Technical Memorandum CN 324.4

NASHUA RIVER WATERSHED
2008 BENTHIC MACROINVERTEBRATE BIOASSESSMENT

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CONTENTS

List of Tables

List of Figures

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) 2008 Nashua River Watershed assessments, aquatic benthic macroinvertebrate biomonitoring was conducted to evaluate the biological health of the selected waterbodies 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 thirteen biomonitoring stations on twelve named streams were sampled to determine the health of aquatic communities of the watershed (Appendix I, Figure 1). Table 1 presents the 2008 sampling locations, along with station identification numbers and sampling dates (Appendix I, Table 1). Sampling rationale for the 2008 Nashua River Watershed macroinvertebrate survey is presented in Appendix I, Table 2.

To provide information for making *Aquatic Life* use-support determinations, macroinvertebrate communities present at biomonitoring stations in the Nashua River Watershed were compared with communities at one reference station most representative of "least disturbed" conditions in the watershed. 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 4th, 5th, 25th and 26th at thirteen sites in the Nashua River Watershed (Appendix I, Table 1). Sampling activities were performed in accordance with the *Sampling & Analysis Plan Surface Water Monitoring, Nashua River Watershed 2008* (MassDEP undated). 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.

Macroinvertebrate Sample Processing and Data Analysis

The macroinvertebrate sample processing and analysis procedures employed for the 2008 Nashua 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:

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

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, 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, 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.

RESULTS AND DISCUSSION

Habitat quality at most stations was considered comparable or supporting when compared to the reference station (Appendix I, Table 3, 4). The Monoosnuc Brook Station (MON02) had the lowest habitat score (114) and was considered "partially supporting" when compared to the reference station. Habitat quality received low scores for embeddedness, sediment deposition, channel alteration, velocity/depth combinations, channel flow status, left bank vegetative protection and stability and both the left bank and right bank riparian vegetative zone width (Appendix I, Table 3).

The Asnebumskit Brook station (AST01) received a habitat score of 138 out of 200. This station received low scores for instream cover for fish, epifaunal substrate, embeddedness, sediment deposition and velocity/depth combinations.

The Catacoonamug Brook station (CAT01) received a habitat score of 138 out of 200. The habitat at this station scored in the suboptimal category for channel alteration and in the marginal category for velocity/depth combinations and left and right bank vegetative protection while scoring in the poor category for left and right bank riparian zone width.

A taxonomic list of the macroinvertebrate organisms collected at each sampling station during the 2008 biomonitoring survey is attached (Appendix II). Included in the list are total organism counts, the functional feeding group designation (FFG) for each macroinvertebrate taxon, and the tolerance value (TV) of each taxon.

<u>RBP Analysis</u>

The RBP III macroinvertebrates data analysis was conducted for the benthic sampling stations. The Nissitissit River station (NT67) was chosen as the watershed reference station due to its Human Disturbance Index (HDI) score of 3, low impervious cover and low urban use (Meek 2013). Although the overall watershed shows limited impacts for certain parameters, it is important to note that there is a dam approximately 0.2 miles upstream of the sampling station and another dam located approximately 1.3 miles downstream. This station received a habitat score of 178 and all parameters were in the optimal category with the exception of channel alteration and velocity/depth combinations which scored in the suboptimal category (Appendix I, Table 3). .

The benthic macroinvertebrate community in the Nissitissit River (Station NT67) exhibited good taxa richness, biotic index, EPT index and a low percent dominant taxon all indicative of good water quality (Appendix I, Table 4). This station scored poorly for the scraper/filterer metric. Only 13 scraper individuals were collected and subsequently the majority of all stations scored well for this metric when compared to this station. Filter collector taxa made up approximately 71% of the benthic community. Hydropsychidae and Philopotamidae made up approximately 50% of the benthic community. The high percentage of filter feeders found at this station is likely indicative of a trophic guild established to exploit an abundance of particulate organic matter originating from the Guarnottas Dam impoundment.

The macroinvertebrate communities present at all stations in the Nashua River Watershed were considered either non-impacted (seven stations), non impacted/slightly impacted (one station) or slightly impacted (four stations) when compared to the reference station on the Nissitissit River (Appendix I, Table 4).

Asnebumskit Brook, immediately upstream at Princeton Street, Holden (Station AST01), was considered "slightly impacted" when compared to the reference station (NT67). This station scored poorly for the EPT Index (only 4 taxa), EPT/Chironomidae and scraper/filterer metrics. Only 3 individuals represented scraper taxa and this explains the poor performance of the scraper/filterer metric when compared to the reference station. Filter collector taxa made up approximately 58% of the taxa found. This station was located approximately 0.4 miles downstream of Eagle Lake and this likely explains the prevalence of filter collector taxa.

The Asnebumskit Brook station habitat score (138) also indicates that habitat is a limiting factor for the macroinvertebrate community (Appendix I, Table 3). One of the habitat shortcomings at this station was the marginal quality of the epifaunal substrate which, along with the station's location downstream from Eagle Lake is likely a strong determinant of the benthic community structure.

Catacoonamug Brook, immediately upstream at Main Street, Shirley (Station CAT01), had a total metric score equal to that of the reference station and was considered "not impacted". Philopotamidae, Hydropsychidae and Baetidae were the three most common families at this station. Habitat limitations were noted at this station (Appendix I, Table 3).

Chaffins Brook, approximately 400 meters downstream of Malden Street, Holden (Station CHF01) was considered "not impacted/slightly impacted" when compared to the reference station. The community at this station was very similar to that at Asnebumskit Brook. Approximately 63% of the benthic community at Chaffins Brook consisted of filter collector taxa. The three most common families at this station were Chironomidae, Hydropyschidae and Philopotamidae. The predicted August flow that is exceeded fifty percent of the time at this station is approximately 1.2 cfs. There are a number of dams along Chaffins Brook with the first one being 0.5 miles upstream from the sampling station. The total habitat score at this site was 176, with all parameters scoring in the optimal category with the exception of embeddedness which was scored in the suboptimal category. Sampling crews noted that the preponderance of boulders at this site may have compromised sampling efficiency.

Gates Brook, approximately 90 meters upstream of mouth at Gates Cove (Wachusett Reservoir) in West Boylston (Station GAT25), was considered "not impacted". This station had two less EPT taxa than the reference station and this resulted in lower scores for the EPT Index and EPT/Chironomidae metrics. This station also received a lower score for percent dominant taxon when compared to the reference. The elmid beetle, *Oulimnius latiusculus,* made up approximately 27% of the benthic community and increased the scraper/filterer metric. This station has a small watershed area, a high percent urban land use in the watershed and a small predicted August 50% flow duration (Appendix I, Table 2). Bank vegetative protection and bank stability on both banks were characterized in the marginal category (Table 3). Channel flow status, which also scored in the marginal category, also limited the habitat quality at this station. Cold water temperatures have been documented in Gates Brook (MassDEP 2013). *Leuctra sp.* and Nemouridae individuals, often associated with small spring-fed brooks, were found at this station.

Malagasco Brook, approximately 100 meters downstream of Route 70 (Main Street) in Boylston (Station MAG01), was considered "not impacted" when compared to the reference station. The benthic community in Malagasco Brook is very similar in terms of the taxa found to that in Gates Brook. The most prevalent family at the Malagasco Brook station was Chironomidae and this station scored poorly on the EPT/Chironomidae metric when compared to the reference station. The Malagasco Brook station has a very small watershed area (Appendix I, Table 2). Cold water temperatures were found during unattended probe deployments conducted by MassDEP in 2008 (MassDEP 2013). Similar to Gates Brook both *Leuctra* sp. and Nemouridae individuals were found. Approximately 38% of the individuals had a tolerance value ranging from 0–3, the highest percentage of all the sampling stations.

Monoosnuc Brook, approximately 90 meters downstream of Whitney Street, Leominster (Station MON02), was considered “slightly impacted”. This station received lower scores for the EPT Index, scraper/filterer index and percent dominant taxon when compared to the reference station. The benthic community comprised 74% filter collector taxa at this station. The three most common families, Hydropsychidae, Philopotamidae and Chironomidae made up approximately 35%, 34% and 23% of the community, respectively. A small impoundment located approximately 0.3 miles upstream near the former Whitney and Company factory mill complex may help explain the predominance of filter collector taxa. Only five percent of the individuals had a tolerance value in the range of 0–3, the second lowest percentage of all the sampling stations. This station also received the lowest habitat score of all sampled stations and was considered “partially supporting” in terms of habitat when compared to the reference station (Appendix 1, Table 3, 4).

The Nashua River, approximately 200 meters downstream from the railroad bridge that crosses McPhearson Road, Ayer/Shirley, MA (Station NM23B) received benthic metric scores comparable to the reference station and was considered “not impacted” (Appendix I, Table 4). The three most common families were Pisidiidae, Baetidae and Hydropsychidae which made up 26%, 22% and 22% of the community, respectively. Filterer collector taxa made up approximately 60% of the benthic community. The community composition is likely partly explained by the station’s location 0.65 miles downstream of the Ice House Dam.

The Nashua River site approximately 400 meters downstream/north from Route 111, Hollis, NH (Station NM30) received a total metric score equal to that of the reference station and was considered “not impacted”. This is the most downstream sampling station on the Nashua River. The station had a larger EPT Index and EPT/Chironomidae ratio than the reference station. Hydropsychidae, Elmidae and Philopotamidae made up approximately 32%, 17% and 15% of the community, respectively. The benthic community at this station was largely similar to that encountered in 1998 (Nuzzo 2000), with the exception that Chironomidae made up a much smaller percentage of the community in 2008.

The North Nashua River, approximately 150 meters downstream from Falulah Road, Fitchburg, MA (Station NN09), received a total metric score of 28 and was considered “slightly impacted”. This station scored poorly on the EPT Index and scraper/filterer metrics when compared to the reference station. This station only had one scraper individual which explains its poor score on the scraper/filterer metric. Approximately 69% of the benthic community was filterer collector taxa. It should be noted less than 1% of the individuals found had a tolerance value in the range 0–3, the lowest percentage of all the sampling stations. The benthic community in the North Nashua River was principally composed of Hydropsychidae, Chironomidae, Philopotamidae and Baetidae and was largely the same as when previously sampled in 2003 (Nuzzo 2006). The benthic community at this station was most similar to the one seen at Monoosnuc Brook.

The Squannacook River, approximately 200 meters downstream/southeast from Rte. 225, Shirley/Groton, MA (Station NT61), was considered “not impacted” when compared to the reference station. The three most common families were Elmidae, Philopotamidae, and Hydropsychidae. The benthic community was generally similar to that seen in 1998 (Nuzzo 2000). Filter collector taxa made up approximately 43% of the community while scraper taxa, mainly *Stenelmis crenata*, made up 27% of the community. This site is located downstream from the Hollingsworth and Vose Company dam and the prominence of filter feeding Hydropsychidae is not unexpected given the station’s location.

The Quinapoxet River, when compared to the reference station, was considered “not impacted”. The station (QP00) only scored poorly on the EPT/Chironomidae metric. The Quinapoxet River station had the highest taxa richness of all the stations sampled. No taxon was greater than 12% of the assemblage at this station and approximately 25% of the taxa had a tolerance value in the range 0–3. The three most common families were Chironomidae, Hydropsychidae and Elmidae, which comprised 33%, 19% and 12% of the benthic community, respectively. The Quinapoxet River station was located on protected MA DCR Wachusett Reservoir watershed lands. The benthic community at this station showed excellent diversity and a number of intolerant taxa, all indicative of a healthy aquatic community.

The Whitman River, approximately 70 meters upstream of Whitmanville Road, Westminster (Station WHR01), had a total metric score of 30 resulting in an assessment of “slightly impacted”. This station scored poorly for EPT/Chironomidae when compared to the reference station. Chironomidae made up approximately 56% of the benthic community in the Whitman River sample. The next two most common families were Heptageniidae and Hydropsychidae, which made up approximately 10% and 6% of the benthic community, respectively.

SUMMARY

Sampling of the benthic macroinvertebrate community was carried out in August 2008 at thirteen sites in the Nashua 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.

A number of the stations sampled in 2008 have been previously sampled (Appendix III). The North Nashua River (Station NN09) has not changed drastically since the last sampling in 2003. The Nashua River (Station 23B) has not shown much change since it was last sampled in 1998. The Squannacook River (Station NT67) also displays similar metrics across previous sampling efforts. The Quinapoxet River has shown high richness values and largely similar metric values through time. The richness values at the Quinapoxet River are in the top 10% of all stations sampled in the MassDEP benthic database. MassDEP sampling has historically focused on targeted sampling of problem areas so there may be some bias in any percentile information presented using the current database but it is believed given the large number of samples collected, this bias should not be too significant. The sampled benthic community in the Nashua River downstream from Route 111, Hollis, NH (Station NM30) has not changed appreciably since the last sampling in 2003. A more thorough analysis of the benthic communities across time would require analysis of general overall weather and sampling conditions in the respective sampling year. The information presented here is for a more general synoptic view of previous sampling efforts.

None of the benthic sampling stations were considered worse than “slightly impacted” when compared to the reference station. The reference station on the Nissitissit River was composed largely of filter collector taxa and this may have influenced all comparisons to the reference. Approximately half of the stations sampled in the Nashua River watershed were composed of 50% or greater filter collector taxa. This is not surprising given that many of the stations are located downstream of an impoundment or pond.

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.

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

Hilsenhoff, W. L. 1987. An improved biotic index of organic stream pollution. The Great Lakes Entomologist, 20(1): 31-39.

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. Undated. *SAMPLING ANALYSIS PLAN Surface Water Monitoring Nashua River Watershed 2008.* CN 324.0. Massachusetts Department of Environmental Protection, Division of Watershed Management. Worcester, MA.

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.

MassDEP. 2013. *NASHUA RIVER WATERSHED 2008 DWM WATER QUALITY MONITORING DATA.* CN 324.2. Massachusetts Department of Environmental Protection, Division of Watershed Management. Worcester, MA.

Meek, J. 2013. Human Disturbance Index. Massachusetts Department of Environmental Protection, Division of Watershed Management. Worcester, MA.

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. 2000. Nashua River Watershed 1998 Biological Assessment. . Massachusetts Department of Environmental Protection, Division of Watershed Management. Worcester, MA.

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

Nuzzo, R.M. 2006. North Nashua River Watershed 2003 Biological Assessment. Massachusetts CN 107.3. Department of Environmental Protection, Division of Watershed Management. Worcester, MA.

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.

USGS. 2013. [Online].USGS StreamStats Online Batch Application. Accessed Multiple Dates 2013. United States Geological Service. Reston, VA. http://streamstatsags.cr.usgs.gov/ss_bp/Default.aspx

APPENDIX I: Tables and Figures

Table 1. List of biomonitoring stations sampled during the 2008 Nashua River Watershed survey including selected watershed and flow characteristics determined from USGS StreamStats (USGS 2013). Some parameters for Station NM30 were not calculated as the station is located in New Hampshire and the Massachusetts StreamStats application was not used. For this station, the New Hampshire StreamStats application was used. Flow parameters for watersheds with drainage areas less than 1.61 square miles, the required minimum for USGS regression equations, were not calculated.

Station ID	Unique ID	Drainage area (mi^2)	Waterbody Name	Site description	Sampling Date	Mean Basin Slope from 250K DEM (percent)	7 Day, 10 Year Low Flow (cubic feet per second)	August 50 Percent Duration (cubic feet per second)	Urban land cover determined from NLCD 2001 land cover dataset (Percent)	Impervious Cover from NLCD 2001 land cover dataset (percent)
AST01	B0665	10.8	Asnebumskit Brook	immediately upstream at Princeton Street, Holden	08/05/08	4.2	0.2	1.5	11.4	3.0
CAT01	B0663	19.1	Catacoonamug Brook	immediately upstream at Main Street, Shirley	08/25/08	3.2	1.4	5.9	18.0	5.9
CHF01	B0666	5.6	Chaffins Brook	east off the end of Meadow Wood Drive, approximately 400 meters downstream of Malden Street, Holden	08/05/08	3.6	0.2	1.2	31.5	11.0
GAT25	B0662	3.1	Gates Brook	approximately 90 meters upstream of mouth at Gates Cove (Wachusett Reservoir), just upstream of access road crossing, West Boylston	08/04/08	3.4	0.1	0.6	55.6	22.0
MAG01	B0664	0.8	Malagasco Brook	approximately 100 meters downstream of Route 70 (Main Street), Boylston	08/04/08	2.8	Not calculated	Not calculated	21.6	6.9
MON02	B0667	10.8	Monoosnuc Brook	approximately 90 meters downstream of Whitney Street, Leominster	08/05/08	6.1	0.4	2.0	22.0	9.5
NM23B	B0078	304.8	Nashua River	approx. 200 meters downstream/north from railroad bridge which crosses McPhearson Road, Ayer/Shirley, MA	08/26/08	4.5	28.6	96.2	19.5	6.9
NM30	B0086	508.9	Nashua River	approx. 400 meters downstream/north from Route 111, Hollis, NH	08/26/08	Not calculated	46.0	Not calculated	Not calculated	Not calculated
NN09	B0076	64.7	North Nashua River	approx. 150 meters downstream/south from Falulah Road, Fitchburg, MA	08/25/08	5.5	4.2	16.5	17.5	6.4
NT61	B0079	69.6	Squannacook River	approx. 200 meters downstream/south from Route 225, Shirley/Groton, MA	8/26/08	4.6	4.6	18.4	9.1	2.2
NT67	B0087	58.0	Nissitissit River	approx. 300 meters downstream/southeast from Prescott Street, Pepperell, MA	08/25/08	3.4	1.7	9.5	6.5	1.3

Table 1 (continued). List of biomonitoring stations sampled during the 2008 Nashua River Watershed survey including selected watershed and flow characteristics determined from USGS StreamStats (USGS 2013). Some parameters for Station NM30 were not calculated as the station is located in New Hampshire and the Massachusetts StreamStats application was not used. For this station, the New Hampshire StreamStats application was used. Flow parameters for watersheds with drainage areas less than 1.61 square miles, the required minimum for USGS regression equations, were not calculated.

Station ID	Unique ID	Drainage area (mi^2)	Waterbody Name	Site description	Sampling Date	Mean Basin Slope from 250K DEM (percent)	7 Day, 10 Year Low Flow (cubic feet per second)	August 50 Percent Duration (cubic feet per second)	Urban land cover determined from NLCD 2001 land cover dataset (Percent)	Impervious Cover from NLCD 2001 land cover dataset (percent)
QP00	B0083	45.2	Quinapoxet River	approx. 175 meters downstream/north from River Street, Holden, MA (in locality of Canada Mills)	08/04/08	4.2	2.2	9.9	13.8	3.8
WHR01	B0668	17.6	Whitman River	approximately 70 meters upstream of Whitmanville Road, Westminster	08/25/08	4.1	0.5	3.0	9.5	2.5

Table 2. Sampling rationale for 2008 Nashua River Watershed biomonitoring survey. Sampling rationale detailed in *Sampling & Analysis Plan Surface Water Monitoring, Nashua River Watershed 2008* (MassDEP undated).

Station ID	Waterbody Name	Site description	Sampling Date	Sampling Rationale
AST01	Asnebumskit Brook	immediately upstream at Princeton Street, Holden	08/05/08	Assess Aquatic Life Use--never sampled
CAT01	Catacoonamug Brook	immediately upstream at Main Street, Shirley	08/25/08	Assess Aquatic Life Use--never sampled
CHF01	Chaffins Brook	east off the end of Meadow Wood Drive, approximately 400 meters downstream of Malden Street, Holden	08/05/08	Assess Aquatic Life Use--currently on 303d list
GAT25	Gates Brook	approximately 90 meters upstream of mouth at Gates Cove (Wachusett Reservoir), just upstream of access road crossing, West Boylston	08/04/08	Assess Aquatic Life Use
MAG01	Malagasco Brook	approximately 100 meters downstream of Route 70 (Main Street), Boylston	08/04/08	Assess Aquatic Life Use--currently on 303d list
MON02	Monoosnuc Brook	approximately 90 meters downstream of Whitney Street, Leominster	08/05/08	Assess Aquatic Life Use--never sampled
NM23B	Nashua River	approx. 200 meters downstream/north from railroad bridge which crosses McPhearson Road, Ayer/Shirley, MA	08/26/08	Assess Aquatic Life Use--currently on 303d list
NM30	Nashua River	approx. 400 meters downstream/north from Route 111, Hollis, NH	08/26/08	Assess Aquatic Life Use--currently on 303d list
NN09	North Nashua River	approx. 150 meters downstream/south from Falulah Road, Fitchburg, MA	08/25/08	Assess Aquatic Life Use--currently on 303d list
NT61	Squannacook River	approx. 200 meters downstream/south from Route 225, Shirley/Groton, MA	8/26/08	Assess Aquatic Life Use
NT67	Nissitissit River	approx. 300 meters downstream/southeast from Prescott Street, Pepperell, MA	08/25/08	Assess Aquatic Life Use
QP00	Quinapoxet River	approx. 175 meters downstream/north from River Street, Holden, MA (in locality of Canada Mills)	08/04/08	Assess Aquatic Life Use
WHR01	Whitman River	approximately 70 meters upstream of Whitmanville Road, Westminster	08/25/08	Assess Aquatic Life Use

Table 3. Habitat assessment summary for biomonitoring stations sampled during the 2008 Nashua 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. 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.

Description	NT67[1]	AST01	CAT01	CHF01	GAT25	MAG01	MON02	NM23B	NM30	NN09	NT61	QP00	WHR01
PARAMETERS (range is 0-20)	SCORE												
Instream Cover	17	10	15	19	17	14	15	15	17	8	20	19	13
Epifaunal Substrate	19	8	19	16	19	16	17	18	18	13	17	17	18
Embeddedness	18	12	19	11	19	19	13	16	18	16	18	16	19
Channel Alteration	14	17	11	20	15	16	16	16	13	15	20	19	19
Sediment Deposition	18	11	19	17	17	17	10	14	19	19	6	16	18
Velocity/depth combinations	15	9	10	17	16	11	13	18	16	13	20	17	10
Channel Flow Status	18	15	18	18	10	19	10	19	20	10	15	17	15
PARAMETERS (range is 0-10 for each bank	SCORE												
Bank Vegetative Protection-Left Bank	10	9	3	10	4	10	2	9	9	10	10	9	10
Bank Vegetative Protection-Right Bank	10	9	3	9	4	10	8	10	10	10	10	10	10
Bank Stability-Left Bank	9	9	8	10	3	10	1	5	9	10	8	8	10
Bank Stability-Right Bank	10	9	10	10	3	10	5	8	10	10	8	8	10
Riparian Vegetative Zone Width-Left Bank	10	10	1	10	9	10	1	10	10	10	10	9	10
Riparian Vegetative Zone Width-Right Bank	10	10	2	9	9	7	3	1	8	9	10	8	10
Total	**178**	**138**	**138**	**176**	**145**	**169**	**114**	**159**	**177**	**153**	**172**	**173**	**172**

[1] Reference station

Table 4. Summary of RBP III analysis of macroinvertebrate communities sampled during the 2008 Nashua River Watershed survey. Shown are the calculated metric values, metric scores (in italics) based on comparability to the reference station (NT67-Nissitissit River). Refer to Table 1 for a listing and description of sampling stations.

SAMPLING STATION	NT67[1]		AST01		CAT01		CHF01		GAT25		MAG01		MON02		NM23B		NM30		NN09		NT61		QP00		WHR01	
STREAM	Nissitissit River		Asnebumskit Brook		Catacoon-amug Brook		Chaffins Brook		Gates Brook		Malagasco Brook		Monoosnuc Brook		Nashua River		Nashua River		North Nashua River		Sqaunna-cook River		Quinapoxet River		Whitman River	
HABITAT SCORE	178		138		138		176		145		169		114		159		177		153		172		173		172	
TAXA RICHNESS	27	*6*	21	*4*	28	*6*	27	*6*	32	*6*	29	*6*	18	*4*	21	*4*	25	*6*	21	*4*	26	*6*	39	*6*	31	*6*
BIOTIC INDEX	4.43	*6*	4.39	*6*	4.95	*6*	4.77	*6*	3.90	*6*	4.11	*6*	4.80	*6*	5.02	*6*	4.44	*6*	5.30	*4*	4.55	*6*	4.33	*6*	4.46	*6*
EPT INDEX	12	*6*	4	*0*	12	*6*	7	*0*	10	*4*	11	*6*	8	*0*	11	*6*	14	*6*	9	*2*	13	*6*	12	*6*	10	*4*
EPT/CHIRONOMIDAE	3.14	*6*	1.39	*2*	9.00	*6*	1.61	*4*	1.55	*4*	1.27	*2*	3.38	*6*	5.27	*6*	37.50	*6*	2.61	*6*	3.60	*6*	1.18	*2*	0.42	*0*
SCRAPER/FILTERER	0.18	*6*	0.05	*2*	0.31	*6*	0.13	*6*	2.29	*6*	0.16	*6*	0.07	*4*	0.33	*6*	0.32	*6*	0.01	*0*	0.63	*6*	0.48	*6*	0.55	*6*
REFERENCE AFFINITY	100%	*6*	68%	*6*	84%	*6*	80%	*6*	67%	*6*	55%	*4*	77%	*6*	66%	*6*	82%	*6*	83%	*6*	81%	*6*	73%	*6*	58%	*4*
% DOMINANT TAXON	11%	*6*	17%	*6*	14%	*6*	16%	*6*	27%	*4*	19%	*6*	25%	*4*	26%	*4*	15%	*6*	15%	*6*	18%	*6*	12%	*6*	27%	*4*
TOTAL METRIC SCORE	42		26		42		34		36		36		30		38		42		28		42		38		30	
HABITAT COMPARABILITY TO REFERENCE	Reference		Supporting		Supporting		Comparable		Supporting		Comparable		Partially Supporting		Comparable		Comparable		Supporting		Comparable		Comparable		Comparable	
BIOLOGICAL CONDITION -DEGREE IMPACTED	Reference Condition		Slightly impacted		Not impacted		Not impacted/ Slightly Impacted		Not impacted		Not impacted		Slightly impacted		Not impacted		Not impacted		Slightly impacted		Not impacted		Not impacted		Slightly impacted	

[1] Reference station

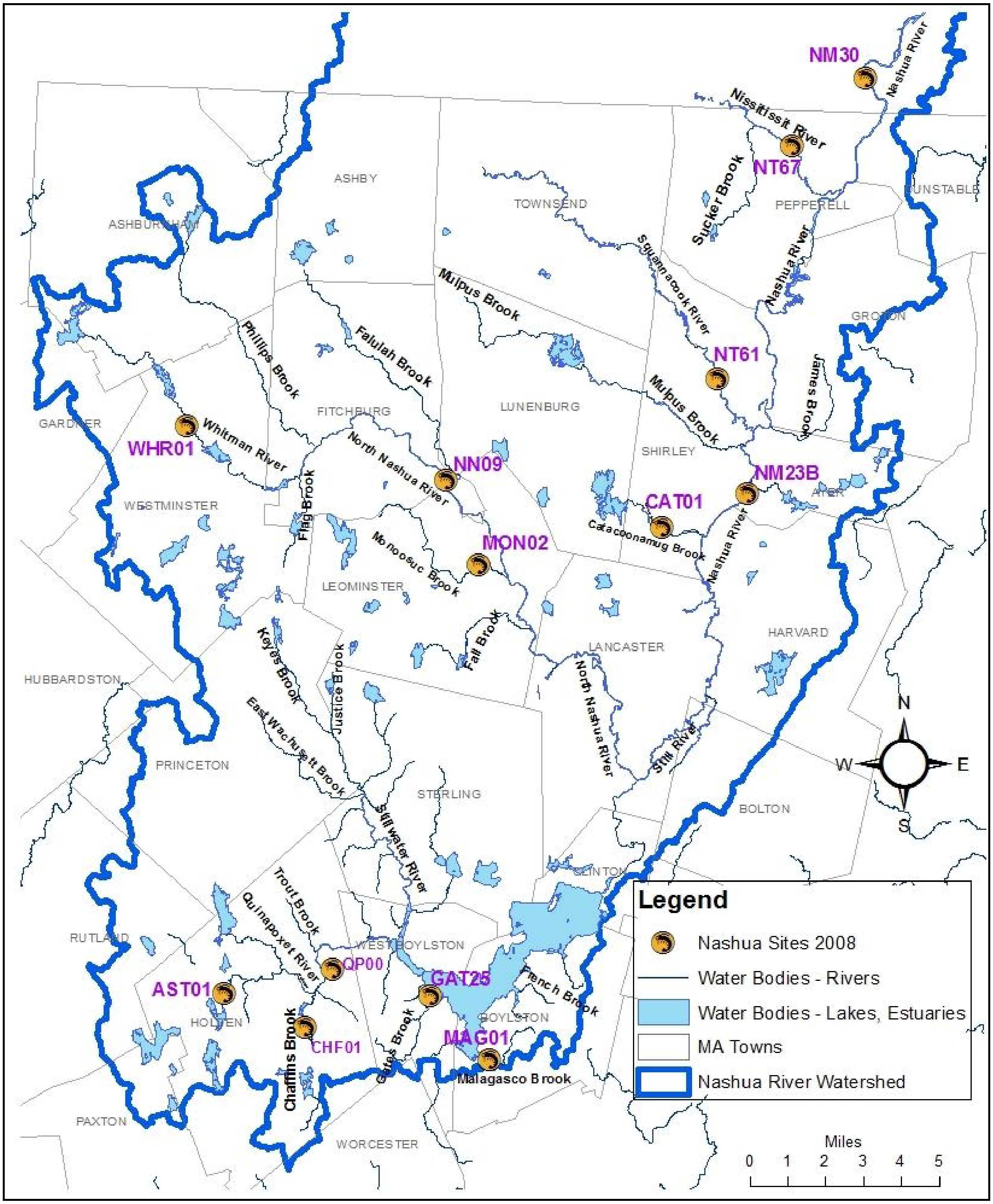

Figure 1: Nashua River Watershed Biomonitoring Stations

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APPENDIX II: Macroinvertebrate Taxa List

Species-level taxa list and counts, functional feeding groups (FFG), and tolerance values (TV) for macroinvertebrates collected from stream sites during the 2008 Nashua River Watershed survey. Refer to Table 1 for a listing and description of sampling stations.

Family	Final Identification	Sampling Sites														
		FFG[1]	Tol-Va[2]	NT67[3]	AST01	CAT01	CHF01	GAT25	MAG01	MON02	NM23B	NM30	NN09	NT61	QP00	WHR01
Hydrobiidae	Hydrobiidae	SC	8								2					
Ancylidae	*Ferrissia* sp.	SC	6			1										
Physidae	Physidae	GC	8					1								
Pisidiidae	Pisidiidae	FC	6		1	1	3	1			26	1				2
	Lumbricina	GC	8					2								
Enchytraeidae	Enchytraeidae	GC	10					1	1							
Naididae	*Nais behningi*	GC	6												1	
Naididae	*Nais communis/variabilis*	GC	8			2										1
Naididae	*Slavina appendiculata*	GC	6												1	
Lumbriculidae	Lumbriculidae	GC	7		5		1	2	3			2			2	3
Crangonyctidae	*Crangonyx* sp.	GC	6		1											
Hydrachnidia	Hydrachnidia	PR	6				1									
Lebertiidae	*Lebertia* sp.	PR	6	1				1								
Sperchonidae	*Sperchon* sp.	PR	6			1		2	1				1			
Sperchonidae	*Sperchonopsis* sp.	PR	6				3									
Torrenticolidae	*Torrenticola* sp.	PR	6				1									
Baetidae	Baetidae	GC	4					3	3			1		1		
Baetidae	*Acentrella turbida*	GC	4							1			3			
Baetidae	Baetis sp.	GC	6			8				1	3	4	2	3	4	
Baetidae	*Baetis flavistriga*	GC	4								2	1				
Baetidae	*Baetis intercalaris*	GC	6	1						2	5		5			
Baetidae	*Baetis pluto*	GC	6			9										
Baetidae	*Baetis tricaudatus*	GC	6					5	6					1	1	
Baetidae	*Heterocloeon curiosum*	GC	2	1												
Baetidae	*Iswaeon anoka*	SC	2	2							12					
Baetidae	*Plauditus* sp.	GC	4									2			3	
Ephemerellidae	*Ephemerella* sp.	GC	1												6	1
Ephemerellidae	*Serratella* sp.	GC	2									1				

Family	Final Identification	Sampling Sites														
		FFG[1]	Tol-Va[2]	NT67[3]	AST01	CAT01	CHF01	GAT25	MAG01	MON02	NM23B	NM30	NN09	NT61	QP00	WHR01
Heptageniidae	Heptageniidae	SC	4			2										
Heptageniidae	*Maccaffertium* sp.	SC	3		2	3	1			2	1	3		1	1	10
Heptageniidae	*Maccaffertium modestum*	SC	1		1						2					
Isonychiidae	*Isonychia bicolor*	FC	2	8		1						1		3		
Aeschnidae	*Boyeria vinosa*	PR	2		3											
Gomphidae	Gomphidae	PR	5	1												
Gomphidae	*Ophiogomphus* sp.	PR	1												1	
Leuctridae	*Leuctra* sp.	SH	0					1	6							2
Nemouridae	Nemouridae	SH	2					1	2							
Perlidae	Perlidae	PR	1				1									
Perlidae	*Acroneuria* sp.	PR	0	1										3		1
Perlidae	*Acroneuria abnormis*	PR	0									1				
Perlidae	*Neoperla* sp.	PR	3											2		
Perlidae	*Paragnetina media*	PR	5			5										
Perlodidae	Perlodidae	PR	2						2							
Corydalidae	*Corydalus* sp.	PR	4	1												
Corydalidae	*Corydalus cornutus*	PR	4										1			
Corydalidae	*Nigronia serricornis*	PR	0	1	7		1	1		1					2	2
Apataniidae	*Apatania* sp.	SC	3						1							
Brachycentridae	*Brachycentrus* sp.	FC	1						1							
Brachycentridae	*Brachycentrus appalachia*	FC	0												1	
Brachycentridae	*Brachycentrus numerosus*	FC	1								2	7				
Brachycentridae	*Micrasema* sp.	SH	2			2									2	
Glossosomatidae	Glossosomatidae	SC	0						2							
Glossosomatidae	*Glossosoma* sp.	SC	0					3		2				1		
Hydropsychidae	Hydropsychidae	FC	4					1		1			3		1	
Hydropsychidae	*Cheumatopsyche* sp.	FC	5	3	12	4	5	3		26	7	3	16	5	1	3
Hydropsychidae	*Diplectrona modesta*	FC	0					2	2							
Hydropsychidae	*Hydropsyche* sp.	FC	4	2	4	4	16	1		3	3	4	5	2	8	
Hydropsychidae	*Hydropsyche betteni*	FC	7	12	5	8	5			7	9	5	5	3	2	1
Hydropsychidae	*Hydropsyche bronta*	FC	6	6									14		2	
Hydropsychidae	*Hydropsyche morosa*	FC	6								2	4	4		5	

Family	Final Identification	Sampling Sites																
		FFG[1]	Tol-Va[2]	NT67[3]	AST01	CAT01	CHF01	GAT25	MAG01	MON02	NM23B	NM30	NN09	NT61	QP00	WHR01
Hydropsychidae	*Hydropsyche sparna*	FC	6	1		4	1				1	16	1	7		2
Hydropsychidae	*Macrostemum* sp.	FC	3	5								3				
Hydroptilidae	Hydroptilidae	GC	4			3										
Hydroptilidae	*Dibusa angata*	SC	6			1										
Hydroptilidae	*Hydroptila* sp.	GC	6								1					
Lepidostomatidae	*Lepidostoma* sp.	SH	1						1			3				
Leptoceridae	*Oecetis* sp.	PR	5			1										1
Philopotamidae	Philopotamidae	FC	3	4												
Philopotamidae	*Chimarra* sp.	FC	4	2												
Philopotamidae	*Chimarra aterrima*	FC	4	10	19	11	16			27			7	2		3
Philopotamidae	*Chimarra obscura*	FC	4			15				9	8	16	8	18		
Philopotamidae	*Chimarra socia*	FC	2	8												
Philopotamidae	*Dolophilodes* sp.	FC	0					7	5							1
Psychomyiidae	*Psychomyia* sp.	GC	2												2	
Rhyacophilidae	*Rhyacophila* sp.	PR	1					1	2							
Rhyacophilidae	*Rhyacophila fuscula*	PR	0					2								
Rhyacophilidae	*Rhyacophila minor*	PR	1					1						2		
Elmidae	Elmidae	SC	4				1	2						1	3	
Elmidae	*Macronychus glabratus*	SH	5		1		2								2	1
Elmidae	*Microcylloepus pusillus*	GC	3			3										
Elmidae	*Optioservus* sp.	SC	4	7								3		2	1	
Elmidae	*Oulimnius latiusculus*	SC	4			3	1	28			3	2		2	2	2
Elmidae	*Promoresia tardella*	SC	2				3	3				1			2	1
Elmidae	*Stenelmis* sp.	SC	5			4			2	1		12				5
Elmidae	*Stenelmis crenata*	SC	5	4									1	17	2	
Psephenidae	*Ectopria nervosa*	SC	5				2	3							3	
Psephenidae	*Psephenus herricki*	SC	4			2						1		3	2	
Athericidae	*Atherix* sp.	PR	4											1		
Ceratopogonidae	*Bezzia/Palpomyia* sp.	PR	6					1	3							
Chironomidae	Chironomini	GC	6	1							1					
Chironomidae	*Microtendipes pedellus* gr.	FC	6										2			
Chironomidae	*Microtendipes rydalensis* gr.	FC	6				1					1				5

Family	Final Identification	Sampling Sites														
		FFG[1]	Tol-Va[2]	NT67[3]	AST01	CAT01	CHF01	GAT25	MAG01	MON02	NM23B	NM30	NN09	NT61	QP00	WHR01
Chironomidae	*Polypedilum* sp.	SH	6						1							
Chironomidae	*Polypedilum aviceps*	SH	4		12		7			2						28
Chironomidae	*Polypedilum flavum*	SH	6	4	1		3			14	3	1		9		
Chironomidae	*Stenochironomus* sp.	GC	5			1					1				1	
Chironomidae	Tanytarsini	FC	6				1						2			
Chironomidae	*Micropsectra* sp.	GC	7				3	1	5							4
Chironomidae	*Rheotanytarsus exiguus* gr.	FC	6	4						1	1		3		1	
Chironomidae	*Rheotanytarsus pellucidus*	FC	5	2	1		6	1	1						12	3
Chironomidae	*Stempellinella* sp.	GC	2													1
Chironomidae	*Sublettea coffmani*	FC	4								1		2			
Chironomidae	*Tanytarsus* sp.	FC	6		1				4							13
Chironomidae	*Diamesa* sp.	GC	5					7	1	1						
Chironomidae	*Pagastia* sp.	GC	1		1			2								
Chironomidae	*Potthastia longimana* gr.	GC	2												3	
Chironomidae	Orthocladiinae	GC	5							1						
Chironomidae	*Brillia* sp.	SH	5						1							
Chironomidae	*Cardiocladius obscurus*	PR	5										3			
Chironomidae	*Corynoneura* sp.	GC	4						1					1		
Chironomidae	*Cricotopus* sp.	SH	7			2				1				1		
Chironomidae	*Cricotopus bicinctus*	GC	7			1					2		4		1	
Chironomidae	*Cricotopus tremulus* gr.	SH	7							1	1					
Chironomidae	*Cricotopus/Orthocladius* sp.	GC	7						1				4			
Chironomidae	*Diplocladius cultriger*	GC	8		1		2		4	1						
Chironomidae	*Eukiefferiella brehmi* gr.	GC	4				1								2	
Chironomidae	*Eukiefferiella claripennis* gr.	GC	8			1										
Chironomidae	*Eukiefferiella devonica* gr.	GC	4			1										
Chironomidae	*Heterotrissocladius* sp.	GC	4					1								
Chironomidae	*Nanocladius* sp.	GC	7	1											1	1
Chironomidae	*Orthocladius* sp.	GC	6										1			
Chironomidae	*Orthocladius dubitatus*	GC	6										1			
Chironomidae	*Orthocladius (Symposiocladius) lignicola*	SH	5												1	

Family	Final Identification	Sampling Sites														
		FFG[1]	Tol-Va[2]	NT67[3]	AST01	CAT01	CHF01	GAT25	MAG01	MON02	NM23B	NM30	NN09	NT61	QP00	WHR01
Chironomidae	*Parachaetocladius* sp.	GC	2						4							
Chironomidae	*Parametriocnemus* sp.	GC	5	3	6	1	1	5						2	1	1
Chironomidae	*Rheocricotopus* sp.	GC	6			1				1					1	
Chironomidae	*Thienemanniella* sp.	GC	6	2									1			
Chironomidae	*Tvetenia* sp.	GC	5												1	
Chironomidae	*Tvetenia paucunca*	GC	5		8		3		3						1	1
Chironomidae	*Tvetenia vitracies*	GC	5	3		1					1		5	1	1	
Chironomidae	Tanypodinae	PR	7												1	
Chironomidae	*Nilotanypus* sp.	PR	6							1					1	1
Chironomidae	*Thienemannimyia* gr.	PR	6	1				3						1	4	1
Empididae	Empididae	PR	6											2		
Sciomyzidae	Sciomyzidae	PR	5		1											
Simuliidae	Simulium sp.	FC	5	3	15	3	8	1	18			5		2		
Simuliidae	*Simulium jenningsi*	FC	4									2				
Simuliidae	*Simulium verecundum* cplx.	FC	5	1			1							1		
Tipulidae	*Antocha* sp.	GC	3		1							2	1		4	
Tipulidae	*Dicranota* sp.	PR	3					1	6							3
Tipulidae	*Hexatoma* sp.	PR	2													1
Tipulidae	*Tipula* sp.	SH	6				1	1								
	Total			106	109	110	102	102	93	107	100	108	105	100	100	105

[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

APPENDIX III: Historical Metric Values for 2008 Sampling Stations

Project Code	UNIQUE ID	Field ID	Collection Date	Total Individuals	Richness	HBI	EPT Index	EPT/CHIR	SC/FC	FC/Total	% Dominant Taxon	Total Habitat Score
Nashua 1998	B0076	NN09	09/01/98	102	19	5.61	4	1.43	0.02	0.64	28%	166
Nashua 2003	B0076	NN09	09/03/03	111	23	5.64	5	0.49	0.03	0.54	14%	164
Nashua 2008	B0076	NN09	08/25/08	105	21	5.30	9	2.61	0.01	0.69	15%	153
Nashua 1998	B0078	NM23B	09/03/98	110	20	5.71	9	3.08	0.05	0.56	24%	142
Nashua 2008	B0078	NM23B	08/26/08	100	21	5.02	11	5.27	0.33	0.60	26%	159
Nashua 1998	B0079	NT61	09/02/98	96	19	4.69	9	2.13	0.47	0.55	24%	136
Nashua 2008	B0079	NT61	08/26/08	100	26	4.55	13	3.60	0.63	0.43	18%	172
Nashua 1998	B0087	NT67	9/2/98	94	36	4.71	12	0.70	0.60	0.32	9%	151
Nashua 2008	B0087	NT67	8/25/08	106	27	4.43	12	3.14	0.18	0.67	11%	178
Nashua 1998	B0083	QP00	09/04/98	105	34	4.24	17	2.19	0.29	0.46	17%	181
Nashua 2003	B0083	QP00	09/17/03	101	36	4.65	14	2.64	0.23	0.43	24%	161
Nashua 2008	B0083	QP00	08/04/08	100	39	4.33	12	1.18	0.48	0.33	12%	173
Nashua 1998	B0086	NM30	09/02/98	96	28	5.02	10	1.88	0.15	0.54	9%	184
Nashua 2008	B0086	NM30	08/26/08	108	25	4.44	14	37.50	0.32	0.63	15%	177