Technical Memorandum CN 322.2

CONNECTICUT RIVER WATERSHED
2008 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 (Barbour et al. 1995, Plafkin et al. 1989). Impacts to the benthic community are typically 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). "Pollution-tolerant" taxa are those that are tolerant to nutrient enrichment, higher temperatures and decreased dissolved oxygen).

As part of the Massachusetts Department of Environmental Protection/Division of Watershed Management's (MassDEP/DWM) 2008 Connecticut River Watershed assessment, aquatic benthic macroinvertebrate biomonitoring was conducted to evaluate the biological health of selected streams 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 named streams were sampled to investigate the effects of potential point and nonpoint sources of pollution—both historical and current—on the aquatic invertebrate populations throughout the watershed. While specific monitoring locations and protocols governing sample collection and data analysis differed over time, MassDEP biologists had, in 2003, assessed three of the streams studied in 2008 (Mitchell, 2006, Carr and Kennedy, 2008). Repeated sampling at the same station allows for comparisons of the biological conditions over time. The 2008 sampling location descriptions, along with station identification numbers, sampling dates and biomonitoring history are presented in Table 1. Sampling sites are depicted on a watershed map in Figure 1.

METHODS

Macroinvertebrate Sampling - RBPIII

Macroinvertebrate sampling activities employed for the 2008 Connecticut River Watershed survey were conducted in accordance with the Sampling & Analysis Plan (SAP) for the Connecticut River Watershed (MassDEP 2008). The sampling procedures are 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.

Macroinvertebrate Sample Processing and Data Analysis

The macroinvertebrate sample processing and analysis procedures employed for the 2008 Connecticut 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.

Table 1. List of biomonitoring stations sampled during the 2008 Connecticut River watershed survey, including station and unique identification numbers, latitude/longitude, sampling site descriptions, and sampling dates. Sites at which previous MassDEP benthic macroinvertebrate assessments were performed are also indicated.

Stream Name	Unique ID	Latitude Longitude	Sampling Site Description	Sampling Date
Lampson Brook	B0636	42.28185 72.42722	Immediately upstream at George Hannum Street, Belchertown	21-JUL-2008
Weston Brook	B0637	42.27015 72.44971	Immediately upstream at Boardman Street, Belchertown	21-JUL-2008
Roaring Brook	B0639	42.46147 72.64309	Approximately 100m downstream from North Street, Whately	22-JUL-2008
Shattuck Brook	B0640	42.72205 72.58702	Adjacent to Keets Brook Road, approximately 370m upstream from Keets Brook Road Branch intersection, Bernardston	23-JUL-2008
Amethyst Brook (1, R)	B0514	42.37856 72.48128	Upstream from swale off end of Allen Mill Road, Amherst	21-JUL-2008
North Branch Manhan River	B0641	42.29220 72.73391	Approximately 215m downstream of Route 66, Northampton	22-JUL-2008
Cushman Brook (1)	B0508	42.41553 72.51258	Approximately 300m upstream from Factory Hollow Pond / State Street, Amherst	21-JUL-2008
Stony Brook	B0635	42.24704 72.58039	Immediately upstream of first footbridge east of Route 116, South Hadley	21-JUL-2008
Sawmill River (1)	B0515	42.54257 72.54901	Upstream at South Ferry Road, Montague	23-JUL-2008
Fall River	B0638	42.62105 72.54989	Approximately 370m upstream from end of Factory Hollow Road, Gill/Greenfield	23-JUL-2008
Mill River	B0634	42.31948 72.66567	Approximately 60m upstream from Clement Street, Northampton	22-JUL-2008

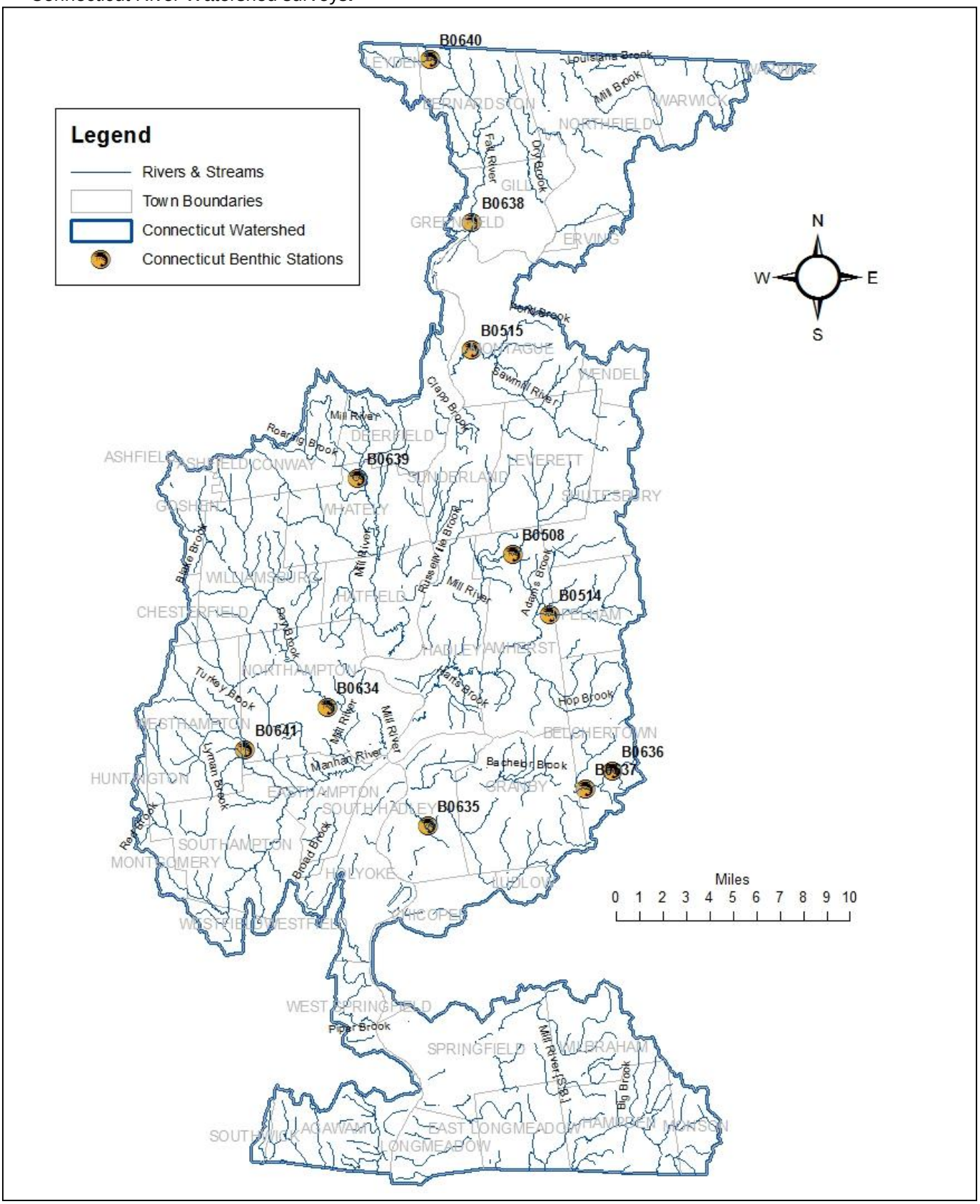
1 = RBP III performed here by MassDEP/DWM in 2003 (Mitchell 2006)
R = 2008 Reference Site

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:

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

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

Figure 1. Geographic locations of benthic macroinvertebrate sampling locations during the 2008 Connecticut River Watershed surveys**.**



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, 1987), 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 bank vegetative protection, right and left bank stability and 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.

A Human Disturbance Index (HDI) (Meek, 2013) was also used to characterize each sampling site and to assist with the selection of a reference site. The HDI incorporates such measures as urban land use, agricultural land use, NPDES discharges, dam density, and impervious surface density, and derives a

score for each HUC 12 (12-digit Hydrologic Unit Code) watershed. The lower the resultant score, the less measureable human disturbance (Table 2).

RESULTS AND DISCUSSION

Aquatic Life use-support determinations were made by comparing macroinvertebrate communities present at biomonitoring stations in the Connecticut River Watershed to the community occurring at a regional reference station exhibiting high quality habitat and assumed to be least disturbed by point and nonpoint sources of water pollution. The monitoring station with the highest habitat score (184) was the North Branch of the Manhan River. However, bridge construction was occurring upstream of the reach during the sampling season. Amethyst Brook had served as the reference site for the 2003 Connecticut River Watershed survey and exhibited the second highest habitat score (179) of all stations monitored in the Connecticut River Watershed in 2008. The excellent habitat at the Amethyst Brook site, along with the high percentage of forested area (91%) in the watershed and low HDI score (2.50), corroborate its use as the reference condition once again.

A taxonomic list of the macroinvertebrate organisms collected at each sampling station during the 2008 biomonitoring survey is provided in Appendix 2. 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 3 presents summaries of the habitat and RBP III macroinvertebrate data analyses for all 2008 Connecticut River Watershed sites. Included for each sampling site are the habitat comparability to the reference condition, biological metric calculations, metric scores, and impairment designations.

With the exception of Lampson Brook (B0636), the macroinvertebrate communities present at all of the sites examined in the Connecticut River Watershed were found to be either non-impaired or only slightly impaired when compared to the reference site on Amethyst Brook (B0514). The community at Lampson Brook was moderately impaired. Lampson Brook obtained a score of 0 (poor) for both the EPT Index and the Scraper/Filterer metrics and the HBI (5.48) was the highest of all of the sites investigated. Fully 72% of the invertebrate specimens collected from Lampson Brook were larval caddisflies in the family Hydropsychidae. These organisms construct silken nets that filter particulate matter suspended in the water column and their presence in abundance is indicative of a plentiful supply of algae cells, detritus and decomposing organic matter typically associated with organic enrichment.

Three of the sites investigated in 2008 were the subjects of previous bioassessments performed by the MassDEP/DWM (Table 4). Four indicative community metrics from the RBP III analyses and the overall impairment status assessments resulting from those analyses were compared from 2003 to 2008 to determine whether the biological condition had changed at those sites (Table 4). While a determination of true statistical trends is not possible using screening level techniques such as the RBP, the overall assessment of these sites remained consistent over the time represented by the two surveys.

Table 2. Habitat Measures for the 2008 Connecticut River Watershed Benthic Macroinvertebrate Sites; USGS StreamStats[1], MassDEP Human Disturbance Index (HDI)[2], MassDEP Benthic Habitat Assessment Scores.

Site	Lampson Brook	Weston Brook	Roaring Brook	Shattuck Brook	Amethyst Brook	North Branch Manhan River	Cushman Brook	Stony Brook	Sawmill River	Fall River	Mill River
Watershed Area (mi^2)	1.31	3.70	5.67	8.87	9.21	14.90	16.50	19.60	30.90	32.00	52.60
% Slope	3.54	3.86	9.75	10.10	5.83	6.47	6.26	1.37	6.86	9.97	6.98
Stream Length (mi)	2.94	8.53	12.30	24.10	27.20	23.80	46.70	36.40	60.70	63.80	104
% Forested	33.65	47.48	90.77	86.51	91.15	80.41	84.86	29.28	76.99	76.29	75.59
% Sand and Gravel	22.31	24.56	4.32	4.12	19.98	22.46	21.71	57.98	27.26	16.35	15.69
% Impervious Cover	7.74	3.55	0.22	0.35	0.40	0.60	0.47	5.71	0.88	2.22	1.42
% Urban	27.10	15.30	3.56	4.60	3.93	4.36	4.40	24.90	6.05	10.10	7.70
HDI Score	4.0	4.0	2.5	2.5	2.5	2.5	2.5	3.0	3.5	4.0	3.0
Habitat Score	148	132	151	142	179	184	167	142	149	139	146

[1](USGS 2012)
[2](Meek 2013)

Table 3. Summary of habitat analysis (i.e. comparability to the reference habitat condition) and RBP III analysis of macroinvertebrate communities sampled in the Connecticut River Watershed on 21 and 23 July 2008. Shown are the calculated metric values, metric scores (in italics) based on comparability to the reference station (Amethyst Brook – B0514), and the corresponding assessment designation for each biomonitoring station. Complete habitat evaluations are presented in Appendix 1. Refer to Table 1 for a listing and description of sampling stations.

SAMPLING STATION	B0514		B0636		B0637		B0639		B0640		B0641		BO508		B0635		B0515		B0638		B0634	
STREAM	Amethyst Brook		Lampson Brook		Weston Brook		Roaring Brook		Shattuck Brook		North Branch Manhan River		Cushman Brook		Stony Brook		Sawmill River		Fall River		Mill River	
HABITAT SCORE	179		148		132		151		142		184		167		142		149		139		146	
HABITAT % REFERENCE	--		83%		74%		84%		79%		103%		93%		79%		83%		78%		82%	
HABITAT COMPARABILITY	--		Support		Partial Support		Support		Support		Comparable		Comparable		Support		Support		Support		Support	
TAXA RICHNESS	33	*6*	21	*4*	28	*6*	28	*6*	33	*6*	29	*6*	24	*4*	24	*4*	30	*6*	30	*6*	29	*6*
BIOTIC INDEX	3.00	*6*	5.48	*2*	4.37	*2*	3.61	*4*	3.87	*4*	3.21	*6*	3.20	*6*	5.02	*2*	4.17	*4*	3.95	*4*	3.91	*4*
EPT INDEX	12	*6*	4	*0*	11	*6*	9	*2*	16	*6*	11	*6*	13	*6*	11	*6*	15	*6*	13	*6*	15	*6*
EPT/CHIRONOMIDAE	1.79	*6*	3.57	*6*	2.48	*6*	2.35	*6*	0.80	*2*	1.81	*6*	0.90	*4*	6.50	*6*	1.43	*6*	1.07	*4*	2.50	*6*
SCRAPER/FILTERER	0.63	*6*	0.04	*0*	0.62	*6*	0.07	*0*	0.54	*6*	0.11	*0*	0.13	*2*	0.42	*6*	0.18	*2*	0.11	*0*	0.38	*6*
REFERENCE AFFINITY	100%	*6*	49%	*2*	68%	*6*	77%	*6*	71%	*6*	69%	*6*	62%	*4*	53%	*4*	69%	*6*	56%	*4*	62%	*4*
% DOMINANT TAXON	21%	*4*	33%	*2*	18%	*6*	15%	*6*	25%	*4*	20%	*4*	20%	*4*	18%	*6*	10%	*6*	26%	*4*	18%	*6*
TOTAL METRIC SCORE	*40*		*16*		*38*		*30*		*34*		*34*		*30*		*34*		*36*		*28*		*38*	
% COMPARABILITY TO REFERENCE	--		40%		95%		75%		85%		85%		75%		85%		90%		70%		95%	
BIOLOGICAL CONDITION -DEGREE IMPACTED	**REFERENCE**		**MODERATLEY IMPAIRED**		**NON-IMPAIRED**		**SLIGHTLY IMPAIRED**		**NON-IMPAIRED**		**NON-IMPAIRED**		**SLIGHTLY IMPAIRED**		**NON-IMPAIRED**		**NON-IMPAIRED**		**SLIGHTLY IMPAIRED**		**NON-IMPAIRED**	

Table 4. Selected macroinvertebrate RBPIII community metrics and impairment status for three sampling stations in the Connecticut River Watershed sampled by MassDEP/DWM in 2003 and 2008. See text for a description of the metrics.

Water Body	Year	Community Metrics				Impairment Status
		Total Richness	EPT Richness	Biotic Index	% Dominant Taxon	
Amethyst Brook, Amherst	2003	34	12	3.48	14	Reference
	2008	33	12	3.00	21	Reference
Cushman Brook, Amherst	2003	28	10	3.86	19	Non-Impaired
	2008	24	13	3.20	20	Slightly-Impaired
Sawmill River, Montague	2003	35	16	4.31	20	Non-Impaired
	2008	30	15	4.17	10	Non-Impaired

SUMMARY

Sampling of the benthic macroinvertebrate community was carried out in July, 2008 at eleven sites in the Connecticut 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, as designated in Massachusetts' Surface Water Quality Standards. Results of these assessments form the basis for reporting and listing waters under sections 305(b) and 303(d) of the Clean Water Act. Field and laboratory methods and data analysis were based on the USEPA's Rapid Biomonitoring Protocols. Station B0514 on Amethyst Brook served as the reference site for all sites.

With the exception of Lampson Brook (B0636), all sites were found to be supporting their designated *Aquatic Life Use*. The macroinvertebrate community at Lampson Brook was moderately impaired and appeared to be structured in response to organic enrichment. Thus, Lampson Brook did not support the *Aquatic Life Use*. The failure of Lampson Brook to support its use designation may be attributed, in part, to the treated wastewater discharge from the Belchertown Water Reclamation Facility located only a few hundred feet upstream from the sampling station. It is likely that the effluent from this facility is contributing to the alteration of the benthic community structure at B0636.

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Appendix 1. Habitat assessment summary for biomonitoring stations sampled during the 2008 Connecticut River Watershed survey. For within-reach parameters, scores ranging from 16-20 = optimal; 11-15 = suboptimal; 6-10 = marginal; 0-5 = poor. For riparian 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		Lampson Brook	Weston Brook	Roaring Brook	Shattuck Brook	Amethyst Brook	North Branch Manhan River	Cushman Brook	Stony Brook	Sawmill River	Fall River	Mill River
PRIMARY PARAMETERS (range is 0-20)		SCORES										
INSTREAM COVER		12	13	12	16	17	20	19	15	16	13	17
EPIFAUNAL SUBSTRATE		16	17	17	18	19	19	20	18	17	16	18
EMBEDDEDNESS		12	15	18	19	17	17	16	19	18	16	16
CHANNEL ALTERATION		13	14	17	16	20	19	19	15	17	18	16
SEDIMENT DEPOSITION		19	17	18	19	19	16	16	19	17	10	16
VELOCITY-DEPTH COMBINATIONS		8	7	10	11	12	20	14	10	17	10	10
CHANNEL FLOW STATUS		16	18	7	8	19	17	14	16	19	14	19
SECONDARY PARAMETERS (range is 0-10 for each bank)		SCORES										
BANK VEGETATIVE PROTECTION	left	10	10	10	2	10	10	5	6	3	9	4
	right	9	4	10	2	10	10	10	7	4	10	10
BANK STABILITY	left	10	6	10	8	10	10	7	5	5	5	1
	right	9	9	9	10	10	9	10	9	5	0	8
RIPARIAN VEGATIVE ZONE WIDTH	left	10	1	10	3	7	9	8	1	6	9	1
	right	4	1	3	10	9	8	9	2	5	9	10
TOTAL SCORE		**148**	**132**	**151**	**142**	**179**	**184**	**167**	**142**	**149**	**139**	**146**

Appendix 2. Taxa list and counts, functional feeding groups (FG), and tolerance values (TV) for macroinvertebrates collected from stream sites during the 2008 Connecticut River Watershed survey from 21 to 23 July 2008. Refer to Table 1 for a listing and description of sampling stations.

TAXON		FFG[1]	TV[2]	Sampling Sites										
				Amethyst Bk.[3]	Lampson Bk.	Weston Bk.	Roaring Bk.	Shattuck Bk.	N. Br. Manhan R.	Cushman Bk.	Stony Bk.	Sawmill R.	Fall R.	Mill R.
				B0514	B0636	B0637	B0639	B0640	B0641	B0508	B0635	B0515	B0638	B0634
Ancylidae	*Ferrissia* sp.	SC	6								1			
Pisidiidae	Pisidiidae	FC	6			2					3			
Enchytraeidae	Enchytraeidae	GC	10				1							
Naididae	*Nais communis/variabilis*	GC	8	1										
Lumbriculidae	Lumbriculidae	GC	7	3	1		3							
Hydrachnidia	Hydrachnidia	PR	6											1
Sperchonidae	*Sperchon* sp.	PR	6								1			
Sperchonidae	*Sperchonopsis* sp.	PR	6				2	1						
Torrenticolidae	*Torrenticola* sp.	PR	6	1										
Baetidae	Baetidae	GC	4			5					2			
Baetidae	*Acentrella turbida*	GC	4						1				2	
Baetidae	*Baetis* sp.	GC	6	1			2			1	5			1
Baetidae	*Baetis flavistriga*	GC	4					2			3		2	3
Baetidae	*Baetis intercalaris*	GC	6							1		6	2	2
Baetidae	*Baetis pluto*	GC	6			1					1			
Baetidae	*Baetis tricaudatus*	GC	6				4	2	6	2		1	3	
Baetidae	*Diphetor hageni*	GC	6					1					1	
Baetidae	*Heterocloeon curiosum*	GC	2								1			
Baetidae	*Plauditus* sp.	GC	4									1	6	
Caenidae	*Caenis* sp.	GC	6									3		
Ephemerellidae	Ephemerellidae	GC	1							2		1		
Ephemerellidae	*Ephemerella molita*	GC	1						3			6		2
Ephemerellidae	*Serratella serrata*	GC	2				1							

Ephemerellidae	*Teloganopsis deficiens*	GC	2							1				
Heptageniidae	Heptageniidae	SC	4			2					4			
Heptageniidae	*Epeorus vitreus*	SC	0							2			1	3
Heptageniidae	*Maccaffertium* sp.	SC	3	1				1			2			2
Isonychiidae	*Isonychia sp.*	FC	2			2								1
Leptohyphidae	*Tricorythodes* sp.	GC	4									4	1	
Leptophlebiidae	Leptophlebiidae	GC	2					2				1		
Leptophlebiidae	*Paraleptophlebia* sp.	GC	1							3				
Aeschnidae	Aeschnidae	PR	3	2										
Aeschnidae	*Boyeria vinosa*	PR	2		1									
Gomphidae	Gomphidae	PR	5	1										
Chloroperlidae	Chloroperlidae	PR	1					1						
Chloroperlidae	*Sweltsa* sp.	PR	0	1				2						
Leuctridae	*Leuctra* sp.	SH	0	21		4	12	3	6	4		7		
Peltoperlidae	*Tallaperla maria*	SH	0				2	1						
Perlidae	Perlidae	PR	1					1						
Perlidae	*Acroneuria* sp.	PR	0	4			1	3	1					
Perlidae	*Agnetina capitata*	PR	2							1		1		
Perlidae	*Paragnetina* sp.	PR	1			1								
Perlidae	*Paragnetina media*	PR	5								1			
Perlodidae	Perlodidae	PR	2					1						
Corydalidae	*Nigronia* sp.	PR	0					1						
Corydalidae	*Nigronia serricornis*	PR	0		1				2					
Brachycentridae	*Micrasema* sp.	SH	2			3								
Glossosomatidae	Glossosomatidae	SC	0											2
Glossosomatidae	*Glossosoma* sp.	SC	0	1		1							1	
Helicopsychidae	*Helicopsyche borealis*	SC	3										1	
Hydropsychidae	Hydropsychidae	FC	4		1			1				2	2	
Hydropsychidae	*Cheumatopsyche* sp.	FC	5	3	19	2	13	5	2	1	18	3	2	2
Hydropsychidae	*Hydropsyche* sp.	FC	4	4	19	3	3	2	7		4	6	1	
Hydropsychidae	*Hydropsyche betteni*	FC	7		34	8				1	8			
Hydropsychidae	*Hydropsyche bronta*	FC	6									4		3
Hydropsychidae	*Hydropsyche morosa*	FC	6											1
Hydropsychidae	*Hydropsyche morosa* gr.	FC	6									1		
Hydropsychidae	*Hydropsyche sparna*	FC	6		1		7	1	5	2	1	2	9	7
Hydroptilidae	*Leucotrichia* sp.	SC	6								6			
Lepidostomatidae	*Lepidostoma* sp.	SH	1	5				1	1			1		
Limnephilidae	*Goera* sp.	SC	3									3		
Limnephilidae	*Pycnopsyche* sp.	SH	4			1								
Philopotamidae	*Chimarra aterrima*	FC	4			19					1			17
Philopotamidae	*Chimarra obscura*	FC	4								8			
Philopotamidae	*Dolophilodes* sp.	FC	0	6	1		15	2	21	21		4	15	12

Polycentropodidae	*Polycentropus* sp.	PR	6	2				1						
Rhyacophilidae	*Rhyacophila* sp.	PR	1						2	2				
Rhyacophilidae	*Rhyacophila acutiloba*	PR	1	1										
Rhyacophilidae	*Rhyacophila formosa*	PR	1											1
Rhyacophilidae	*Rhyacophila fuscula*	PR	0				1			1				1
Rhyacophilidae	*Rhyacophila minor*	PR	1					3	1	1				
Elmidae	*Macronychus glabratus*	SH	5								1			
Elmidae	*Microcylloepus pusillus*	GC	3								2			
Elmidae	*Optioservus* sp.	SC	4				2			1		4		4
Elmidae	*Optioservus ovalis*	SC	4			5		3						
Elmidae	*Oulimnius latiusculus*	SC	4	9	1	10	1	3						
Elmidae	*Promoresia tardella*	SC	2			2			5	2				
Elmidae	*Stenelmis* sp.	SC	5		1									7
Elmidae	*Stenelmis crenata*	SC	5	3		3					7			
Psephenidae	*Ectopria nervosa*	SC	5		1	3								
Psephenidae	*Psephenus herricki*	SC	4	1							2	1	1	
Ptilodactylidae	*Anchytarsus bicolor*	SH	4		1									
Ceratopogonidae	*Bezzia/Palpomyia* sp.	PR	6					3				2	1	
Chironomidae	*Cryptochironomus* sp.	PR	8	1										
Chironomidae	*Microtendipes* sp.	FC	5			1								
Chironomidae	*Microtendipes pedellus* gr.	FC	6										1	
Chironomidae	*Microtendipes rydalensis* gr.	FC	6	3								3		
Chironomidae	*Parachironomus* sp.	PR	10										1	
Chironomidae	*Polypedilum aviceps*	SH	4	6		1	2	24	8	15		8	26	3
Chironomidae	*Polypedilum flavum*	SH	6										1	3
Chironomidae	*Micropsectra* sp.	GC	7		1			12	4					3
Chironomidae	*Rheotanytarsus exiguus* gr.	FC	6	1		1			1	4		11	4	3
Chironomidae	*Rheotanytarsus pellucidus*	FC	5					2			1			1
Chironomidae	*Stempellinella* sp.	GC	2	2				1				2		
Chironomidae	*Sublettea coffmani*	FC	4										1	
Chironomidae	*Tanytarsus* sp.	FC	6	7	2	1	1		1	8		7	1	
Chironomidae	*Diamesa* sp.	GC	5		7		1				3			2
Chironomidae	*Potthastia gaedii* gr.	GC	2										1	
Chironomidae	*Potthastia longimana* gr.	GC	2				1						1	
Chironomidae	Orthocladiinae	GC	5								1			
Chironomidae	*Brillia* sp.	SH	5	1										
Chironomidae	*Brillia flavifrons*	SH	5		2									
Chironomidae	*Cardiocladius obscurus*	PR	5											1
Chironomidae	*Corynoneura* sp.	GC	4				3	1						
Chironomidae	*Cricotopus bicinctus*	GC	7		1		1						3	
Chironomidae	*Cricotopus/Orthocladius* sp.	GC	7						1		1			
Chironomidae	*Diplocladius cultriger*	GC	8		1		1							

Chironomidae	*Eukiefferiella brehmi* gr.	GC	4					1	1			1		
Chironomidae	*Eukiefferiella claripennis* gr.	GC	8		1				1					
Chironomidae	*Eukiefferiella devonica* gr.	GC	4						2					
Chironomidae	*Orthocladius dubitatus*	GC	6									1		
Chironomidae	*Parachaetocladius* sp.	GC	2	1					1	1				
Chironomidae	*Parametriocnemus* sp.	GC	5	3	1	7	9	1	2	10		5	3	6
Chironomidae	*Rheocricotopus* sp.	GC	6											1
Chironomidae	*Thienemanniella* sp.	GC	6				2						1	
Chironomidae	*Tvetenia paucunca*	GC	5	2	4	4	5	1	5	12			1	
Chironomidae	*Tvetenia vitracies*	GC	5	1							4			
Chironomidae	*Thienemannimyia* gr.	PR	6		1	6		2	4	1		2	1	1
Empididae	Empididae	PR	6			1	1		1					
Empididae	*Hemerodromia* sp.	PR	6			1						2		
Empididae	*Neoplasta* sp.	PR	6					1						1
Simuliidae	*Simulium* sp.	FC	5			3	3		9	2	9	2		
Tipulidae	Tipulidae	SH	5										1	
Tipulidae	*Antocha* sp.	GC	3				2							
Tipulidae	*Dicranota* sp.	PR	3	2			1	1	2					
Tipulidae	*Hexatoma* sp.	PR	2	1				3	1	1		1	2	
Tipulidae	*Tipula* sp.	SH	6			1					1			
TOTAL				**102**	**103**	**104**	**103**	**97**	**107**	**103**	**102**	**109**	**100**	**97**

[1]Functional Feeding Group (FFG) 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