2

Appendix 3b. Benthic macroinvertebrates from Dublin Creek, Ontario, 2009.

		Dublin Creek	Dublin Creek	Dublin Creek
		DC-1-1	DC-1-2	DC-1-3
		Riffle	Pool	Riffle
		09-Oct	09-Oct	09-Oct
Leuctridae	Juvenile/damaged			
	<i>Leuctra</i>			
	<i>Paraleuctra</i>			
Capniidae	Juvenile/damaged			
	<i>Allocapnia</i>			
	<i>Paracapnia</i>			
Perlidae	Juvenile/damaged			
	<i>Acroneuria</i>	1		
	<i>Claassenia</i>			
	<i>Paragnetina</i>			
Perlodidae	Juvenile/damaged			
Chloroperlidae				
Coleoptera				
Dryopidae	<i>Helichus</i>			
Elmidae	Juvenile/damaged			
	<i>Dubiraphia</i>			
	<i>Optioservus</i>			1
Trichoptera	Juvenile/damaged/ Pupa			
Philopotamidae	<i>Dolophilodes</i>			
	<i>Chimarra</i>			
Polycentropodidae	Juvenile/damaged			
	<i>Polycentropus</i>			
Hydropsychidae	Juvenile			
	<i>Cheumatopsyche</i>			
	<i>Hydropsyche</i>	1		1
	<i>Parapsyche</i>			
Rhyacophilidae	<i>Rhyacophila</i>			
Glossosomatidae	<i>Glossosoma</i>			
	<i>Protoptila</i>			
Hydroptilidae	<i>Hydroptila</i>			1
	<i>Oxyethira</i>			
Lepidostomatidae	<i>Lepidostoma</i>			
Limnephilidae	Juvenile/damaged			
	<i>Hydatophylax</i>			
Goeridae	<i>Goera</i>			
Leptoceridae	<i>Mystacides</i>			
	<i>Oecetis</i>			
Diptera	Damaged/pupa			
Ceratopogonidae	<i>Bezzia/Palpomyia</i>			
	<i>Ceratopogon</i>			
	<i>Dasyhelea</i>			
	<i>Mallacohelea</i>			
	<i>Probezzia</i>	1	2	
	<i>Stilobezia</i>			
Chironomidae		60	159	50
Psychodidae	<i>Psychoda</i>			
Simuliidae	<i>Cnephia/Ectemnia</i>			
	<i>Simulium</i>			
Tipulidae	Juvenile/damaged			
	<i>Antocha</i>			
	<i>Dicronata</i>			
	<i>Hexatoma</i>	3		
Athericidae	<i>Atherix</i>			
Empididae	<i>Chelifera/Metachela</i>	1	1	
	<i>Hemerodromia</i>			
Total number of individuals		101	170	120
% Sorted		5.0	1.3	5.0

Appendix 4a. Benthic macroinvertebrates from Wolf River, Ontario, 2009.

		Wolf River WR-4-1	Wolf River WR-4-2	Wolf River WR-4-3
		Riffle 22-Jun	Pool 22-Jun	Riffle 22-Jun
PLATYHELMINTHES				
NEMATODA			1	
MOLLUSCA				
Gastropoda				
Ancylidae				
Lymnaeidae				
Physidae				
Planorbidae				
Bivalvia				
Sphaeriidae			1	
ANNELIDA				
Oligochaeta		1		1
Hirudinea				
ARTHROPODA				
Hydracarina				
Decapoda				
Cambaridae	<i>Orconectes</i>			
Isopoda				
Asellidae	<i>Caecidotea</i>			
Insecta				
Ephemeroptera				
Amelitidae	Juvenile <i>Ameletus</i>			
Siphonuridae	<i>Parameletus</i>			1
Baetidae	Juvenile/damaged	3	11	5
	<i>Acentrella</i>			
	<i>Baetis</i>	1		
	<i>Plauditus</i>			
Isonychiidae	<i>Isonychia</i>			
Heptageniidae	Juvenile/damaged			
	<i>Epeorus (Iron)</i>			1
	<i>Heptagenia</i>			
	<i>Leucrocuta</i>	1		
	<i>Maccaffertium</i>			
	<i>Rhithrogena</i>			
	<i>Stenacron</i>			
	<i>Stenonema</i>			
Ephemerellidae	Juvenile/damaged			
	<i>Attenella</i>			2
	<i>Ephemerella</i>			
	<i>Eurylophella</i> (s str.)		2	
	<i>Serratella</i>			
Caenidae	<i>Caenis</i>			
Baetiscidae	<i>Baetisca</i>			
Leptophlebiidae	Juvenile/damaged			
	<i>Habrophlebia</i>			
	<i>Leptophlebia</i>			
	<i>Paraleptophlebia</i>			1
Odonata				
Gomphidae	Juvenile/damaged			
	<i>Dromogomphus</i>		1	
	<i>Ophiogomphus</i>	1		1
Aeschnidae	<i>Basiaeschna</i>			
	<i>Boyeria</i>			
Cordulegastridae	<i>Cordulegaster</i>			
Corduliidae	Juvenile			
Plecoptera				
Taeniopterygidae	Juvenile/damaged			
	Juvenile/damaged			
	<i>Oemopteryx</i>			
	<i>Taeniopteryx</i>			
Nemouridae	Juvenile/damaged			
	<i>Nemoura</i>			

Appendix 4b. Benthic macroinvertebrates from Wolf River, Ontario, 2009.

		Wolf River	Wolf River	Wolf River
		WR-4-1	WR-4-2	WR-4-3
		Riffle	Pool	Riffle
		22-Jun	22-Jun	22-Jun
Leuctridae	Juvenile/damaged			
	<i>Leuctra</i>			
	<i>Paraleuctra</i>			
Capniidae	Juvenile/damaged			
	<i>Allocapnia</i>			
	<i>Paracapnia</i>			
Perlidae	Juvenile/damaged			
	<i>Acroneuria</i>			
	<i>Claassenia</i>			
	<i>Paragnetina</i>			
Perlodidae	Juvenile/damaged			
Chloroperlidae				
Coleoptera				
Dryopidae	<i>Helichus</i>			
Elmidae	Juvenile/damaged			
	<i>Dubiraphia</i>			
	<i>Optioservus</i>			
Trichoptera	Juvenile/damaged/ Pupa			1
Philopotamidae	<i>Dolophilodes</i>			
	<i>Chimarra</i>			2
Polycentropodidae	Juvenile/damaged			
	<i>Polycentropus</i>			
Hydropsychidae	Juvenile			
	<i>Cheumatopsyche</i>			1
	<i>Hydropsyche</i>	5		4
	<i>Parapsyche</i>			
Rhyacophilidae	<i>Rhyacophila</i>			
Glossosomatidae	<i>Glossosoma</i>			
	<i>Protoptila</i>			
Hydroptilidae	<i>Hydroptila</i>			
	<i>Oxyethira</i>			
Lepidostomatidae	<i>Lepidostoma</i>	1		2
Limnephilidae	Juvenile/damaged			
	<i>Hydatophylax</i>			
Goeridae	<i>Goera</i>			
Leptoceridae	<i>Mystacides</i>			
	<i>Oecetis</i>			
Diptera	Damaged/pupa			
Ceratopogonidae	<i>Bezzia/Palpomyia</i>			
	<i>Ceratopogon</i>			
	<i>Dasyhelea</i>			1
	<i>Mallacohelea</i>			
	<i>Probezzia</i>			
	<i>Stilobezia</i>			
Chironomidae		5	72	12
Psychodidae	<i>Psychoda</i>			
Simuliidae	<i>Cnephia/Ectemnia</i>			
	<i>Simulium</i>	103	13	76
Tipulidae	Juvenile/damaged			
	<i>Antocha</i>			
	<i>Dicronata</i>			
	<i>Hexatoma</i>	1		
Athericidae	<i>Atherix</i>			
Empididae	<i>Chelifera/Metachel</i>			1
	<i>Hemerodromia</i>	3	1	5
Total number of individuals		125	102	117
% Sorted		3.8	11.3	6.3

Appendix 5a. Benthic macroinvertebrates from Wolf River, Ontario, 2009.

		Wolf River WR-4-1	Wolf River WR-4-2	Wolf River WR-4-3
		Riffle 30-Sep	Pool 30-Sep	Riffle 30-Sep
PLATYHELMINTHES				
NEMATODA			1	1
MOLLUSCA				
Gastropoda				
Ancylidae		1		
Lymnaeidae				
Physidae				
Planorbidae				
Bivalvia				
Sphaeriidae				
ANNELIDA				
Oligochaeta		4	10	7
Hirudinea				
ARTHROPODA				
Hydracarina		2		2
Decapoda				
Cambaridae	<i>Orconectes</i>			
Isopoda				
Asellidae	<i>Caecidotea</i>			
Insecta				
Ephemeroptera				
Amelitidae	Juvenile <i>Ameletus</i>		1	1
Siphonuridae	<i>Parameletus</i>			
Baetidae	Juvenile/damaged <i>Acentrella</i> <i>Baetis</i> <i>Plauditus</i>		1	
Isonychiidae	<i>Isonychia</i>	1		
Heptageniidae	Juvenile/damaged <i>Epeorus (Iron)</i> <i>Heptagenia</i> <i>Leucrocuta</i> <i>Maccaffertium</i> <i>Rhithrogena</i> <i>Stenacron</i> <i>Stenonema</i>	10		6
		2		1
				2
				4
		1		
Ephemerellidae	Juvenile/damaged <i>Attenella</i> <i>Ephemerella</i> <i>Eurylophella (s str.)</i> <i>Serratella</i>	3		5
			4	
Caenidae	<i>Caenis</i>			
Baetiscidae	<i>Baetisca</i>		3	
Leptophlebiidae	Juvenile/damaged <i>Habrophlebia</i> <i>Leptophlebia</i> <i>Paraleptophlebia</i>	4		1
		1		1
Odonata				
Gomphidae	Juvenile/damaged <i>Dromogomphus</i> <i>Ophiogomphus</i>			
Aeschnidae	<i>Basiaeschna</i> <i>Boyeria</i>	1		
Cordulegastridae	<i>Cordulegaster</i>			
Corduliidae	Juvenile			
Plecoptera				
Taeniopterygidae	Juvenile/damaged <i>Oemopteryx</i> <i>Taeniopteryx</i>	1		1
		1		1
Nemouridae	Juvenile/damaged <i>Nemoura</i>			

Appendix 5b. Benthic macroinvertebrates from Wolf River, Ontario, 2009.

		Wolf River	Wolf River	Wolf River
		WR-4-1	WR-4-2	WR-4-3
		Riffle	Pool	Riffle
		30-Sep	30-Sep	30-Sep
Leuctridae	Juvenile/damaged			
	<i>Leuctra</i>			
	<i>Paraleuctra</i>			
Capniidae	Juvenile/damaged			
	<i>Allocapnia</i>			
	<i>Paracapnia</i>			
Perlidae	Juvenile/damaged			
	<i>Acroneuria</i>	3		
	<i>Claassenia</i>			
	<i>Paragnetina</i>			
Perlodidae	Juvenile/damaged			
Chloroperlidae				
Coleoptera				
Dryopidae	<i>Helichus</i>			
Elmidae	Juvenile/damaged	1		
	<i>Dubiraphia</i>			
	<i>Optioservus</i>			
Trichoptera	Juvenile/damaged/ Pupa			
Philopotamidae	<i>Dolophilodes</i>			
	<i>Chimarra</i>	6	1	3
Polycentropodidae	Juvenile/damaged			
	<i>Polycentropus</i>			
Hydropsychidae	Juvenile			
	<i>Cheumatopsyche</i>	1		1
	<i>Hydropsyche</i>	35	1	18
	<i>Parapsyche</i>			
Rhyacophilidae	<i>Rhyacophila</i>			1
Glossosomatidae	<i>Glossosoma</i>	3		2
	<i>Protoptila</i>			
Hydroptilidae	<i>Hydroptila</i>			
	<i>Oxyethira</i>		1	
Lepidostomatidae	<i>Lepidostoma</i>	3	1	1
Limnephilidae	Juvenile/damaged		1	
	<i>Hydatophylax</i>			
Goeridae	<i>Goera</i>			
Leptoceridae	<i>Mystacides</i>			
	<i>Oecetis</i>			
Diptera	Damaged/pupa			
Ceratopogonidae	<i>Bezzia/Palpomyia</i>			
	<i>Ceratopogon</i>			
	<i>Dasyhelea</i>			
	<i>Mallacohalea</i>			
	<i>Probezzia</i>		1	
	<i>Stilobezia</i>			
Chironomidae		25	79	43
Psychodidae	<i>Psychoda</i>			
Simuliidae	<i>Cnephia/Ectemnia</i>			
	<i>Simulium</i>			
Tipulidae	Juvenile/damaged			
	<i>Antocha</i>			
	<i>Dicronata</i>			
	<i>Hexatoma</i>			1
Athericidae	<i>Atherix</i>	3		4
Empididae	<i>Chelifera/Metachel</i>			2
	<i>Hemerodromia</i>			
Total number of individuals		112	105	109
% Sorted		3.8	6.3	2.5

Appendix 6a. Benthic macroinvertebrates from Cedar Creek, Ontario, 2009.

		Cedar Creek	Cedar Creek	Cedar Creek
		CD-1-1	CD-1-2	CD-1-3
		Riffle	Pool	Riffle
		19-Oct	19-Oct	19-Oct
PLATYHELMINTHES				
NEMATODA				
MOLLUSCA				
Gastropoda				
Ancylidae				
Lymnaeidae		1		
Physidae				
Planorbidae				
Bivalvia				
Sphaeriidae		1		
ANNELIDA				
Oligochaeta		10	10	10
Hirudinea				
ARTHROPODA				
Hydracarina				
		2	3	1
Decapoda				
Cambaridae	<i>Orconectes</i>			
Isopoda				
Asellidae	<i>Caecidotea</i>			
Insecta				
Ephemeroptera	Juvenile			
Amelitidae	<i>Ameletus</i>			
Siphonuridae	<i>Parameletus</i>			
Baetidae	Juvenile/damaged	1	2	
	<i>Acentrella</i>			
	<i>Baetis</i>		3	7
	<i>Plauditus</i>	19	4	19
Isonychiidae	<i>Isonychia</i>			
Heptageniidae	Juvenile/damaged	6	2	
	<i>Epeorus (Iron)</i>	1		6
	<i>Heptagenia</i>			
	<i>Leucrocuta</i>	1		
	<i>Maccaffertium</i>			
	<i>Rhithrogena</i>	2	3	8
	<i>Stenacron</i>			
	<i>Stenonema</i>			
Ephemerellidae	Juvenile/damaged	5	1	2
	<i>Attenella</i>			
	<i>Ephemerella</i>	15	11	14
	<i>Eurylophella (s str.)</i>			
	<i>Serratella</i>			
Caenidae	<i>Caenis</i>			
Baetiscidae	<i>Baetisca</i>			
Leptophlebiidae	Juvenile/damaged		1	4
	<i>Habrophlebia</i>			
	<i>Leptophlebia</i>	1	3	4
	<i>Paraleptophlebia</i>			
Odonata				
Gomphidae	Juvenile/damaged			
	<i>Dromogomphus</i>			
	<i>Ophiogomphus</i>			1
Aeschnidae	<i>Basiaeschna</i>			
	<i>Boyeria</i>			
Cordulegastridae	<i>Cordulegaster</i>			
Corduliidae	Juvenile			
Plecoptera				
Taeniopterygidae	Juvenile/damaged			
	<i>Oemopteryx</i>			
	<i>Taeniopteryx</i>			
Nemouridae	Juvenile/damaged		1	
	<i>Nemoura</i>		1	1

Appendix 6b. Benthic macroinvertebrates from Cedar Creek, Ontario, 2009.

		Cedar Creek	Cedar Creek	Cedar Creek
		CD-1-1	CD-1-2	CD-1-3
		Riffle	Pool	Riffle
		19-Oct	19-Oct	19-Oct
Leuctridae	Juvenile/damaged		2	
	<i>Leuctra</i>			
	<i>Paraleuctra</i>	2	1	
Capniidae	Juvenile/damaged			
	<i>Allocapnia</i>		1	
	<i>Paracapnia</i>	1		
Perlidae	Juvenile/damaged			1
	<i>Acroneuria</i>		2	1
	<i>Claassenia</i>			
	<i>Paragnetina</i>	2		
Perlodidae	Juvenile/damaged			
Chloroperlidae				
Coleoptera				
Dryopidae	<i>Helichus</i>			
Elmidae	Juvenile/damaged	2		
	<i>Dubiraphia</i>			
	<i>Optioservus</i>			
Trichoptera	Juvenile/damaged/ Pupa			
Philopotamidae	<i>Dolophilodes</i>	1		2
	<i>Chimarra</i>			
Polycentropodidae	Juvenile/damaged			
	<i>Polycentropus</i>			
Hydropsychidae	Juvenile			
	<i>Cheumatopsyche</i>			
	<i>Hydropsyche</i>	6	2	7
	<i>Parapsyche</i>			
Rhyacophilidae	<i>Rhyacophila</i>	2	1	4
Glossosomatidae	<i>Glossosoma</i>	2	3	7
	<i>Protoptila</i>			
Hydroptilidae	<i>Hydroptila</i>			
	<i>Oxyethira</i>			
Lepidostomatidae	<i>Lepidostoma</i>	11	10	4
Limnephilidae	Juvenile/damaged			
	<i>Hydatophylax</i>			
Goeridae	<i>Goera</i>			
Leptoceridae	<i>Mystacides</i>			
	<i>Oecetis</i>	1		
Diptera	Damaged/pupa			
Ceratopogonidae	<i>Bezzia/Palpomyia</i>			
	<i>Ceratopogon</i>		3	
	<i>Dasyhelea</i>			
	<i>Mallacohelea</i>			
	<i>Probezzia</i>		4	3
	<i>Stilobezia</i>			
Chironomidae		24	43	18
Psychodidae	<i>Psychoda</i>			
Simuliidae	<i>Cnephia/Ectemnia</i>			
	<i>Simulium</i>			
Tipulidae	Juvenile/damaged			
	<i>Antocha</i>			
	<i>Dicronata</i>		2	
	<i>Hexatoma</i>			
Athericidae	<i>Atherix</i>			
Empididae	<i>Chelifera/Metachel</i>	1		
	<i>Hemerodromia</i>			
Total number of individuals		118	121	124
% Sorted		10.0	6.3	8.8

Appendix 7a. Benthic macroinvertebrates from Whitewood Creek, Ontario, 2009.

		Whitewood Ck	Whitewood Ck	Whitewood Ck
		Wh-1-1	Wh-1-2	Wh-1-3
		Riffle	Pool	Riffle
		09-Sep	09-Sep	09-Sep
PLATYHELMINTHES				
NEMATODA				
MOLLUSCA				
Gastropoda				
Ancylidae				
Lymnaeidae				
Physidae				
Planorbidae			1	
Bivalvia				
Sphaeriidae			7	
ANNELIDA				
Oligochaeta		20	19	10
Hirudinea				
ARTHROPODA				
Hydracarina				
Decapoda				
Cambaridae	<i>Orconectes</i>			
Isopoda				
Asellidae	<i>Caecidotea</i>			
Insecta				
Ephemeroptera	Juvenile			
Amelitidae	<i>Ameletus</i>			
Siphonuridae	<i>Parameletus</i>			
Baetidae	Juvenile/damaged	6	13	
	<i>Acentrella</i>			1
	<i>Baetis</i>		1	
	<i>Placiditus</i>	1	1	
Isonychiidae	<i>Isonychia</i>			
Heptageniidae	Juvenile/damaged	2	1	
	<i>Epeorus (Iron)</i>	1		
	<i>Heptagenia</i>			
	<i>Leucrocuta</i>			
	<i>Maccaffertium</i>		1	
	<i>Rhithrogena</i>	3	1	18
	<i>Stenacron</i>			
	<i>Stenonema</i>	1		
Ephemerellidae	Juvenile/damaged	18		
	<i>Attenella</i>			4
	<i>Ephemerella</i>	2		
	<i>Eurylophella (s str.)</i>		3	
	<i>Serratella</i>	4		5
Caenidae	<i>Caenis</i>			
Baetiscidae	<i>Baetisca</i>			
Leptophlebiidae	Juvenile/damaged	2	4	3
	<i>Habrophlebia</i>			
	<i>Leptophlebia</i>	2		4
	<i>Paraleptophlebia</i>			
Odonata				
Gomphidae	Juvenile/damaged			
	<i>Dromogomphus</i>			
	<i>Ophiogomphus</i>			
Aeschnidae	<i>Basiaeschna</i>			
	<i>Boyeria</i>			
Cordulegastridae	<i>Cordulegaster</i>		2	1
Corduliidae	Juvenile			
Plecoptera				
Taeniopterygidae	Juvenile/damaged			
	<i>Oemopteryx</i>			
	<i>Taeniopteryx</i>			
Nemouridae	Juvenile/damaged			
	<i>Nemoura</i>	10	3	14

Appendix 7b. Benthic macroinvertebrates from Whitewood Creek, Ontario, 2009.

		Whitewood Ck	Whitewood Ck	Whitewood Ck
		Wh-1-1	Wh-1-2	Wh-1-3
		Riffle	Pool	Riffle
		09-Sep	09-Sep	09-Sep
Leuctridae	Juvenile/damaged	2		
	<i>Leuctra</i>		2	
	<i>Paraleuctra</i>			
Capniidae	Juvenile/damaged			
	<i>Allocapnia</i>			
	<i>Paracapnia</i>			6
Perlidae	Juvenile/damaged			
	<i>Acroneuria</i>			
	<i>Claassenia</i>			
	<i>Paragnetina</i>			
Perlodidae	Juvenile/damaged			
Chloroperlidae		6		1
Coleoptera				
Dryopidae	<i>Helichus</i>			
Elmidae	Juvenile/damaged	2		4
	<i>Dubiraphia</i>			
	<i>Optioservus</i>	2	1	
Trichoptera	Juvenile/damaged/ Pupa		1	
Philopotamidae	<i>Dolophilodes</i>			2
	<i>Chimarra</i>			
Polycentropodidae	Juvenile/damaged			
	<i>Polycentropus</i>	4		
Hydropsychidae	Juvenile	2		
	<i>Cheumatopsyche</i>			
	<i>Hydropsyche</i>	4		2
	<i>Parapsyche</i>			
Rhyacophilidae	<i>Rhyacophila</i>	1		1
Glossosomatidae	<i>Glossosoma</i>	7	3	2
	<i>Protoptila</i>			
Hydroptilidae	<i>Hydroptila</i>			
	<i>Oxyethira</i>			
Lepidostomatidae	<i>Lepidostoma</i>	2	11	5
Limnephilidae	Juvenile/damaged			
	<i>Hydatophylax</i>			
Goeridae	<i>Goera</i>	1		
Leptoceridae	<i>Mystacides</i>			
	<i>Oecetis</i>			
Diptera	Damaged/pupa		2	
Ceratopogonidae	<i>Bezzia/Palpomyia</i>		2	
	<i>Ceratopogon</i>			
	<i>Dasyhelea</i>			
	<i>Mallacohalea</i>			
	<i>Probezzia</i>			1
	<i>Stilobezia</i>			
Chironomidae		20	23	23
Psychodidae	<i>Psychoda</i>		1	
Simuliidae	<i>Cnephia/Ectemnia</i>			
	<i>Simulium</i>			
Tipulidae	Juvenile/damaged			
	<i>Antocha</i>			
	<i>Dicronata</i>		1	
	<i>Hexatoma</i>			
Athericidae	<i>Atherix</i>			
Empididae	<i>Chelifera/Metachela</i>			
	<i>Hemerodromia</i>			
Total number of individuals		125	104	107
% Sorted		5.0	21.3	12.5

Appendix 8a. Benthic macroinvertebrates from Pitch Creek, Ontario, 2009.

		Pitch Creek	Pitch Creek	Pitch Creek
		P-1-1	P-1-2	P-1-3
		Riffle	Pool	Riffle
		06-Oct	06-Oct	06-Oct
PLATYHELMINTHES		3		3
NEMATODA				1
MOLLUSCA				
Gastropoda				
Ancylidae				
Lymnaeidae				
Physidae		2	2	
Planorbidae				
Bivalvia				
Sphaeriidae			1	
ANNELIDA				
Oligochaeta		7	5	6
Hirudinea				
ARTHROPODA				
Hydracarina		1	2	
Decapoda				
Cambaridae	<i>Orconectes</i>			
Isopoda				
Asellidae	<i>Caecidotea</i>			
Insecta				
Ephemeroptera				
Amelitidae	Juvenile <i>Ameletus</i>			
Siphonuridae	<i>Parameletus</i>			
Baetidae	Juvenile/damaged <i>Acentrella</i>		5	
	<i>Baetis</i>	4	21	2
	<i>Plauditus</i>	7		5
Isonychiidae	<i>Isonychia</i>			
Heptageniidae	Juvenile/damaged <i>Epeorus (Iron)</i>	2	2	2
	<i>Heptagenia</i>	8		3
	<i>Leucrocuta</i>	2	4	
	<i>Maccaffertium</i>			
	<i>Rhithrogena</i>			
	<i>Stenacron</i>			
	<i>Stenonema</i>			
Ephemerellidae	Juvenile/damaged <i>Attenella</i>	30		17
	<i>Ephemerella</i>	7	2	3
	<i>Eurylophella (s str.)</i>			
	<i>Serratella</i>			
Caenidae	<i>Caenis</i>			
Baetiscidae	<i>Baetisca</i>			
Leptophlebiidae	Juvenile/damaged <i>Habrophlebia</i>	8	3	2
	<i>Leptophlebia</i>	10	2	19
	<i>Paraleptophlebia</i>			
Odonata				
Gomphidae	Juvenile/damaged <i>Dromogomphus</i>		1	
	<i>Ophiogomphus</i>	1		
Aeschnidae	<i>Basiaeschna</i>		1	1
	<i>Boyeria</i>			
Cordulegastridae	<i>Cordulegaster</i>			
Corduliidae	Juvenile			
Plecoptera				
Taeniopterygidae	Juvenile/damaged <i>Oemopteryx</i>			
	<i>Taeniopteryx</i>			
Nemouridae	Juvenile/damaged <i>Nemoura</i>	1	3	

Appendix 8b. Benthic macroinvertebrates from Pitch Creek, Ontario, 2009.

		Pitch Creek	Pitch Creek	Pitch Creek
		P-1-1	P-1-2	P-1-3
		Riffle	Pool	Riffle
		06-Oct	06-Oct	06-Oct
Leuctridae	Juvenile/damaged			
	<i>Leuctra</i>			
	<i>Paraleuctra</i>	1	2	1
Capniidae	Juvenile/damaged			
	<i>Allocapnia</i>			
	<i>Paracapnia</i>			
Perlidae	Juvenile/damaged			1
	<i>Acroneuria</i>	1	2	
	<i>Claassenia</i>			1
	<i>Paragnetina</i>			
Perlodidae	Juvenile/damaged			
Chloroperlidae				
Coleoptera				
Dryopidae	<i>Helichus</i>			
Elmidae	Juvenile/damaged	2		
	<i>Dubiraphia</i>			
	<i>Optioservus</i>	1	1	4
Trichoptera	Juvenile/damaged/ Pupa			
Philopotamidae	<i>Dolophilodes</i>	2		1
	<i>Chimarra</i>	1		
Polycentropodidae	Juvenile/damaged	1		1
	<i>Polycentropus</i>			
Hydropsychidae	Juvenile			1
	<i>Cheumatopsyche</i>			
	<i>Hydropsyche</i>	10		7
	<i>Parapsyche</i>			
Rhyacophilidae	<i>Rhyacophila</i>		1	2
Glossosomatidae	<i>Glossosoma</i>	1	1	4
	<i>Protoptila</i>			
Hydroptilidae	<i>Hydroptila</i>			
	<i>Oxyethira</i>			
Lepidostomatidae	<i>Lepidostoma</i>	6	40	2
Limnephilidae	Juvenile/damaged			
	<i>Hydatophylax</i>			
Goeridae	<i>Goera</i>			
Leptoceridae	<i>Mystacides</i>			
	<i>Oecetis</i>			
Diptera	Damaged/pupa			
Ceratopogonidae	<i>Bezzia/Palpomyia</i>			
	<i>Ceratopogon</i>			
	<i>Dasyhelea</i>			
	<i>Mallacöhelea</i>		3	
	<i>Probezzia</i>			
	<i>Stilobezia</i>			
Chironomidae		18	15	18
Psychodidae	<i>Psychoda</i>			
Simuliidae	<i>Cnephia/Ectemnia</i>			
	<i>Simulium</i>			
Tipulidae	Juvenile/damaged			
	<i>Antocha</i>			
	<i>Dicronata</i>			
	<i>Hexatoma</i>			
Athericidae	<i>Atherix</i>	5	1	1
Empididae	<i>Chelifera/Metachel</i>			
	<i>Hemerodromia</i>			
Total number of individuals		142	120	111
% Sorted		2.5	5.0	3.8

Appendix 9a. Benthic macroinvertebrates from Barrett River, Ontario, 2009.

		Barrett R	Barrett R	Barrett R
		B-1-1	B-1-2	B-1-3
		Riffle	Pool	Riffle
		08-Oct	08-Oct	08-Oct
PLATYHELMINTHES				
NEMATODA				
MOLLUSCA				
Gastropoda				
Ancylidae				
Lymnaeidae				
Physidae				
Planorbidae				
Bivalvia				
Sphaeriidae				
ANNELIDA				
Oligochaeta		16	14	
Hirudinea		4		1
ARTHROPODA				
Hydracarina				1
Decapoda				
Cambaridae	<i>Orconectes</i>			
Isopoda				
Asellidae	<i>Caecidotea</i>			
Insecta				
Ephemeroptera	Juvenile	1		
Amelitidae	<i>Ameletus</i>			
Siphonuridae	<i>Parameletus</i>			
Baetidae	Juvenile/damaged		1	
	<i>Acentrella</i>			
	<i>Baetis</i>	3	5	1
	<i>Plauditus</i>	2		1
Isonychiidae	<i>Isonychia</i>			
Heptageniidae	Juvenile/damaged	4		3
	<i>Epeorus (Iron)</i>	2		1
	<i>Heptagenia</i>			
	<i>Leucrocuta</i>	5	2	7
	<i>Maccaffertium</i>		1	
	<i>Rhithrogena</i>			
	<i>Stenacron</i>			
	<i>Stenonema</i>			
Ephemerellidae	Juvenile/damaged			
	<i>Attenella</i>			
	<i>Ephemerella</i>			
	<i>Eurylophella</i> (s str.)	2	6	
	<i>Serratella</i>			
Caenidae	<i>Caenis</i>			
Baetiscidae	<i>Baetisca</i>			
Leptophlebiidae	Juvenile/damaged			
	<i>Habrophlebia</i>		1	
	<i>Leptophlebia</i>			
	<i>Paraleptophlebia</i>			
Odonata				
Gomphidae	Juvenile/damaged			
	<i>Dromogomphus</i>			
	<i>Ophiogomphus</i>			1
	<i>Basiaeschna</i>			
	<i>Boyeria</i>			
Cordulegastridae	<i>Cordulegaster</i>			
Corduliidae	Juvenile			
Plecoptera	Juvenile/damaged			1
Taeniopterygidae	Juvenile/damaged			
	<i>Oemopteryx</i>			
	<i>Taeniopteryx</i>			
Nemouridae	Juvenile/damaged			
	<i>Nemoura</i>	5	8	5

Appendix 9b. Benthic macroinvertebrates from Barrett River, Ontario, 2009.

		Barrett R	Barrett R	Barrett R
		B-1-1	B-1-2	B-1-3
		Riffle 08-Oct	Pool 08-Oct	Riffle 08-Oct
Leuctridae	Juvenile/damaged	1		
	<i>Leuctra</i>			
	<i>Paraleuctra</i>		1	
Capniidae	Juvenile/damaged			
	<i>Allocaenia</i>			
	<i>Paracania</i>			
Perlidae	Juvenile/damaged			
	<i>Acroneuria</i>			1
	<i>Claassenia</i>			
	<i>Paragnetina</i>			
Perlodidae	Juvenile/damaged			
Chloroperlidae				
Coleoptera				
Dryopidae	<i>Helichus</i>			
Elmidae	Juvenile/damaged			
	<i>Dubiraphia</i>			
	<i>Optioservus</i>			
Trichoptera	Juvenile/damaged/ Pupa			
Philopotamidae	<i>Dolophilodes</i>			2
	<i>Chimarra</i>			
Polycentropodidae	Juvenile/damaged			
	<i>Polycentropus</i>			
Hydropsychidae	Juvenile	1		
	<i>Cheumatopsyche</i>			
	<i>Hydropsyche</i>	8		
	<i>Parapsyche</i>			
Rhyacophilidae	<i>Rhyacophila</i>	1		1
Glossosomatidae	<i>Glossosoma</i>	5		
	<i>Protophila</i>			
Hydroptilidae	<i>Hydroptila</i>			
	<i>Oxyethira</i>			
Lepidostomatidae	<i>Lepidostoma</i>	4	5	6
Limnephilidae	Juvenile/damaged			
	<i>Hydatophylax</i>			
Goeridae	<i>Goera</i>			
Leptoceridae	<i>Mystacides</i>			
	<i>Oecetis</i>			
Diptera	Damaged/pupa			
Ceratopogonidae	<i>Bezzia/Palpomyia</i>			
	<i>Ceratopogon</i>			
	<i>Dasyhelea</i>			
	<i>Mallacohalea</i>			
	<i>Probezzia</i>	1		
	<i>Stilobezia</i>			
Chironomidae		49	57	77
Psychodidae	<i>Psychoda</i>			
Simuliidae	<i>Cnephia/Ectemnia</i>			
	<i>Simulium</i>			
Tipulidae	Juvenile/damaged			
	<i>Antocha</i>			
	<i>Dicronata</i>			
	<i>Hexatoma</i>			
Athericidae	<i>Atherix</i>			
Empididae	<i>Chelifera/Metachel</i>	1		1
	<i>Hemerodromia</i>			
Total number of individuals		115	101	110
% Sorted		5.0	8.8	7.5

Appendix 10a. Benthic macroinvertebrates from Coldwater River, Ontario, 2009.

		Coldwater River	Coldwater River	Coldwater River
		CW-1-1	CW-1-2	CW-1-3
		Pool	Riffle	Riffle
		08-Oct	08-Oct	08-Oct
PLATYHELMINTHES				
NEMATODA		7		
MOLLUSCA				
Gastropoda				
Ancylidae				
Lymnaeidae				
Physidae				
Planorbidae				
Bivalvia				
Sphaeriidae				
ANNELIDA				
Oligochaeta		14	4	1
Hirudinea				
ARTHROPODA				
Hydracarina			1	3
Decapoda				
Cambaridae	<i>Orconectes</i>			
Isopoda				
Asellidae	<i>Caecidotea</i>			
Insecta				
Ephemeroptera				
Amelitidae	<i>Ameletus</i>			
Siphonuridae	<i>Parameletus</i>			
Baetidae	Juvenile/damaged	2	3	
	<i>Acentrella</i>			2
	<i>Baetis</i>	2		1
	<i>Plauditus</i>			3
Isonychiidae	<i>Isonychia</i>			
Heptageniidae	Juvenile/damaged		3	10
	<i>Epeorus (Iron)</i>			1
	<i>Heptagenia</i>		1	1
	<i>Leucrocuta</i>			
	<i>Maccaffertium</i>		1	
	<i>Rhithrogena</i>			
	<i>Stenacron</i>			
	<i>Stenonema</i>			
Ephemerellidae	Juvenile/damaged			
	<i>Attenella</i>			
	<i>Ephemerella</i>			3
	<i>Eurylophella</i> (s str.)	2		
	<i>Serratella</i>			
Caenidae	<i>Caenis</i>			
Baetiscidae	<i>Baetisca</i>			
Leptophlebiidae	Juvenile/damaged		1	2
	<i>Habrophlebia</i>			
	<i>Leptophlebia</i>		1	2
	<i>Paraleptophlebia</i>			
Odonata				
Gomphidae	Juvenile/damaged			
	<i>Dromogomphus</i>			
	<i>Ophiogomphus</i>			
Aeschnidae	<i>Basiaeschna</i>			
	<i>Boyeria</i>			
Cordulegastridae	<i>Cordulegaster</i>			
Corduliidae	Juvenile		1	
Plecoptera	Juvenile/damaged			1
Taeniopterygidae	Juvenile/damaged			
	<i>Oemopteryx</i>			
	<i>Taeniopteryx</i>			
Nemouridae	Juvenile/damaged			
	<i>Nemoura</i>	3	8	9

Appendix 10b. Benthic macroinvertebrates from Coldwater River, Ontario, 2009.

		Coldwater River	Coldwater River	Coldwater River
		CW-1-1	CW-1-2	CW-1-3
		Pool	Riffle	Riffle
		08-Oct	08-Oct	08-Oct
Leuctridae	Juvenile/damaged			
	<i>Leuctra</i>			
	<i>Paraleuctra</i>	2	3	8
Capniidae	Juvenile/damaged			
	<i>Allocaenia</i>			
	<i>Paracania</i>			
Perlidae	Juvenile/damaged			1
	<i>Acroneuria</i>			
	<i>Claassenia</i>			
	<i>Paragnetina</i>			
Perlodidae	Juvenile/damaged			1
Chloroperlidae				
Coleoptera				
Dryopidae	<i>Helichus</i>			
Elmidae	Juvenile/damaged			
	<i>Dubiraphia</i>			
	<i>Optioservus</i>			
Trichoptera	Juvenile/damaged/ Pupa			
Philopotamidae	<i>Dolophilodes</i>			2
	<i>Chimarra</i>			
Polycentropodidae	Juvenile/damaged			
	<i>Polycentropus</i>			
Hydropsychidae	Juvenile		1	1
	<i>Cheumatopsyche</i>			
	<i>Hydropsyche</i>		2	7
	<i>Parapsyche</i>			
Rhyacophilidae	<i>Rhyacophila</i>			
Glossosomatidae	<i>Glossosoma</i>		1	2
	<i>Protoptila</i>			
Hydroptilidae	<i>Hydroptila</i>			
	<i>Oxyethira</i>			
Lepidostomatidae	<i>Lepidostoma</i>	2	1	
Limnephilidae	Juvenile/damaged	1	1	
	<i>Hydatophylax</i>			
Goeridae	<i>Goera</i>			
Leptoceridae	<i>Mystacides</i>			
	<i>Oecetis</i>			
Diptera	Damaged/pupa			
Ceratopogonidae	<i>Bezzia/Palpomylia</i>			
	<i>Ceratopogon</i>			
	<i>Dasyhelea</i>			
	<i>Mallacohelea</i>			
	<i>Probezzia</i>	1		
	<i>Stilobezia</i>			
Chironomidae		67	96	41
Psychodidae	<i>Psychoda</i>			
Simuliidae	<i>Cnephia/Ectemnia</i>			
	<i>Simulium</i>			1
Tipulidae	Juvenile/damaged			
	<i>Antocha</i>			
	<i>Dicronata</i>			
	<i>Hexatoma</i>			
Athericidae	<i>Atherix</i>			
Empididae	<i>Chelifera/Metachela</i>			
	<i>Hemerodromia</i>		1	
Total number of individuals		103	130	103
% Sorted		1.3	2.5	5.0

Appendix 11a. Benthic macroinvertebrates from Current River, Ontario, 2009.

		Current River	Current River	Current River
		CU-14-1	CU-14-2	CU-14-3
		Riffle	Pool	Riffle
		30-Sep	30-Sep	30-Sep
PLATYHELMINTHES				
NEMATODA				
MOLLUSCA				
Gastropoda				
Ancylidae				
Lymnaeidae				
Physidae				
Planorbidae			1	1
Bivalvia				
Sphaeriidae		4		5
ANNELIDA				
Oligochaeta		5	1	9
Hirudinea				
ARTHROPODA				
Hydracarina		1	1	1
Decapoda				
Cambaridae	<i>Orconectes</i>			
Isopoda				
Asellidae	<i>Caecidotea</i>			
Insecta				
Ephemeroptera	Juvenile			
Amelitidae	<i>Ameletus</i>			
Siphonuridae	<i>Parameletus</i>			
Baetidae	Juvenile/damaged			
	<i>Acentrella</i>			
	<i>Baetis</i>	1		
	<i>Plauditus</i>			
Isonychiidae	<i>Isonychia</i>			
Heptageniidae	Juvenile/damaged	1		
	<i>Epeorus (Iron)</i>			
	<i>Heptagenia</i>			
	<i>Leucrocuta</i>			1
	<i>Maccaffertium</i>			
	<i>Rhithrogena</i>			
	<i>Stenacron</i>			
	<i>Stenonema</i>			1
Ephemerellidae	Juvenile/damaged	1		1
	<i>Attenella</i>	2		
	<i>Ephemerella</i>			
	<i>Eurylophella (s str.)</i>	1	8	5
	<i>Serratella</i>			2
Caenidae	<i>Caenis</i>			
Baetiscidae	<i>Baetisca</i>	1		
Leptophlebiidae	Juvenile/damaged	3	3	1
	<i>Habrophlebia</i>			
	<i>Leptophlebia</i>	1	4	5
	<i>Paraleptophlebia</i>			
Odonata				
Gomphidae	Juvenile/damaged		1	4
	<i>Dromogomphus</i>			
	<i>Ophiogomphus</i>			
Aeschnidae	<i>Basiaeschna</i>			
	<i>Boyeria</i>			
Cordulegastridae	<i>Cordulegaster</i>			
Corduliidae	Juvenile			
Plecoptera				
Taeniopterygidae	Juvenile/damaged			
	<i>Oemopteryx</i>			
	<i>Taeniopteryx</i>	1		
Nemouridae	Juvenile/damaged			
	<i>Nemoura</i>			1

Appendix 11b. Benthic macroinvertebrates from Current River, Ontario, 2009.

		Current River	Current River	Current River
		CU-14-1	CU-14-2	CU-14-3
		Riffle	Pool	Riffle
		30-Sep	30-Sep	30-Sep
Leuctridae	Juvenile/damaged			
	<i>Leuctra</i>			
	<i>Paraleuctra</i>			
Capniidae	Juvenile/damaged			
	<i>Allocapnia</i>			
	<i>Paracapnia</i>			
Perlidae	Juvenile/damaged			
	<i>Acroneuria</i>			
	<i>Claassenia</i>			
	<i>Paragnetina</i>			
Perlodidae	Juvenile/damaged			
Chloroperlidae				
Coleoptera				
Dryopidae	<i>Helichus</i>			1
Elmidae	Juvenile/damaged	1	1	2
	<i>Dubiraphia</i>		1	
	<i>Optioservus</i>			1
Trichoptera	Juvenile/damaged/ Pupa			
Philopotamidae	<i>Dolophilodes</i>			
	<i>Chimarra</i>	1		2
Polycentropodidae	Juvenile/damaged			
	<i>Polycentropus</i>			1
Hydropsychidae	Juvenile			3
	<i>Cheumatopsyche</i>			
	<i>Hydropsyche</i>	2		2
	<i>Parapsyche</i>			
Rhyacophilidae	<i>Rhyacophila</i>			1
Glossosomatidae	<i>Glossosoma</i>			
	<i>Protoptila</i>			
Hydroptilidae	<i>Hydroptila</i>		4	2
	<i>Oxyethira</i>	1	2	
Lepidostomatidae	<i>Lepidostoma</i>			2
Limnephilidae	Juvenile/damaged			
	<i>Hydatophylax</i>			
Goeridae	<i>Goera</i>			
Leptoceridae	<i>Mystacides</i>		2	1
	<i>Oecetis</i>			
Diptera	Damaged/pupa			
Ceratopogonidae	<i>Bezzia/Palpomyia</i>			
	<i>Ceratopogon</i>			
	<i>Dasyhelea</i>			
	<i>Mallacohlelea</i>			
	<i>Probezzia</i>	8		
	<i>Stilobezia</i>			
Chironomidae		80	105	63
Psychodidae	<i>Psychoda</i>			
Simuliidae	<i>Cnephia/Ectemnia</i>			
	<i>Simulium</i>			
Tipulidae	Juvenile/damaged			
	<i>Antocha</i>			
	<i>Dicronata</i>			
	<i>Hexatoma</i>			
Athericidae	<i>Atherix</i>			
Empididae	<i>Chelifera/Metachel</i>			
	<i>Hemerodromia</i>	8		2
Total number of individuals		123	134	120
% Sorted		3.8	2.5	2.5

Appendix 12a. Benthic macroinvertebrates from Jackpine River, Ontario, 2009.

		Jackpine River	Jackpine River	Jackpine River
		JP-1-1	JP-1-2	JP-1-3
		Riffle	Pool	Riffle
		26-Sep	26-Sep	26-Sep
PLATYHELMINTHES				1
NEMATODA				
MOLLUSCA				
Gastropoda				
Ancylidae				
Lymnaeidae				
Physidae				
Planorbidae				
Bivalvia				
Sphaeriidae				
ANNELIDA				
Oligochaeta		10	20	5
Hirudinea				
ARTHROPODA				
Hydracarina		2	3	
Decapoda				
Cambaridae	<i>Orconectes</i>			
Isopoda				
Asellidae	<i>Caecidotea</i>			
Insecta				
Ephemeroptera				
Amelitidae	Juvenile <i>Ameletus</i>			
Siphonuridae	<i>Parameletus</i>			
Baetidae	Juvenile/damaged <i>Acentrella</i>	1		1
	<i>Baetis</i>			
	<i>Plauditus</i>	1		3
Isonychiidae	<i>Isonychia</i>			
Heptageniidae	Juvenile/damaged <i>Epeorus (Iron)</i>	2	5	3
	<i>Heptagenia</i>			1
	<i>Leucrocuta</i>	1	1	4
	<i>Maccaffertium</i>	2	4	
	<i>Rhithrogena</i>	9		1
	<i>Stenacron</i>			
	<i>Stenonema</i>			
Ephemerellidae	Juvenile/damaged <i>Attenella</i>	1		
	<i>Ephemerella</i>			5
	<i>Eurylophella</i> (s str.)		4	
	<i>Serratella</i>			
Caenidae	<i>Caenis</i>			
Baetiscidae	<i>Baetisca</i>			
Leptophlebiidae	Juvenile/damaged <i>Habrophlebia</i>	5		5
	<i>Leptophlebia</i>	2	3	
	<i>Paraleptophlebia</i>			
Odonata				
Gomphidae	Juvenile/damaged <i>Dromogomphus</i>			
	<i>Ophiogomphus</i>			
Aeschnidae	<i>Basiaeschna</i>			
	<i>Boyeria</i>			
Cordulegastridae	<i>Cordulegaster</i>			
Corduliidae	Juvenile			
Plecoptera				
Taeniopterygidae	Juvenile/damaged <i>Oemopteryx</i>			1
	<i>Taeniopteryx</i>		1	
Nemouridae	Juvenile/damaged <i>Nemoura</i>	2	7	1

Appendix 12b. Benthic macroinvertebrates from Jackpine River, Ontario, 2009.

		Jackpine River	Jackpine River	Jackpine River
		JP-1-1	JP-1-2	JP-1-3
		Riffle	Pool	Riffle
		26-Sep	26-Sep	26-Sep
Leuctridae	Juvenile/damaged			
	<i>Leuctra</i>			
	<i>Paraleuctra</i>		1	
Capniidae	Juvenile/damaged			
	<i>Allocapnia</i>			
	<i>Paracapnia</i>			
Perlidae	Juvenile/damaged			
	<i>Acroneuria</i>			3
	<i>Claassenia</i>			
	<i>Paragnetina</i>			
Perlodidae	Juvenile/damaged			
Chloroperlidae				
Coleoptera				
Dryopidae	<i>Helichus</i>			
Elmidae	Juvenile/damaged			
	<i>Dubiraphia</i>		2	
	<i>Optioservus</i>			
Trichoptera	Juvenile/damaged/ Pupa	1		
Philopotamidae	<i>Dolophilodes</i>			3
	<i>Chimarra</i>			
Polycentropodidae	Juvenile/damaged			
	<i>Polycentropus</i>			
Hydropsychidae	Juvenile	1		5
	<i>Cheumatopsyche</i>			
	<i>Hydropsyche</i>	10		9
	<i>Parapsyche</i>			
Rhyacophilidae	<i>Rhyacophila</i>	1		2
Glossosomatidae	<i>Glossosoma</i>	2	1	
	<i>Protophila</i>			
Hydroptilidae	<i>Hydroptila</i>			
	<i>Oxyethira</i>			
Lepidostomatidae	<i>Lepidostoma</i>	11	2	15
Limnephilidae	Juvenile/damaged			
	<i>Hydatophylax</i>			
Goeridae	<i>Goera</i>			
Leptoceridae	<i>Mystacides</i>			
	<i>Oecetis</i>			
Diptera	Damaged/pupa			
Ceratopogonidae	<i>Bezzia/Palpomyia</i>			
	<i>Ceratopogon</i>			
	<i>Dasyhelea</i>			
	<i>Mallacohhelea</i>			
	<i>Probezzia</i>		25	
	<i>Stilobezia</i>	1		
Chironomidae		44	42	41
Psychodidae	<i>Psychoda</i>			
Simuliidae	<i>Cnephia/Ectemnia</i>			
	<i>Simulium</i>			
Tipulidae	Juvenile/damaged			
	<i>Antocha</i>			
	<i>Dicronata</i>			
	<i>Hexatoma</i>			
Athericidae	<i>Atherix</i>			
Empididae	<i>Chelifera/Metachel</i>		2	3
	<i>Hemerodromia</i>	3		2
Total number of individuals		112	123	114
% Sorted		17.5	5.0	20.0

Appendix 13a. Benthic macroinvertebrates from McVicar Creek (Urban), Ontario, 2009.

		McVicar Ck Urban	McVicar Ck Urban	McVicar Ck Urban
		MvU-2-1	MvU-2-2	MvU-2-3
		Riffle	Pool	Riffle
		24-Sep	24-Sep	24-Sep
PLATYHELMINTHES				
NEMATODA			2	
MOLLUSCA				
Gastropoda				
Ancylidae				
Lymnaeidae				
Physidae				
Planorbidae				
Bivalvia				
Sphaeriidae		1		
ANNELIDA				
Oligochaeta		46	12	75
Hirudinea				
ARTHROPODA				
Hydracarina		5	2	3
Decapoda				
Cambaridae	<i>Orconectes</i>			
Isopoda				
Asellidae	<i>Caecidotea</i>			
Insecta				
Ephemeroptera				
Amelitidae	Juvenile <i>Ameletus</i>			
Siphonuridae	<i>Parameletus</i>			
Baetidae	Juvenile/damaged <i>Acentrella</i> <i>Baetis</i> <i>Plauditus</i>			
Isonychiidae	<i>Isonychia</i>			
Heptageniidae	Juvenile/damaged <i>Epeorus (Iron)</i> <i>Heptagenia</i> <i>Leucrocuta</i> <i>Maccaffertium</i> <i>Rhithrogena</i> <i>Stenacron</i> <i>Stenonema</i>	1		
Ephemerellidae	Juvenile/damaged <i>Attenella</i> <i>Ephemerella</i> <i>Eurylophella (s str.)</i> <i>Serratella</i>			
Caenidae	<i>Caenis</i>			
Baetiscidae	<i>Baetisca</i>			
Leptophlebiidae	Juvenile/damaged <i>Habrophlebia</i> <i>Leptophlebia</i> <i>Paraleptophlebia</i>		1	
Odonata				
Gomphidae	Juvenile/damaged <i>Dromogomphus</i> <i>Ophiogomphus</i>			
Aeschnidae	<i>Basiaeschna</i> <i>Boyeria</i>			
Cordulegastridae	<i>Cordulegaster</i>			
Corduliidae	Juvenile			
Plecoptera				
Taeniopterygidae	Juvenile/damaged <i>Oemopteryx</i> <i>Taeniopteryx</i>			
Nemouridae	Juvenile/damaged <i>Nemoura</i>	1		

Appendix 13b. Benthic macroinvertebrates from McVicar Creek (Urban), Ontario, 2009.

		McVicar Ck Urban	McVicar Ck Urban	McVicar Ck Urban
		MvU-2-1	MvU-2-2	MvU-2-3
		Riffle	Pool	Riffle
		24-Sep	24-Sep	24-Sep
Leuctridae	Juvenile/damaged			
	<i>Leuctra</i>		1	
	<i>Paraleuctra</i>			
Capniidae	Juvenile/damaged			
	<i>Allocapnia</i>			
	<i>Paracapnia</i>			
Perlidae	Juvenile/damaged			
	<i>Acroneuria</i>			
	<i>Claassenia</i>			
	<i>Paragnetina</i>			
Perlodidae	Juvenile/damaged			
Chloroperlidae				
Coleoptera				
Dryopidae	<i>Helichus</i>			
Elmidae	Juvenile/damaged			3
	<i>Dubiraphia</i>			
	<i>Optioservus</i>			3
Trichoptera	Juvenile/damaged/ Pupa			
Philopotamidae	<i>Dolophilodes</i>			
	<i>Chimarra</i>			
Polycentropodidae	Juvenile/damaged			
	<i>Polycentropus</i>			
Hydropsychidae	Juvenile	8		
	<i>Cheumatopsyche</i>			
	<i>Hydropsyche</i>	4	1	3
	<i>Parapsyche</i>			
Rhyacophilidae	<i>Rhyacophila</i>	1		
Glossosomatidae	<i>Glossosoma</i>			
	<i>Protoptila</i>			
Hydroptilidae	<i>Hydroptila</i>			
	<i>Oxyethira</i>			
Lepidostomatidae	<i>Lepidostoma</i>			
Limnephilidae	Juvenile/damaged			
	<i>Hydatophylax</i>			
Goeridae	<i>Goera</i>			
Leptoceridae	<i>Mystacides</i>		37	
	<i>Oecetis</i>			
Diptera	Damaged/pupa			
Ceratopogonidae	<i>Bezzia/Palpomyia</i>			
	<i>Ceratopogon</i>			
	<i>Dasyhelea</i>			
	<i>Mallacohelea</i>			
	<i>Probezzia</i>	1		
	<i>Stilobezia</i>			
Chironomidae		30	41	13
Psychodidae	<i>Psychoda</i>			
Simuliidae	<i>Cnephia/Ectemnia</i>	1		
	<i>Simulium</i>			
Tipulidae	Juvenile/damaged			
	<i>Antocha</i>		2	
	<i>Dicronata</i>			1
	<i>Hexatoma</i>			
Athericidae	<i>Atherix</i>			
Empididae	<i>Chelifera/Metachel</i>	2	2	1
	<i>Hemerodromia</i>			
Total number of individuals		101	101	102
% Sorted		13.8	28.8	5.0

Appendix 14a. Benthic macroinvertebrates from McIntyre River (Urban 2), Ontario, 2009.

		McIntyre River	McIntyre River	McIntyre River
		MIU-2-1	MIU-2-2	MIU-2-3
		Riffle	Pool	Riffle
		24-Sep	24-Sep	24-Sep
PLATYHELMINTHES				
NEMATODA				
MOLLUSCA				
Gastropoda				
Ancylidae		1	1	
Lymnaeidae				
Physidae			1	
Planorbidae				
Bivalvia				
Sphaeriidae				
ANNELIDA				
Oligochaeta		7	10	13
Hirudinea		1		
ARTHROPODA				
Hydracarina		3	3	2
Decapoda				
Cambaridae	<i>Orconectes</i>			
Isopoda				
Asellidae	<i>Caecidotea</i>			
Insecta				
Ephemeroptera	Juvenile			
Amelitidae	<i>Ameletus</i>			
Siphonuridae	<i>Parameletus</i>			
Baetidae	Juvenile/damaged	1	3	
	<i>Acentrella</i>			
	<i>Baetis</i>			
	<i>Plauditus</i>			
Isonychiidae	<i>Isonychia</i>			
Heptageniidae	Juvenile/damaged	1	6	1
	<i>Epeorus (Iron)</i>			
	<i>Heptagenia</i>			
	<i>Leucrocuta</i>	2	3	2
	<i>Maccaffertium</i>			2
	<i>Rhithrogena</i>			
	<i>Stenacron</i>			
	<i>Stenonema</i>			
Ephemerellidae	Juvenile/damaged			
	<i>Attenella</i>			
	<i>Ephemerella</i>			
	<i>Eurylophella</i> (s str.)			
	<i>Serratella</i>			
Caenidae	<i>Caenis</i>			
Baetiscidae	<i>Baetisca</i>			
Leptophlebiidae	Juvenile/damaged	1	1	
	<i>Habrophlebia</i>			
	<i>Leptophlebia</i>			1
	<i>Paraleptophlebia</i>			
Odonata				
Gomphidae	Juvenile/damaged			
	<i>Dromogomphus</i>			
	<i>Ophiogomphus</i>			
Aeschnidae	<i>Basiaeschna</i>			
	<i>Boyeria</i>			
Cordulegastridae	<i>Cordulegaster</i>			
Corduliidae	Juvenile			
Plecoptera				
Taeniopterygidae	Juvenile/damaged			
	<i>Oemopteryx</i>	2		
	<i>Taeniopteryx</i>			
Nemouridae	Juvenile/damaged			
	<i>Nemoura</i>		2	

Appendix 14b. Benthic macroinvertebrates from McIntyre River (Urban 2), Ontario, 2009.

		McIntyre River	McIntyre River	McIntyre River
		MIU-2-1	MIU-2-2	MIU-2-3
		Riffle	Pool	Riffle
		24-Sep	24-Sep	24-Sep
Leuctridae	Juvenile/damaged		1	1
	<i>Leuctra</i>			
	<i>Paraleuctra</i>			1
Capniidae	Juvenile/damaged			
	<i>Allocapnia</i>			
	<i>Paracapnia</i>			
Perlidae	Juvenile/damaged			
	<i>Acroneuria</i>			
	<i>Claassenia</i>			
	<i>Paragnetina</i>			
Perlodidae	Juvenile/damaged			4
Chloroperlidae				
Coleoptera				
Dryopidae	<i>Helichus</i>			
Elmidae	Juvenile/damaged	2	1	6
	<i>Dubiraphia</i>			
	<i>Optioservus</i>			1
Trichoptera	Juvenile/damaged/ Pupa			
Philopotamidae	<i>Dolophilodes</i>			
	<i>Chimarra</i>			
Polycentropodidae	Juvenile/damaged			
	<i>Polycentropus</i>			
Hydropsychidae	Juvenile	1		
	<i>Cheumatopsyche</i>			1
	<i>Hydropsyche</i>	9		11
	<i>Parapsyche</i>			
Rhyacophilidae	<i>Rhyacophila</i>			1
Glossosomatidae	<i>Glossosoma</i>			1
	<i>Protoptila</i>			
Hydroptilidae	<i>Hydroptila</i>			
	<i>Oxyethira</i>			
Lepidostomatidae	<i>Lepidostoma</i>	7	5	28
Limnephilidae	Juvenile/damaged			
	<i>Hydatophylax</i>			
Goeridae	<i>Goera</i>			
Leptoceridae	<i>Mystacides</i>			
	<i>Oecetis</i>		3	4
Diptera	Damaged/pupa	1		
Ceratopogonidae	<i>Bezzia/Palpomyia</i>			
	<i>Ceratopogon</i>			
	<i>Dasyhelea</i>			
	<i>Mallacohelea</i>			
	<i>Probezzia</i>			
	<i>Stilobezia</i>			
Chironomidae		65	67	39
Psychodidae	<i>Psychoda</i>			
Simuliidae	<i>Cnephia/Ectemnia</i>			
	<i>Simulium</i>			
Tipulidae	Juvenile/damaged			
	<i>Antocha</i>	2	1	
	<i>Dicronata</i>			
	<i>Hexatoma</i>			
Athericidae	<i>Atherix</i>			1
Empididae	<i>Chelifera/Metachel</i>			1
	<i>Hemerodromia</i>		1	1
Total number of individuals		106	109	122
% Sorted		2.5	7.5	5.0

Appendix 15a. Benthic macroinvertebrates from McIntyre River (Urban 1), Ontario, 2009.

		McIntyre River	McIntyre River	McIntyre River
		MIU-1-1	MIU-1-2	MIU-1-3
		Riffle	Pool	Riffle
		22-Sep	22-Sep	22-Sep
PLATYHELMINTHES				
NEMATODA				
		3	1	
MOLLUSCA				
Gastropoda				
Ancylidae				1
Lymnaeidae				
Physidae				
Planorbidae				
Bivalvia				
Sphaeriidae				
ANNELIDA				
Oligochaeta				
		26	14	11
Hirudinea				
ARTHROPODA				
Hydracarina				
		2	3	1
Decapoda				
Cambaridae	<i>Orconectes</i>	1	1	
Isopoda				
Asellidae	<i>Caecidotea</i>		2	1
Insecta				
Ephemeroptera				
Juvenile				
Amelitidae	<i>Ameletus</i>			
Siphonuridae	<i>Parameletus</i>			
Baetidae	Juvenile/damaged	1	1	
	<i>Acentrella</i>			
	<i>Baetis</i>			
	<i>Plauditus</i>			
Isonychiidae	<i>Isonychia</i>			
Heptageniidae	Juvenile/damaged	5	16	2
	<i>Epeorus (Iron)</i>			
	<i>Heptagenia</i>			
	<i>Leucrocuta</i>	4	2	
	<i>Maccaffertium</i>	1	14	1
	<i>Rhithrogena</i>			
	<i>Stenacron</i>			
	<i>Stenonema</i>			
Ephemerellidae	Juvenile/damaged			
	<i>Attenella</i>			
	<i>Ephemerella</i>			
	<i>Eurylophella (s str.)</i>		2	
	<i>Serratella</i>			
Caenidae	<i>Caenis</i>	1		
Baetiscidae	<i>Baetisca</i>			
Leptophlebiidae	Juvenile/damaged		1	
	<i>Habrophlebia</i>			
	<i>Leptophlebia</i>	3	1	
	<i>Paraleptophlebia</i>			
Odonata				
Gomphidae	Juvenile/damaged			
	<i>Dromogomphus</i>			
	<i>Ophiogomphus</i>			1
Aeschnidae	<i>Basiaeschna</i>			
	<i>Boyeria</i>			
Cordulegastridae	<i>Cordulegaster</i>			
Corduliidae	Juvenile			
Plecoptera				
Juvenile/damaged				
Taeniopterygidae	Juvenile/damaged			
	<i>Oemopteryx</i>			
	<i>Taeniopteryx</i>			
Nemouridae	Juvenile/damaged			
	<i>Nemoura</i>	4		

Appendix 15b. Benthic macroinvertebrates from McIntyre River (Urban 1), Ontario, 2009.

		McIntyre River	McIntyre River	McIntyre River
		MIU-1-1	MIU-1-2	MIU-1-3
		Riffle	Pool	Riffle
		22-Sep	22-Sep	22-Sep
Leuctridae	Juvenile/damaged			
	<i>Leuctra</i>			
	<i>Paraleuctra</i>		1	
Capniidae	Juvenile/damaged	1		
	<i>Allocapnia</i>			
	<i>Paracapnia</i>			
Perlidae	Juvenile/damaged			
	<i>Acroneuria</i>			
	<i>Claassenia</i>			
	<i>Paragnetina</i>			
Perlodidae	Juvenile/damaged	1		4
Chloroperlidae				
Coleoptera				
Dryopidae	<i>Helichus</i>			
Elmidae	Juvenile/damaged	5		2
	<i>Dubiraphia</i>		1	
	<i>Optioservus</i>	3		4
Trichoptera	Juvenile/damaged/ Pupa			
Philopotamidae	<i>Dolophilodes</i>			
	<i>Chimarra</i>			
Polycentropodidae	Juvenile/damaged			
	<i>Polycentropus</i>			
Hydropsychidae	Juvenile			1
	<i>Cheumatopsyche</i>			1
	<i>Hydropsyche</i>			8
	<i>Parapsyche</i>			
Rhyacophilidae	<i>Rhyacophila</i>			
Glossosomatidae	<i>Glossosoma</i>			
	<i>Protophila</i>	1		
Hydroptilidae	<i>Hydroptila</i>			
	<i>Oxyethira</i>			
Lepidostomatidae	<i>Lepidostoma</i>			
Limnephilidae	Juvenile/damaged			
	<i>Hydatophylax</i>			
Goeridae	<i>Goera</i>			
Leptoceridae	<i>Mystacides</i>			
	<i>Oecetis</i>	1	1	
Diptera	Damaged/pupa			
Ceratopogonidae	<i>Bezzia/Palpomyia</i>			
	<i>Ceratopogon</i>			
	<i>Dasyhelea</i>			
	<i>Mallacohelea</i>			
	<i>Probezzia</i>			
	<i>Stilobezia</i>			
Chironomidae		47	43	77
Psychodidae	<i>Psychoda</i>			
Simuliidae	<i>Cnephia/Ectemnia</i>			
	<i>Simulium</i>			
Tipulidae	Juvenile/damaged			
	<i>Antocha</i>			
	<i>Dicronata</i>			
	<i>Hexatoma</i>			
Athericidae	<i>Atherix</i>			2
Empididae	<i>Chelifera/Metachel</i>			
	<i>Hemerodromia</i>			
Total number of individuals		110	104	117
% Sorted		7.5	15.0	3.8