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CHICOPEE RIVER WATERSHED
2008 BENTHIC MACROINVERTEBRATE BIOASSESSMENT

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INTRODUCTION

Biological monitoring is a useful means of detecting anthropogenic impacts to the aquatic community. Resident biota (e.g., benthic macroinvertebrates, fish, periphyton) in a water body are natural monitors of environmental quality and can reveal the effects of episodic and cumulative pollution and habitat alteration (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 Chicopee 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 fifteen biomonitoring stations on twelve named streams were sampled to determine the health of aquatic communities of the watershed (Figures 1-4). Table 1 presents the 2008 sampling locations, along with station identification numbers and sampling dates. Two sites along the mainstem Quaboag River were sampled, bracketing the Warren Wastewater Treatment Plant (WWTP) to determine any potential impacts to the Quaboag River from the wastewater treatment plant. Sampling rationale for the 2008 Chicopee River Watershed macroinvertebrate survey is presented in Table 2.

To provide information for making *Aquatic Life* use-support determinations, macroinvertebrate communities present at biomonitoring stations in the Chicopee River Watershed were compared with communities occurring at one of two watershed reference stations most representative of "least disturbed" conditions. The two watershed reference stations were established based on watershed size, one for sampling stations with drainage areas less than fifty square miles and one for those sampling stations with drainage areas greater than fifty square miles. The small watershed (drainage areas less than fifty square miles) reference station (EBS00) was established on the East Branch Swift River. The large watershed (watershed greater than fifty square miles) reference station (WR34) was established on the Ware River. 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 September 4th, 9th, 10th, 17th and 25th at fifteen sites in the Chicopee River Watershed (Table 1). Sampling activities were performed in accordance with the Sampling & Analysis Plan (SAP) for the Chicopee River Watershed (Reardon 2008). The sampling procedures are further described in the standard operating procedures *Water Quality Monitoring in Streams Using Aquatic Macroinvertebrates* (Nuzzo 2003), and are based on US EPA Rapid Bioassessment Protocols (RBPs) for wadeable streams and rivers (Plafkin et al. 1989). The macroinvertebrate collection procedure utilized kick-sampling, a method of sampling benthic organisms by kicking or disturbing bottom sediments and catching the dislodged organisms in a net as the current carries them downstream. Sampling was conducted by MassDEP/DWM biologists throughout a 100 m reach, in riffle/run areas with fast currents and rocky (cobble, pebble, and gravel) substrates—generally the most productive habitats, supporting the most diverse communities in the stream system. Ten kicks in squares approximately 0.46 m x 0.46 m were composited for a total sample area of about 2 m^2. Samples were labeled and preserved in the field with denatured 95% ethanol, then brought to the MassDEP/DWM lab for further processing.

Table 1. List of biomonitoring stations sampled during the 2008 Chicopee River Watershed survey including selected watershed and flow characteristics determined from USGS StreamStats (USGS 2013). 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)
BB00	B0648	1.0	Bottle Brook	approximately 210 meters upstream of the Dunhamptown Palmer Road crossing nearest the West Brimfield Palmer Road intersection, Brimfield	9/10/2008	7.0	Not Calculated	Not Calculated	4.1	0.2
CH06	B0655	690.2	Chicopee River	immediately upstream at River Street/West Street bridge, Springfield/Ludlow	9/4/2008	4.7	101.0	299.0	8.2	1.5
EBF00	B0653	5.2	East Branch Fever Brook	approximately 100 meters downstream/west from Camel Hump Road, Petersham	9/4/2008	4.9	0.4	1.6	6.2	0.4
EBS00	B0654	27.9	East Branch Swift River	immediately upstream at Glen Valley Road, Petersham	9/4/2008	4.2	1.6	7.4	5.0	0.5
EBW60	B0652	12.6	East Branch Ware River	approximately 100 meters downstream/west from Old Colony Road, Princeton	9/9/2008	4.2	0.8	3.6	6.1	0.8
FNBDN	B0107	1.3	Forget-me-not Brook	approx. 60 meters downstream/southwest from East Brookfield Road, North Brookfield, MA (downstream of North Brookfield WWTP outfall)	9/10/2008	3.9	Not Calculated	Not Calculated	28.7	8.1
JB00	B0650	7.1	Jabish Brook	approximately 100 meters downstream from Jabish Street, Belchertown	9/10/2008	3.9	0.5	2.3	9.7	1.2
QUAB-DN2	B0646	149.4	Quaboag River	east of Route 67, (upstream near USGS flow gaging station #01176000), Palmer/Brimfield (approximately 200 meters south of Warren town line).	9/25/2008	4.4	13.6	50.5	9.9	1.8
QUAB-UP	B0647	146.2	Quaboag River	immediately upstream at Gilbert Road, Warren	9/25/2008	4.2	13.0	49.0	10.0	1.8
SM00	B0642	41.1	Sevenmile River	approximately 100 meters downstream from Bridge Street, East Brookfield	9/25/2008	4.0	2.3	10.6	12.7	2.6
SMG00	B0643	9.2	Sevenmile River	approximately 100 meters downstream from Cooney Road, Spencer	9/9/2008	5.1	0.4	2.2	6.5	0.7

Table 1 (continued). List of biomonitoring stations sampled during the 2008 Chicopee River Watershed survey including selected basin and flow characteristics determining from USGS StreamStats (USGS 2013)

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)
THB01	B0651	17.3	Turkey Hill Brook	approximately 100 meters downstream/southwest from Hastings Road, Spencer	9/9/2008	3.6	0.5	3.2	10.4	1.5
TMB00	B0644	13.6	Twelvemile Brook	approximately 100 meters downstream from Crane Hill Road, Wilbraham	9/17/2008	5.5	1.2	4.6	7.9	1.0
WA09A	B0104	198.2	Ware River	approx. 120 meters downstream/west from Route 32, Ware, MA	9/4/2008	4.5	22.2	75.6	7.2	1.2
WR34	B0669	159.0	Ware River	approximately 150 meters downstream/south from Bridge Street, Hardwick	9/4/2008	4.0	15.6	57.0	6.5	1.0

Macroinvertebrate Sample Processing and Data Analysis

The macroinvertebrate sample processing and analysis procedures employed for the 2008 Chicopee 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 characteristics, 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."

Table 2. Sampling rationale for 2008 Chicopee River Watershed biomonitoring survey. Sampling rationale detailed in Chicopee River Watershed Sampling and Analysis Plan (Reardon 2008).

Station ID	Waterbody Name	Site description	Sampling Date	Sampling Rationale
BB00	Bottle Brook	approximately 210 meters upstream of the Dunhamptown Palmer Road crossing nearest the West Brimfield Palmer Road intersection, Brimfield	9/10/2008	Assess Aquatic Life Use--never sampled, high gradient stream, Massachusetts Department of Fish and Game (MA DFG) previously found Eastern Brook Trout
CH06	Chicopee River	immediately upstream at River Street/West Street bridge, Springfield/Ludlow	9/4/2008	Assess Aquatic Life Use--located in urbanized area Springfield/Ludlow
EBF00	East Branch Fever Brook	approximately 100 meters downstream/west from Camel Hump Road, Petersham	9/4/2008	Assess Aquatic Life Use--on protected Massachusetts Department of Conservation and Recreation (MA DCR) Quabbin Watershed lands
EBS00	East Branch Swift River	immediately upstream at Glen Valley Road, Petersham	9/4/2008	Reference station--small watershed stations
EBW60	East Branch Ware River	approximately 100 meters downstream/west from Old Colony Road, Princeton	9/9/2008	Assess Aquatic Life Use---on segment impaired for Organic enrichment/Low DO
FNBDN	Forget-me-not Brook	approx. 60 meters downstream/southwest from East Brookfield Road, North Brookfield, MA (downstream of North Brookfield WWTP outfall)	9/10/2008	Assess Aquatic Life Use--downstream North Brookfield WWTP, last sampled 1998
JB00	Jabish Brook	approximately 100 meters downstream from Jabish Street, Belchertown	9/10/2008	Assess Aquatic Life Use--never sampled
QUAB-DN2	Quaboag River	east of Route 67, (upstream near USGS flow gaging station #01176000), Palmer/Brimfield (approximately 200 meters south of Warren town line).	9/25/2008	Assess Aquatic Life Use--downstream Warren WWTP, last sampled 1998, located near Central Environmental Regional Office (CERO) Strategic Monitoring and Assessment for River basin Teams (SMART) sampling station
QUAB-UP	Quaboag River	immediately upstream at Gilbert Road, Warren	9/25/2008	Assess Aquatic Life Use--upstream Warren WWTP, last sampled 1998
SM00	Sevenmile River	approximately 100 meters downstream from Bridge Street, East Brookfield	9/25/2008	Assess Aquatic Life Use
SMG00	Sevenmile River	approximately 100 meters downstream from Cooney Road, Spencer	9/9/2008	Assess Aquatic Life Use--location of CERO SMART sampling station
THB01	Turkey Hill Brook	approximately 100 meters downstream/southwest from Hastings Road, Spencer	9/9/2008	Assess Aquatic Life Use--never sampled
TMB00	Twelvemile Brook	approximately 100 meters downstream from Crane Hill Road, Wilbraham	9/17/2008	Assess Aquatic Life Use--never sampled
WA09A	Ware River	approx. 120 meters downstream/west from Route 32, Ware, MA	9/4/2008	Assess Aquatic Life Use--downstream Ware WWTP, last sampled 1998
WR34	Ware River	approximately 150 meters downstream/south from Bridge Street, Hardwick	9/4/2008	Reference station--large watershed stations

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 was generally good at most of the sampled stations and most stations were comparable to their appropriate reference station (Table 3). The Jabish Brook Station (JB00) had the lowest habitat score (148). Habitat quality received low scores for embeddedness, sediment deposition, channel alteration and the right bank riparian vegetative zone width (Table 3). The Ware River Station (WA09A) received low scores for sediment deposition, frequency of riffles, channel flow status and the right bank riparian vegetative zone width.

The East Branch Fever Brook station (EBF00) received its lowest scores for instream cover for fish, channel alteration, channel flow status and frequency of riffles (Table 3). It is important to note that the East Branch Fever Brook station was located in the protected Quabbin Reservoir watershed and channel alteration noted at the sampling site was considered due to historic activity (evidence of early 20th century dam, mill and channelization).

The Chicopee River station (CH06) received a habitat score of 161 out of 200. This station received low scores for channel alteration, left bank vegetative protection and left bank riparian vegetative zone width. This station was located downstream of the Indian Orchard hydroelectric station in the city of Springfield. Although the percent imperviousness for the entire watershed area that drains to this station is low (Table 2) the local land use is highly urbanized with much higher percent imperviousness than the larger watershed. This station was located immediately downstream of a city of Springfield combined sewer overflow. Chemical and raw sewage water odors were noted at this sampling station.

The Sevenmile River station (SM00) received a habitat score of 161 out of 200. The habitat at this station scored poorly for left bank stability and right bank riparian vegetative zone width while also receiving lower marks for embeddedness, channel alteration, sediment deposition and frequency of riffles.

Taxonomic lists of the macroinvertebrate organisms collected at each sampling station during the 2008 biomonitoring survey are attached in the appendices. Included in the lists are total organism counts, the functional feeding group designation (FFG) for each macroinvertebrate taxon, and the tolerance value (TV) of each taxon.

The RBP III macroinvertebrate data analysis was conducted for sampling stations with drainage areas less than fifty square miles separately from those sampling stations with drainage areas greater than fifty square miles. Table 4 presents a summary of the RBP III macroinvertebrate data analyses for all sites with drainage areas less than fifty square miles while Table 5 presents the results of those sampling station with drainage areas greater than fifty square miles. Included are biological metric calculations,

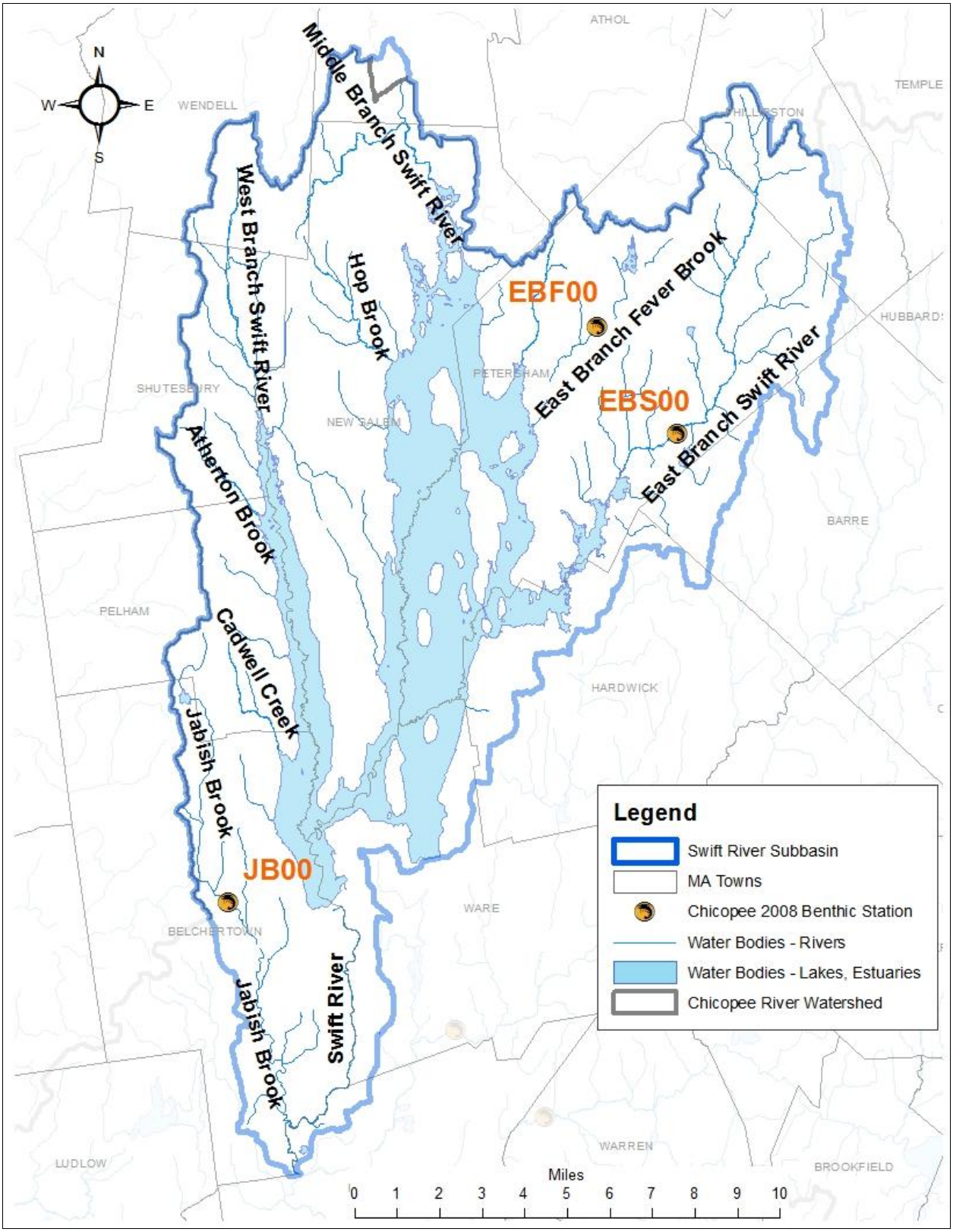

Figure 1: Chicopee River Watershed Biomonitoring Stations: Swift River Subbasin

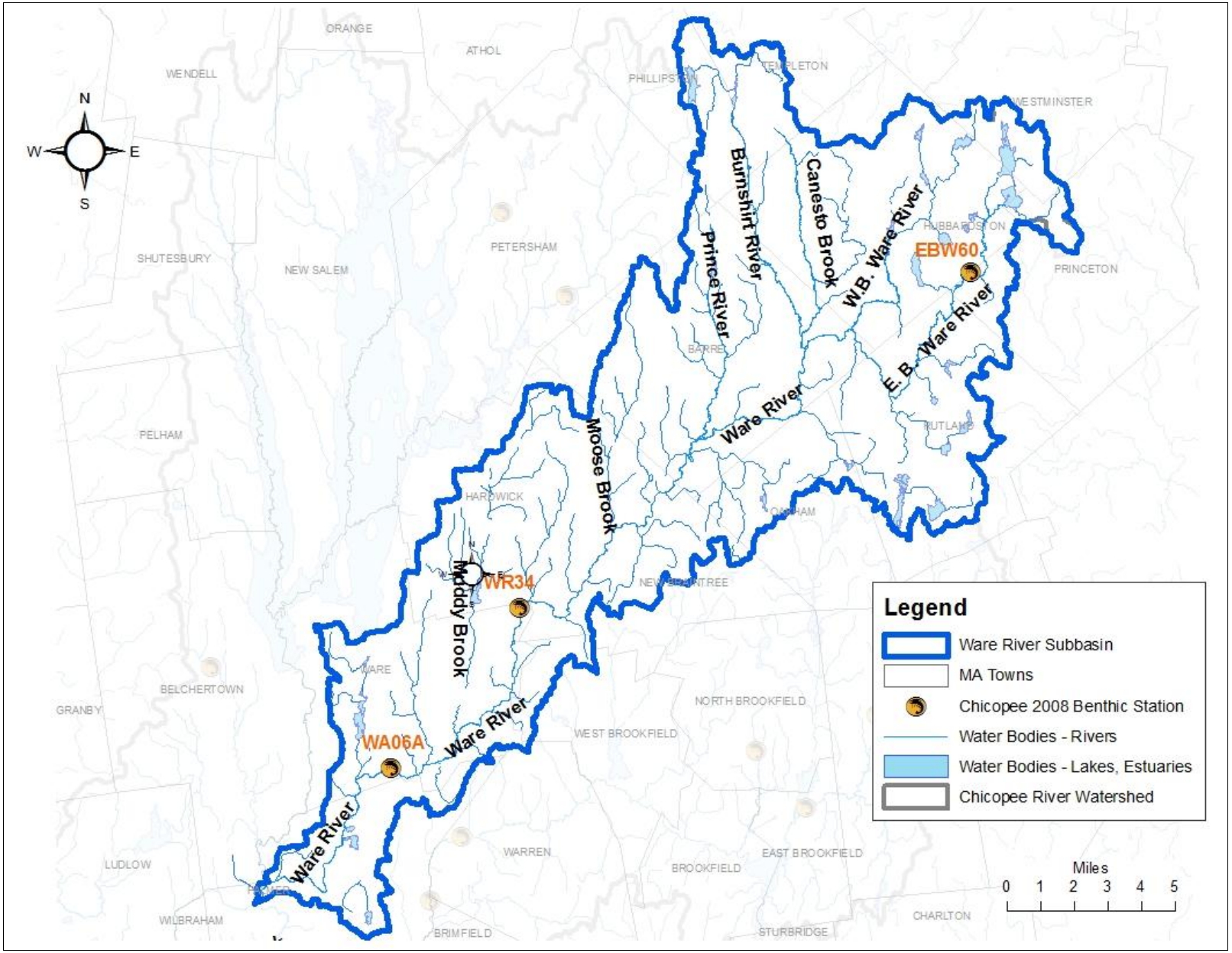

Figure 2: Chicopee River Watershed Biomonitoring Stations: Ware River Subbasin

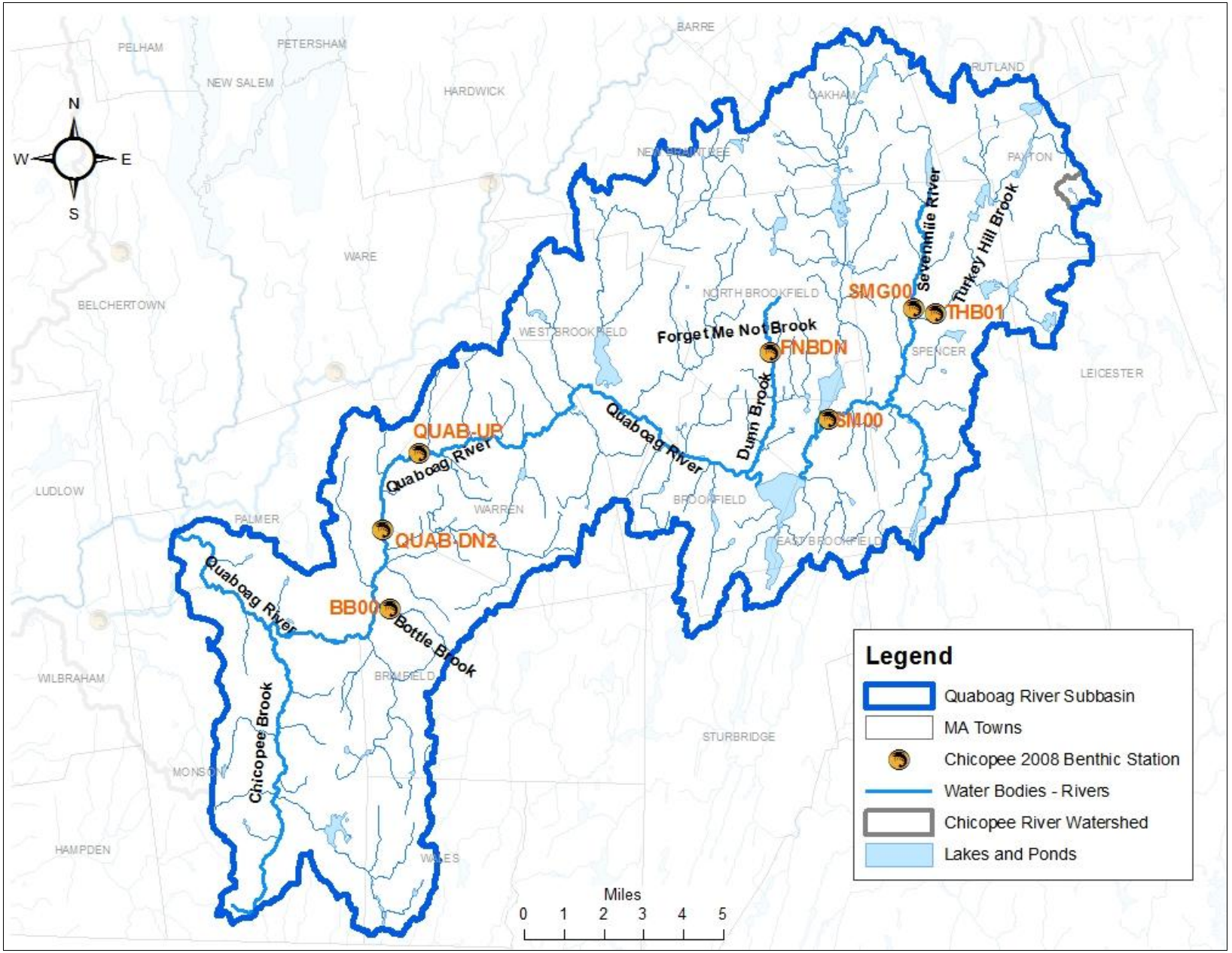

Figure 3: Chicopee River Watershed Biomonitoring Stations: Quaboag River Subbasin

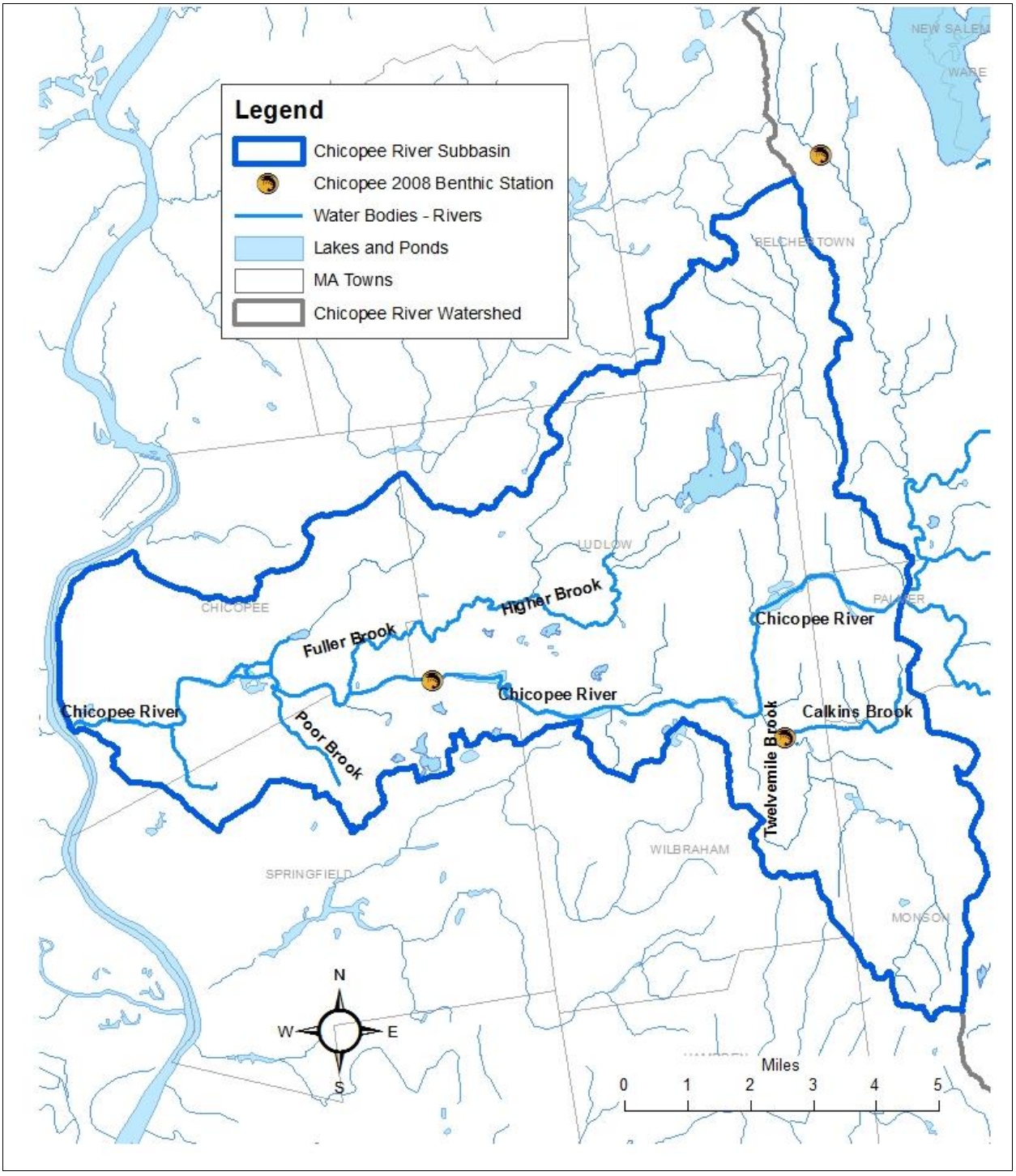

Figure 4: Chicopee River Watershed Biomonitoring Stations: Chicopee River Subbasin

metric scores, and impairment designations. In addition, the benthic communities above and below the Warren WWTP were analyzed through an upstream/downstream comparison (Table 6).

Small Watershed RBP Analysis

The benthic macroinvertebrate community at Station EBS00 (East Branch Swift River) exhibited good taxa richness, a good EPT index, and a low HBI index indicative of excellent water quality. This station had a Human Disturbance score of 2, the lowest score for all of the small watershed stations sampled (Meek 2013).

The macroinvertebrate communities present at the majority of stations in the smaller watersheds (<50 square miles) ranged from 57%-76% comparable to the East Branch Swift reference community, resulting in assessments of "slightly impacted". The small watershed reference station had an EPT index of 18 and subsequently all other stations with the exception of TMB00 in the small watershed category scored poorly when compared to the reference station for this metric.

Bottle Brook, upstream of the Dunhamptown Palmer Road crossing, Brimfield (Station BB00), was 71% comparable to the reference community, resulting in an assessment of "slightly impacted". Bottle Brook at this station is a small high-gradient, first-order stream. This station had lower metric scores for taxa richness and the EPT Index when compared to the reference station. The reduced taxa richness and EPT Index may be due the fact the stream is an oligotrophic, high-gradient stream. The majority of the macroinvertebrate community was composed of intolerant taxa and this station had the lowest biotic index of all stations sampled in 2008. The roach stonefly, *Tallaperla maria*, comprised approximately 30% of the benthic community. The Peltoperlidae (roach stoneflies) are often found in high-gradient, first-order streams with cold water temperatures.

East Branch Fever Brook, downstream/west from Camel Hump Road, Petersham (Station EBF00), was 71% comparable to the reference community resulting in an assessment of "slightly impacted". This station had lower metric scores for taxa richness, EPT Index and EPT/Chironomidae when compared to the reference station. The Chironomidae made up approximately 36% of the benthic community. The MA DCR has documented pH less than 6.0 at their East Branch Fever Brook sampling station (MA DCR 2006). The MA DCR has also measured summertime daytime dissolved oxygen values that ranged from 4.74 to 7.78 mg/L (MA DCR 2006). This sampling station was noted to be downstream of the site of a historic dam and mill. The channelization of the sampled reach appears to be due to this historic activity. A large wetland area is also located approximately 0.25 miles upstream. Given that the watershed upstream of the East Branch Fever Brook station is largely protected by MA DCR and exhibits low impervious cover (Table 1), the benthic community is largely structured in response to the presence of upstream wetlands and associated low oxygen values.

East Branch Ware River (EBW60) was 71% comparable to the reference station and considered "slightly impacted". The macroinvertebrate community had lower metric scores for tax richness, EPT Index and EPT/Chironomidae when compared to the reference station. Similar to the East Branch Fever Brook station, 30% of the benthic community was made up of Chironomidae. Sampling data collected by DWM in 2008 indicate adequate water quality conditions (Reardon 2013). The habitat metric scores were also comparable to the reference. The habitat metrics at this site generally scored well with the exception of riparian zone width which scored poorly on one bank.

Forget-me-not Brook downstream of North Brookfield WWTP (Station FNBDN), when compared to the watershed reference station (EBS00), was considered "slightly impacted". The site had an elevated HBI score and a low taxa richness and EPT Index. Approximately 40% of the community at this station consisted of filtering-collector taxa, which indicates a community structured in response to high loading of particulates. This fact, combined with the lowered richness and higher HBI score, indicates organic enrichment. When last sampled in 1998, filter-feeders composed 76% of the sample (Fiorentino 1999). Although the most recent sampling shows a reduction in the hyperdominance of filter feeders, this station continues to show an unbalanced benthic community.

Jabish Brook, downstream from Jabish Street, Belchertown (JB00), was considered "slightly impacted". The macroinvertebrate community had lower metric scores for EPT Index and EPT/Chironomidae when compared to the reference station. This station received the lowest habitat score of all stations sampled. Nonpoint sources impacts appear to be affecting stream habitat at this site but the benthic community was still considered only "slightly impacted" when compared to the reference station.

The Sevenmile River downstream of Cooney Road, Spencer (Station SMG00) was considered "slightly impacted" when compared to the reference station (EBS00). The benthic community was composed of approximately 54% filtering-collector taxa, largely hydropsychid caddisflies. The community composition may be explained by an impoundment of the Sevenmile River approximately 0.5 miles upstream of the sampling station. Flow alteration due to a construction company's withdrawal upstream of this station has also been noted as a concern. Water quality samples collected at this station are indicative of good water quality conditions (Reardon 2013) and habitat quality at this station was comparable to the reference station.

The Sevenmile River, downstream from Bridge Street, East Brookfield (SM00), was 81% comparable to the reference community resulting in an assessment of "not/slightly impacted". This station had lower metric scores for EPT Index, taxa richness and a higher biotic index when compared to the reference station. Although it scored low for the EPT Index, it should be noted that 14 EPT taxa were found and the majority of taxa had low tolerance values.

Turkey Hill Brook, upstream of Wire Village Rd., Spencer (Station THB01), was considered "slightly impacted" when compared to the reference station (EBS00). The benthic community was composed of approximately 60% filtering-collector taxa, principally the filter-feeding caddisfly, *Cheumatopsyche sp.* and the fingernet caddisfly, *Chimarra aterrima*. The predominance of filtering-collector taxa is likely due to the location of Turkey Hill Brook, whose headwaters are the Sudgen Reservoir. The water quality samples collected in 2008 are not indicative of adverse conditions (Reardon 2013) and the habitat quality was comparable to the reference station.

Twelvemile Brook, downstream from Crane Hill Road, Wilbraham (Station TMB00), was considered "non-impacted" when compared to the reference station. This station had a similar number of EPT taxa as the reference station. The habitat metrics at this site generally scored well with the exception of sediment deposition. Excellent water quality conditions were documented at this site in 2008 (Reardon 2013).

Large Watershed RBP Analysis

The Ware River, downstream from Bridge Street, Hardwick (Station WR34), received a total metric score of 38 and was designated the reference station for sampling stations with watershed size greater than fifty square miles. This station had good taxa richness and a number of EPT taxa, although the percent dominant taxon was high for a reference station. This station was composed of 38% Elmidae, primarily the riffle beetle *Stenelmis* sp*.* The riffle beetle is in the scraper functional feeding group and scraper taxa made up forty-six percent of the benthic community at this station. Riffle beetles are often found in fast flowing areas with high dissolved oxygen. Average dissolved oxygen measured at this station during unattended multiprobe deployments ranged from 7.6 mg/L to 8.5 mg/L, while dissolved oxygen concentration showed little diel variation (Reardon 2013). The Ware River is impounded at numerous locations upstream of the sampling station but the Ware River in Gilbertville near the sampling station has more gradient and more riffles, providing reaeration of the water. Fast flows were noted on the day of sampling.

The second most prevalent taxon at the Ware River station downstream from Bridge Street, Hardwick was the small minnow mayfly *Baetis intercalaris.* This taxon is a member of a more pollution-tolerant, mayfly family. The Ware River station WR34 received the highest habitat score of the large watershed stations (Table 5). The habitat metrics at this site generally scored well, with the exception of riparian zone width and left bank vegetative protection, which scored in the suboptimal range on one bank. The sampled reach was channelized with riprap on both banks, likely to protect the sewer infrastructure that runs along one bank, but this channelization was not recent. Although the Ware River benthic station WR34 represents the best available conditions for large watershed RBP analysis, given the percent

dominance values, moderately pollution-tolerant taxa and high percent scrapers, the benthic community seems to reflect some impacts. The benthic community is likely structured in response to habitat, fast and well oxygenated flows, and productivity from upstream impoundments.

The Chicopee River, upstream at River Street/West Street bridge, Springfield/Ludlow (Station CH06), was considered "not impacted" when compared to the reference station (WR34). The macroinvertebrate community had lower metric scores for taxa richness and scraper/filterer when compared to the reference station. Approximately 53% of the benthic community at this station was composed of filtering-collector taxa. Fingernail clams, Pisidiidae, were the most prevalent taxon, making up approximately 23% of the community. The high percentage of filterering-collector taxa is logical given the benthic station's location just downstream of the Indian Orchard Impoundment. Eighty percent of the benthic community had pollution tolerance scores between 4-6.

The habitat metrics all scored in the optimal category with the exception of left bank vegetative protection and right bank riparian vegetative zone width. Average dissolved oxygen measured at this station during unattended multiprobe deployments ranged from 7.1 mg/L to 8.4 mg/L (Reardon 2013). The organic substrate components at this station were approximately 70% detritus and 30% black, very fine organics. The black fine organics were very noticeable at this site and may be due to the upstream impoundment or impacts due to the nearby combined sewer overflow. The benthic community appears structured in response to upstream nutrient/organic enrichment.

The Quaboag River, east of Route 67, (upstream near USGS flow gaging station #01176000), Palmer/Brimfield (QUAB-DN2), was considered "not impacted" when compared to the large watershed reference station (WR34). The benthic community at this station scored higher than the reference station on the taxa richness and EPT index metrics. Approximately twenty percent of the benthic community had pollution tolerance scores between 0-3 while eighty percent had pollution tolerance scores between 4-6. The percent dominant taxon metric was only 9% for this station and indicates a very evenly distributed assemblage.

Average dissolved oxygen values measured at the nearby water quality station (QRG) during unattended multiprobe deployments ranged from 7.5 mg/L to 8.1 mg/L (Reardon 2013). Instream temperatures up to 28.7 degrees Celsius have been documented in the Quaboag River (Reardon, 2013). Despite these high temperatures, Perlidae were found at the benthic station, although their presence may be due to drift. Overall the benthic data indicate a healthy aquatic community.

The Quaboag River, immediately upstream at Gilbert Road, Warren (QUAB-UP), was considered "not impacted" when compared to the large watershed reference station (WR34). With the exception of the scraper/filterer ratio and Reference Affinity metrics, all metrics scored well when compared to the reference station. This station had the best EPT Index metric score of all the large watershed stations. The percent filterering-collector taxa at this station was slightly higher than the downstream Quaboag River station (QUAB-DN2). Approximately seventeen percent of the benthic community had pollution tolerance scores between 0-3 while around eighty percent had pollution tolerance scores between 4-6. This benthic station was also characterized by an evenly distributed assemblage. Filtering-collector taxa made up approximately forty-seven percent of the assemblage, primarily made up of the common netspinner caddisflies, Hydropsychidae. This may be due to the station's location approximately 0.6 miles downstream from the old Hardwick Knitter's factory impoundment.

Dissolved oxygen values at the nearby water quality station (Station QA06A) all met the warmwater criterion (Reardon 2013). Station QUAB-UP received a habitat metric score of 172. Most habitat metrics at this site generally scored within the optimal category. However, the instream cover for fish, frequency of riffles and right bank riparian vegetative zone width scored within the suboptimal category while the left bank riparian vegetative zone width scored in the marginal category. Although the high percent of filter feeders in the benthic community suggests some organic enrichment, the benthic assemblage was considered not impacted when compared to the reference station.

The Ware River, approximately 120 meters downstream/west from Route 32, Ware, MA (WA09A), was considered "not impacted" when compared to the large watershed reference station. The Ware River

station received a total metric score of 38, the same as that of the large watershed reference station. Station WA09A scored well for all metrics with the exception of percent dominant taxon and scraper/filterer. This station had a better EPT Index than the reference station. The percent filterer-collector taxa in the benthic community (approximately 36%) was greater than in the reference station and this explains the lower scraper/filter metric score. The filterer-collector taxa were primarily composed of Hydropsychidae and Philopotamidae. The most abundant family in the assemblage was Elmidae, made up of the algal scraping *Stenelmis crenata* and *Optioservus* sp.

The benthic community in the Ware River at Station WA09A was generally intolerant of pollution. Approximately thirty percent of the benthic community had pollution tolerance scores between 0-3 while sixty-three percent had pollution tolerance scores from 4-6. This station received a habitat metric score of 158. Approximately half of the habitat metrics at this site scored within the optimal category. Embeddedness, sediment deposition, frequency of riffles, channel flow status and left bank stability scored in the suboptimal category. Right bank vegetative zone width scored in the marginal category. Average dissolved oxygen concentrations (defined as the average of the 24-hour-daily means for a >1 day deployment) measured at this station during unattended multiprobe deployments ranged from 7.4 mg/L to 8.8 mg/L with pronounced diel shifts on two occasions (Reardon 2013). Significant supersaturation was also seen on one occasion (Reardon 2013). Seventy-five percent algae coverage and significant moss coverage was noted in the sampled reach. The presence of the scraper taxa and the diel dissolved oxygen shifts indicate a productive environment. The benthic assemblage was approximately evenly divided between scraper taxa and filtering-collector taxa. This suggests that the benthic community is responding to both the algae and suspended food sources.

Upstream/Downstream Warren WWTP RBP Analysis

Table 6 presents the RBP analysis of benthic communities at a station above the Warren WWTP (Station QUAB-UP) and below the treatment plant (Station QUAB-DN2). The downstream sampling location was considered “not impacted/slightly impacted” when compared to the upstream reference site. The upstream and downstream stations were very similar in terms of the taxa that made up the benthic community at each location, although the downstream station had greater taxa richness. Similar to sampling results in 1998 (Fiorentino 1999), there appears to be no additive detrimental effect from the Warren WWTP discharge.

Table 3. Habitat assessment summary for biomonitoring stations sampled during the 2008 Chicopee River Watershed survey. For within-reach 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 Table 1 for a listing and description of sampling stations.

Description	BB00	CH06	EBF00	EBS00[1]	EBW60	FNBDN	JB00	QUAB-DN2	QUAB-UP	SM00	SMG00	THB01	TMB00	WA09A	WR34[2]
INSTREAM PARAMETERS	SCORE														
(range is 0-20)															
Instream Cover	19	18	13	18	19	17	13	14	14	18	17	18	18	16	19
Epifaunal Substrate	20	17	18	19	19	18	18	17	19	18	18	19	19	18	20
Embeddedness	19	17	18	19	20	18	13	17	17	15	16	17	16	15	19
Channel Alteration	20	11	15	20	19	20	13	20	18	15	19	17	19	19	16
Sediment Deposition	17	19	19	19	20	16	11	18	19	15	16	17	10	13	19
Frequency of Riffles	17	18	15	15	18	15	14	10	15	15	18	16	18	14	18
Channel Flow Status	20	19	10	15	20	20	20	20	20	19	20	20	20	14	17
BANK AND RIPARIAN ZONE PARAMETERS	SCORE														
(range is 0-10 for each bank															
Bank Vegetative Protection-Left Bank	10	2	10	10	10	9	10	10	9	8	10	10	10	10	8
Bank Vegetative Protection-Right Bank	10	10	10	10	10	9	8	10	10	10	10	10	10	9	10
Bank Stability-Left Bank	9	10	10	10	8	9	8	10	10	6	7	9	8	7	10
Bank Stability-Right Bank	9	9	10	10	8	9	7	10	10	9	10	9	9	9	10
Riparian Vegetative Zone Width-Left Bank	10	2	10	9	6	8	7	10	4	10	10	9	8	10	9
Riparian Vegetative Zone Width-Right Bank	8	9	10	10	8	10	6	10	7	3	10	9	9	4	7
Total	**188**	**161**	**168**	**184**	**185**	**178**	**148**	**176**	**172**	**161**	**181**	**180**	**174**	**158**	**182**

[1] Reference station- for all stations and stations with drainage area less than 50 square miles
[2] Reference station- for stations with drainage area greater than 50 square miles

Table 4. Summary of RBP III analysis of macroinvertebrate communities sampled during the 2008 Chicopee River Watershed survey (Drainage Area<50 square miles). Shown are the calculated metric values, metric scores (in italics) based on comparability to the reference station (EBS00- East Branch Swift River). Refer to Table 1 for a listing and description of sampling stations.

SAMPLING STATION	**BB00**		**EBF00**		**EBS00**[1]		**EBW60**		**FNBDN**		**JB00**		**SM00**		**SMG00**		**THB01**		**TMB00**	
STREAM	Bottle Brook		East Branch Fever Brook		East Branch Swift River		East Branch Ware River		Forget-me-not Brook		Jabish Brook		Sevenmile River		Sevenmile River		Turkey Hill Brook		Twelvemile Brook	
HABITAT SCORE	188		168		184		185		178		148		161		181		180		174	
TAXA RICHNESS	28	*4*	29	*4*	37	*6*	29	*4*	15	*2*	33	*6*	29	*4*	24	*4*	29	*4*	33	*6*
BIOTIC INDEX	2.52	*6*	4.02	*6*	3.63	*6*	3.84	*6*	5.39	*2*	3.68	*6*	4.37	*4*	4.27	*4*	3.78	*6*	4.07	*6*
EPT INDEX	9	*0*	12	*0*	18	*6*	7	*0*	5	*0*	12	*0*	14	*2*	12	*0*	14	*2*	19	*6*
EPT/CHIRONOMIDAE	2.26	*4*	1.19	*2*	3.47	*6*	1.10	*2*	5.09	*6*	1.37	*2*	4.91	*6*	4.12	*6*	4.53	*6*	15.25	*6*
SCRAPER/FILTERER	0.61	*6*	0.40	*6*	0.64	*6*	0.75	*6*	0.72	*6*	1.39	*6*	0.74	*6*	0.23	*4*	0.07	*0*	0.56	*6*
REFERENCE AFFINITY	0.21	*6*	73%	*6*	100%	*6*	69%	*6*	62%	*4*	73%	*6*	73%	*6*	77%	*6*	77%	*6*	68%	*6*
% DOMINANT TAXON	27%	*4*	11%	*6*	8%	*6*	13%	*6*	25%	*4*	9%	*6*	13%	*6*	30%	*2*	23%	*4*	10%	*6*
TOTAL METRIC SCORE	30		30		42		30		24		32		34		26		28		42	
% COMPARABILITY TO REFERENCE	71%		71%		100%		71%		57%		76%		81%		62%		67%		100%	
BIOLOGICAL CONDITION -DEGREE IMPACTED	Slightly impacted		Slightly impacted		Reference		Slightly impacted		Slightly impacted		Slightly impacted		Not/Slightly impacted		Slightly impacted		Slightly impacted		Not impacted	

[1] Reference station

Table 5. Summary of RBP III analysis of macroinvertebrate communities sampled during the 2008 Chicopee River Watershed survey (Drainage Area>50 square miles). Shown are the calculated metric values, metric scores (in italics) based on comparability to the reference station (WR34 - Ware River). Refer to Table 1 for a listing and description of sampling stations.

SAMPLING STATION	**WR34**[1]		**WA09A**		**CH06**		**QUAB-UP**		**QUAB-DN2**	
STREAM	Ware River		Ware River		Chicopee River		Quaboag River		Quaboag River	
HABITAT SCORE	182		158		161		172		176	
TAXA RICHNESS	30	*6*	25	*6*	19	*4*	29	*6*	38	*6*
BIOTIC INDEX	4.46	*6*	3.70	*6*	4.47	*6*	4.39	*6*	4.41	*6*
EPT INDEX	11	*6*	15	*6*	11	*6*	18	*6*	16	*6*
EPT/CHIRONOMIDAE	2.24	*6*	19.67	*6*	NA	*6**	16.50	*6*	7.25	*6*
SCRAPER/FILTERER	2.56	*6*	1.22	*4*	0.53	*2*	0.69	*2*	0.32	*0*
REFERENCE AFFINITY	100%	*6*	77%	*6*	61%	*4*	64%	*4*	61%	*4*
% DOMINANT TAXON	33%	*2*	24%	*4*	23%	*4*	14%	*6*	9%	*6*
TOTAL METRIC SCORE	38		38		32		36		34	
% COMPARABILITY TO REFERENCE	100%		100%		84%		95%		89%	
BIOLOGICAL CONDITION -DEGREE IMPACTED	Reference		Not impacted		Not impacted		Not impacted		Not impacted	

[1] Reference station
* per Nuzzo (2013)—EPT abundance far outnumbered Chironomidae (0 in subsample)

Table 6. Summary of RBP III analysis of macroinvertebrate communities sampled during the 2008 Chicopee River Watershed survey (above and below Warren WWTP). Shown are the calculated metric values, metric scores (in italics) based on comparability to the reference station (QUAB-UP, Quaboag River). Refer to Table 1 for a listing and description of sampling stations.

SAMPLING STATION	**QUAB-UP**[1]		**QUAB-DN2**	
STREAM	Quaboag River		Quaboag River	
HABITAT SCORE	172		176	
TAXA RICHNESS	29	*6*	38	*6*
BIOTIC INDEX	4.39	*6*	4.41	*6*
EPT INDEX	18	*6*	16	*4*
EPT/CHIRONOMIDAE	16.50	*6*	7.25	*2*
SCRAPER/FILTERER	0.69	*6*	0.32	*4*
REFERENCE AFFINITY	64%	*6*	61%	*6*
% DOMINANT TAXON	14%	*6*	9%	*6*
TOTAL METRIC SCORE	42		34	
% COMPARABILITY TO REFERENCE	100%		81%	
BIOLOGICAL CONDITION -DEGREE IMPACTED	Not impacted		Not/slightly impacted	

[1] Reference station

SUMMARY

Sampling of the benthic macroinvertebrate community was carried out in September 2008 at fifteen sites in the Chicopee 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 Bioassessment Protocols.

None of the benthic sampling stations were considered worse than "slightly impacted" when compared to their appropriate reference station. The Forget-me-not Brook sampling station (FNBDN) has shown improvement since its last sampling in 1998 but still reflects some impacts. The sampling station was on a segment of Forget-me-not Brook that is currently on the Integrated List of Waters in Category 5- "Waters Requiring a TMDL". The current benthic community composition does not support removal of the "organic enrichment/low DO" source of impairment.

The Chicopee River station (CH06) appeared structured in response to nutrient/organic enrichment. Any future studies in the Chicopee River should also quantify the benthic invertebrate densities. The benthic invertebrate densities when compared to a reference station could be used to ascertain relative productivity. Visual inspection of the sampling net during fieldwork suggested high invertebrate densities at this station.

The majority of waterbodies sampled showed no or slight impact when compared to their respective reference stations. The East Branch Swift River supported a diverse macroinvertebrate community composed of many pollution-intolerant taxa. Given the low Human Disturbance Index at this station, it is an excellent candidate for further use as a reference station.

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APPENDIX I: Macroinvertebrate Taxa List (small watershed stations)

Species-level taxa list and counts, functional feeding groups (FG), and tolerance values (TV) for macroinvertebrates collected from stream sites during the 2008 Chicopee River Watershed survey for small watershed sampling stations (drainage area less than fifty square miles). Refer to Table 1 for a listing and description of sampling stations.

Family	Final Identification	Sampling Sites											
		FFG[1]	TolVal[2]	BB00	EBW60	EBF00	EBS00[3]	FNBDN	JB00	SM00	SMG00	THB01	TMB00
Planorbidae	*Armiger crista*	SC	8										1
Pisidiidae	Pisidiidae	FC	6		7	9	2						
Enchytraeidae	Enchytraeidae	GC	10					1					
Lumbriculidae	Lumbriculidae	GC	7	1		3		4	6		4	4	1
Gammaridae	*Gammarus* sp.	GC	6							1			
Sperchonidae	*Sperchonopsis* sp.	PR	6	1									
Baetidae	Baetidae	GC	4				5						
Baetidae	*Baetis* sp.	GC	6	3			4				2		1
Baetidae	*Baetis flavistriga*	GC	4				1	8		1	1		
Baetidae	*Baetis intercalaris*	GC	6							1			
Baetidae	*Iswaeon anoka*	SC	2							3			
Baetidae	*Plauditus* sp.	GC	4				5		2			1	2
Ephemerellidae	Ephemerellidae	GC	1										1
Ephemerellidae	*Ephemerella* sp.	GC	1						1			3	
Ephemerellidae	*Ephemerella subvaria*	GC	1						3	1	3	2	2
Ephemerellidae	*Eurylophella* sp.	GC	2		2								1
Ephemerellidae	*Teloganopsis deficiens*	GC	2	1		1					1	1	4
Heptageniidae	Heptageniidae	SC	4				1	1			2		1
Heptageniidae	*Epeorus* sp.	SC	0				1						
Heptageniidae	*Maccaffertium* sp.	SC	3		7	10	2	3	6	1	7	3	
Heptageniidae	*Maccaffertium modestum*	SC	1						3				
Heptageniidae	*Maccaffertium vicarium*	SC	2			1							
Isonychiidae	*Isonychia* sp.	FC	2				1					4	
Isonychiidae	*Isonychia bicolor*	FC	2										2
Leptophlebiidae	*Habrophlebia vibrans*	GC	4		1								
Leptophlebiidae	*Paraleptophlebia* sp.	GC	1		6		5		1				
Calopterygidae	Calopterygidae	PR	5						1				
Gomphidae	Gomphidae	PR	5		1								
Gomphidae	*Ophiogomphus* sp.	PR	1				1						
Chloroperlidae	*Alloperla* sp.	GC	0				1					1	

Family	Final Identification	Sampling Sites											
		FFG[1]	TolVal[2]	BB00	EBW60	EBF00	EBS00[3]	FNBDN	JB00	SM00	SMG00	THB01	TMB00
Chloroperlidae	*Sweltsa* sp.	PR	0	1									
Leuctridae	*Leuctra* sp.	SH	0			2			2				
Peltoperlidae	*Tallaperla maria*	SH	0	29									
Perlidae	*Acroneuria* sp.	PR	0						1				
Perlidae	*Acroneuria abnormis*	PR	0		2	1	8				3	3	
Perlidae	*Paragnetina* sp.	PR	1			2							
Perlidae	*Paragnetina immarginata*	PR	1				1						
Perlidae	*Paragnetina media*	PR	5			1				5	2	2	2
Taeniopterygidae	*Taeniopteryx* sp.	SH	2							4			1
Corydalidae	*Corydalus cornutus*	PR	4							1			
Corydalidae	*Nigronia serricornis*	PR	0	6	5	7			3	5	3	6	1
Sialidae	*Sialis* sp.	PR	4			1							
Apataniidae	*Apatania* sp.	SC	3										1
Brachycentridae	*Brachycentrus appalachia*	FC	0				2						
Brachycentridae	*Brachycentrus numerosus*	FC	1		1								
Brachycentridae	*Micrasema* sp.	SH	2				1						2
Glossosomatidae	*Glossosoma* sp.	SC	0					1			1		1
Helicopsychidae	*Helicopsyche borealis*	SC	3				6						
Hydropsychidae	Hydropsychidae	FC	4	1				1					
Hydropsychidae	*Cheumatopsyche* sp.	FC	5		4		4	12	7	14	30	23	7
Hydropsychidae	*Diplectrona modesta*	FC	0	4									
Hydropsychidae	*Hydropsyche* sp.	FC	4	1				5		3	1	1	2
Hydropsychidae	*Hydropsyche betteni*	FC	7		5			25		3	1		5
Hydropsychidae	*Hydropsyche bronta*	FC	6				1			1			4
Hydropsychidae	*Hydropsyche morosa*	FC	6									1	
Hydropsychidae	*Hydropsyche morosa* gr.	FC	6				7						
Hydropsychidae	*Hydropsyche sparna*	FC	6		1	2	1		1	1	1	1	6
Hydropsychidae	*Macrostemum* sp.	FC	3							2	1		
Lepidostomatidae	*Lepidostoma* sp.	SH	1	1	1				1				
Leptoceridae	*Mystacides sepulchralis*	GC	4						1				
Leptoceridae	*Oecetis* sp.	PR	5		1		1						
Philopotamidae	Philopotamidae	FC	3				1						2
Philopotamidae	*Chimarra* sp.	FC	4							1			
Philopotamidae	*Chimarra aterrima*	FC	4		12	13	5			2	14	19	8
Philopotamidae	*Chimarra obscura*	FC	4							11			
Philopotamidae	*Dolophilodes* sp.	FC	0	7			2		7			2	3

Family	Final Identification	Sampling Sites											
		FFG[1]	TolVal[2]	BB00	EBW60	EBF00	EBS00[3]	FNBDN	JB00	SM00	SMG00	THB01	TMB00
Rhyacophilidae	*Rhyacophila* sp.	PR	1									1	
Rhyacophilidae	*Rhyacophila minor*	PR	1	4					1				3
Elmidae	Elmidae	SC	4	2					2	2	1		3
Elmidae	*Dubiraphia* sp.	GC	6							1			
Elmidae	*Macronychus glabratus*	SH	5									1	
Elmidae	*Optioservus* sp.	SC	4				1			2		1	3
Elmidae	*Optioservus ovalis*	SC	4					7	1				1
Elmidae	*Optioservus trivittatus*	SC	4										1
Elmidae	*Oulimnius latiusculus*	SC	4	3			1	1	3	5			8
Elmidae	*Promoresia tardella*	SC	2	4		7			5	1			4
Elmidae	*Stenelmis* sp.	SC	5		5	3							
Elmidae	*Stenelmis crenata*	SC	5	3			1	15	2	10			3
Psephenidae	*Ectopria nervosa*	SC	5	2			2	3	1		1		1
Psephenidae	*Psephenus herricki*	SC	4			3	3		2	7			
Ceratopogonidae	*Bezzia/Palpomyia* sp.	PR	6		3		1		1				
Chironomidae	Chironomini	GC	6	1									
Chironomidae	*Microtendipes pedellus* gr.	FC	6	2					1				
Chironomidae	*Microtendipes rydalensis* gr.	FC	6								2		
Chironomidae	*Nilothauma* sp.	GC	6		1								
Chironomidae	*Polypedilum aviceps*	SH	4	3	2	3	7		9		6	4	
Chironomidae	*Polypedilum flavum*	SH	6					9					
Chironomidae	*Polypedilum illinoense* gr.	SH	6	1									
Chironomidae	*Micropsectra* sp.	GC	7	1	4	4			9			1	
Chironomidae	*Rheotanytarsus exiguus* gr.	FC	6									1	
Chironomidae	*Rheotanytarsus pellucidus*	FC	5			1				1	1	1	
Chironomidae	*Stempellinella* sp.	GC	2		4	3							
Chironomidae	*Sublettea coffmani*	FC	4				1					2	
Chironomidae	*Tanytarsus* sp.	FC	6			6							
Chironomidae	*Brillia* sp.	SH	5					1			1		
Chironomidae	*Corynoneura* sp.	GC	4		1				2				
Chironomidae	*Cricotopus* sp.	SH	7				1						
Chironomidae	*Cricotopus/Orthocladius* sp.	GC	7				1			8			
Chironomidae	*Diplocladius cultriger*	GC	8	3							1		
Chironomidae	*Eukiefferiella* sp.	GC	6				1						
Chironomidae	*Eukiefferiella brehmi* gr.	GC	4	5									
Chironomidae	*Eukiefferiella devonica* gr.	GC	4							1			

Family	Final Identification	Sampling Sites											
		FFG[1]	TolVal[2]	BB00	EBW60	EBF00	EBS00[3]	FNBDN	JB00	SM00	SMG00	THB01	TMB00
Chironomidae	*Eukiefferiella pseudomontana* gr.	GC	8										1
Chironomidae	*Limnophyes* sp.	GC	8						1				
Chironomidae	*Nanocladius* sp.	GC	7										1
Chironomidae	*Nanocladius branchicolus*	GC	3			4							
Chironomidae	*Orthocladius dubitatus*	GC	6				1						
Chironomidae	*Parachaetocladius* sp.	GC	2	1	10	2	3		1				
Chironomidae	*Parametriocnemus* sp.	GC	5	3	4	1						2	
Chironomidae	*Rheocricotopus* sp.	GC	6			1							
Chironomidae	*Thienemanniella* sp.	GC	6		2				1				
Chironomidae	*Tvetenia paucunca*	GC	5		1	1		1	3	1	6	2	2
Chironomidae	*Tvetenia vitracies*	GC	5				4					1	
Chironomidae	*Thienemannimyia* gr.	PR	6	3	7	4						1	
Empididae	Empididae	PR	6						1				
Empididae	*Clinocera* sp.	PR	6	1									
Empididae	*Hemerodromia* sp.	PR	6		5	1	3			2	1		
Simuliidae	*Simulium* sp.	FC	5	8		1	1		2	3	2	3	10
Simuliidae	*Simulium verecundum* cplx.	FC	5										1
Tipulidae	*Antocha* sp.	GC	3										1
Tipulidae	*Dicranota* sp.	PR	3	1	2	1	1		7			1	
Tipulidae	*Hexatoma* sp.	PR	2			1	1						
Tipulidae	*Tipula* sp.	SH	6					1					
Totals				107	100	107	103	99	101	105	99	99	104

[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 II: Macroinvertebrate Taxa List (large watershed stations)

Species-level taxa list and counts, functional feeding groups (FG), and tolerance values (TV) for macroinvertebrates collected from stream sites during the 2008 Chicopee River Watershed survey for small watershed sampling stations (drainage area less than fifty square miles). Refer to Table 1 for a listing and description of sampling stations.

Family	Final Identification	FFG[1]	TolVal[2]	Sampling Sites				
				CH06	QUAB-UP	QUAB-DN2	WA09A	WR34[3]
Ancylidae	*Ferrissia* sp.	SC	6		1	2	1	
Pisidiidae	Pisidiidae	FC	6	23		2		1
Lumbriculidae	Lumbriculidae	GC	7	3	2	1		
Gammaridae	*Gammarus* sp.	GC	6			1		
Baetidae	Baetidae	GC	4	2	1	2	2	
Baetidae	*Acentrella turbida*	GC	4			2	2	
Baetidae	*Baetis* sp.	GC	6	1		4		
Baetidae	*Baetis flavistriga*	GC	4	7	1		1	
Baetidae	*Baetis intercalaris*	GC	6	2	2			11
Baetidae	*Heterocloeon curiosum*	GC	2		3		6	
Baetidae	*Iswaeon anoka*	SC	2	1				
Baetidae	*Plauditus* sp.	GC	4		1	1		
Ephemerellidae	*Ephemerella* sp.	GC	1	4		2	3	2
Ephemerellidae	*Ephemerella subvaria*	GC	1		2	1		1
Ephemerellidae	*Teloganopsis deficiens*	GC	2		1			
Heptageniidae	Heptageniidae	SC	4		2	1	4	2
Heptageniidae	*Epeorus* sp.	SC	0					2
Heptageniidae	*Maccaffertium* sp.	SC	3	3	5	1	2	3
Heptageniidae	*Maccaffertium modestum*	SC	1			1		1
Heptageniidae	*Maccaffertium vicarium*	SC	2					1
Isonychiidae	*Isonychia bicolor*	FC	2		1	1		
Coenagrionidae	*Argia* sp.	PR	6			1		
Gomphidae	Gomphidae	PR	5		1			
Perlidae	Perlidae	PR	1					1
Perlidae	*Acroneuria abnormis*	PR	0			5	3	1
Perlidae	*Neoperla* sp.	PR	3					2
Perlidae	*Paragnetina* sp.	PR	1		1			
Perlodidae	Perlodidae	PR	2				1	
Taeniopterygidae	*Taeniopteryx* sp.	SH	2		1			

Family	Final Identification	FFG[1]	TolVal[2]	Sampling Sites				
				CH06	QUAB-UP	QUAB-DN2	WA09A	WR34[3]
Corydalidae	*Corydalus cornutus*	PR	4			1	1	2
Corydalidae	*Nigronia serricornis*	PR	0			1		
Apataniidae	*Apatania* sp.	SC	3		1			
Brachycentridae	*Brachycentrus numerosus*	FC	1	1				
Brachycentridae	*Micrasema* sp.	SH	2		1	1		
Glossosomatidae	*Glossosoma* sp.	SC	0				1	
Glossosomatidae	*Protoptila* sp.	SC	1	1				
Helicopsychidae	*Helicopsyche borealis*	SC	3				1	
Hydropsychidae	Hydropsychidae	FC	4				1	
Hydropsychidae	*Cheumatopsyche* sp.	FC	5	3	13	8	3	1
Hydropsychidae	*Hydropsyche* sp.	FC	4	5	8	3	5	
Hydropsychidae	*Hydropsyche betteni*	FC	7	1			1	
Hydropsychidae	*Hydropsyche morosa*	FC	6		9	6	3	3
Hydropsychidae	*Hydropsyche scalaris*	FC	2			1		
Hydropsychidae	*Hydropsyche sparna*	FC	6		6	6		4
Hydropsychidae	*Macrostemum* sp.	FC	3	4	1		3	
Hydroptilidae	*Leucotrichia* sp.	SC	6			1		
Lepidostomatidae	*Lepidostoma* sp.	SH	1			1		
Philopotamidae	Philopotamidae	FC	3	1				
Philopotamidae	*Chimarra aterrima*	FC	4		3	9		
Philopotamidae	*Chimarra obscura*	FC	4	14	3			
Philopotamidae	*Chimarra socia*	FC	2				16	3
Psychomyiidae	*Psychomyia* sp.	GC	2			1		
Rhyacophilidae	*Rhyacophila minor*	PR	1				1	
Elmidae	Elmidae	SC	4	4	4			2
Elmidae	*Ancyronyx variegata*	GC	5					1
Elmidae	*Macronychus glabratus*	SH	5			4		
Elmidae	*Microcylloepus pusillus*	GC	3			2		
Elmidae	*Optioservus* sp.	SC	4	1	14	2	9	1
Elmidae	*Oulimnius latiusculus*	SC	4	6	2	2	1	
Elmidae	*Promoresia elegans*	SC	2	1				1
Elmidae	*Stenelmis* sp.	SC	5	9	3	4		33
Elmidae	*Stenelmis crenata*	SC	5				25	
Psephenidae	*Psephenus herricki*	SC	4	2	1	1		
Chironomidae	*Polypedilum* sp.	SH	6					1
Chironomidae	*Polypedilum aviceps*	SH	4					1

Family	Final Identification	FFG[1]	TolVal[2]	Sampling Sites				
				CH06	QUAB-UP	QUAB-DN2	WA09A	WR34[3]
Chironomidae	*Polypedilum flavum*	SH	6			2	1	1
Chironomidae	*Stenochironomus* sp.	GC	5					1
Chironomidae	*Rheotanytarsus exiguus* gr.	FC	6		1	2		1
Chironomidae	*Rheotanytarsus pellucidus*	FC	5					1
Chironomidae	*Stempellinella* sp.	GC	2					1
Chironomidae	*Tanytarsus* sp.	FC	6			1		
Chironomidae	*Diamesa* sp.	GC	5					1
Chironomidae	*Potthastia longimana* gr.	GC	2					1
Chironomidae	*Cardiocladius obscurus*	PR	5			1	1	2
Chironomidae	*Cricotopus/Orthocladius* sp.	GC	7		1			
Chironomidae	*Lopescladius* sp.	GC	4					2
Chironomidae	*Nanocladius* sp.	GC	7			1		
Chironomidae	*Orthocladius dubitatus*	GC	6					1
Chironomidae	*Tvetenia paucunca*	GC	5		2	1		
Chironomidae	*Tvetenia vitracies*	GC	5				1	3
Empididae	*Hemerodromia* sp.	PR	6			2	1	
Simuliidae	*Simulium* sp.	FC	5	1	3	6	4	3
Simuliidae	*Simulium jenningsi*	FC	4					1
Simuliidae	*Simulium verecundum* cplx.	FC	5			2		
Tipulidae	*Antocha* sp.	GC	3			1		
Totals				100	101	101	104	100

[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