MILLERS RIVER WATERSHED
2005-2009
MACROINVERTEBRATE ASSESSMENTS
(Franklin & Worcester Counties, Massachusetts)

Prepared for

MILLERS RIVER WATERSHED COUNCIL, INC.
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By

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EXECUTIVE SUMMARY

- The Millers River, located in north central Massachusetts, is a valuable resource to the region. The river and its tributaries support a number of recreational uses including canoeing, kayaking, swimming, and fishing; and have long supported industry to the present day. The entire length of the Millers River mainstem from Winchendon downriver is listed as water quality impaired for excessive nutrient loading. Point-source discharges from municipal waste-water treatment facilities along the river are suspected causes of this impairment, along with non-point sources such as stormwater runoff. While the Massachusetts Department of Environmental Protection, Division of Watershed Management has periodically assessed the biological health of selected reaches throughout the watershed, limited state resources preclude more frequent or intensive (i.e. a larger number of monitoring stations) sampling, potentially allowing impairment in unsampled portions of the watershed to go undetected.

- Recognizing the need to more thoroughly assess biological conditions in the Millers River watershed, in 2005 the Millers River Watershed Council (MRWC) implemented a macroinvertebrate monitoring program for the watershed. The objectives of the program are to 1) augment MassDEP biomonitoring efforts to assess surface waters in the watershed with respect to their aquatic-life-use status and 2) familiarize citizens of the watershed with biological monitoring to increase support for and participation in watershed enhancement and protection activities. Under this program, sampling was performed in 2005-2007 and 2009 in mainstem Millers River and tributary reaches.

- Sampling of the mainstem Millers River in 2005 suggested that macroinvertebrate community conditions ranged from slightly impacted at one site (BO459) to unimpacted at the other two test sites. The Millers River in South Royalston scored in the slightly impacted range. Importantly, MRWC sampled approximately 250 m further downstream in 2005 than where MassDEP sampled in 2000; in 2005 sampling occurred below the Royalston Waste Water Treatment Facility at 15 Blossom Road in South Royalston, whereas sampling by MassDEP in 2000 occurred above this facility that is permitted to discharge its effluent into the Millers River. Results from this reach suggest that the heavy algal growth provides a rich source of fine organic particulate matter for filtering macroinvertebrates, and the resulting community is one dominated by organisms that derive their food from the abundant fine particulate matter suspended in the water column, rather than from other sources such as algae or more coarse material such as leaves. While this study did not sample both upstream and downstream of the treatment facility, the source of the elevated nutrient loading necessary to support the dense growth of filamentous algae likely results from the facility.

- In 2006, six of seven tributary streams sampled scored in the no-impact range, while one – the Lake Rohunta outlet – scored in the moderately impacted range. The Lake Rohunta outlet stream scored "borderline" slightly impacted/moderately impacted. The Lake Rohunta stream is the outlet to a relatively large, shallow, eutrophied body of water, and so supports a community tolerant to a wide range of environmental conditions such as lower dissolved oxygen concentrations and higher water temperatures.

- 2007 sampling results included the first round of MRWC sampling of the Otter River. 2007 Otter River results consistently showed moderate impact across all sites. Pairs of sites bracketing the Seamans Paper Company and the Templeton WWTP received similar RBPIII scores. Interestingly, all 5 Otter River stations received RBPIII scores in 2009 corresponding to slight or no impact. While all metrics showed improvement from 2007 to 2009, increases in total and EPT richness were largely responsible for the large difference in total scores between years. In fact, these differences between years appear to be primarily related to an increase in the total richness and EPT richness from 2007 to 2009 across all Otter River sites. Similar increases in richness from 2007 to 2009 were observed at the Lawrence Brook station, suggesting that the apparent improvement in the Otter River from 2007 to 2009 is more likely attributable to inter-annual variation in community conditions as affected by year-to-year variation in climate, local weather, and streamflows. 2007 also included sampling of Beaver Brook, the North Branch of the Millers River, and West Brook. Beaver Brook and West Brook each scored in the moderately impacted range. The North Branch of the Millers River in Winchendon received a slight impact classification.

- The MRWC macroinvertebrate sampling program has added significantly to our present understanding of ecological conditions of rivers and streams in the Millers River watershed. Several years of monitoring the mainstem Millers River suggest that the lower reaches consistently support minimally impacted biological conditions. The mainstem Millers in South Royalston below the Templeton WWTP exhibited characteristics that are indicative of increased nutrient loading, but even these conditions met biological water quality criteria. Many previously unassessed tributaries to the Millers River are currently supporting unimpacted biological communities. Our results also suggest that conditions in the Otter River may vary considerably from year to year, as 2007 results suggested moderate impact across all sites, while 2009 results suggested little or no impact. Importantly, these apparent year-to-year differences may result largely from inter-annual variation in climate, precipitation and their attendant effects on local instream conditions.

- MRWC will consider periodically assessing macroinvertebrate communities in select river and stream reaches. Preliminarily, resampling could focus on tributaries; additionally, regular monitoring of the lower Millers Rivers (BO444) and the Otter River might be advisable.

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INTRODUCTION

The Millers River, located in north central Massachusetts, is a valuable resource to the region. The river and its tributaries support a number of recreational uses including canoeing, kayaking, swimming, and fishing; and have long supported industry to the present day. The river flows through several urban centers, most notably Athol and Orange in the middle of the watershed. Much progress has been made towards improving water quality in the river from a half century ago, when "the color and smell of the Millers River varied on a daily basis." Nonetheless, threats to the river's health persist to this day, most notably non-point source pollution and alteration of natural river flows. The entire length of the Millers River mainstem from Winchendon downriver is listed as water quality impaired for excessive nutrient loading. Point-source discharges from municipal waste-water treatment facilities along the river are suspected causes of this impairment, along with non-point sources such as stormwater runoff.

In 1995, 2000, 2005, and 2010, the Massachusetts Department of Environmental Protection (MassDEP), Division of Watershed Management assessed the biological health of selected reaches throughout the watershed. These efforts are valuable to tracking aquatic resource conditions in the watershed, but limited resources preclude more frequent or intensive (i.e. a larger number of monitoring stations) sampling and allow impairment in unsampled portions of the watershed to go undetected. In 1995 and 2000, MassDEP biological sampling occurred in both the Millers River mainstem and numerous tributaries. In 2005, time and resource constraints precluded as rigorous a sampling effort, resulting in dropping mainstem river sites from the sampling.

Recognizing the need to more thoroughly assess biological conditions in the Millers River watershed, in 2005 the Millers River Watershed Council (MRWC) implemented a macroinvertebrate monitoring program for the watershed. The objectives of the program are to 1) augment MassDEP biomonitoring efforts to assess surface waters in the watershed with respect to their aquatic-life-use status and 2) familiarize citizens of the watershed with biological monitoring to increase support for and participation in watershed enhancement and protection activities. The program includes both professional and volunteer elements, and therefore represents a "hybrid" program. In order to provide useful data to the state, the program uses MassDEP's professional field and laboratory biomonitoring protocols. Volunteers are trained by the program lead, Dr. Michael Cole, to collect field data and to assist with sample sorting. All field sampling and sample processing is overseen by Dr. Cole. Macroinvertebrate identification is performed exclusively by Dr. Cole, who uses the same levels of taxonomic resolution used by the state.

This program was initiated in 2005 as a pilot assessment of four previously assessed MassDEP biological sampling stations. In subsequent years – 2006, 2007 and 2009 – the program was expanded to include a larger number of assessment sites and to include stream and river reaches that had not been previously assessed. This document reports on the methods and results of these four years of MRWC volunteer macroinvertebrate monitoring efforts in the Millers River watershed.

METHODS

SAMPLE SITE SELECTION

In 2005, MassDEP data were acquired and examined to determine where monitoring had occurred in the watershed in the last ten years. MassDEP staff was consulted for recommendations for pilot-assessment site selection based on known problem areas and data gaps. Based on this information, we selected sites that allowed investigation of areas of the watershed of interest to resource managers, yet went unassessed in 2005 by MassDEP. The mainstem Millers River was targeted because data exist for 1995 and 2000, yet these sites were not sampled in 2005 by MassDEP. Three previously assessed sites were selected along the mainstem: one near the confluence of the Connecticut River (MassDEP site B444), one in Farley (BO446), and one in South Royalston (BO459). The South Royalston site (BO459) occurred approximately 250 m downstream of the location sampled by MassDEP in 2000. Lawrence Brook above Northeast Fitzwilliam Road (BO449) was selected as the reference site because this site was used as the 2000 reference location for the mainsteam Millers River sampling sites (Table 1).

In 2006, program sampling was expanded to include a number of previously unassessed tributary streams in the watershed (Table 1). While intended to be included in the 2006 assessment, the addition of previously MassDEP-assessed stations in the Otter River occurred in 2007. Five stations in the Otter River were established for sampling by MRWC in 2007 after additional consults with MassDEP staff (Bob Nuzzo and others). The upstream-most location (BO219) occurs at the Templeton/Gardner town line and is downstream of the Gardner Waste Water Treatment Plant (WWTP) and a number of sand and gravel operations. Stations BO220 and ORSP02 occur upstream and downstream of the Seaman Paper Company in Gardner, effectively bracketing the company's discharge activity into the Otter River. Similarly, stations BO221 and ORTW02 bracket the Templeton Waster Water Treatment Plant in Baldwinville.

In addition to the five Otter River sites, the Millers River stations BO444 and BO446 were resampled in 2007. The North Branch of the Millers River (NBM01) and West Brook (WBM01) were also included in the 2007 sampling round after high water precluded their sampling in 2006. The most recent round of sampling performed in 2009 represented a re-sampling of the 2007 Otter River stations and the lowermost Millers River station (Table 1).

FIELD DATA COLLECTION

Macroinvertebrate samples were collected in the early fall of each sampling year using methods employed by the MassDEP for assessing the condition of macroinvertebrate communities in Massachusetts streams (Nuzzo 2003). These methods are based on the US EPA Rapid Bioassessment Protocols (RBPs) for wadeable streams and rivers (Barbour et al. 1999). Sampling activities were conducted in accordance with the Quality Assurance Project Plan (QAPP) for the MRWC benthic macroinvertebrate monitoring program (Ussach and Cole 2006). Macroinvertebrates were collected from each site using kick-sampling, a method by which organisms are sampled by disturbing streambed substrates and catching dislodged organisms in a net. At each sample site, ten kick samples of approximately 0.46 m x 0.46 m were collected and composited for a total

sampled area of approximately 2 m^2. Sampling targeted fast-water areas with coarse substrate within each of the sample sites. Samples were labeled and preserved in the field with denatured 95% ethanol for later processing and identification in a laboratory.

Table 1. Stream reaches sampled for macroinvertebrates in the Millers River watershed between 2005 and 2009.

Waterbody	Station Code	Location Description	Year Sampled			
			2005	2006	2007	2009
Beaver Brook	BO450	Downstream Templeton Dev Cntr WWTF			Y	
Keyup Brook	KBM01	Downstream of Rt 2 in Erving		Y		
Lk Rohunta Outlet	LRM01	Upstream side of Daniel Shays Highway		Y		
Lawrence Brook	BO449	200 m upstr NE Fitzwilliam Road, Royalston	**Y**	**Y**	**Y**	**Y**
Millers River	BO444	350 m upstream confluence with CT River	**Y**	**Y**	**Y**	**Y**
Millers River	BO446	50 m upstream of Farley Bridge	Y		Y	
Millers River	BO459	150 downstr of the South Royalston WWTP	Y			
Mormon Hollow Br	MHBM01	Upstream side of Mormon Hollow Road, Wendell		Y		
Moss Brook	MBM01	Downstream of Rt 2A		Y		
North Br Millers R	NBM01	Downstream Rt 202, Winchendon			Y	
Orcutt Brook	OBM01	Upstream side of Rt 2A, Orange		Y		
Otter River	BO219	Upstream side of Bridge Street bridge			Y	Y
Otter River	BO220	Upstream Seaman Paper - US of Main Street			Y	Y
Otter River	BO221	Upstream Templeton WWTP			Y	Y
Otter River	ORSP02	Downstream of Seaman Paper			Y	Y
Otter River	ORTW02	Downstream of Templeton WWTP			Y	Y
West Brook	WBM01	Upstream of Brookside Road, Athol			Y	
Wetstone Brook	WSBM01	75 m upstream of Depot Road, Wendell		Y		

SAMPLE SORTING AND MACROINVERTEBRATE IDENTIFICATION

Samples were sorted to remove a 100-organism subsample from the original sample using procedures described in Nuzzo (2003). Samples were first distributed in gridded pans. Macroinvertebrates were sorted from randomly selected grids until 100 organisms (±10%) were removed. The remainder of the unsorted grids was then scanned for large/rare organisms that were not encountered during the 100-organism subsampling. These organisms were then removed and placed in a separate "large/rare" organism vial.

Specimens were identified to the lowest practical taxonomic level (generally genus or species) as allowed by specimen condition and maturity. Taxonomic keys used included Merritt and Cummins 1996, Wiggins 1996, Stewart and Stark 2002, Peckarsky et al. 1990, and Epler 2000.

DATA ANALYSIS

Macroinvertebrate taxonomic data were analyzed using MassDEP's modification (Nuzzo 2003) of EPA's Rapid Bioassessment Protocol III multimetric scoring and analysis (Barbour et al. 1999) to determine the condition of macroinvertebrate communities. Multimetric analysis employs a set of metrics, each of which describes an attribute of the macroinvertebrate community that is known to be responsive to one or more types of pollution or habitat degradation. Because a number of biological attributes

are simultaneously evaluated, the multimetric approach is a robust assessment tool and a deficiency in any one metric should not invalidate assessment results (Barbour et al. 1999). Each attribute value is first calculated from the taxonomic data and then converted to a standardized score by comparison with the reference site score (Table 2). Standardized scores of all metrics are then summed to produce a single multimetric score that is a numeric measure of overall biological integrity. MassDEP currently employs a 7-metric set for use with fast-water samples from streams (Table 2).

Metric Descriptions (from Fiorentino and Miaetta 2002)

1. Taxa Richness—A count of the number of taxa present. Taxa richness generally increases with increasing water quality and habitat quality.

2. EPT Index—The number of taxa from the orders Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies). As a group these are considered three of the more sensitive aquatic insect orders. Therefore, the greater the contribution to total richness from these three orders, the healthier the community.

3. Biotic Index—Based on the Hilsenhoff Biotic Index (HBI), this is an index designed to produce a numerical value to indicate the level of organic pollution (Hilsenhoff 1982). Organisms have been assigned a value ranging from zero to ten based on their tolerance to organic pollution. A value of zero indicates the taxon is highly intolerant of pollution and is likely to be found only in pollution-free waters. A value of ten indicates the taxon is tolerant of pollution and may be found in highly polluted waters. The number of organisms and the individually assigned values are used in a mathematical formula that describes the degree of organic pollution at the study site.

The formula for calculating HBI is:

$$HBI = \sum \frac{x_i t_i}{n}$$

where

x_i = number of individuals within a taxon
t_i = tolerance value of a taxon
n = total number of organisms in the sample

4. Ratio of EPT and Chironomidae Abundance—Uses the ratio of EPT to Chironomidae abundance as a measure of community balance. Macroinvertebrate communities with a disproportionately large number of the generally tolerant Chironomidae relative to the more sensitive insect groups may indicate a stressed community.

Table 2. Metric set and scoring criteria (relative to reference station) used to assess the condition of macroinvertebrate communities in the Millers River watershed.

	Scoring Criteria			
Metric	**6**	**4**	**2**	**0**
Taxa Richness	>80%	60-80%	40-59%	<40%
EPT	>90%	80-90%	70-79%	<70%
EPT/Chironomidae (abundance ratio)	>75%	50-75%	25-49%	<25%
HBI (modified)	>85%	70-85%	50-69%	<50%
Scraper/Filtering collector Ratio	>50%	35-50%	20-34%	<20%
% Contribution of Dominant Taxon	<20%	20-29%	30-40%	>40%
Similarity Index: % Reference Affinity	>64%	50-64%	35-49%	<35%

5. Percent Contribution Dominant Taxon—The percent contribution of the numerically dominant taxon (genus or species) to the total numbers of organisms. A community dominated by few species indicates environmental stress.

6. Ratio of Scraper and Filtering Collector Functional Feeding Groups—This ratio reflects the community food base. The proportion of the two feeding groups is important because predominance of a particular feeding type may indicate an unbalanced community responding to an overabundance of a particular food source (Barbour et al. 1999). Scrapers predominate when diatoms are the dominant food resource, and decrease in abundance when filamentous algae and mosses prevail. Filtering collectors thrive where filamentous algae and mosses are prevalent and where fine particulate organic matter (FPOM) levels are high.

7. Community Similarity—Compares study site community data to a reference site community. Similarity is often based on indices that compare community composition. Most Community Similarity indices stress richness and/or richness and abundance. Generally speaking, communities from non-reference reaches will become less similar from the reference condition as stress increases. In the case of the Millers River watershed bioassessment, an index of macroinvertebrate community composition was calculated based on similarity (i.e., affinity) to the reference community, expressed as percent composition of the following organism groups: Oligochaeta, Ephemeroptera, Plecoptera, Coleoptera, Trichoptera, Chironomidae, and Other. This approach is based on a modification of the Percent Model Affinity (Novak and Bode 1992). The reference site affinity (RSA) metric is 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 RBPIII scores as follows:

<35% receives 0 points; 2 points in the range from 35 to 49%; 4 points for 50 to 64%; and 6 points for ≥65%.

Metric values for each study site were scored based on comparability to a "least impacted" reference station, and scores were totaled. The percent comparability of total metric scores for each study site to those for the reference site is then used to assign a biological condition or impact class to the site. RBP III utilizes four categories in its impact classification of non-impacted (>83% reference comparability), slightly impacted (54-79% reference comparability), moderately impacted (21-50% reference comparability), and severely impacted (<17% reference comparability). For this study, the Lawrence Brook reach was used as the reference site for comparison with all other sites sampled in each year.

RESULTS & DISCUSSION

Sampling that was limited to the mainstem Millers River (and the Lawrence Brook reference site) in 2005 suggested that macroinvertebrate community conditions ranged from slightly impacted at one site (BO459) to unimpacted at the other two test sites (Table 3). The Lawrence Brook reference site supported the highest total macroinvertebrate taxa richness, the highest scraper-to-filterer ratio, and the lowest collective community tolerance to organic enrichment pollution, as indicated by the low HBI score (Table 4).

Relative to these conditions at Lawrence Brook, macroinvertebrate communities scored in the unimpacted range at the two lower Millers River sites, BO444 and BO446. These two sites received RBPIII multimetric scores of 38 and 34, respectively, representing 90% and 81% attainment of reference conditions. The macroinvertebrate communities in these reaches were characterized by an EPT richness similar to that sampled from the reference reach. Total taxa richness was only slightly lower at these two sites than at the reference reach. The collective community tolerance to organic enrichment pollution was slightly to moderately higher at these two reaches than at the reference reach (Table 4), and is likely a result of the nutrient loading problems that are known to occur in the Millers River.

The Millers River in South Royalston (BO459) scored in the slightly impacted range, receiving a RBPIII score of 24 out of a possible 42 points (Table 3). This site received an unimpacted score of 36/42 in 2000 by MassDEP and is the only site in this assessment to differ in impact level from 2000. Importantly, we sampled approximately 250 m further downstream in 2005 than where MassDEP sampled in 2000; in 2005 sampling occurred below the Royalston Waste Water Treatment Facility at 15 Blossom Road in South Royalston, whereas sampling by MassDEP in 2000 occurred above this facility that is permitted to discharge its effluent into the Millers River. The macroinvertebrate community at this site was characterized as having a high collective tolerance to organic enrichment pollution, low EPT/Chironomidae ratio, and a low scraper-to-filterer ratio. The scraper to filterer ratio is five times lower than that measured at the upstream MassDEP site in 2000. This low ratio reflects the abundance of filtering organisms, particularly *Hydropsyche Morosa* group and *Macrostemum* sp. caddisflies that this reach currently supports. Their numeric dominance in this reach

results from the heavy algal growth that provides a rich source of fine organic particulate matter for filtering macroinvertebrates. The resulting community is one dominated by organisms that derive their food from the abundant fine particulate matter suspended in the water column, rather than from other sources such as algae or more coarse material such as leaves. While this study did not sample both upstream and downstream of the treatment facility, the source of the elevated nutrient loading necessary to support the dense growth of filamentous algae likely results from the facility.

Table 3. RBP III multimetric scores and corresponding biological condition classifications (level of impact) of macroinvertebrate communities sampled from the Millers River watershed from 2005 through 2009.

	Station	RBPIII Score and Impact Class			
Waterbody	Code	2005	2006	2007	2009
Lawrence Brook	**BO449**	**40**	**42**	**42**	**42**
Beaver Brook	BO450			12 Mod	
Keyup Brook	KBM01		38 None		
Lk Rohunta Outlet	LRM01		22 Mod		
Millers River	BO444	38 None	36 None	30 Slight (26)	38 None
Millers River	BO446	34 None		38 None	
Millers River	BO459	24 Slight			
Mormon Hollow Brk	MHBM01		42 None		
Moss Brook	MBM01		42 None		
N Br Millers River	NBM01			22 Slight	
Orcutt Brook	OBM01		40 None		
Otter River	BO219			18 Mod	24 Slight
Otter River	BO220			20 Mod	26 Slight
Otter River	BO221			18 Mod	40 None
Otter River	ORSP02			16 Mod	24 Slight
Otter River	ORTW02			22 Slight	32 Slight (38)
West Brook	WBM01			18 Mod	
Wetstone Brook	WSBM01		40 None (38)		

While the South Royalston sample station, BO459, has not been sampled again since 2005, both BO444 and BO446 have more recently been sampled. The Millers River upstream of the confluence with the Connecticut River (BO444) has been sampled in each year in which sampling has occurred (Table 1). Scores have been similar among years, ranging from 30 to 38 (a duplicate sample scored a 26 in 2007), and 3 of 4 of these scoring in the no-impact range (Table 3). BO444 scored as slightly impacted as 2007, representing the only deviation from a "no impact" score in the 4 years of sampling. This ostensible reduction in condition class resulted from high scraper-to-filter ratio at the Lawrence Brook reference site in 2007 which led to very low scores for this metric at most all test stations in 2007 (Table 4). BO446 was sampled a second time by MRWC in 2007 and received a RBPIII score of 38, scoring in the same "no impact" class as in 2005.

In 2006, 6 of the 7 tributary streams sampled scored in the no-impact range, while one – the Lake Rohunta outlet – scored in the moderately impacted range (Table 3). The Lake Rohunta outlet stream scored "borderline" slightly impacted/moderately impacted. The Lake Rohunta stream is the outlet to a relatively large, shallow, eutrophied body of water, and so supports a community tolerant to a wide range of environmental conditions such as lower dissolved oxygen concentrations and higher water temperatures. The observed low scraper–to–filter ratio suggests that elevated levels of fine particulate organic matter are carried through the reach, and the low EPT richness suggests at least seasonal conditions that are not conducive to the survival of more sensitive mayfly, stonefly, and caddisfly taxa (Table 4). The Lake Rohunta outlet notwithstanding, tributary streams sampled in 2006 compared favorably to the Lawrence Brook reference station. In fact, EPT richness was higher in each of the 5 tributary samples than in the Lawrence Brook sample (Table 4).

2007 sampling results included the first round of MRWC sampling of the Otter River. 2007 Otter River results consistently showed moderate impact across all sites ranging from upstream (BO219) to downstream (ORTW02). Pairs of sites bracketing the Seamans Paper Company (BO220 and ORSP02) and the Templeton WWTP (BO221 and ORTW02) received similar RBPIII scores of 20 and 16, and 18 and 22, respectively (Table 3). Relative to the Lawrence Brook reference site, all Otter River stations were characterized by lower total taxa richness, lower EPT richness, higher HBI scores, and lower scraper-to-filterer ratios (Table 4).

2007 also included sampling of Beaver Brook (BO450, a tributary to the Otter River), the North Branch of the Millers River (NBM01), and West Brook (WBM01). Beaver Brook and West Brook each scored in the moderately impacted range (Table 3). Beaver Brook received an RPBIII multimetric score of 12, the lowest score that any MRWC-sampled station has received during the 4-sampling-year program. The sample from this station was numerically dominated by the filtering-collector midges, *Tanytarsus*/*Micropsectra* sp.; almost half of the individuals in the sample (42%) were this taxon, resulting in a low EPT-to-Chironomidae ratio, a high HBI, and a low-scraper-to-filterer ratio (Table 4). West Brook received a slightly higher RBPIII multimetric score of 18, and exhibited similar community attributes, including numeric dominance by another filtering-collector Chironominae midge, *Microtendipes* sp. The North Branch of the Millers River in Winchendon (NBM01) received a RBPIII score of 22, corresponding to a slight impact (Table 3).

As previously mentioned, a 2009 re-sampling of the lower Millers River (BO444) once again suggested no impact, as the station received a RBPIII score of 36 or higher for the 3rd year in 4 (Table 3). Interestingly, all 5 Otter River stations received RBPIII scores in 2009 corresponding to slight or no impact, after all had received moderate impact scores in 2007 (Table 3). The most dramatic among these differences was a RBPIII increase at BO221 from 18 in 2007 to 40 in 2009. While all metrics showed improvement from 2007 to 2009, increases in total and EPT richness were largely responsible for the large difference in total scores between years. In fact, these differences between years appear to be primarily related to an increase in the total richness and EPT richness from 2007 to 2009 across all Otter River sites (Table 4). Total richness across all Otter River stations averaged 20 in 2007 versus 25 in 2009, while EPT average EPT richness increased from 10 to 14. Similar increases in richness from 2007 to 2009 were observed

at the Lawrence Brook station, suggesting that the apparent improvement in the Otter River from 2007 to 2009 is more likely attributable to inter-annual variation in community conditions as affected by year-to-year variation in climate, local weather, and streamflows.

Table 4. Metric values derived from macroinvertebrate samples collected from the Millers River watershed from 2005 to 2009.

Station Code	Richness	EPT Richness	EPT/Chironomidae	HBI modified	Scraper-Filterer Ratio	% Dominant Taxon	% Reference Affinity
			2005				
BO449	**35**	**16**	**6.6**	**3.1**	**0.9**	**24**	**100**
BO444	28	16	5.0	4.4	0.7	19	72
BO446	27	17	20.3	3.8	0.4	22	77
BO459	29	14	3.2	5.0	0.1	25	63
			2006				
BO449	**36**	**15**	**5.6**	**3.4**	**0.9**	**20**	**100**
BO444	24	14	71.0	4.7	1.1	26	86
KBM01	32	17	10.3	2.0	1.4	32	65
LRM01	16	6	5.1	5.1	0.1	20	71
MBM01	36	19	10.8	2.6	4.0	13	73
MHBM01	29	20	14.8	1.7	0.6	19	84
OBM01	35	16	2.9	3.7	0.5	14	78
WSBM01	29	17	58.0	3.6	1.0	22	74
			2007				
BO449	**31**	**15**	**5.2**	**3.4**	**3.3**	**19**	**100**
BO219	17	9	16.8	4.8	0.2	26	49
BO220	18	10	80.0	4.4	0.3	20	50
BO221	23	10	8.8	5.1	0.2	38	56
BO444	32	16	2.6	4.4	0.7	24	77
BO446	27	17	13.8	3.6	1.0	10	70
BO450	25	10	0.4	4.9	0.1	42	44
NBM01	31	10	0.4	4.3	0.9	19	57
ORSP02	18	8	3.2	5.1	0.1	19	46
ORTW02	21	11	5.5	4.9	0.3	30	60
WBM01	25	7	0.8	4.7	0.4	28	62
			2009				
BO449	**37**	**19**	**3.5**	**3.1**	**1.1**	**12**	**100**
BO219	26	12	14.8	4.6	0.3	18	51
BO220	26	16	28.7	4.7	0.3	20	51
BO221	35	17	6.2	3.5	1.1	14	74
BO444	35	20	6.1	4.0	0.7	12	63
ORSP02	25	13	9.7	4.5	0.4	22	51
ORTW02	25	15	20.0	4.2	0.7	24	54

MassDEP has been performing benthic macroinvertebrate monitoring at a number of these stations in the MRWC program since 1995. MassDEP last reported on sampling from nine stations in the Millers River in 2005 (results of their 2010 sampling are not yet complete). Two of these stations – BO221 and BO219 – were included in the MassDEP 2005 sampling round. BO221 scored in the "comparable" (no impact) range, while BO219 scored in the "supporting" (slight/no impact range). MRWC sampling of these stations in 2007 suggested more impacted conditions. A review of metric calculations for both stations in each year reveals that the community attributes were similar between years. For example, BO221 total taxa richness was 25 and 23 in 2005 and 2007, respectively. BO221 EPT richness was 10 in each year. 2005 and 2007 metrics were similar for BO219, as well. In fact, the difference in apparent level of impact is related to the use of different reference sites in 2005 and 2007. MRWC has continued to use the historic Lawrence Brook station as the reference site for other stations in the watershed. In contrast, MassDEP discontinued using the Lawrence Brook reference site and is now using a station with lower overall taxonomic richness and EPT richness than Lawrence Brook supported.

TAXONOMY QUALITY CONTROL RESULTS

Three processed samples were sent to an independent professional macroinvertebrate taxonomist for quality control re-identification of the sample material. All three samples passed re-inspections with an average Bray-Curtis similarity of over 96%.

CONCLUSIONS & RECOMMENDATIONS

The MRWC macroinvertebrate sampling program has added significantly to our present understanding of ecological conditions of rivers and streams in the Millers River watershed. Several years of monitoring the mainstem Millers River suggest that the lower reaches consistently support minimally impacted biological conditions. The mainstem Millers in South Royalston below the Templeton WWTP exhibited characteristics that are indicative of increased nutrient loading, but even these conditions met biological water quality criteria. Many previously unassessed tributaries to the Millers River are currently supporting unimpacted biological communities. Our results also suggest that conditions in the Otter River may vary considerably from year to year, as 2007 results suggested moderate impact across all sites, while 2009 results suggested little or no impact. Importantly, these apparent year-to-year differences may result largely from inter-annual variation in climate, precipitation and their attendant effects on local instream conditions.

Because MassDEP will continue to have difficulty achieving sufficient sampling in the watershed, MRWC will consider periodically assessing macroinvertebrate communities in select river and stream reaches. Choice of reaches and frequency of sampling can be determined after MassDEP review of these data and further consults with MassDEP staff. Preliminarily, resampling could focus on tributaries; additionally

regular monitoring of the lower Millers River (BO444) and the Otter River might be advisable.

Further consideration should also be given to the choice of reference station. While it is not presently known why MassDEP chose to relocate the reference station in 2005, metrics derived from the 2005 MassDEP reference reach suggest that the new reference station does not produce the same metric values as did the Lawrence Brook reach. Consequently, reaches held in comparison to the new reference reach will not be held to the same standards as if they were being evaluated relative to Lawrence Brook. MRWC should consult with MassDEP on this issue before conducting further biological monitoring work.

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