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CHARLES RIVER WATERSHED
2007 BENTHIC MACROINVERTEBRATE BIOASSESSMENT WITH FISH POPULATION DATA

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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) 2007 Charles 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 2006a). 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 13 biomonitoring stations on one unnamed and eight named streams were sampled to determine the health of aquatic communities throughout the watershed (Appendix I, Figure 1). Appendix I, Table 1 presents the 2007 sampling locations, along with station identification numbers and sampling dates. Sampling rationale for the 2007 Charles 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 Charles River Watershed were compared with communities at one reference station considered 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).

In addition to the macroinvertebrate assessments, fish population assessments were made at five locations (See Appendix IV, Table1). Fish sampling was conducted in accordance with *Fish Population Collection Procedures for Evaluation of Resident Fish Populations* (MassDEP 2006b). Results of the fish population and habitat assessment are presented in Appendix IV Tables 2 and 3, respectively.

METHODS

Macroinvertebrate Sampling - RBPIII

Macroinvertebrate sampling and habitat assessments were conducted on July 17 – 20 at 13 sites in the Charles River Watershed (Appendix I, Table 1). Sampling activities were performed in accordance with the sampling and analysis plan (MassDEP undated). The sampling procedures are further described in the standard operating procedures (Nuzzo 2003), and are based on US EPA Rapid Bioassessment Protocols (RBPs) (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 2007 Charles 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). The Unnamed Tributary to the Charles River station (W1587) had the lowest habitat score (127) and was considered “partially supporting” when compared to the reference station. Habitat quality received low scores for instream cover, velocity depth combinations, channel flow status, and the the left bank riparian vegetative zone width (Appendix I, Table 3).

A taxonomic list of the macroinvertebrate organisms collected at each sampling station during the 2007 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. A summary of samples by tolerance ranges is presented in Appendix I, Table 5.

Benthic monitoring was last conducted in July 2002 and July 1997 in the Charles River Watershed (Fiorentino 2005, Fiorentino et. al 2000). Select benthic metrics from these sampling efforts are presented along with results from the 2007 sampling in Appendix III.

RBP Analysis

The RBP III macroinvertebrates data analysis was conducted for the benthic sampling stations. The Stony Brook station (ST01) was chosen as the watershed reference station. This station was used as the reference station for previous benthic sampling. The station has a Human Disturbance Index (HDI) score of 3.5 (Meek 2013). Stony Brook is used as a drinking water source and is designated a Class A waterbody. This station received a habitat score of 174 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).

Items highlighted by the author attempt to elucidate the nature of the benthic community at sampled stations. The functional feeding groups present in a benthic sample give an indication of the types of food sources available that shape the structure of the benthic community. The distribution of tolerance values in a sample is described to spotlight where the benthic community composition is on a range between pollution intolerance to pollution tolerance. Communities that consist of individuals with lower tolerance values indicate better water quality. The three most common families found in a benthic sample are itemized to give an overall general view of the benthic community composition.

There are many factors affecting benthic community composition at a sampling site but it is important to consider the location of a station along the hydrological network. Ponds and impoundments along a river

often act as sources of particulate food supply. Filter feeders are often found in high densities downstream of ponds and impoundments. Their densities may decrease and taxa composition may shift with distance downstream from a pond or impoundment. A shift in the importance of coarse particulate organic matter to fine particulate organic matter as a food source is also often found along the stream network from headwaters to mouth. Readers wishing more information are referred to the River Continuum Concept, a framework that broadly describes ecosystem function along streams from headwaters to mouth (Vannote et. al, 1980).

The benthic macroinvertebrate community in Stony Brook (Station ST01) exhibited a favorable biotic index, an average EPT index and an average total richness (Appendix 1, Table 4). This station scored poorly for the scraper/filterer metric. Filter collector taxa made up approximately 43% of the benthic community. Twenty five percent of the individuals found had a tolerance value 0–3, the highest percentage of all the sampling stations (Appendix I, Table 5).

The macroinvertebrate communities present at all stations in the Charles River watershed, with the exception of one, were considered either non-impacted or slightly impacted when compared to the reference station on Stony Brook. Two stations were considered non-impacted, three stations were considered non-impacted/ slightly impacted, six stations were considered slightly impacted and one station (W1587) was considered moderately impacted (Appendix I, Table 4).

The Dopping Brook site, approximately 100 meters downstream/south from Whitney Street, Holliston MA (Station BB02), received an RBP metric score of 24 and was considered “slightly impacted” when compared to the reference station (ST01). This station scored poorly for the EPT Index and the EPT/Chironomidae when compared to the reference station. The HBI score at this station was higher than the reference station but still scoring in the good water quality range (Hilsenhoff 1988). The Dopping Brook station received a metric score of 4 for percent dominant taxon since 22% of the benthic community was composed of one taxon, the riffle beetle, *Stenelmis crenata*. The three most common families were Elmidae, Gammaridae and Chironomidae which made up 22%, 19% and 18% of the community respectively. The majority of the benthic community was facultative in terms tolerance values, with the majority of individuals having tolerance values between 5 and 6 (Appendix 1 Table 5).

The Dopping Brook station received a habitat score of 158. Six of the 10 habitat parameters scored in the optimal category. The station scored in the marginal category for instream cover and in the suboptimal category for epifaunal substrate, velocity/depth combinations and channel flow status. The Dopping Brook station is located downstream of wetlands upstream of Brook Street in Holliston. The station itself is in an area designated as wetlands on the United States Geological Survey (USGS) topographic map. The aquatic vegetation at the station was indicative of the low gradient nature of the stream and included *Callitriche* sp. (water starwort), *Lemna* sp. (duckweed), *Sparganium* sp. (burreed) and *Peltandra virginica* (arrow arum). Low dissolved oxygen has been documented at nearby water quality stations (W1589, W0416, Davis 2013). The subwatershed that includes the Dopping Brook station has an estimated reduction in median August flow of approximately 22% (Meek 2013). The benthic community at this station is likely structured in response to the low gradient wetland influenced nature of Dopping Brook, although nearby landuse may also impact the stream.

The Bogastow Brook station, downstream from Route 115 (and downstream from Bogastow Pond), Millis MA (Station BB08), when compared to the reference station, was considered “not impacted”. This station received a lower score for the HBI metric when compared to the reference station. This station received a metric score of 4 for percent dominant taxon since 20% of the benthic community was composed of the filter feeding caddisfly, *Cheumatopsyche sp*. The three most common families were Hydropsychidae, Elmidae and Philopotamidae which made up 35%, 19% and 18% of the community, respectively. The two dominant functional feeding groups, filter collector and scraper taxa, made up 62% and 32%, respectively, of the benthic community. The predominance of filter collector taxa at this station is logical given its location approximately 0.15 miles downstream of Bogastow Pond. Ponds are often sources of coarse particulate organic matter (CPOM) that serve as food resources for these feeding groups.

The Charles River, approx. 100 meters downstream from Watertown dam, Watertown, MA (Station CR00), was 70% comparable to the reference station and was considered “slightly impacted”. This station

received a lower score for the HBI Index, EPT Index, EPT/Chironomidae and the scraper/filterer metrics when compared to the reference station. The three most common families were Hydropsychidae Gammaridae and Chironomidae which made up 27%, 23% and 13% of the community, respectively. The two dominant functional feeding groups, filterer-collector and gatherer-collector taxa, made up 48% and 37%, respectively, of the benthic community. The majority of the taxa at this station are facultative in terms of tolerance, with 82% of the sample with tolerance values between 4 and 6. The benthic community at this station is broadly similar to the one sampled in 2002 (Fiorentino 2005, Appendix III).

The Charles River, approx. 100 meters downstream from Dover Dam, Dover/Needham, MA (Station CR02), when compared to the reference station (ST01), was considered "not impacted/slightly impacted". This station received a lower score for the HBI Index, EPT/Chironomidae and the scraper/filterer metrics when compared to the reference station. The four most common families were Hydropsychidae, Pisidiidae, Philopotamidae and Simuliidae which made up approximately 23%, 19%, 11% and 11% of the community, respectively. Filterer-collector taxa made up 67% of the benthic community while scraper taxa made up only 10% of the benthic community. Dissolved oxygen measurements at the nearby water quality station (W1141) did not show supersaturation but were generally elevated, indicating some instream productivity (Davis 2013). This segment of the Charles River is currently being managed to reduce nutrients under a Total Maximum Daily Load (TMDL) (Charles River Watershed Association and Numeric Environmental Services Inc., 2011). A significant shift in the benthic community at this station over the five years since it was last sampled was not found. The benthic community sampled in 2007 showed similar composition and features as the one sampled in 2002 (Fiorentino 2005).

The Charles River, approx. 120 meters downstream from Walker Street, (upstream of Charles River Water Pollution Control District discharge), Medway, MA (Station CR03), received an RBP metric score of 38 and was considered "not impacted" relative to the reference. CR03 received a low metric score for percent dominant taxon. Thirty-five percent of the benthic sample was composed of the Fingernet Caddisfly, *Chimarra obscura*. The three most common families were Philopotamidae, Elmidae and Hydropsychidae, which made up approximately 35%, 23% and 13% of the community, respectively. The benthic community was composed of approximately 52% filterer-collector, 33% scraper, and 16% gatherer-collector taxa. The majority of the taxa were facultative in their tolerance values, with 87% of the individuals having tolerance values between 4 and 6 (Appendix I Table 5).

The Charles River, approx. 120 meters downstream/east from Dean Street bridge, (downstream of Charles River Water Pollution Control District), Millis, MA (Staion CR04), was considered "not impacted" when compared to the reference. This station received lower scores for the HBI, EPT/Chironomidae and the scraper/filterer metrics when compared to the reference station. This station also scored poorly on the percent dominant taxon metric as *Chimarra obscura* made up 32% of the sample. Hydropsychidae, Philopotamidae, and Chironomidae made up approximately 40%, 32% and 11% of the community, respectively. The benthic community was dominated by filterer-collector taxa, which comprised approximately 80% of the sample. The next two most common functional feeding groups, gatherer-collector taxa and scraper taxa made up approximately 10% and 7% of the sample, respectively. The majority of the taxa were facultative in their tolerance values, with approximately 75% of the individuals having tolerance values between 4 and 6 (Appendix I Table 5).

Rock Meadow Brook, upstream/southwest of Summer Street, Westwood, MA (Station RM01), received a metric score of 32 and was considered "not impacted/slightly impacted" when compared to the reference station. RM01 received lower metric scores for the biotic index, EPT/Chironomidae and scraper/filterer metrics when compared to the reference station. Hydropsychidae made up 38% of the benthic community. There was a three way tie for the second most abundant family with Chironomidae, Elmidae and Philopotamidae each making up 11% of the benthic community. The benthic community was approximately 60% filter collector, 14% scraper, and 14% gatherer collector taxa. The majority of individuals were facultative in terms of tolerance values at this station.

The Stop River, approximately 120 meters downstream/north from Campbell Street, Norfolk, MA (Station SR02), was 60% comparable to the reference and considered "slightly impacted". This station received lower metric scores for the taxa richness, biotic index, EPT Index and scraper/filterer metrics when compared to the reference station. The dominant taxon, the filter-feeding caddisfly *Cheumatopsyche* sp.,

made up 28% of the sample. This station had a low EPT index of 4 and low total taxa richness (11). The three most common families were Hydropsychidae, Elmidae and Philopotamidae. These families made up 51%, 23% and 21% of the benthic community. Filterer-collector taxa hyperdominated the benthic community, making up 75% of the assemblage. This station is located approximately 200 meters downstream from Highland Lake, which likely explains, in part, the prominence of filterer-collector taxa.

The Stop River, approximately 30 meters downstream/north from Noon Hill Road, Medfield, MA (Station SR03), received a metric score of 28 and was considered "slightly impacted". This station is located downstream of the MCI Norfolk-Walpole WWTF discharge. Similar to sampling in 2002 the most dominant taxon was *Cheumatopsyche* sp. This net-spinning caddisfly made up 35% of the benthic community. The benthic community was approximately 58% filterer-collector, 26% gatherer-collector taxa and 13% scraper taxa. The EPT Index was low with only 5 EPT taxa. This station scored lower for biotic index, EPT Index, and scraper/filterer metrics when compared to the reference station. The Stop River at this station is low-gradient with fringing wetlands and benthic substrate characterized by 60% sand in the sampled reach. The benthic community is largely similar to that seen in 2002 (Fiorentino 2005, Appendix III)

Trout Brook, approx. 55 meters downstream/north from Haven Street, Dover, MA (TB01), received a metric score of 30 and was considered "slightly impacted". This station received lower scores for the HBI Index and the scraper/filterer metrics when compared to the reference station. Thirty-eight percent of the benthic community was composed of *Cheumatopsyche* sp. and, consequently, the station received a score of 2 for the percent dominant taxon metric. The station was dominated by the Hydropsychidae family, which made up 66% of the benthic community and by filterer-collector taxa, more generally, which made up 79% of the assemblage. The second and third most common families were Elmidae and Philopotamidae, which made up 9% and 7% of the assemblage respectively.

Trout Brook has the lowest percent urban land cover, lowest impervious cover and the highest total habitat score (180) of all the stations sampled in 2007 in the Charles watershed (Appendix I Table 1). Groundwater withdrawals in the Trout Brook subwatershed have been estimated to reduce the median August flow by 8% (Meek 2013). Dissolved oxygen values below 5 mg/l and water temperatures up to 24.7 degrees Celsius were documented at the nearby water quality station (W0408) in 2007 (Davis 2013). In spite of the non-ideal conditions, a reproducing population of brook trout has been documented at this station (R.J. Maietta, MassDEP, personal communication). The sampling station was located downstream of wetlands south of Haven Street, and this may be influencing water quality conditions.

The RBP score for Mill Brook, approximately 55 meters downstream/north from Haven Street, Dover, MA (Station W1586), was 80% of the reference station score and, therefore, considered "not impacted/slightly impacted". This station received lower scores for the HBI, EPT Index and the EPT/Chironomidae metrics when compared to the reference station. The three most common families were Chironomidae, Elmidae and Philopotamidae, which made up 28%, 23% and 15% of the community, respectively. The benthic community was of approximately 42% filter collector, 27% scraper, and 21% gatherer collector taxa. This station had the lowest percent dominant taxon value (15%) of all the sampled 2007 Charles Watershed stations.

The Unnamed tributary to the Charles River, approximately 20 meters downstream/southeast from South Street, Natick MA (Station W1587), was considered "moderately impacted" when compared to the reference station. This station received low scores for the HBI, EPT Index, EPT/Chironomidae and the scraper/filterer metrics. In addition, the percent dominant taxon at this station was 30%, also contributing to the station's low RBP score of 14. The three most common families were Hydropsychidae, Chironomidae and Pisidiidae, which made up 36%, 33% and 8% of the community, respectively. This station had only 4 EPT taxa. Filterer-collectors made up 52% of the assemblage. Shredder taxa were the second most common functional feeding group (17%), exclusively made up of two species of Chironomidae, *Polypedilum flavum and Polypedilum scalaenum.* Only approximately 2% of the benthic community was composed of taxa with tolerance values between 0 and 3 (Appendix I Table 5).

The habitat quality at the Unnamed tributary to the Charles River (Station W1587) was the worst of all the stations sampled during the 2007 Charles Watershed survey (Appendix I, Table 4). The sampling station was also located downstream of an impoundment and the upper reaches of the watershed have fairly

extensive wetlands. These features are likely to affect the benthic community at this station. The stream also has a small drainage area (3.7 square miles). August streamflow that is exceeded fifty percent of the time, as predicted by the USGS for this station, is approximately 0.9 cfs (Appendix I, Table 1). Channel flow status at this station scored in the marginal category during habitat assessment. Dissolved oxygen at this station was generally greater than 5.0 mg/L and the average total phosphorus of water quality samples taken at this station was approximately 0.050 mg/L at the nearby water quality station (W1587) (Davis 2013). It is unclear whether the impacts seen at this station are due to instream habitat limitations or upstream influences (e.g., impoundment, wetlands).

SUMMARY

Sampling of the benthic macroinvertebrate community was carried out in July 2007 at thirteen sites in the Charles 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 2007 had been sampled previously (Appendix III). The Charles River downstream of the Watertown dam (Station CR00) has not changed drastically since the last sampling in 2002 and shows similar metric values across the years sampled. The Charles River (Station CR02A) has not shown much change since it was last sampled in 2002. The Charles River downstream from Walker Street, Medway (Station CR03) also displays similar metrics across previous sampling efforts. The Charles River downstream from the Dean Street Bridge (CR04) has shown some improvement in the EPT Index and the Biotic Index since 2002. This station is downstream of the Charles River Water Pollution Control District which has seen stricter total phosphorus limits since the early 2000's. This station may serve as a good sentinel station to help gauge any response in the benthic community.

The sampled benthic community in the Rocky Meadow Brook in Westwood (Station RM01) scored better in terms of EPT Index when compared to the last sampling in 2002 (8 vs. 4 EPT) but scored similarly for the other metrics. The Stop River downstream from Campbell Street, Norfolk (Station SR02) was last sampled in 1997 and has had a consistently poor EPT Index and low richness values. The next downstream station on the Stop River (Station SR03) has shown higher richness values than Station SR02 but has also generally shown low EPT Index values. The benthic community at this station has shown greater numbers of scraper taxa in 2002 and 2007 sampling in comparison to 1997 sampling. The prevalence of filterer-collector taxa, although around 50% of the benthic community in more recent sampling, is less than was found during 1997 sampling, when 85% of the benthic community was filterer-collector taxa.

The RBP metrics at the reference station, Stony Brook (Station ST01) have largely remained similar through time with the exception of taxa richness, which appears reduced since the 1997 sampling. The benthic community samples at Trout Brook (TB01) have shown a shift from being dominated by Chironomidae, principally the gathering collector *Tvetenia paucunca,* to a predominance of filter feeder taxa. The EPT/Chironomidae ratio has increased from 1997 to 2007 as did the percentage of filter feeders. It is important to note the July 1997 rainfall at the DCR rain gage in Needham (Station NEE716) was approximately 17 % of the average July rainfall for the period of record at the rain gage (MA DCR 2013). Rainfall for both July 2002 and July 2007 was approximately average. The varying rainfall and its impacts on both habitat availability and the flow regime may explain some of the differences in the benthic community in the benthic samples at Trout Brook. The other metrics for this station generally did not show a significant change.

The majority of the taxa found in the benthic samples were facultative in terms of their tolerance values (Appendix I, Table 5). The average percent filterer-collector taxa for all samples was 57%, likely due to the fact that many of the stations were downstream of an impoundment. Only one of the benthic sampling stations (W1587) was considered "moderately impacted" when compared to the reference station. All of the other waterbodies sampled were characterized as not or slightly impacted when compared to the reference station.

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APPENDIX I: Tables and Figures

Table 1. List of biomonitoring stations sampled during the 2007 Charles River Watershed survey including selected watershed and flow characteristics determined from USGS StreamStats (USGS 2013).

Station ID	Unique ID	Drainage area (mi^2)	Waterbody Name	Site description	Sampling Date	Mean Basin Slope from 1:250K Digital Elevation Model (percent)	7-Day, 10-Year Low Flow (cubic feet per second)	August streamflow exceeded 50 percent of the time (cubic feet per second)	Urban land cover determined from NLCD [1] 2001 land cover dataset (Percent)	Impervious Cover from NLCD [1] 2001 land cover dataset (percent)
BB02	B0613	1.6	Dopping Brook	approximately 100 meters downstream/south from Whitney Street, Holliston MA	7/19/2007	4.1	0.1	0.4	16.7	5.8
BB08	B0614	23.7	Bogastow Brook	approximately 200 meters downstream/east from Route 115 (below multiple channels downstream from Bogastow Pond), Millis MA	7/17/2007	2.1	0.9	5	27.7	8.5
CR00	B0059	272.7	Charles River	approx. 100 meters downstream/east from Watertown dam, (upstream/west of Route 16 bridge), Watertown, MA	7/19/2007	2.3	22.8	88.6	41.8	15.5
CR02A	B0487	182.6	Charles River	approx. 100 meters downstream from Dover Dam, Dover/Needham, MA	7/19/2007	2.2	12.8	54.3	32.8	11
CR03	B0055	65.5	Charles River	approx. 120 meters downstream/east from Walker Street, (upstream of Charles River Water Pollution Control District discharge), Medway, MA	7/17/2007	2.4	3.4	16.3	36.3	14.2
CR04	B0056	84.1	Charles River	approx. 120 meters downstream/east from Dean Street bridge, (downstream of Charles River Water Pollution Control District), Millis, MA	7/17/2007	2.4	5.4	23.9	35	13.1
RM01	B0111	1.7	Rock Meadow Brook	upstream/southwest of Summer Street, Westwood, MA	7/18/2007	3.2	0.1	0.4	44.7	13.3
SR02	B0066	10.2	Stop River	approx. 120 meters downstream/north from Campbell Street, Norfolk, MA	7/20/2007	1.6	0.5	2.7	31.2	8.2
SR03	B0067	13.7	Stop River	approx. 30 meters downstream/north from Noon Hill Road, Medfield, MA	7/20/2007	1.9	0.6	3.4	29.2	7.5
ST01	B0073	10.5	Stony Brook	approx. 50 meters downstream/southeast from Church Street, Weston, MA (in both braids)	7/18/2007	2.3	0.6	2.8	23.3	4.8
TB01	B0069	3.7	Trout Brook	approx. 55 meters downstream/north from Haven Street, Dover, MA	7/18/2007	2.9	0.1	0.7	14.1	3.3

Table 1 (continued). List of biomonitoring stations sampled during the 2007 Charles River Watershed survey including select watershed and flow characteristics determined from USGS StreamStats (USGS 2013).

Station ID	Unique ID	Drainage area (mi^2)	Waterbody Name	Site description	Sampling Date	Mean Basin Slope from 1:250K Digital Elevation Model (percent)	7-Day, 10-Year Low Flow (cubic feet per second)	August streamflow exceeded 50 percent of the time (cubic feet per second)	Urban land cover determined from NLCD [1] 2001 land cover dataset (Percent)	Impervious Cover from NLCD [1] 2001 land cover dataset (percent)
W1586	B0612	3.6	Mill Brook	approximately 200 meters upstream/northeast from Route 27 (at transfer station), Medfield MA	7/18/2007	1.7	0.1	0.7	27.8	6.9
W1587	B0615	3.7	Unnamed and/or Undefined Saris	unnamed tributary to the Charles River, approximately 20 meters downstream/southeast from South Street, Natick MA	7/20/2007	2.4	0.2	0.9	20	5.7

1- National Land Cover Database

Table 2. Sampling rationale for the 2007 Charles River Watershed biomonitoring survey as detailed in the sampling and analysis plan (MassDEP undated).

Station ID	Waterbody Name	Site description	Sampling Date	Sampling Rationale
BB02	Dopping Brook	approximately 100 meters downstream/south from Whitney Street, Holliston MA	7/19/2007	Assess Aquatic Life Use--downstream of potential nonpoint source pollution
BB08	Bogastow Brook	approximately 200 meters downstream/east from Route 115 (below multiple channels downstream from Bogastow Pond), Millis MA	7/17/2007	Assess Aquatic Life Use--currently on 303d list
CR00	Charles River	approx. 100 meters downstream/east from Watertown dam, (upstream/west of Route 16 bridge), Watertown, MA	7/19/2007	Assess Aquatic Life Use--currently on 303d list
CR02A	Charles River	approx. 100 meters downstream from Dover Dam, Dover/Needham, MA	7/19/2007	Assess Aquatic Life Use--currently on 303d list
CR03	Charles River	approx. 120 meters downstream/east from Walker Street, (upstream of Charles River Water Pollution Control District discharge), Medway, MA	7/17/2007	Assess Aquatic Life Use--currently on 303d list
CR04	Charles River	approx. 120 meters downstream/east from Dean Street bridge, (downstream of Charles River Water Pollution Control District), Millis, MA	7/17/2007	Assess Aquatic Life Use--currently on 303d list
RM01	Rock Meadow Brook	upstream/southwest of Summer Street, Westwood, MA	7/18/2007	Assess Aquatic Life Use--currently on 303d list
SR02	Stop River	approx. 120 meters downstream/north from Campbell Street, Norfolk, MA	7/20/2007	Assess Aquatic Life Use--currently on 303d list
SR03	Stop River	approx. 30 meters downstream/north from Noon Hill Road, Medfield, MA	7/20/2007	Assess Aquatic Life Use--currently on 303d list
ST01	Stony Brook	approx. 50 meters downstream/southeast from Church Street, Weston, MA (in both braids)	7/18/2007	Assess Aquatic Life Use--reference station
TB01	Trout Brook	approx. 55 meters downstream/north from Haven Street, Dover, MA	7/18/2007	Assess Aquatic Life Use--currently on 303d list (cause unknown)
W1586	Mill Brook	approximately 200 meters upstream/northeast from Route 27 (at transfer station), Medfield MA	7/18/2007	Assess Aquatic Life Use--never sampled
W1587	Unnamed and/or Undefined Saris	unnamed tributary to the Charles River, approximately 20 meters downstream/southeast from South Street, Natick MA	7/20/2007	Assess Aquatic Life Use--never sampled

Table 3. Habitat assessment summary for biomonitoring stations sampled during the 2007 Charles River Watershed survey. For instream parameters, scores ranging from 16-20 = optimal; 11-15 = suboptimal; 6-10 = marginal; 0-5 = poor. For bank and 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 Appendix I, Table 1 for a listing and description of sampling stations.

Sampling Station	ST01[1]	BB02	BB08	CR00	CR02A	CR03	CR04	RM01	SR02	SR03	TB01	W1586	W1587
PARAMETERS (range is 0-20)	SCORE												
Instream Cover	16	10	10	17	14	11	17	5	19	15	16	7	5
Epifaunal Substrate	17	11	17	19	18	19	18	15	19	15	18	16	14
Embeddedness	20	16	16	18	15	17	16	14	20	14	19	17	18
Channel Alteration	15	19	11	12	11	17	11	20	15	15	16	16	15
Sediment Deposition	19	16	10	13	15	15	8	11	18	12	18	18	13
Velocity/ Depth Combinations	13	12	8	19	15	12	14	9	19	14	15	9	11
Channel Flow Status	17	15	9	11	19	18	17	14	18	17	18	18	9
PARAMETERS (range is 0-10 for each bank	SCORE												
Bank Vegetative Protection-Left Bank	9	10	10	10	10	10	8	10	9	9	10	10	7
Bank Vegetative Protection-Right Bank	9	10	10	8	10	9	10	10	9	10	10	10	7
Bank Stability-Left Bank	10	10	10	8	10	8	10	10	8	5	10	10	7
Bank Stability-Right Bank	9	10	8	7	10	7	8	10	9	5	10	10	7
Riparian Vegetative Zone Width-Left Bank	10	10	10	3	10	5	5	10	9	10	10	10	5
Riparian Vegetative Zone Width-Right Bank	10	9	10	2	9	7	9	10	9	8	10	9	9
Total	**174**	**158**	**139**	**147**	**166**	**155**	**151**	**148**	**181**	**149**	**180**	**160**	**127**
Comparability to Reference	Comparable	Comparable	Supporting	Supporting	Comparable	Comparable	Supporting	Supporting	Comparable	Supporting	Comparable	Comparable	Partially Supporting

[1] Reference station-

Table 4. Summary of RBP III analysis of macroinvertebrate communities sampled during the 2007 Charles River Watershed survey. Shown are the calculated metric values and metric scores (in italics) based on comparability to the reference station (ST01--Stony Brook). Refer to Appendix I, Table 1 for a listing and description of sampling stations.

SAMPLING STATION	ST01[1]		BB02		BB08		CR00		CR02A		CR03		CR04		RM01		SR02		SR03		TB01		W1586		W1587	
STREAM	Stony Brook		Dopping Brook		Bogastow Brook		Charles River		Charles River		Charles River		Charles River		Rock Meadow Brook		Stop River		Stop River		Trout Brook		Mill Brook		Unnamed and/or Undefined Saris	
HABITAT SCORE	174		158		139		147		166		155		151		148		181		149		180		160		127	
TAXA RICHNESS	17	*6*	22	*6*	16	*6*	19	*6*	20	*6*	19	*6*	18	*6*	23	*6*	11	*4*	17	*6*	17	*6*	22	*6*	22	*6*
BIOTIC INDEX	3.81	*6*	5.31	*4*	4.50	*4*	5.03	*4*	4.76	*4*	4.20	*6*	5.10	*4*	4.90	*4*	4.84	*4*	5.26	*4*	5.08	*4*	4.60	*4*	5.72	*2*
EPT INDEX	7	*6*	3	*0*	7	*6*	6	*4*	10	*6*	10	*6*	10	*6*	8	*6*	4	*0*	5	*2*	7	*6*	6	*4*	4	*0*
EPT/CHIRONOMIDAE	10.00	*6*	0.84	*0*	68.00	*6*	3.54	*2*	5.55	*4*	7.78	*6*	7.45	*4*	4.82	*2*	14.40	*6*	11.33	*6*	16.20	*6*	1.17	*0*	1.17	*0*
SCRAPER/FILTERER	0.76	*6*	0.68	*6*	0.52	*6*	0.21	*2*	0.15	*2*	0.61	*6*	0.09	*0*	0.24	*2*	0.14	*0*	0.23	*2*	0.15	*2*	0.65	*6*	0.12	*0*
REFERENCE AFFINITY	100	*6*	52	*4*	81	*6*	72	*6*	65	*4*	78	*6*	57	*4*	67	*6*	66	*6*	73	*6*	63	*4*	72	*6*	58	*4*
% DOMINANT TAXON	23%	*4*	22%	*4*	20%	*4*	25%	*4*	19%	*6*	35%	*2*	32%	*2*	13%	*6*	28%	*4*	35%	*2*	38%	*2*	15%	*6*	30%	*2*
TOTAL METRIC SCORE	40		24		38		28		32		38		26		32		24		28		30		32		14	
% COMPARABILITY TO REFERENCE	100%		60%		95%		70%		80%		95%		65%		80%		60%		70%		75%		80%		35%	
BIOLOGICAL CONDITION -DEGREE IMPACTED	Reference Condition		Slightly impacted		Not impacted		Slightly impacted		Not impacted/ Slightly impacted		Not impacted		Slightly impacted		Not impacted/ Slightly impacted		Slightly impacted		Slightly impacted		Slightly impacted		Not impacted/ Slightly impacted		Moderately impacted	

[1] Reference station

Table 5. Summary of Samples by Taxa Tolerance Values.

Station ID	% Sample with Tolerance Values 0 to 3	% Sample with Tolerance Values 4 to 6	% Sample with Tolerance Values 7 to 10
W1587	2%	84%	14%
CR04	5%	75%	20%
SR03	6%	76%	19%
TB01	6%	74%	20%
BB02	8%	79%	13%
RM01	8%	79%	13%
W1586	11%	81%	8%
CR03	13%	87%	1%
BB08	13%	76%	11%
CR00	13%	82%	5%
SR02	15%	68%	18%
CR02A	16%	78%	6%
ST01	25%	74%	1%

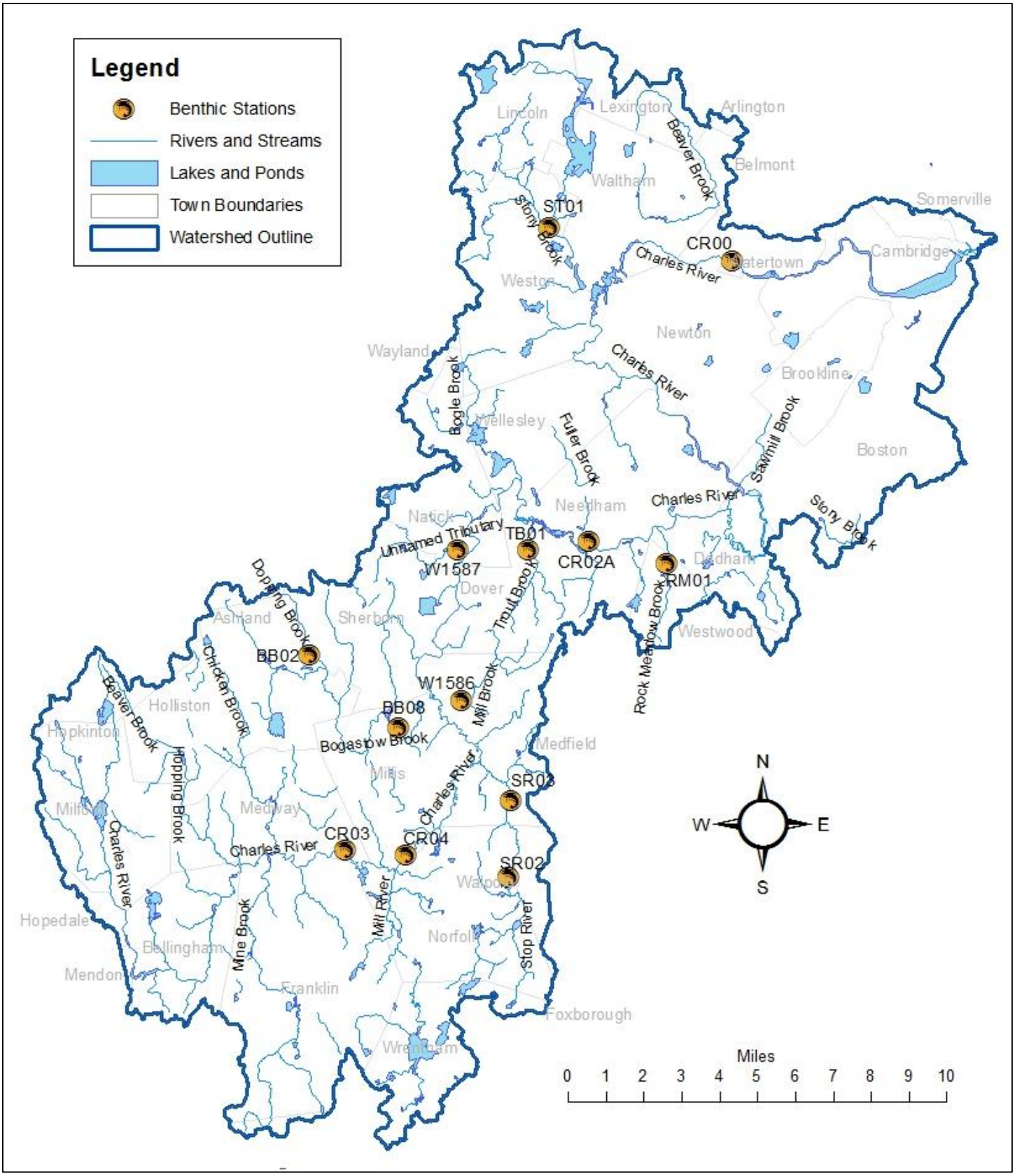

Figure 1: Charles River Watershed Biomonitoring Stations.

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APPENDIX II: Macroinvertebrate Taxa List

Species-level taxa list and counts, functional feeding groups (FG), and tolerance values (TV) for macroinvertebrates collected from stream sites during the 2007 Charles River Watershed survey. Refer to Table 1 for a listing and description of sampling stations.

Family	Final Identification	Sampling Sites														
		FFG[1]	TV[2]	ST01[3]	BB02	BB08	CR00	CR02A	CR03	CR04	RM01	SR02	SR03	TB01	W1586	W1587
Hydrobiidae	Hydrobiidae	SC	8				2									
Ancylidae	*Laevapex fuscus*	SC	7													
Planorbidae	*Gyraulus* sp.	SC	8													1
Planorbidae	*Menetus dilatatus*	SC	6													
Corbiculidae	*Corbicula* sp.	FC	6				3									
Pisidiidae	Pisidiidae	FC	6	4	2	2		20			2	2	2		1	9
Tubificidae	Tubificidae	GC	10				1									1
Tubificidae	*Aulodrilus* sp.	GC	7										1			
Lumbriculidae	Lumbriculidae	GC	7	1									1		1	1
Asellidae	*Caecidotea* sp.	GC	8													
Asellidae	*Caecidotea communis*	GC	8		7									2		
Asellidae	*Caecidotea racovitzai racovitzai*	GC	8													5
Gammaridae	*Gammarus* sp.	GC	6		20		23	2					16			
Hyalellidae	*Hyalella azteca*	GC	8													1
Hydrachnidia	Hydrachnidia	PR	6		1											
Hygrobatidae	*Hygrobates* sp.	PR	6								2		1			
Lebertiidae	*Lebertia* sp.	PR	6											1		
Sperchonidae	Sperchonidae	PR	6								1					
Sperchonidae	*Sperchonopsis* sp.	PR	6												1	
Baetidae	*Baetis* sp.	GC	6	8					2	1	1				1	
Baetidae	*Baetis flavistriga*	GC	4				2		2							
Baetidae	*Baetis intercalaris*	GC	6					1								
Baetidae	*Baetis pluto*	GC	6			2			4							
Baetidae	*Heterocloeon curiosum*	GC	2						2	1						
Baetidae	*Iswaeon anoka*	SC	2				3	7	1	3						
Baetidae	*Plauditus* sp.	GC	4										8	1		
Ephemerellidae	*Teloganopsis deficiens*	GC	2	9												

Family	Final Identification	Sampling Sites														
		FFG[1]	TV[2]	ST01[3]	BB02	BB08	CR00	CR02A	CR03	CR04	RM01	SR02	SR03	TB01	W1586	W1587
Heptageniidae	Heptageniidae	SC	4								1					
Heptageniidae	*Maccaffertium* sp.	SC	3	3											3	
Heptageniidae	*Maccaffertium modestum*	SC	1			12	2	2					6	2		2
Isonychiidae	*Isonychia bicolor*	FC	2						1							
Leptohyphidae	*Tricorythodes* sp.	GC	4					2								
Leptophlebiidae	Leptophlebiidae	GC	2											1		
Leptophlebiidae	*Paraleptophlebia* sp.	GC	1		1											
Aeschnidae	*Boyeria vinosa*	PR	2								1					
Calopterygidae	Calopterygidae	PR	5													
Calopterygidae	*Calopteryx* sp.	PR	6								1					
Coenagrionidae	Coenagrionidae	PR	9			1										
Cordulegastridae	*Cordulegaster* sp.	PR	3												1	
Zygoptera	Zygoptera	PR	6		3						2					
	Plecoptera	GC	3								3					
Perlidae	*Paragnetina* sp.	PR	1	1												
Corydalidae	*Nigronia serricornis*	PR	0	2	5	1					1				1	
Brachycentridae	*Micrasema* sp.	SH	2					6		1						
Glossosomatidae	Glossosomatidae	SC	0								1					
Glossosomatidae	*Glossosoma* sp.	SC	0	3					8						2	
Hydropsychidae	*Cheumatopsyche* sp.	FC	5		2	20	25	19	2	8	12	29	37	40	6	33
Hydropsychidae	*Hydropsyche* sp.	FC	4	11	6	5					11	6		10		
Hydropsychidae	*Hydropsyche betteni*	FC	7		7	10	2	6		21	12	17	16	19	7	6
Hydropsychidae	*Hydropsyche sparna*	FC	6	1					11	12						
Hydroptilidae	Hydroptilidae	GC	4						1	1						
Hydroptilidae	*Hydroptila* sp.	GC	6													
Leptoceridae	Leptoceridae	PR	4					1								
Leptoceridae	*Ceraclea* sp.	GC	3					2				1				
Leptoceridae	*Mystacides* sp.	GC	4													
Leptoceridae	*Oecetis* sp.	PR	5					3								
Leptoceridae	*Triaenodes* sp.	SH	6			1										
Limnephilidae	*Pycnopsyche* sp.	SH	4								1					
Philopotamidae	*Chimarra aterrima*	FC	4	24		17					11			7	15	

Family	Final Identification	Sampling Sites														
		FFG[1]	TV[2]	ST01[3]	BB02	BB08	CR00	CR02A	CR03	CR04	RM01	SR02	SR03	TB01	W1586	W1587
Philopotamidae	*Chimarra obscura*	FC	4			1	12	12	36	33		19	1			1
Polycentropodidae	*Polycentropus* sp.	PR	6							1						
Uenoidae	*Neophylax oligius*	SC	3											1		
Elmidae	Elmidae	SC	4									2				
Elmidae	*Macronychus glabratus*	SH	5				1									
Elmidae	*Microcylloepus pusillus*	GC	3				8					14				
Elmidae	*Optioservus* sp.	SC	4			1			7	2						
Elmidae	*Optioservus trivittatus*	SC	4													
Elmidae	*Oulimnius latiusculus*	SC	4	20		2			4					3	11	
Elmidae	*Promoresia tardella*	SC	2	9					1					2	4	
Elmidae	*Stenelmis* sp.	SC	5			16	3	2	12	2	11		8	4		4
Elmidae	*Stenelmis crenata*	SC	5		23							7			8	
Psephenidae	*Psephenus herricki*	SC	4			1										
Chironomidae	*Cryptochironomus* sp.	PR	8										1			
Chironomidae	*Microtendipes pedellus* gr.	FC	6						1							
Chironomidae	*Microtendipes rydalensis* gr.	FC	6													
Chironomidae	*Phaenopsectra* sp.	SC	7									1				
Chironomidae	*Polypedilum aviceps*	SH	4												4	
Chironomidae	*Polypedilum flavum*	SH	6				3	2		2		2		2		16
Chironomidae	*Polypedilum illinoense* gr.	SH	6		1		1								1	
Chironomidae	*Polypedilum scalaenum*	SH	6													2
Chironomidae	*Rheotanytarsus exiguus* gr.	FC	6		4		4	1	2	1		1				2
Chironomidae	*Rheotanytarsus pellucidus*	FC	5	1	2		1	2			1		2			1
Chironomidae	*Stempellinella* sp.	GC	2		1											
Chironomidae	*Tanytarsus* sp.	FC	6	1	3		1			1	2				3	3
Chironomidae	*Chaetocladius* sp.	GC	6													2
Chironomidae	*Corynoneura* sp.	GC	4		1										1	
Chironomidae	*Cricotopus bicinctus*	GC	7										1			
Chironomidae	*Cricotopus/Orthocladius* sp.	GC	7						1							
Chironomidae	*Nanocladius* sp.	GC	7					1								
Chironomidae	*Parametriocnemus* sp.	GC	5		1						4			1	4	4

Family	Final Identification	Sampling Sites														
		FFG[1]	TV[2]	ST01[3]	BB02	BB08	CR00	CR02A	CR03	CR04	RM01	SR02	SR03	TB01	W1586	W1587
Chironomidae	*Rheocricotopus* sp.	GC	6											1		
Chironomidae	*Synorthocladius* sp.	GC	6							1						
Chironomidae	*Tvetenia paucunca*	GC	5	2	2			1			4	1		1	14	
Chironomidae	*Tvetenia vitracies*	GC	5				3	4	5	6			1			
Chironomidae	*Nilotanypus* sp.	PR	6			1										
Chironomidae	*Pentaneura inconspicua*	PR	6													
Chironomidae	*Thienemannimyia* gr.	PR	6	2	4								1		2	6
Empididae	*Clinocera* sp.	PR	6													2
Empididae	*Hemerodromia* sp.	PR	6		1											5
Simuliidae	*Simulium* sp.	FC	5	4	8	7		12	1	6	4		4	6	11	2
Tipulidae	*Antocha* sp.	GC	3								1					
Tipulidae	*Dicranota* sp.	PR	3		1											
Tipulidae	*Tipula* sp.	SH	6								1					

[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 2007 Sampling Stations

(Fiorentino 2005, Fiorentino et al. 2000, note this appendix includes duplicate samples, all sampling was RBPIII except RM01 in 1997)

Project Code	UNIQUE ID	Field ID	Benthic Sample ID	Collection Date	Biological Condition-Degree Impairment	Richness	HBI	EPT Index	EPT/CHIR	SC/FC	FC/Total	% Dominant Taxon	Total Habitat Score
Charles 2007	B0613	BB02	2007016	7/19/07	Slightly Impacted	22	5.31	3	0.84	0.68	0.32	22%	158
Charles 2007	B0614	BB08	2007011	7/17/07	Not Impacted	16	4.50	7	68.00	0.52	0.62	20%	139
Charles 1997	B0059	CR00	1997033	7/15/97	Moderate[1]	20	5.39	4	2.38	--	0.60	18%	116
Charles 2002	B0059	CR00	2002008	7/16/02	Slightly Impacted[3]	23	5.52	6	0.80	0.30	0.39	18%	152
Charles 2007	B0059	CR00	2007018	7/19/07	Slightly Impacted	19	5.03	6	3.54	0.21	0.48	25%	147
Charles 2002	B0487	CR02A	2002011	7/17/02	Slightly Impacted[3]	18	5.23	6	7.50	0.11	0.78	32%	169
Charles 2007	B0487	CR02A	2007017.1	7/19/07	Not impacted/ Slightly impacted -	20	4.76	10	5.55	0.15	0.67	19%	166
Charles 2007	B0487	CR02A	2007017.2	7/19/07	Not impacted	22	4.80	11	6.11	0.26	0.62	26%	166
Charles 1997	B0055	CR03	1997031	7/9/97	Reference Station[1]	24	4.84	9	8.71	0.25	0.61	23%	149
Charles 2002	B0055	CR03		7/15/02	Reference Station[3]	17	4.47	7	7.67	0.51		17%	158
Charles 2007	B0055	CR03	2007009	7/17/07	Not impacted	19	4.20	10	7.78	0.61	0.52	35%	155
Charles 1997	B0056	CR04	1997032	7/9/97	Moderate[1]	21	5.88	6	2.05	0.03	0.70	27%	160
Charles 2002	B0056	CR04	2002004	7/15/02	Moderately Impacted[3]	16	6.97	5	2.50	0.13	0.69	37%	147
Charles 2007	B0056	CR04	2007010	7/17/07	Slightly Impacted	18	5.10	10	7.45	0.09	0.80	32%	151
Charles 1997	B0111	RM01	1997047*	7/16/97	--	11		4					121

Project Code	UNIQUE ID	Field ID	Benthic Sample ID	Collection Date	Biological Condition-Degree Impairment	Richness	HBI	EPT Index	EPT/CHIR	SC/FC	FC/Total	% Dominant Taxon	Total Habitat Score
Charles 2002	B0111	RM01	2002015	7/18/02	Moderately Impacted	24	5.48	4	1.71	0.06	0.65	18%	165
Charles 2007	B0111	RM01	2007013	7/18/07	Not impacted/ Slightly impacted	23	4.90	8	4.82	0.24	0.60	13%	148
Charles 1997	B0066	SR02	1997035	7/8/97	Moderate[2]	10	5.72	3	0.58	0.14	0.68	57%	177
Charles 2007	B0066	SR02	2007021	7/20/07	Slightly Impacted	11	4.84	4	14.40	0.14	0.73	28%	181
Charles 1997	B0067	SR03	1997036	7/8/97	Moderate	19	5.38	4	7.27	0.04	0.85	48%	129
Charles 2002	B0067	SR03	2002007	7/16/02	Slightly Impacted	21	5.18	3	6.38	0.49	0.49	40%	152
Charles 2007	B0067	SR03	2007020.A	7/20/07	Slightly Impacted	17	5.26	5	11.33	0.23	0.58	35%	149
Charles 2007	B0067	SR03	2007020.B	7/20/07	Slightly Impacted	19	5.46	6	7.20	0.18	0.55	33%	149
Charles 2007	B0067	SR03	2007020.C	7/20/07	Slightly Impacted	22	5.27	8	6.80	0.23	0.49	32%	149
Charles 1997	B0073	ST01	1997037	7/15/97	Reference Station	30	3.10	12	3.41	0.20	0.50	23%	154
Charles 2002	B0073	ST01	2002009	7/16/02	Reference Station[4]	20	2.79	11	9.25	0.59	0.33	22%	182
Charles 2007	B0073	ST01	2007012	7/18/07	Reference Station[5]	17	3.81	7	10.00	0.76	0.43	23%	174
Charles 1997	B0069	TB01	1997038	7/16/97	Moderate	22	5.75	7	0.28	0.59	0.16	45%	179
Charles 2002	B0069	TB01	2002012.1	7/17/02	Moderately Impacted	24	4.65	7	0.73	4.09	0.11	29%	182
Charles 2002	B0069	TB01	2002012.2	7/17/02	Slightly Impacted	25	4.95	8	2.38	1.16	0.27	23%	182
Charles 2007	B0069	TB01	2007014	7/18/07	Slightly Impacted	17	5.08	7	16.20	0.15	0.79	38%	180
Charles 2007	B0612	W1586	2007015	7/18/07	Not impacted/ Slightly impacted	22	4.60	6	1.17	0.65	0.42	15%	160

Project Code	UNIQUE ID	Field ID	Benthic Sample ID	Collection Date	Biological Condition-Degree Impairment	Richness	HBI	EPT Index	EPT/CHIR	SC/FC	FC/Total	% Dominant Taxon	Total Habitat Score
Charles 2007	B0615	W1587	2007019	7/20/07	Moderately Impacted	22	5.72	4	1.17	0.12	0.52	30%	127

* qualitative sample

Notes:
1- 1997 Charles River reference station was CR03; CR04 and CR00 were compared to this station in 1997 to determine biological condition-degree impairment for the Charles River.
2 – A duplicate sample for station SR02 in 1997, not detailed in this table, had a biological condition of Moderate/Severe.
3- 2002 Charles River reference station was CR03; CR04, CR00 and CR02A were compared to this station in 2002 to determine biological condition-degree impairment for the Charles River.
4- Reference station for all non-Charles River stations in 2002.
5- For 2007 sampling station ST01 was the reference station against which all other stations were compared.

APPENDIX IV: Fish population sampling

Table IV-1. List of fish population stations sampled during the 2007 Charles River Watershed survey including selected watershed and flow characteristics determined from USGS StreamStats (USGS 2013).

Station ID	Unique ID	Drainage area (mi^2)	Waterbody Name	Site description	Sampling Date	Mean Basin Slope from 1:250K Digital Elevation Model (percent)	7-Day, 10-Year Low Flow (cubic feet per second)	August streamflow exceeded 50 percent of the time (cubic feet per second)	Urban land cover determined from NLCD [1] 2001 land cover dataset (Percent)	Impervious Cover from NLCD [1] 2001 land cover dataset (percent)
BB08	B0614	23.7	Bogastow Brook	approximately 200 meters downstream/east from Route 115 (below multiple channels downstream from Bogastow Pond), Millis MA	8/16/2007	2.1	0.9	5	27.7	8.5
ST01	B0073	10.5	Stony Brook	approx. 50 meters downstream/southeast from Church Street, Weston, MA (in both braids)	8/02/2007	2.3	0.6	2.8	23.3	4.8
ST01A	none	22.1	Stony Brook	just upstream from Stony Brook Reservoir	10/22/2007	2.77	1.41	6.3	33.9	11.4
SV01	W1590	2.21	Seaverns Brook	approximately 1100 feet downstream from Park Road, Weston	8/16/2007	3.44	0.045	0.32	32	6.7
SV01A	none	0.54	Seaverns Brook	Downstream of Shaylor Lane, Weston	8/16/2007	2.77	n/c	n/c	40.8	10.2
TB01	B0069	3.7	Trout Brook	approx. 55 meters downstream/north from Haven Street, Dover, MA	8/02/2007	2.9	0.1	0.7	14.1	3.3

[1] National Land Cover Database

n/c = Not calculated. Flow parameters for watersheds with drainage areas less than 1.61 square miles, the required minimum for USGS regression equations, were not calculated.

Table IV-2. Species and counts for fish collected during the 2007 Charles River Watershed biomonitoring survey. Refer to Appendix IV, Table 1 for a listing and description of sampling stations (values in parentheses signify young of year).

Common name	Scientific name	Tolerance[1]	Macrohabitat Classification[2]	BB08	ST01	ST01A	SV01	SV01A	TB01
American eel	*Anguilla rostrata*	T	FD		2	1			
white sucker	*Catostomus commersonii*	T	FD			1	32(5)	18(7)	12
yellow bullhead	*Ameiurus natalis*	T	MHG	20(1)					
redfin pickerel	*Esox americanus*	T	MHG	8	2				11(5)
brown trout	*Salmo trutta*	I	FD		2				
brook trout	*Salvelinus fontinalis*	I	FS		4(1)	1			36(13)
banded sunfish	*Enneacanthus obesus*	I	MHG						14
redbreast sunfish	*Lepomis auritus*	T	MHG	4					
Bluegill	*Lepomis macrochirus*	T	MHG		2(1)				
largemouth bass	*Micropterus salmoides*	T	MHG	1(1)	2(2)				2(2)
darter[3]	*Etheostoma* sp.	I or M	MHG or FS		1(1)				

1 Halliwell et al. 1999.

2 Bain and Meixler 2000.

3 swamp darter or tessellated darter (no voucher taken)

Table IV-3. Habitat assessment summary for fish population stations sampled during the 2007 Charles River Watershed survey. For instream 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.

Description	ST01[1]	ST01A	BB08	SV01	SV01A	TB01
PARAMETERS						
(range is 0-20)						
Instream Cover	16	15	17	10	16	17*
Epifaunal Substrate	18	17	17	16	17	16*
Embeddedness	13	19	13	11	16	18”
Channel Alteration	15	16	15	11	16	20
Sediment Deposition	18	19	15	16	18	13*
Velocity Depth Combinations	16	16	8	10	5	16*
Channel Flow Status	18	18	12	5	1	15*
PARAMETERS						
(range is 0-10 for each bank)						
Bank Vegetative Protection-Left Bank	10	3	10	9	8	10
Bank Vegetative Protection-Right Bank	10	2	10	9	10	10
Bank Stability-Left Bank	10	10	9	8	9	10
Bank Stability-Right Bank	10	9	6	6	9	10
Riparian Vegetative Zone Width-Left Bank	10	9	10	3	6	10
Riparian Vegetative Zone Width-Right Bank	10	9	9	5	10	10
Total	**174**	**160**	**151**	**119**	**141**	**175**

[1] Reference station-

*only in upper half of reach, lower half was more low-gradient pool/glide type habitat