Technical Memorandum CN 232.3

FARMINGTON RIVER WATERSHED
2006 BENTHIC MACROINVERTEBRATE BIOASSESSMENT

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INTRODUCTION

Biological monitoring is a useful means of detecting anthropogenic impacts to the aquatic community. Resident biota (e.g., benthic macroinvertebrates, fish, periphyton) in a water body are natural monitors of environmental quality and can reveal the effects of episodic and cumulative pollution and habitat alteration (Plafkin et al. 1989, Barbour et al. 1995).

As part of the Massachusetts Department of Environmental Protection/Division of Watershed Management's (MassDEP/DWM) 2006 Farmington River Watershed assessments, aquatic benthic macroinvertebrate biomonitoring was conducted to evaluate the biological health of the Farmington River and selected tributaries and to determine their status with respect to the support of the *Aquatic Life* use, as designated in the *Massachusetts Surface Water Quality Standards* (SWQS) (MassDEP 2006). These assessments form the basis for reporting and listing waters pursuant to sections 305(b) and 303(d) of the Clean Water Act (CWA). A total of eleven biomonitoring stations on ten named streams were sampled to determine the health of aquatic communities of the watershed (Figure 1). Table 1 presents the 2006 sampling locations, along with station identification numbers and sampling dates. One of the goals of the 2006 macroinvertebrate sampling was to determine the biological health of waterbodies not previously assessed and increase the coverage of assessed waterbodies. Watershed issues of concern and sampling rationale for the 2006 Farmington River Watershed macroinvertebrate survey are presented in Table 2.

To provide information for making *Aquatic Life* use-support determinations, macroinvertebrate communities present at biomonitoring stations in the Farmington River Watershed were compared with communities occurring at a regional reference station most representative of "least disturbed" conditions in the watershed. The watershed reference station (FR09) was established on Hubbard Brook. This station has been used in previous biomonitoring surveys (Fiorentino 1997; Fiorentino 2003). Impacts to the benthic community may be indicated by the absence of generally pollution-sensitive macroinvertebrate taxa such as Ephemeroptera, Plecoptera, and Trichoptera (EPT); dominance of a particular taxon, especially the pollution-tolerant Chironomidae and Oligochaeta taxa; low total taxa richness; or shifts in community composition relative to the reference station (Plafkin et al. 1989).

METHODS

Macroinvertebrate Sampling - RBPIII

Macroinvertebrate sampling and habitat assessments were conducted on August 15th and 16th, 2006 at eleven sites in the Farmington Watershed (Table 1). Sampling activities were performed in accordance with the Sampling & Analysis Plan (SAP) for the Farmington River Watershed (O'Brien-Clayton 2006). The sampling procedures are further described in the standard operating procedures *Water Quality Monitoring in Streams Using Aquatic Macroinvertebrates* (Nuzzo 2003), and are based on US EPA Rapid Bioassessment Protocols (RBPs) for wadeable streams and rivers (Plafkin et al. 1989). The macroinvertebrate collection procedure utilized kick-sampling, a method of sampling benthic organisms by kicking or disturbing bottom sediments and catching the dislodged organisms in a net as the current carries them downstream. Sampling was conducted by MassDEP/DWM biologists throughout a 100 m reach, in riffle/run areas with fast currents and rocky (cobble, pebble, and gravel) substrates—generally the most productive habitats, supporting the most diverse communities in the stream system. Ten kicks in squares approximately 0.46 m x 0.46 m were composited for a total sample area of about 2 m^2. Samples were labeled and preserved in the field with denatured 95% ethanol, then brought to the MassDEP/DWM lab for further processing.

Table 1. List of biomonitoring stations sampled during the 2006 Farmington River watershed survey, including station and unique identification numbers, drainage areas, sampling site descriptions, and sampling dates.

Station ID	Unique ID	Drainage Area (mi^2)	Waterbody	Site Description	Sampling Date
TB00	B0582	7.1	Thomas Brook	Upstream at Route 8, Otis, MA	16 Aug 2006
FR01B	B0205	17.3	West Branch Farmington River	Downstream of MASS DPW yard on Route 8, Otis, MA	16 Aug 2006
DB00	B0581	4.0	Dimmock Brook	~15m upstream from Route 23, Otis, MA	16 Aug 2006
FR04	B0208	4.1	Benton Brook	~200m downstream from North Beech Plain Road, Sandisfield, MA	16 Aug 2006
FR03	B0207	16.6	Fall River	~100m upstream from Reservoir Road, Otis, MA	16 Aug 2006
BR01	B0583	8.5	Buck River	East of Route 57, opposite the Sandisfield Post Office, Sandisfield, MA	16 Aug 2006
FR06B	B0212	22.2	Clam River	~25m upstream from South Beech Plain Road bridge, Sandisfield, MA	16 Aug 2006
FR05B	B0210	91.7	West Branch Farmington River	~15m upstream from Clark Road footbridge, Sandisfield, MA	15 Aug 2006
CPB00	B0580	1.1	Cranberry Pond Brook	~10m upstream of the most upstream crossing of Colebrook River Road, Tolland, MA	15 Aug 2006
FR09	B0215	11.6	Hubbard Brook	~50m upstream from Hartland Road, Granville, MA	15 Aug 2006
FR08B	B0585	10	Sandy Brook	Upstream of State Line Hill Road, Norfolk, CT	15 Aug 2006

Macroinvertebrate Sample Processing and Data Analysis

The macroinvertebrate sample processing and analysis procedures employed for the 2006 Farmington River watershed biomonitoring samples are described in the standard operating procedures (Nuzzo 2003). Macroinvertebrate sample processing entailed distributing whole samples in pans, randomly selecting grids within the pans, and sorting specimens from the other materials in the sample until approximately 100 organisms (±10%) were extracted. Specimens were identified to genus or species as allowed by available keys, specimen condition, and specimen maturity.

Based on the taxonomy, various community, population, and functional parameters, or "metrics", were calculated which allow measurement of important aspects of the biological integrity of the macroinvertebrate community. This integrated approach provides more assurance of a valid assessment because a variety of biological parameters are evaluated, and the deficiency of any one metric should not invalidate the entire approach (Plafkin et al. 1989). Taxonomic data were analyzed using a modification of Rapid Bioassessment Protocol III (RBP III) metrics and scores (Plafkin et al. 1989). The modifications were: substitution of "reference site affinity" (RSA) for the Community Loss Index and elimination of the shredder/total ratio (no separate leaf-pack material was collected). The reference site affinity metric is a modification of Percent Model Affinity (Novak and Bode 1992). Instead of using the model's percentages for Oligochaeta, Ephemeroptera, Plecoptera, Trichoptera, Coleoptera, Chironomidae, and "other," these percentages were taken from the reference site data. The RSA score is then calculated as:

$$100 - \Sigma (\delta \times 0.5)$$

Table 2. List of watershed issues and sampling rationale for 2006 Farmington River Watershed biomonitoring survey.Issues to be investigated were identified in the Farmington River Watershed Sampling and Analysis Plan (O'Brien-Clayton 2006).

Farmington River Watershed Station ID	Watershed Issues/Sampling Rationale
TB00	Thomas Brook – Never been assessed by MassDEP.
FR01B	West Branch Farmington. – Aquatic Life impaired due to fishery bioassessment. Suspected cause of impairment is elevated temperatures in this river classified as a coldwater fishery.
DB00	Dimmock Brook - Never been assessed by MassDEP.
FR04	Benton Brook. – No known issues. Sampled to provide long term dataset and to allow comparisons to historical data.
FR03	Fall River. Possible hydromodification issues.
BR01	Buck River – No known issues. Sampled to provide long term dataset and to allow comparisons to historical data.
FR06B	Clam River – No known issues. Sampled to provide long term dataset and to allow comparisons to historical data.
FR05B	West Branch Farmington. – Aquatic Life impaired due to fishery bioassessment. Suspected cause of impairment is elevated temperatures in this river classified as a coldwater fishery. Localized trash and sedimentation issues.
CPB00	Cranberry Pond Brook – Never been assessed by MassDEP.
FR09	Hubbard Brook – Reference station. No known issues.
FR08B	Sandy Brook – No known issues. Sampled to provide long term dataset and to allow comparisons to historical data.

where δ is the difference between the reference percentage and the sample percentage for each taxonomic grouping. RSA percentages convert to RBP III scores as follows: 0 points for <35%; 2 points in the range from 35 to 49%; 4 points for 50 to 64%; and 6 points if ≥65%. The entire suite of metrics used for the analysis was:

- Richness—the total number of different species present in the subsample plus those detected from a "large/rare" search of the whole sample (those taxa missed in subsampling);

- HBI—Hilsenhoff Biotic Index (Hilsenhoff 1982), as modified in Nuzzo (2003); the HBI is the sum of the products of each taxon's abundance and its corresponding pollution tolerance value, divided by the total count in the subsample;

- EPT—sum of richness among the orders Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies) as determined from the specimens in the subsample plus those detected in a "large/rare" search of the whole sample; these orders tend to be dominated by species generally considered to be pollution sensitive;

- $EPT_a/Chiro_a$—ratio of total abundance among EPT taxa to total abundance among Chironomidae taxa;

- SC/FC—ratio of the proportion of sample that is represented by individuals that predominantly feed by scraping to those that are primarily filter-feeders;

- % Dominant—most abundant taxon as a percent of the assemblage; >20% is generally considered hyperdominant and indicative of a stressor impact;

- RSA—reference site affinity (described above).

Metric values for each station were scored based on comparability to the reference station, and scores were totaled. The percent comparability of total metric scores for each study site to those for the selected "least-impacted" reference station yielded an impairment score for each site. RBP III analysis separates sites into four categories: "non-impaired", "slightly impaired", "moderately impaired", and "severely impaired". Each impairment category corresponds to a specific *Aquatic Life* use-support determination used in the CWA Section 305(b) water quality reporting process—non-impaired and slightly impaired benthic invertebrate communities are generally indicative of conditions supporting the *Aquatic Life* use, whereas water bodies exhibiting moderately or severely impaired communities are generally assessed as "non-support."

Habitat Assessment

Habitat qualities were scored for each sampling reach using the assessment procedure in Plafkin et al. (1989), as modified in Barbour et al. (1999). An evaluation of physical and biological habitat quality is critical to any assessment of ecological integrity (Karr et al. 1986; Plafkin et al. 1989). Habitat assessment supports understanding of the relationship between physical habitat quality and biological conditions, identifies obvious constraints on the attainable potential of a site, assists in the selection of appropriate sampling stations, and provides basic information for interpreting biosurvey results (US EPA 1995). The matrix used to assess habitat quality is based on key physical characteristics of the water body and the immediate riverfront area. Most parameters evaluated are instream physical attributes that are potential sources of limitation to the aquatic biota (Plafkin et al. 1989). The ten habitat parameters are as follows: instream cover, epifaunal substrate, embeddedness, sediment deposition, channel alteration, velocity/depth combinations, channel flow status, right and left (when facing downstream) bank vegetative protection, right and left bank stability, right and left bank riparian vegetative zone width. Habitat parameters are scored, totaled, and compared to the reference station to infer the extent to which the condition of the habitat, rather than water quality effects, may account for differences in macroinvertebrate community structure at the study sites.

Figure 1: Farmington River Watershed Biomonitoring Stations

RESULTS AND DISCUSSION

Habitat quality was generally excellent at all biomonitoring sites (Table 3). All habitat scores at these sites compared very favorably to the reference site and all stations exceeded 75% of the maximum attainable value of 200. Limitations in channel flow status and riparian zone width were noted at some of the stations (Table 3).

A taxonomic list of the macroinvertebrate organisms collected at each sampling station during the 2006 biomonitoring survey is attached as an Appendix. Included in the list are total organism counts, the functional feeding group designation (FG) for each macroinvertebrate taxon, and the tolerance value (TV) of each taxon. Table 4 presents a summary of the RBP III macroinvertebrate data analyses for all sites Included are biological metric calculations, metric scores, and impairment designations.

The benthic macroinvertebrate community at Station FR09 (Hubbard Brook) received the maximum total metric score attainable (i.e., 42), supporting its designation as the reference condition (Table 4). This site exhibited excellent taxa richness, a high EPT index, a low HBI index and a well balanced community indicative of excellent water quality.

The macroinvertebrate communities present at all of the biomonitoring stations except FR04 (Benton Brook) ranged from 67%-90% comparable to the reference community, resulting in assessments of "non-impaired", "slightly impaired" or bordering between the two. The macroinvertebrate community in Benton Brook, however, was only 33% comparable to that of the reference site and was considered "moderately impaired". The community at the Benton Brook station was characterized by a high HBI index, low EPT index, low EPT/Chironomidae ratio and a low scraper/filterer ratio when compared to the reference station. Approximately thirty percent of the macroinvertebrate sample was composed of the filter-feeding caddisflies, *Cheumatopsyche sp*. and *Hydropsyche betteni*. Another third of the sample was composed of the chironomid (midge) taxa, *Rheotanytarsus exiguus* gr. and *Diamesa sp.* The Benton Brook station is located downstream of Camp Sequena Pond and the Benton Brook watershed has a storage ratio of 20 days (Weiskel et. al., 2010). The presence of impoundments along this stream may explain the number of filter feeders at this station.

Historically, the benthic community at the Benton Brook station was characterized as "non-impaired". Some community metrics outperformed those of the reference stream (Valley Brook) in both 2001 and 1996 (Fiorentino 2003, Fiorentino 1997). For example, station FR04 supported the "highest richness of pollution sensitive EPT taxa of any of the low-order test streams sampled" during the 2001 Farmington River biomonitoring survey (Fiorentino 2003). The benthic community was also characterized by numerous algal scraping taxa, resulting in a high (1.56) Scrapers/Filterers metric value (Fiorentino 2003). In 2006, this metric was reduced to 0.02, providing further evidence of the drastic change in the composition of the macroinvertebrate community.

It is unclear what has caused the shift from a community with high numbers of pollution sensitive forms and characterized by numerous scraper taxa to a community in 2006 that was predominated by filter-feeding taxa with low numbers of pollution sensitive varieties. It is clear, though, that the benthic community in Benton Brook was structured in response to one or more unidentified stressors. The 2006 bioassessment of Benton Brook should lead to the conclusion that the *Aquatic Life Use* is not supported.

Table 3. Habitat assessment summary for biomonitoring stations sampled during the 2006 Farmington River Watershed survey. For within-reach parameters, scores ranging from 16-20 = optimal; 11-15 = suboptimal; 6-10 = marginal; 0-5 = poor. For secondary parameters, scores ranging from 9-10 = optimal; 6-8 = suboptimal; 3-5 = marginal; 0-2 = poor. Maximum habitat score for any site = 200. Refer to Table 1 for a listing and description of sampling stations.

STATION	TB00 (Thomas Brook)	FR01B (West Branch Farmington River)	DB00 (Dimmock Brook)	FR04 (Benton Brook)	FR03 (Fall River)	BR01 (Buck River)	FR06B (Clam River)	FR05B (West Branch Farmington River)	CPB00 (Cranberry Pond Brook)	FR09[1] (Hubbard Brook)	FR08B (Valley Brook)
PRIMARY PARAMETERS (range is 0-20)	**SCORE**										
INSTREAM COVER	17	19	17	16	16	20	18	16	13	19	17
EPIFAUNAL SUBSTRATE	18	20	17	16	18	20	19	20	17	18	18
EMBEDDEDNESS	19	20	18	17	19	20	19	20	18	20	19
CHANNEL ALTERATION	14	20	20	19	20	20	14	19	20	20	19
SEDIMENT DEPOSITION	19	19	16	15	19	19	18	20	18	20	18
VELOCITY-DEPTH COMBINATIONS	10	16	14	17	15	18	16	18	14	14	11
CHANNEL FLOW STATUS	15	17	6	9	10	9	13	6	7	9	10
SECONDARY PARAMETERS (range is 0-10 for each bank)	**SCORE**										
BANK VEGETATIVE PROTECTION left	10	10	10	10	10	10	9	10	10	10	10
BANK VEGETATIVE PROTECTION right	10	10	10	10	10	10	10	10	10	10	10
BANK STABILITY left	10	10	8	6	10	10	10	10	8	10	10
BANK STABILITY right	10	10	10	9	10	8	10	5	9	9	9
RIPARIAN VEGETATIVE ZONE WIDTH left	10	10	2	1	10	10	3	10	10	10	10
RIPARIAN VEGETATIVE ZONE WIDTH right	10	4	10	10	8	2	4	3	10	10	2
TOTAL SCORE	**172 86%**	**185 93%**	**158 79%**	**155 78%**	**175 88%**	**176 88%**	**163 82%**	**167 84%**	**164 82%**	**179 90%**	**163 82%**

[1] Reference station

Table 4. Summary of RBP III analysis of macroinvertebrate communities sampled during the 2006 Farmington River Watershed survey. Shown are the calculated metric values, metric scores (in italics) based on comparability to the reference station (FR09-Hubbard Brook). Refer to Table 1 for a listing and description of sampling stations.

SAMPLING STATION	TB00		FR01B		DB00		FR04		FR03		BR01		FR06B		FR05B		CPB00		FR09		FR08B	
STREAM	Thomas Brook		West Branch Farmington		Dimmock Brook		Benton Brook		Fall River		Buck River		Clam River		West Branch Farmington		Cranberry Pond Brook		Hubbard Brook		Sandy Brook	
HABITAT SCORE	172		185		158		155		175		176		163		167		164		179		163	
TAXA RICHNESS	32	*6*	26	*4*	27	*4*	20	*2*	24	*4*	33	*6*	37	*6*	35	*6*	32	*6*	37	*6*	34	*6*
BIOTIC INDEX	3.54	*6*	4.19	*4*	3.80	*4*	5.17	*2*	3.98	*4*	3.28	*6*	3.93	*4*	3.77	*4*	2.78	*6*	3.07	*6*	2.34	*6*
EPT INDEX	13	*0*	8	*0*	9	*0*	5	*0*	9	*0*	15	*2*	18	*4*	18	*4*	15	*2*	20	*6*	19	*6*
EPT/CHIRONOMIDAE	2.05	*4*	1.52	*4*	1.26	*2*	0.82	*2*	2.44	*6*	1.31	*2*	0.80	*2*	4.67	*6*	2.04	*4*	2.83	*6*	5.07	*6*
SCRAPER/FILTERER	0.96	*6*	0.45	*6*	0.54	*6*	0.02	*0*	0.39	*6*	0.73	*6*	1.08	*6*	1.89	*6*	0.59	*6*	0.71	*6*	0.24	*2*
% DOMINANT TAXON	13%	*6*	13%	*6*	19%	*6*	22%	*4*	15%	*6*	22%	*6*	19%	*6*	12%	*6*	10%	*6*	7%	*6*	20%	*6*
REFERENCE AFFINITY	82%	*6*	72%	*6*	73%	*6*	57%	*4*	70%	*6*	67%	*4*	69%	*6*	76%	*6*	89%	*6*	100%	*6*	82%	*4*
TOTAL METRIC SCORE	*34*		*30*		*28*		*14*		*32*		*32*		*34*		*38*		*36*		*42*		*36*	
% COMPARABILITY TO REFERENCE	*81%*		*71%*		*67%*		*33%*		*76%*		*76%*		*81%*		*90%*		*86%*		--		*86%*	
BIOLOGICAL CONDITION -DEGREE IMPACTED	Slightly/ Non-Impaired		Slightly Impaired		Slightly Impaired		Moderately Impaired		Slightly Impaired		Slightly Impaired		Slightly/ Non-Impaired		Non-Impaired		Non-Impaired		Reference Condition		Non-Impaired	

SUMMARY AND RECOMMENDATIONS

Sampling of the benthic macroinvertebrate community was carried out in August, 2006 at eleven sites in the Farmington River Watershed to evaluate the biological health of selected streams and to determine their status with respect to the support of the *Aquatic Life* use. Results of these assessments form the basis for reporting and listing waters under sections 305(b) and 303(d) of the Clean Water Act. In addition, some sites were chosen to evaluate the potential effects of particular activities within their watersheds. Field and laboratory methods and data analysis were based on the USEPA's Rapid Biomonitoring Protocols. Station FR09 on Hubbard Brook, served as the reference site. With one exception, the water bodies ranged between "non-impaired" and "slightly impaired" and these waters were considered to be supporting the *Aquatic Life Use.* Benton Brook (FR04) was the only macroinvertebrate community degraded to the point where the *Aquatic Life Use* is not supported. It is recommended that follow-up sampling be conducted at Benton Brook to monitor the health of the benthic community at this site and possibly determine sources of impact to the stream. A reference station in both a small watershed size stream and another reference station in a large watershed size river should be selected in future biomonitoring surveys to provide better benthic community comparisons and to more accurately determine benthic community health.

LITERATURE CITED

Barbour, M. T., J. Gerritsen, B. D. Snyder and J. B. Stribling. 1999. Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates and Fish, Second Edition. EPA 841-B-99-002. U.S. Environmental Protection Agency; Office of Water; Washington, DC.

Barbour, M. T., J. B. Stribling, and J. R. Carr. 1995. The multimetric approach for establishing biocriteria and measuring biological condition. pp. 63-80. *in* W. S. Davis and T. P. Simon (eds.). Biological Assessment and Criteria: Tools for Water Resource Planning and Decision Making. Lewis Publishers, Boca Raton, FL. 415 p.

Deurring, C.L. 2005. *Farmington River Watershed 2001 Water Quality Assessment Report.* CN 91.0 Massachusetts Department of Environmental Protection, Division of Watershed Management, Worcester, MA.

Fiorentino, J. 1997. CN 91.0. Farmington River Watershed Benthic Macroinvertebrate Biomonitoring. Technical memorandum TM-31-1. Massachusetts Department of Environmental Protection, Division of Watershed Management. Worcester, MA. 20 p.

Fiorentino, J. 2003. CN 91.0. Farmington River Watershed 2001 Biological Assessment. Technical memorandum TM-31-2. Massachusetts Department of Environmental Protection, Division of Watershed Management. Worcester, MA. 30 p.

Hilsenhoff, W. L. 1982. Using a Biotic Index to Evaluate Water Quality in Streams. Technical Bulletin No. 132. Department of Natural Resources, Madison, WI.

Karr, J. R., K. D. Fausch, P. L. Angermeier, P. R. Yant, and I. J. Schlosser. 1986. Assessing Biological Integrity in Running Waters: A Method and Its Rationale. Special Publication 5. Illinois Natural History Survey. Champaign, IL. 28 p.

MassDEP. 2006. Massachusetts Surface Water Quality Standards. (Revision of 314 CMR 4.00, effective December 29, 2006). Massachusetts Department of Environmental Protection. Boston, MA. 114 p.

Novak, M. A. and R. W. Bode. 1992. Percent model affinity: a new measure of macroinvertebrate community composition. J. N. Am. Benthol. Soc., 11(4): 80-110.

Nuzzo, R. M. 2003. CN 39.2. Standard Operating Procedures: Water Quality Monitoring in Streams Using Aquatic Macroinvertebrates. Massachusetts Department of Environmental Protection, Division of Watershed Management. Worcester, MA. 35 p.

Obrien-Clayton, K. 2006. CN 232.0. 2006 Farmington River Watershed Sampling & Analysis Plan. Massachusetts Department of Environmental Protection, Division of Watershed Management. Worcester, MA. 22 p.

Plafkin, J. L., M. T. Barbour, K. D. Porter, S. K. Gross and R. M. Hughes. 1989. Rapid Bioassessment Protocols for Use in Streams and Rivers: Benthic Macroinvertebrates and Fish. EPA/444/4-89-001. Assessment and Watershed Protection Division, U.S. Environmental Protection Agency, Washington, DC.

US EPA. 1995. Generic Quality Assurance Project Plan Guidance for Programs Using Community Level Biological Assessment in Wadeable Streams and Rivers. U.S. Environmental Protection Agency, Office of Water. 71 p.

Weiskel, P.K., Brandt, S.L., DeSimone, L.A., Ostiguy, L.J., and Archfield, S.A., 2010, Indicators of streamflow alteration, habitat fragmentation, impervious cover, and water quality for Massachusetts stream basins: U.S. Geological Survey Scientific Investigations Report 2009–5272, 70 p., plus CD–ROM. (Also available at http://pubs.usgs.gov/sir/2009/527)

APPENDIX

Species-level taxa list and counts, functional feeding groups (FG), and tolerance values (TV) for macroinvertebrates collected from stream sites during the 2006 Farmington River Watershed survey between 15 and 16 August 2006. Refer to Table 1 for a listing and description of sampling stations.

			Sampling Sites										
TAXON	**FG[1]**	**TV[2]**	**TB00**	**FR01B**	**DB00**	**FR04**	**FR03**	**BR01**	**FR06B**	**FR05B**	**CPB00**	**FR09[3]**	**FR08B**
Pisidiidae	FC	6				1							
Enchytraeidae	GC	10						1	1				
Nais communis/variabilis	GC	8	2										
Lumbriculidae	GC	7				3							
Hydrachnidia	PR	6	2		1				1				
Clathrosperchon sp.	PR	6	1										
Sperchon sp.	PR	6								1			
Sperchonopsis sp.	PR	6	1	1								1	
Torrenticola sp.	PR	6			1								
Baetidae	GC	4		4	1			2	2	1	1		
Acentrella turbida	SC	4		3		1		2	2	4			
Acerpenna sp.	GC	5										2	
Baetis sp.	GC	6	1							12			6
Baetis flavistriga	GC	4		13				4	1			8	
Baetis tricaudatus	GC	6					2		3				
Diphetor hageni	GC	6									1		
Heterocloeon curiosum	GC	2		3									
Plauditus sp.	GC	4		2				4	5				4
Ephemerellidae	GC	1	1										
Ephemerella sp.	GC	1						3					
Ephemerella molita	GC	1								1			
Ephemerella subvaria	GC	1							3				
Eurylophella sp.	GC	2									2	1	
Epeorus vitreus	SC	0						5	3	3		2	3
Maccaffertium sp.	SC	3	4				2				7	4	
Maccaffertium vicarium	SC	2			16								
Isonychia sp.	FC	2	4	5	1	2		3	1				5
Leptophlebiidae	GC	2							1	1	3	2	3
Paraleptophlebia sp.	GC	1	5		8			5					

TAXON	FG[1]	TV[2]	Sampling Sites										
			TB00	FR01B	DB00	FR04	FR03	BR01	FR06B	FR05B	CPB00	FR09[3]	FR08B
Boyeria vinosa	PR	2					1						
Gomphidae	PR	5		1	1								
Stylogomphus albistylus	PR	1	1										
Plecoptera	GC	3	1				3						
Capniidae	SH	1	1										
Chloroperlidae	PR	1										1	
Alloperla sp.	GC	0								2		1	
Sweltsa sp.	PR	0						1		1	9	1	3
Leuctridae	SH	0									2		
Leuctra sp.	SH	0							1			5	2
Tallaperla maria	SH	0			2	4	6	1	2			5	3
Acroneuria sp.	PR	0					1				2	1	
Acroneuria abnormis	PR	0						1		6			
Agnetina capitata	PR	2							1				
Neoperla sp.	PR	3			4								
Paragnetina sp.	PR	1										5	
Paragnetina immarginata	PR	1	1						3	3		3	10
Paragnetina media	PR	5										1	
Perlesta placida	PR	5	4										
Perlodidae	PR	2						3		1		1	1
Isogenoides sp.	PR	0							2				
Corydalus cornutus	PR	4		2						5			
Nigronia serricornis	PR	0	1		2	2	2	1	3	3	1	1	1
Sialis sp.	PR	4			1								
Brachycentrus americanus	FC	1									1		
Micrasema sp.	SH	2							1			6	2
Culoptila sp.	SC	1								1			
Glossosoma sp.	SC	0	3					1	1				1
Helicopsyche borealis	SC	3								2			
Hydropsychidae	FC	4					1				3		
Cheumatopsyche sp.	FC	5	1		3	23	13		5	6		7	
Diplectrona modesta	FC	0									8		
Hydropsyche sp.	FC	4		4							1		

TAXON	FG[1]	TV[2]	Sampling Sites										
			TB00	FR01B	DB00	FR04	FR03	BR01	FR06B	FR05B	CPB00	FR09[3]	FR08B
Hydropsyche betteni	FC	7			1	11	11						1
Hydropsyche morosa gr.	FC	6		1					1	4			
Hydropsyche slossonae	FC	4							1				
Hydropsyche sparna	FC	6	9	1			1	5		1		4	3
Hydroptila sp.	GC	6								2			
Lepidostoma sp.	SH	1						1			1	1	4
Chimarra aterrima	FC	4	8	11	13		2			4		3	
Dolophilodes distinctus	FC	0	2				2	5		1	7	4	21
Polycentropodidae	FC	6									2		
Rhyacophila acutiloba	PR	1											2
Rhyacophila carolina gr.	PR	1									1		
Rhyacophila fuscula	PR	0											1
Rhyacophila minor	PR	1											1
Macronychus glabratus	SH	5		4									
Optioservus sp.	SC	4							2				
Optioservus ovalis	SC	4							1				
Optioservus trivittatus	SC	4							1	9			
Oulimnius latiusculus	SC	4			1			2	1	3	2	1	
Promoresia elegans	SC	2								1			
Promoresia tardella	SC	2	13	4	4		15	1			4	7	1
Stenelmis sp.	SC	5	3	6						9	2		
Hydraena sp.	PR	5										1	
Ectopria nervosa	SC	5									2	1	
Psephenus herricki	SC	4	2						3	2			3
Atherix sp.	PR	4						1	1				3
Ceratopogonidae	PR	6	1										
Bezzia sp.	PR	6						3					
Palpomyia/Bezzia sp.	PR	6							1				1
Microtendipes pedellus gr.	FC	6											2
Microtendipes rydalensis gr.	FC	6		2					1	1		1	
Polypedilum aviceps	SH	4		1	2	3		21	20	4	1	8	4
Polypedilum flavum	SH	6								1			
Robackia sp.	GC	4								1			

TAXON	FG[1]	TV[2]	Sampling Sites										
			TB00	FR01B	DB00	FR04	FR03	BR01	FR06B	FR05B	CPB00	FR09[3]	FR08B
Micropsectra sp.	GC	7						1			4		1
Micropsectra/Tanytarsus sp.	FC	7										1	
Rheotanytarsus exiguus gr.	FC	6		1		18			3	1	5		
Rheotanytarsus pellucidus	FC	5		3	2		1	1					
Stempellinella sp.	GC	2			1			2			2		
Sublettea coffmani	FC	4		1									
Tanytarsus sp.	FC	6			19			1	1				
Diamesa sp.	GC	5	6			19	2		1				
Pagastia sp.	GC	1		1									
Cardiocladius obscurus	PR	5				1			1				
Corynoneura sp.	GC	4	1										
Cricotopus sp.	SH	7		6		1	1						
Diplocladius sp.	GC	8	1				1						
Eukiefferiella sp.	GC	6	1			1	1						
Eukiefferiella brehmi gr.	GC	4				1	7	2					
Eukiefferiella claripennis gr.	GC	8					1						
Eukiefferiella devonica gr.	GC	4		2			2						1
Heleniella sp.	GC	5									1		
Limnophyes sp.	GC	8										1	
Lopescladius sp.	GC	4						2					
Nanocladius sp.	GC	7			1							1	
Orthocladius sp.	GC	6				2							
Parachaetocladius sp.	GC	2	8	7	2					1	1	1	1
Parametriocnemus sp.	GC	5	3	1	3		1	1	17	3	7	7	
Rheocricotopus sp.	GC	6		6									
Synorthocladius sp.	GC	6					1						
Thienemanniella sp.	GC	6			1	2							
Tvetenia paucunca	GC	5	1		1	1					2		2
Thienemannimyia gr.	PR	6	1		7	1		4	5		2	4	4
Clinocera sp.	PR	6						1	3			1	2
Hemerodromia sp.	PR	6		1		4				1			
Simulium sp.	FC	5	2			2	13				2	1	1
Tipulidae	SH	5						1					

TAXON	FG[1]	TV[2]	Sampling Sites										
			TB00	FR01B	DB00	FR04	FR03	BR01	FR06B	FR05B	CPB00	FR09[3]	FR08B
Antocha sp.	GC	3					4			1			1
Dicranota sp.	PR	3					1	1			1	1	
Hexatoma sp.	PR	2	3		1			1	1		1		
Total			**99**	**97**	**100**	**103**	**98**	**94**	**107**	**103**	**91**	**107**	**104**

[1]Functional Feeding Group (FG) lists the primary feeding habit of each species and follows the abbreviations: SH-Shredder; GC-Gathering Collector; FC-Filtering Collector; SC-Scraper; PR-Predator.

[2]Tolerance Value (TV) is an assigned value used in the calculation of the Biotic Index. Tolerance values range from 0 for organisms very intolerant of organic wastes to 10 for very tolerant organisms.

[3] Reference station