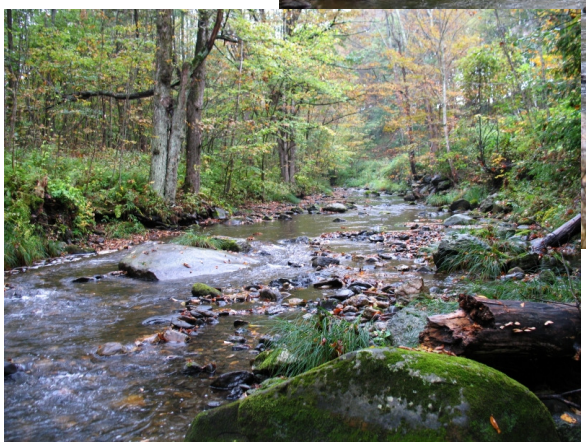
SOUTH RIVER WATERSHED
2006 MACROINVERTEBRATE ASSESSMENT
(Franklin County, Massachusetts)



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EXECUTIVE SUMMARY

- As part of the Deerfield River Watershed Association's (DRWA) commitment to protecting the watershed's resources, the DRWA has performed water quality monitoring to supplement the efforts of regulatory agencies to monitor the watershed's condition. In recognizing the need to more thoroughly assess biological conditions in the Deerfield River watershed, the DRWA implemented in 2005 a long-term macroinvertebrate monitoring program. The objectives of the program are to 1) augment MA DEP/DWM 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 South River watershed was sampled in 2006 under this program.

- Twelve river and stream reaches were selected in the South River watershed for sampling in 2006. Eight sites were selected on the South River ranging from within the town of Ashfield downriver to the confluence with the Deerfield River. The Bear River, a less developed and neighboring drainage to the north, was selected as the reference site against which to compare conditions in the mainstem South River below its confluence with Creamery Brook. Five tributaries to the South River were also sampled, including two reaches on the upper mainstem of the South River which are small enough to warrant comparison with other tributaries in the watershed. Lower Chapel Brook was selected as the reference reach for the tributaries in this assessment, as it occurs in a largely forested drainage.

- Macroinvertebrate communities sampled from the six South River sample sites ranged from slightly impacted at five of the six reaches to non-impacted (SORM4) relative to the Bear River reference reach. Multimetric scores ranged from 26 at SORM05 to 42 at SORM04. All six South River sites received low scores for EPT richness relative to the Bear River site. Overall, South River mainstem sites were only minimally impaired relative to the Bear River reference reach and were similar in their condition from just below the confluence with Creamery Brook all of the way downriver to the confluence with the Deerfield River. Such results would be expected from a river in a watershed that is still largely forested and human land uses are a patchwork of light agriculture and rural residential land uses.

- The Chapel Brook reference site supported a diverse macroinvertebrate community with both high total taxonomic richness and high EPT richness. Relative to the Chapel Brook reference reach, South River tributary macroinvertebrate conditions ranged from moderately impacted at the upper South River site, SORM07, to unimpacted at Creamery Brook. Three sites – Pumpkin Hollow Brook (BHBM01), Poland Brook (PLBM01), and the

uppermost South River site (SORM08) – all scored in the slightly impaired range. Results of BMI surveys of these tributary reaches further suggest that benthic communities throughout most of the South River watershed are affected little by human activity. Local sources of agricultural runoff, although not directly observed, may be resulting in slight shifts in community structure that result in an increased collective community tolerance to this type of pollution. Also, based on observations that large amounts of sediment are being deposited in lower-gradient reaches in the South River, macroinvertebrate communities may also presently be slightly affected by fine sediments in parts of the watershed. Sources of these sediments include the many miles of unstable river banks that occur in the South River. Aside from the potential influence of these two types of disturbance and the potential local effects of development in Ashfield on the upper South River, impacts to benthic communities in the watershed appear to be minimal.

- Maintenance of healthy benthic communities and therefore overall ecological health of the South River watershed rests on continued stewardship of these aquatic resources and adjacent riparian habitats. Prevention of further loss of mature riparian zones in the watershed is necessary to ensure the continued health of these communities. Even better, restoration of degraded riparian areas within the watershed – along the mainstem of the South River above and below Conway, in particular – would result in benefits to these resources such as reduced sediment loads, increased channel stability, and increased amounts of woody debris and food materials for aquatic life.

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ACKNOWLEDGMENTS

This project was made possible with the help of a number of individuals. I thank the entire DRWA Board of Directors for their support for the project. Thank you to Bob Nuzzo, Peter Mitchell, and John Fiorentino of the MA DEP/DWM for their review of the original DRWA study plan to develop a comprehensive biomonitoring program for the Deerfield River watershed. I am also grateful to DRWA members Robert May (board member) and Jim Dowd for providing valuable assistance with collection of South River samples and data in the field.

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INTRODUCTION

The Massachusetts Department of Environmental Protection, Division of Watershed Management (DWM) currently assesses the biological health in each of the Deerfield River's major tributaries every five years in partial fulfillment of their federal mandate to report on the status of the Commonwealth's waters under the Clean Water Act. DWM suggests that an ideal monitoring plan for the Deerfield River Watershed would include 35-40 biomonitoring stations (MA DWM 2005) to adequately assess the watershed's rivers and streams with respect to assessing attainment of the aquatic-life-use water quality standard. Owing to budgetary and staffing limitations, assessment efforts fall well short of these recommendations. In 2005, for example, DWM sampled from approximately 20 sites distributed throughout the entire Massachusetts portion of the watershed.

As part of the Deerfield River Watershed Association's (DRWA) commitment to protecting the watershed's resources, the DRWA has performed water quality monitoring to supplement the DWM's efforts to monitor the watershed's condition. In recognizing the need to more thoroughly assess biological conditions in the Deerfield River watershed, the DRWA implemented in 2005 a long-term macroinvertebrate monitoring program for the watershed. The objectives of the program are to 1) augment DEP 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 DWM'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. The program sampling design is based on the sampling program of the DWM insofar as sampling is rotated through subwatersheds from one year to the next, just as DWM rotates through major watersheds of the state on an annual basis. Under this design, DRWA will survey from five subwatersheds during the first five years of the program. The Green River was assessed in 2005 (Cole 2006), the South River in 2006 (reported herein), while the North River, Cold River, and Chickley River subwatersheds are scheduled for sampling in 2007 through 2009. Smaller tributaries draining directly to the Deerfield River, such as Pelham and Clesson brooks, will be sampled as well, likely in the same year that neighboring larger drainages are sampled. Under this program, the DRWA will assess biological conditions in 60 to 70 stream and river reaches in these first five years.

The South River subwatershed was selected for the program's second year of sampling. The communities of Ashfield and Conway both occur within the subwatershed, making the South River watershed the second most populous in the Deerfield River watershed. The South River originates in the Ashfield area. The recreationally popular Ashfield Lake is an impoundment occurring in the upper reaches of the South River. From Ashfield, the South River flows east to Conway, confluenting

with Poland and Creamery brooks, entering from the south along the way. Between Ashfield and Conway, the South River flows through a mix of forested, rural residential, and agricultural lands. Two distinctly different reach and adjacent valley types occur below the town of Conway. In Conway, the river first makes an abrupt turn to the north and meanders through light agriculture and rural residential lands on a wide valley floor for about three miles before making another turn to the east towards its confluence with the Deerfield River. In these last 2.5 miles below Reeds Bridge Road, the river becomes confined by steep heavily forested hillsides as it enters the South River State Forest for nearly its last two miles before confluenting with the Deerfield.

Massachusetts Department of Fish and Game Waterways Program sponsored Shoreline Surveys of the South River in November 2005. These surveys suggested that the most prevalent water quality issues in the South River were sediment loading (as suggested by notes relating to heavy bank erosion in places) and potential farm animal use of the river. Other potential issues include bacteria contamination from leaking sewage lines and septic systems. One of the recommendations that resulted from the fall 2005 shoreline surveys included performing this macroinvertebrate assessment of the watershed to ascertain current ecological conditions in relation to these issues.

METHODS

SAMPLE SITE SELECTION

Sample sites for this study were selected to provide adequate coverage of the South River and its major tributaries (Figure 1). Twelve river and stream reaches were selected for sampling in 2006. Eight sites were selected on the mainstem South River from its headwaters just below the Ashfield Lake dam down to the confluence with the Deerfield River (Table 1). The Bear River, a smaller tributary to the Deerfield River, was selected as the reference site against which to compare conditions in the South River below its confluence with Creamery Brook. The lower reaches of four larger tributaries to the South River were also sampled (Table 1), including Poland Brook, Creamery Brook, Chapel Brook, and Pumpkin Hollow Brook. Flowing primarily through forestland, Chapel Brook was selected as a reference site for comparison with the other sampled tributaries. The South River above the confluence with Creamery Brook is a small stream, smaller than Creamery Brook. Therefore South River sites SORM07 and SORM08, both occurring upriver of the confluence, were treated as tributary reaches and compared with the Chapel Brook reference site.

Figure 1. Macroinvertebrate assessment sites in the South River watershed, Franklin County, Massachusetts, sampled in September 2006.

FIELD DATA COLLECTION

Macroinvertebrate samples were collected between September 10 and September 24, 2006 using methods employed by the DWM 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). 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

Table 1. Stream reaches sampled for macroinvertebrates in the South River watershed, Franklin county, Massachusetts in September 2006.

Site	River	Location
SORM01	South River	100 m above confluence with Deerfield River
SORM02	South River	Upstream of Reed's Bridge just below gaging station
SORM03	South River	~100 m upstream of Emerson Hollow Rd & Shelburne Falls Rd intersection
SORM04	South River	~75 m above confluence with Pumpkin Hollow Brook
SORM05	South River	250 m above 116 bridge at Eldridge Road
SORM06	South River	1/6 mile below Bullitt Road crossing
SORM07	South River	upstream side of Emmett Road crossing
SORM08	South River	upstream side of Baptist Corner Road crossing in Ashfield
CMBM01	Creamery Brook	50 m above confluence with South River
PLBM01	Poland Brook	50 m above confluence with South River
CPBM01	Chapel Brook (trib ref)	50 m upstream of N Poland and Main Poland roads intersection
PHBM01	Pumpkin Hollow Brook	75 m above confluence with South River
BRRM01	Bear River (ref*)	75 m upstream of Shelburne Falls Road crossing

*Reference reach located outside of the South River watershed

sampled area of approximately 2 m^2. Samples were labeled and preserved in the field with 70% isopropyl alcohol for later processing and identification in a laboratory. Sampling targeted fast-water areas with coarse substrate within each of the sample sites (collected samples in this habitat type throughout a 100-m reach, if habitat availability allowed).

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 Weiderholm 1983.

DATA ANALYSIS

Macroinvertebrate taxonomic data were analyzed using DWM'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. DWM currently employs a 7-metric set for use with fast-water samples from streams (Table 2).

Table 2. MA DEP metric set and scoring criteria (relative to reference station) used to assess the condition of macroinvertebrate communities in the South River watershed, fall 2006.

	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%

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.

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 with comparable habitat will become more dissimilar as stress increases. In the case of the Deerfield 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 Bear River, another tributary to the Deerfield River, was used as the reference site for mainstem South River sites, and Chapel Brook was used as the reference site for other South River tributary streams.

QUALITY CONTROL

A Quality Assurance Project Plan (QAPP) was developed and written for this project (Cole and Walk 2005). The QAPP included all required state and federal elements and was approved by MA DEP and the US Environmental Protection Agency prior to the beginning of this assessment. Elements of the QAPP included the project background, site selection rationale, measurement quality objectives, training, documentation, sampling design, protocols, quality control requirements, instrument/equipment testing and maintenance, data management, data review, and data validation. Although the details of the QAPP are too lengthy to present in the context of this report, several of the critical elements of the QAPP are as follows.

Volunteers collecting field samples and data were trained on the day they assisted in the field and worked closely at all times in the field with Dr. Michael Cole. All macroinvertebrate identifications were performed by Michael Cole, a professional aquatic entomologist. Representative specimens of each taxon encountered were labeled and

saved as vouchers for later reference and verification, as needed. Sorted macroinvertebrate samples were preserved in 80% ethyl alcohol and archived. Unsorted fractions of all samples were also preserved and will be archived for two years following project completion. All data entered into spreadsheets were checked for transcription errors and outliers before analyses were performed. Analyses were also checked for errors in formulae used and results.

RESULTS & DISCUSSION

PHYSICAL CONDITIONS

Among mainstem South River reaches (below the confluence with Creamery Brook), the South River above (SORM05) the below (SORM03) Conway center received the lowest visual habitat scores (Table 3). SORM03 received the lowest scores for substrate, bank, and riparian conditions among sampled mainstem South River reaches. The four other South River reaches received similar habitat assessment scores ranging from 136 to 166, all comparable to the Bear River reference reach score of 160 (Table 3). Fine sediment concentrations appeared to be highest in the two reaches below Conway center – SORM02 and SORM03 – as indicated by both visual habitat assessment scores (Table 3) and visual estimates of substrate composition (Figure 2). Relatively high levels of fine sediment in reaches below Conway are consistent with observations that much of the lower South River north of Conway (between SORM02 and SORM03) has severely unstable banks that are actively eroding. Much of the lower South River floodplain is agricultural land that has been cleared to the riverbank, denuding entire lengths of the river in this area of mature riparian vegetation.

Reaches SORM01, SORM04, and SORM06 had similar substrate composition, with larger proportions of large substrates (boulder, cobble, and pebble) than the other South River reaches. The larger proportion of large substrates in these reaches appeared to be related to the higher channel gradient occurring in these areas. It should also be noted that SORM01 occurs approximately ¼ mile downriver of an old dam on the South River behind which much fine sediment is deposited, likely resulting on lower sediment loads entering this lowermost reach. Riparian conditions were least disturbed at SORM01, the lowermost reach occurring just upriver of the confluence with the Deerfield River. A mature riparian zone occurs well upslope into the adjacent upland forest at this site. Every other site had riparian zone conditions/width constrained by a road or agricultural/residential land use on one or both sides (Table 3).

South River tributaries supported less favorable habitat conditions relative to the Chapel Brook reference reach (CPBM01), ranging from a low rapid habitat assessment score of 72 from the upper South River in Ashfield (SORM08) to a high of 138 from lower Creamery Brook above the confluence with the South River (Table 4). Habitat conditions in SORM08 were poorest among all reaches sampled in the watershed. This reach, occurring at the lower end of the section of the South River flowing through the town Ashfield, was characterized by large amounts of fine sediment deposition, unstable banks, and a channel with frequent areas of aggradation and scour (Figure 3). A short section of this length of river flows through a forested tract of land, but only a short

Table 3. Habitat assessment scores of six reaches in the South River sampled for macroinvertebrates in September 2006. The Bear River (BRRM01), an adjacent watershed, was sampled to represent reference conditions. For primary parameters (first 7 in table), scores ranging from 16-20 = optimal; 11-15 = suboptimal; 6-10 = marginal; 0-5 = poor. For secondary parameters (last 3 in table), scores ranging from 9-10 = optimal; 6-8 = suboptimal; 3-5 = marginal; 0-2 = poor. Roaring Brook (RBM1) represents reference conditions.

	Site						
Variable	BRRM01	SORM01	SORM02	SORM03	SORM04	SORM05	SORM06
INSTREAM COVER	14	15	16	12	15	12	14
EPIFAUNAL SUBSTRATE	17	18	16	12	17	15	18
EMBEDDEDNESS	19	13	10	11	14	14	12
CHANNEL ALTERATION	16	18	12	13	12	13	11
SEDIMENT DEPOSITION	15	15	11	11	12	13	14
VELOCITY-DEPTH COMBINATIONS	17	15	12	11	15	12	13
CHANNEL FLOW STATUS	18	18	17	12	18	16	16
BANK VEGETATIVE PROTECTION	6,6	8,8	8,8	5,5	6,6	5,5	7,7
BANK STABILITY	7,7	9,9	8,8	5,5	6,6	5,5	7,7
RIPARIAN VEGETATIVE ZONE WIDTH	10,8	10,10	8,8	4,4	10,3	9,3	2,8
TOTAL SCORE	**160**	**166**	**142**	**110**	**140**	**127**	**136**

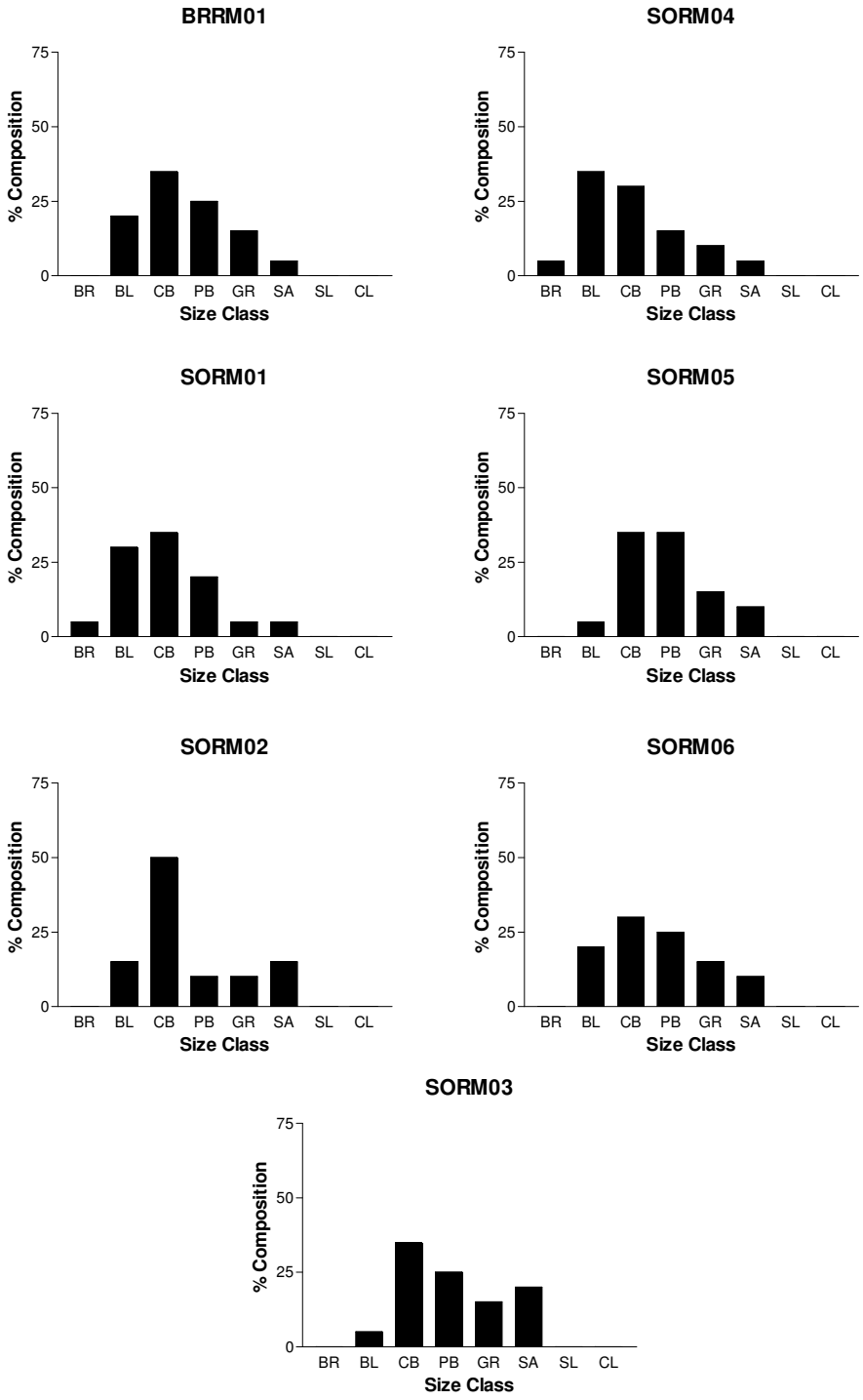

Figure 2. Visual estimates of substrate composition in six South River reaches and the Bear River reference reach sampled for macroinvertebrates in September 2006. BR = bedrock; BL = boulder, >256 mm, CB = cobble, 64-256 mm; PB = pebble, 16-64 mm; GR = gravel, 2-16 mm; SA = sand, 0.06-2 mm; SL = silt, 0.004-0.06 mm; CL = clay, <0.004 mm (slick).

Figure 3. The upper South River upstream of Baptist Church Road (in and above sampling reach SORM08) was characterized by frequent areas of heavy fine sediment deposition (left photo) and channel aggradation (right photo), suggesting a highly modified hydrology.

distance upstream, the brook flows is tightly straddled by residential land use through the town of Ashfield, where riparian zones are narrow and not well vegetated.

Pumpkin Hollow Brook in Conway received the next lowest rapid habitat score of 122. Riparian zone encroachment by residential development, lack of habitat complexity, and dominance by smaller substrates were the primary factors resulting in the lower habitat score. Similarly, the upper South River upstream of the Emmett Road crossing (SORM07) was dominated by gravel and sand sediments, resulting in a rapid habitat assessment score of only 127. Despite only being less than a mile downstream of SORM08 overall habitat conditions appear to improve significantly, as the channel appeared considerably more stable. Forested riparian and adjacent land use conditions for most of the length between SORM07 and SORM08 are likely responsible for maintaining a stable bank and channel form at SORM07.

Poland and Creamery brooks received similar rapid habitat assessment scores of 137 and 138, respectively. Physical conditions were generally similar in these two reaches, characterized by heterogeneous substrate conditions (Figure 4), moderately stable banks, and encroachment by roads and rural residential land use on one bank (Table 4).

Table 4. Habitat assessment scores of six tributaries to the South River sampled for macroinvertebrates in September 2006. For primary parameters (first 7 in table), scores ranging from 16-20 = optimal; 11-15 = suboptimal; 6-10 = marginal; 0-5 = poor. For secondary parameters (last 3 in table), scores ranging from 9-10 = optimal; 6-8 = suboptimal; 3-5 = marginal; 0-2 = poor. Chapel Brook (CHBM01) represents reference conditions.

	Site					
Variable	CPBM01	CMBM01	PHBM01	PLBM01	SORM07	SORM08
INSTREAM COVER	17	15	11	14	12	7
EPIFAUNAL SUBSTRATE	19	16	13	13	13	9
EMBEDDEDNESS	18	12	11	12	9	7
CHANNEL ALTERATION	15	15	13	14	12	6
SEDIMENT DEPOSITION	16	12	12	13	10	5
VELOCITY-DEPTH COMBINATIONS	18	13	10	14	12	8
CHANNEL FLOW STATUS	14	13	16	17	16	8
BANK VEGETATIVE PROTECTION	6,6	7,7	6,6	8,8	7,7	3,3
BANK STABILITY	5,5	6,6	6,6	6,7	8,8	2,2
RIPARIAN VEGETATIVE ZONE WIDTH	6,10	6,10	4,8	1,10	5,8	9,3
TOTAL SCORE	**155**	**138**	**122**	**137**	**127**	**72**

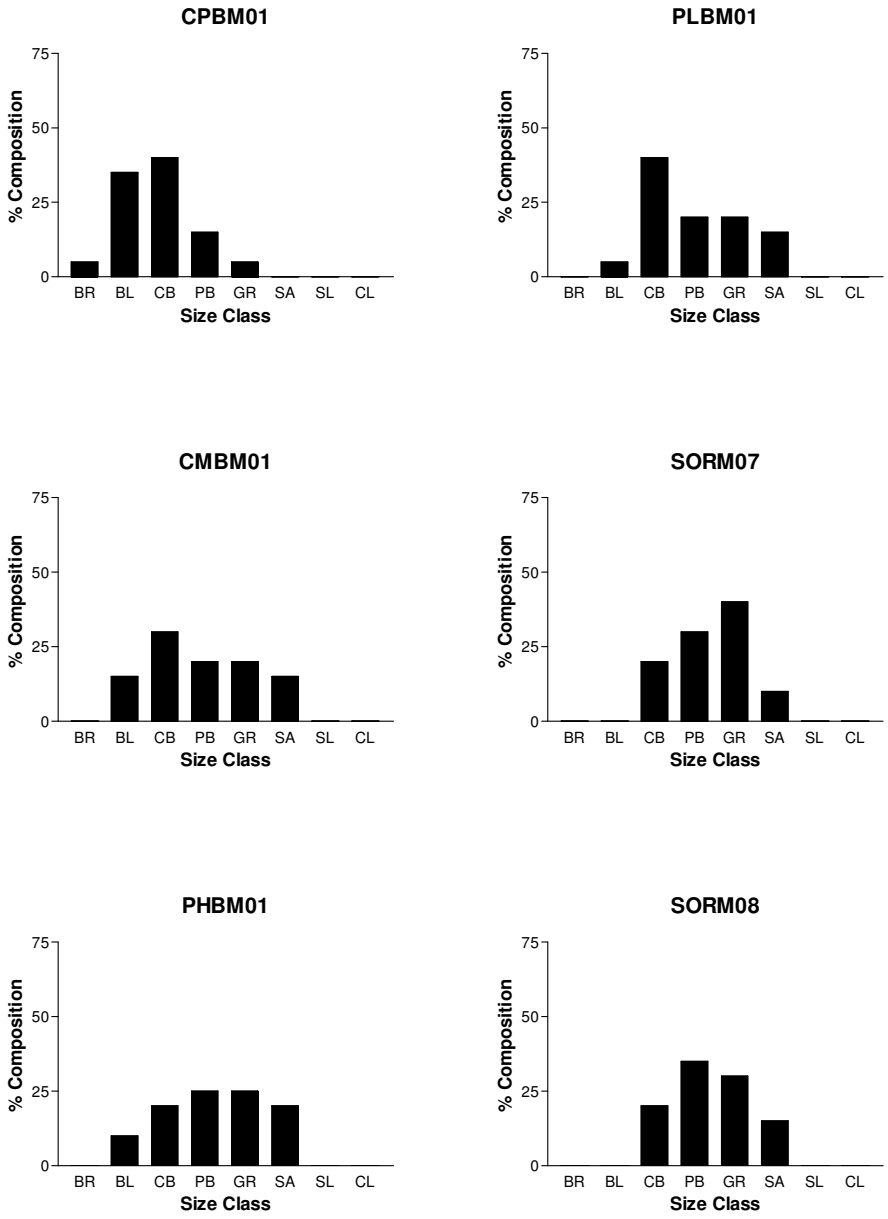

Figure 4. Visual estimates of substrate composition in six South River tributary reaches sampled for macroinvertebrates in September 2006. BR = bedrock; BL = boulder, >256 mm, CB = cobble, 64-256 mm; PB = pebble, 16-64 mm; GR = gravel, 2-16 mm; SA = sand, 0.06-2 mm; SL = silt, 0.004-0.06 mm; CL = clay, <0.004 mm (slick).

MACROINVERTEBRATE COMMUNITIES

South River Mainstem Reaches (below confluence with Creamery Brook)

Macroinvertebrate communities sampled from the six South River sample sites ranged from slightly impacted at five of the six reaches to non-impacted from SORM4 in Conway relative to the Bear River reference reach (Table 5). Multimetric scores ranged from 26 at SORM05 to 42 at SORM04. All six South River sites received low scores for EPT richness relative to the Bear River site (Table 6); twenty-eight EPT taxa were sampled from the Bear River, while the number of EPT taxa collected from the South River mainstem sites ranged from 16 to 21.

SORM05, located on the South River a short distance above the bridge at the Eldridge Road intersection, received the lowest score among South River mainstem reaches. In addition to supporting a low EPT taxonomic richness relative to the Bear River reference reach, a large number of the filter feeding Hydropsychidae caddisflies occurred at this site, resulting in the lowest scraper-to-filterer ratio among all of the South River sites (Table 6 & Figure 5). The substrate composition at this site was noticeably different than at other South River mainstem sites, largely dominated by cobble and pebble substrates and was wide and shallow with little mature riparian vegetation to provide shade to the river. These conditions are conducive to algae growth which may support the large number of filter-feeding caddisflies in the reach.

Performance by other metrics in all South River reaches was generally similar to those measured from the Bear River reference site (Table 6). Hilsenhoff HBIs, for example, deviated little from the Bear River reference value, suggesting that macroinvertebrate communities in the South River are composed largely of organisms that are relatively intolerant to organic enrichment pollution, therefore suggesting that agricultural runoff and other sources of organic pollution are likely not significant problems in the river.

Table 5. RBP III summary scores, reference comparability scores, and corresponding biological condition classifications of macroinvertebrate communities sampled from six reaches in the South River and one site from the Bear River (as a reference reach), Franklin County, Massachusetts in fall 2006.

	South River Site						
Metric	**BRRM01**	**SORM01**	**SORM02**	**SORM03**	**SORM04**	**SORM05**	**SORM06**
Total Score	42	32	32	28	42	26	34
% Comparability to Reference	100	76	76	67	100	62	81
Biological Condition	**Reference**	**Slightly impacted**	**Slightly impacted**	**Slightly impacted**	**Non-impacted**	**Slightly impacted**	**Non-impacted/slight**

Overall, South River mainstem sites generally supported communities only minimally impaired relative to the Bear River reference reach, and were similar in their condition from just below the confluence with Creamery Brook all of the way downriver to the confluence with the Deerfield River. Such results would be expected from a river in a watershed that is still largely forested and human land uses are a patchwork of light agriculture and rural residential land uses.

Our results are similar to those obtained by DWM's last published benthic assessment of the South River. In 2000, DWM sampled the lower South River at SORM02 (referred to as SOR01 in their 2004 report; DWM 2004). Based on their assessment site score of 38, DWM classified the lower South River as unimpaired. Our slightly lower score of 32 resulted in a slightly impaired determination. This difference could be interpreted to suggest that conditions in the lower South River have potentially declined since the DWM 2000 sampling. However, the lower score in 2006 largely resulted from the difference in Bear River metric values between 2000 and 2006 against which the South River data were compared. In 2000, EPT richness from the Bear River sample was only 15. EPT richness was almost twice as high (28) in 2006 (Table 6). Consequently, this metric received a much lower standardized score at SORM02 in 2006 than in 2000 relative to the reference site condition, even though the raw metric value (16) did not change from 2000 to 2006. This result points out the variability that can occur in benthic investigations and that's likely the result of sampling error, as it's highly unlikely that the Bear River EPT richness has actually increased by nearly 100% since 2000.

Table 6. Metric values (and standardized metric scores) derived from macroinvertebrate samples collected from six reaches in the South River and one reach from the Bear River (as a reference site), Franklin County, Massachusetts in fall 2006.

		South River Site					
Metric	**BRRM01**	**SORM01**	**SORM02**	**SORM03**	**SORM04**	**SORM05**	**SORM06**
Richness	35 (6)	35 (6)	27 (4)	36 (6)	41 (6)	32 (6)	30 (6)
EPT Richness	28 (6)	21 (2)	16 (0)	17 (0)	28 (6)	19 (0)	19 (0)
EPT/Chironomidae	17.0 (6)	25 (6)	13.8 (6)	4.2 (2	21.8 (6)	10.7 (4)	18.2 (6)
HBI modified	3.2 (6)	3.7 (4)	3.2 (6)	3.4 (6)	3.4 (6)	3.6 (6)	3.0 (6)
Scraper/Filterer Ratio	2.3 (6)	0.6 (2)	2.2 (6)	1.1 (4)	1.3 (6)	0.3 (0)	0.9 (4)
% Dominant Taxon	18.3 (6)	13.9 (6)	21.4 (6)	19 (6)	10.8 (6)	14.0 (6)	11.4 (6)
% Reference Affinity	100.0 (6)	65.4 (6)	52.7 (6)	50.7 (4)	76.1 (6)	55.2 (4)	68.2 (6)

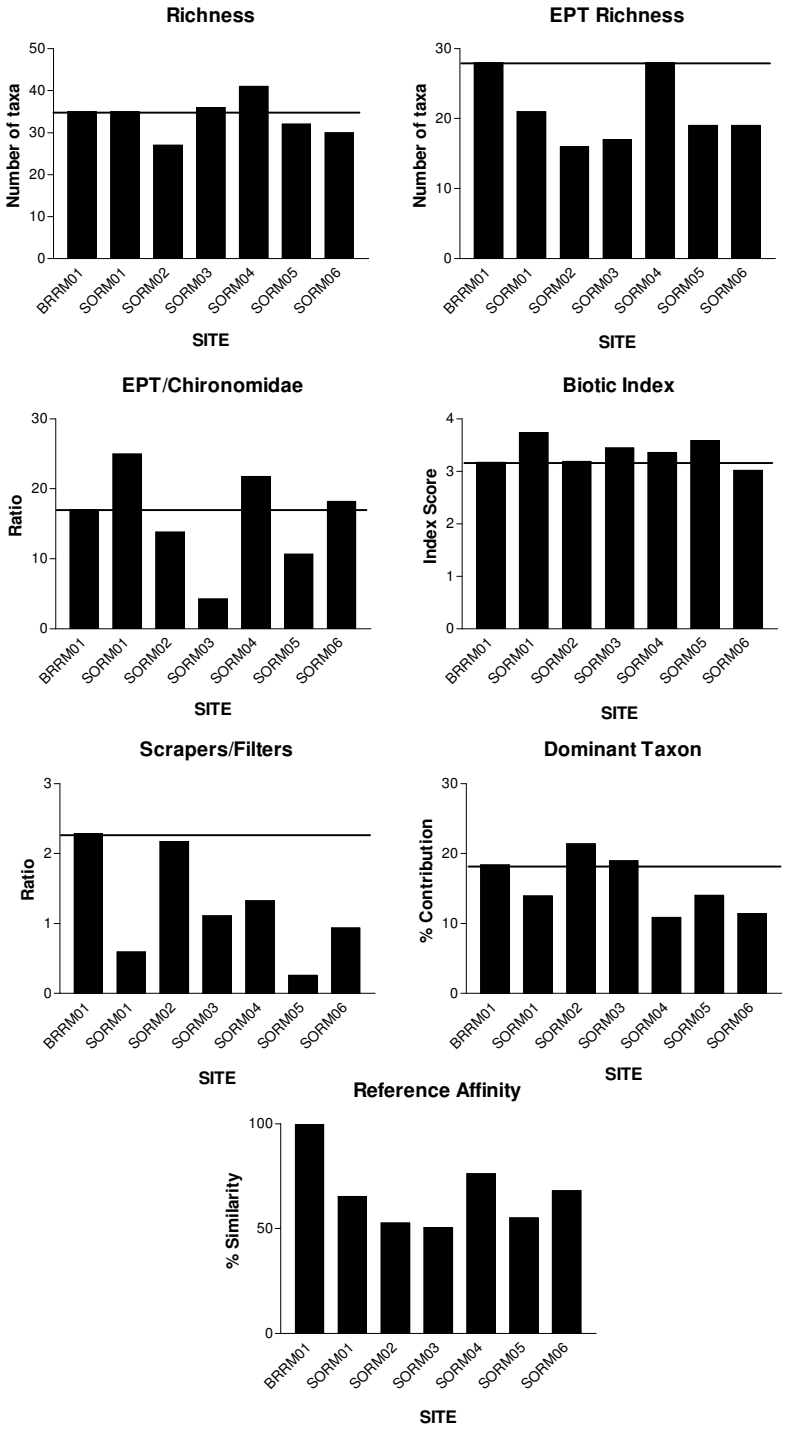

Figure 5. Metric attribute values calculated from macroinvertebrate samples collected from the South River, Franklin County, Massachusetts and from the Bear River reference site in fall 2006. Black horizontal lines indicate value of attribute at reference site on the Cold River.

Aware that sampling-error-introduced variability in reference site conditions can lead to spurious impairment-class determinations at test sites, DRWA sampled the 2006 tributary reference site, Chapel Brook, twice in fall 2006 to ascertain the effect of sampling error on resulting metric values for the site. The two samples received very similar scores for most metrics, but differences in EPT-to-Chironomidae ratios were sufficient to result in the second sample receiving a lower standard score for this metric (2 rather than 6) and a correspondingly lower total metric score of 38 rather than 42.

South River Tributary Reaches

The Chapel Brook reference site supported a macroinvertebrate community with a high total taxonomic richness (39 taxa) and high EPT richness (26 taxa). A relatively high EPT/Chironomidae ratio suggests dominance by the more sensitive EPT taxa (Table 8, Figure 6). A low HBI score suggests that Chapel Brook supports a benthic community that is intolerant of organic-enrichment pollution. The scraper-to-filterer ratio was high, suggesting little influence of fine organic material on structuring the benthic community. Relative to the Chapel Brook reference reach, South River tributary macroinvertebrate conditions ranged from moderately impacted at the upper South River site, SORM07, to unimpacted at Creamery Brook (Table 7). Three sites – Pumpkin Hollow Brook (BHBM01), Poland Brook (PLBM01), and the uppermost South River site (SORM08) – all scored in the slightly impaired range.

SORM07, the South River at Emmett Road, received the lowest total BMI score of 22. EPT richness, total taxonomic richness, and HBI scores were each significantly lower than those from the Chapel Brook reference reach, and were responsible for the low total score SORM07 received (Tables 7 & 8). The underperformance of these metrics at this site was unexpected because the section of the South River upstream of this site flows through forested land with a mature riparian zone for at least a half mile downstream of the town of Ashfield. Additionally, SORM8, the upper South River on the upstream side of Baptist Corner Road, received a higher total BMI score of 28, despite the physical conditions within this reach being more degraded than those at SORM07. Because SORM08 is located not more than a half mile downstream from the Ashfield Lake outlet, a poorer BMI condition could have been expected owing to possible adverse effects from the lake on stream temperatures and or nutrient loading, but these problems don't appear to be occurring to any significant extent. In support of this contention, many young-of-the-year brook trout were observed in the wooded section of the upper South River above Baptist Corner Road during reconnaissance surveys of the watershed in late summer 2006. It should also be noted that the Baptist Corner Road bridge/box culvert has an outlet drop of nearly two feet at summertime baseflows, resulting in a fish passage barrier.

Despite adjacent agricultural activity that encroaches on the riparian zone in places further up the drainage, lower Creamery Brook scored as unimpaired. All metric scores, aside from the EPT-to-Chironomidae ratio were similar to those from the Chapel Brook reference reach (Tables 7 & 8). Lower Pumpkin Hollow Brook and lower Poland Brook received very similar BMI scores each resulting in a slightly impaired determination. Each had higher HBI scores than the Chapel Brook reference site (Table

8 and Figure 6), suggesting that some organic enrichment from adjacent land-use activities may be occurring in these two brooks. EPT richness was significantly lower in Pumpkin Hollow Brook than in the Chapel Brook reference reach (Table 8), while Poland Brook's EPT richness was very similar to that of the reference reach. However, Poland Brook's similar EPT richness can be attributed, in part, to the six species of *Hydropsyche* sampled from this site, which resulted in a lower scraper-to-filterer ratio and score for this site. Interestingly, *Hydropsyche* species richness was highest in lower Poland Brook among all South River watershed sites sampled. SORM04 supported five of these species, but *Hydropsyche ventura*, a relatively uncommon Hydropsychidae caddisfly, was found only in PLBM01.

Results of BMI surveys of these tributary reaches further suggest that benthic communities throughout most of the South River watershed are affected little by human activity. Local sources of agricultural runoff, although not directly observed, may be resulting in slight shifts in community structure that result in an increased collective tolerance to this type of pollution. Also, based on observations throughout the watershed that large amounts of sediment are being deposited in lower-gradient reaches of the river, macroinvertebrate communities may also presently be slightly affected by fine sediments in parts of the watershed. Sources of these sediment include the many miles of unstable river banks that occur in the South River (Figure 7). Aside from the potential influence of these two types of disturbance and the potential local effects of development in Ashfield on the upper South River, impacts to benthic communities in the watershed appear to be minimal.

Maintenance of healthy benthic communities and therefore overall ecological health of the South River watershed rests on continued stewardship of these aquatic resources and adjacent riparian habitats. Prevention of further loss of mature riparian zones in the watershed is necessary to ensure the continued health of these communities. Even better, restoration of degraded riparian areas within the watershed – along the mainstem of the South River above and below Conway, in particular – would result in benefits to these resources such as reduced sediment loads, increased channel stability, and increased amounts of woody debris and food materials for aquatic life.

Table 7. RBP III summary scores, reference comparability scores, and corresponding biological condition classifications of macroinvertebrate communities sampled from six tributaries to the South River, Franklin County, Massachusetts in fall 2006.

	Tributary Site					
Metric	**CPBM01**	**CMBM01**	**PHBM01**	**PLBM01**	**SORM07**	**SORM08**
Total Score	42	34	26	28	22	28
% Comparability to Reference	100	81	62	67	52	67
Biological Condition	**REF**	**Non-impacted**	**Slightly impacted**	**Slightly impacted**	**Slight/moderately impacted**	**Slightly impacted**

Table 8. Metric values (and standardized metric scores) derived from macroinvertebrate samples collected from South River tributaries, Franklin County, Massachusetts in fall 2006.

	Site					
Metric	**CPBM01**	**CMBM01**	**PHBM01**	**PLBM01**	**SORM07**	**SORM08**
Richness	39 (6)	36 (6)	31 (4)	39 (6)	26 (4)	25 (4)
EPT Richness	25 (6)	22 (4)	16 (0)	26 (6)	15 (0)	18 (2)
EPT/Chironomidae	15.7 (6)	6.1 (2)	7.2 (2)	4.1 (2)	4.2 (2)	91.0 (6)
HBI modified	2.3 (6)	3.1 (4)	3.4 (2)	3.6 (2)	4.3 (2)	3.9 (2)
Scraper/Filterer Ratio	1.0 (6)	0.6 (6)	1.6 (6)	0.2 (2)	2.7 (6)	0.5 (6)
% Dominant Taxon	11.3 (6)	10.6 (6)	11.8 (6)	10.3 (6)	26.5 (4)	30.9 (2)
% Reference Affinity	100 (6)	72.7 (6)	68.9 (6)	70.7 (6)	52.9 (4)	87.7 (6)

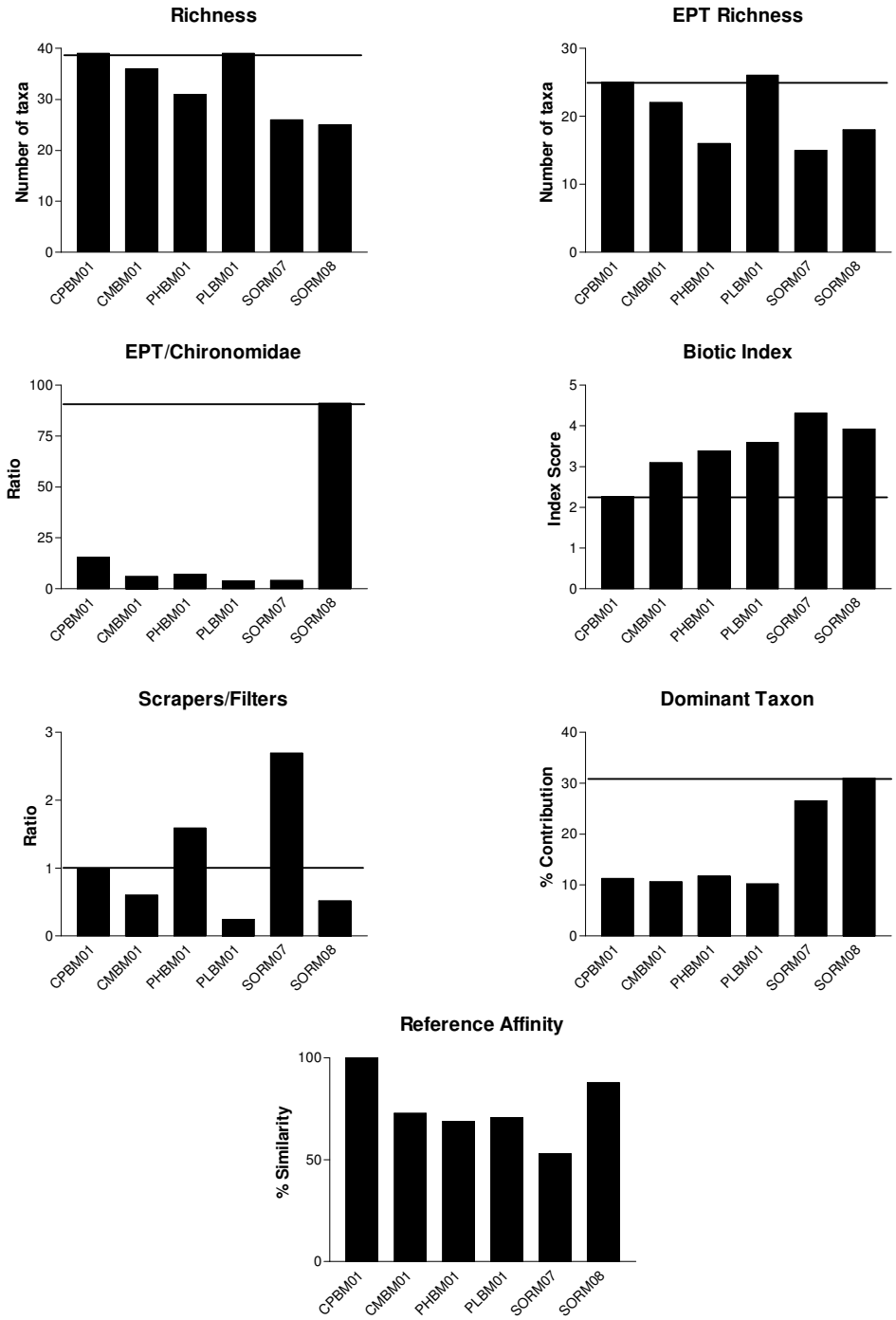

Figure 6. Metric attribute values calculated from macroinvertebrate samples collected from tributary streams to the South River in Franklin County, Massachusetts in fall 2005. Black horizontal lines indicate value of attribute at the reference site on the Chapel Brook (CPBM01).

Figure 7. Photograph of severely eroding river banks along the South River north of Conway. This photo was taken in spring 2007.

QUALITY CONTROL RESULTS

Two samples were collected in duplicate for this study – CMBM01 and PHBM01. CMBM1 samples received total metric scores of 34 and 38, resulting in reference comparability scores 81% and 90% and each scoring as non-impacted. PHBM1 samples received total metric scores of 26 and 28, resulting in reference comparability scores 62% and 67% and each scoring as slightly-impacted. The tributary reference site was also sampled twice in 2006, but on two different dates. Chapel Brook was first sampled on September 10 and then again on September 23. The September 23 sample was chosen as the reference sample because the date was closer to the date the other South River samples were collected. The September 10 sample was used to determine the combined effects of time (two weeks) and sampling error on the resulting scores. The two sites scored very similarly, as discussed earlier, as the September 23 sample (the reference sample) scored a 42, while the September 10 sample scored a 38 (unimpaired). These results collectively suggest that protocols followed in this study were sufficient to produce repeatable impairment determinations.

Residues of two sorted samples were checked for sorting efficacy; each had been sorted at rates exceeding 95% macroinvertebrate removal (96% and 98%).

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LITERATURE CITED

Barbour, M. T., J. Gerritsen, B. D. Snyder, and J. B. Stribling. 1999. Rapid Bioassessment Protocols for Use in Streams and Rivers: Periphyton, Benthic Macroinvertebrates, and Fish. Second Edition. EPA 841-B-99-002. Office of Water, US Environmental Protection Agency, Washington, DC. 151 p. + appendices

Cole, M.B. and M.F. Walk, 2005. Quality Assurance Project Plan for the 2005-2009 Deerfield River Watershed Volunteer Macroinvertebrate Monitoring Program. Prepared for the Massachusetts Department of Environmental Protection and the US EPA. 27 pp. + appendices.

MA DEP. 1999. Massachusetts Section 303(d) List of Waters – 1998. Massachusetts Department of Environmental Protection, Division of Watershed Management. Worcester, MA. 129 p.

MA DWM. 2004. Deerfield River Watershed 2000 Water Quality Assessment Report. MA DEP/DWM, Worcester, MA.

MA DWM 2005. SAP for 2005 DWM Monitoring in the Deerfield Watershed. MA DEP, Worcester, MA.

Merritt, R.W. and K.W. Cummins (eds.). 1996. An introduction to the aquatic insects of North America. Kendall/Hunt Publishing Co. Dubuque, IA. 862 p.

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

Peckarsky, P.R. Fraissinet, M.A. Penton, and D.J. Conklin, Jr. 1990. Freshwater macroinvertebrates of northeastern North America. Comstock Publishing Assoc. Ithaca, NY. 442 p.

Schefter, P. W., and G. B. Wiggins. 1986. A Systematic Study of the Nearctic Larvae of the *Hydropsyche morosa* Group (Trichoptera: Hydropsychidae). Life Sciences Miscellaneous Publication of the Royal Ontario Museum, Toronto.

Schuster, G. A., and D. A. Etnier. 1978. A Manual for the Identification of the Larvae of the Caddisfly Genera *Hydropsyche* Pictet and *Symphitopsyche* Ulmer in Eastern and Central North America (Trichoptera: Hydropsychidae). U.S. Environmental Protection Agency publication EPA-600/4-78-060. USEPA, Cincinnati, Ohio.

Stewart K.W., and P. B. Stark. 2002. Nymphs of North American Stonefly Genera. Second Edition. The Caddis Press. Columbus, Ohio. xii+510 pp.

Wiederholm, T. (ed.). 1983. Chironomidae of the Holarctic region: Keys and diagnoses (Part 1. larvae). Ent. Scand. Suppl. 19. 457 p.

Wiggins G.B. 1996. Larvae of the North American Caddisfly Genera. Second Edition. University of Toronto Press. Toronto ON.

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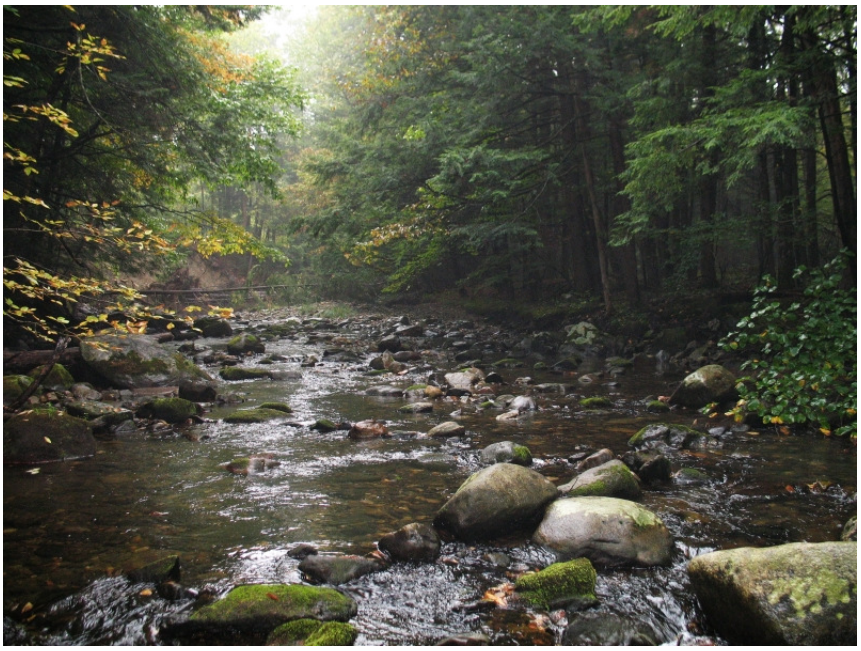
APPENDIX I – SAMPLE SITE PHOTOS



BRRM1 – Bear River ~75 m upstream of Shelburne Falls Road crossing.

CPBM1 – Chapel Brook ~50 m upstream of N Poland and Main Poland roads intersection.

CRBM01 – Creamery Brook ~50 m above the confluence with the South River

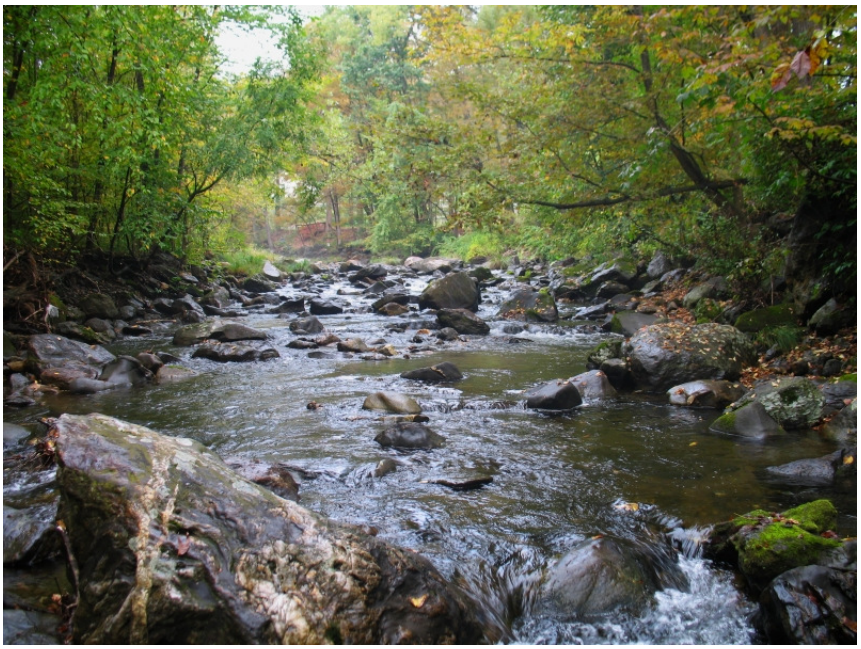
BHBM01 –Pumpkin Hollow Brook ~75 m above the confluence with the South River

PLBM01 – Poland Brook ~50 m above the confluence with the South River.

SORM01 – South River 100 m above confluence with Deerfield River

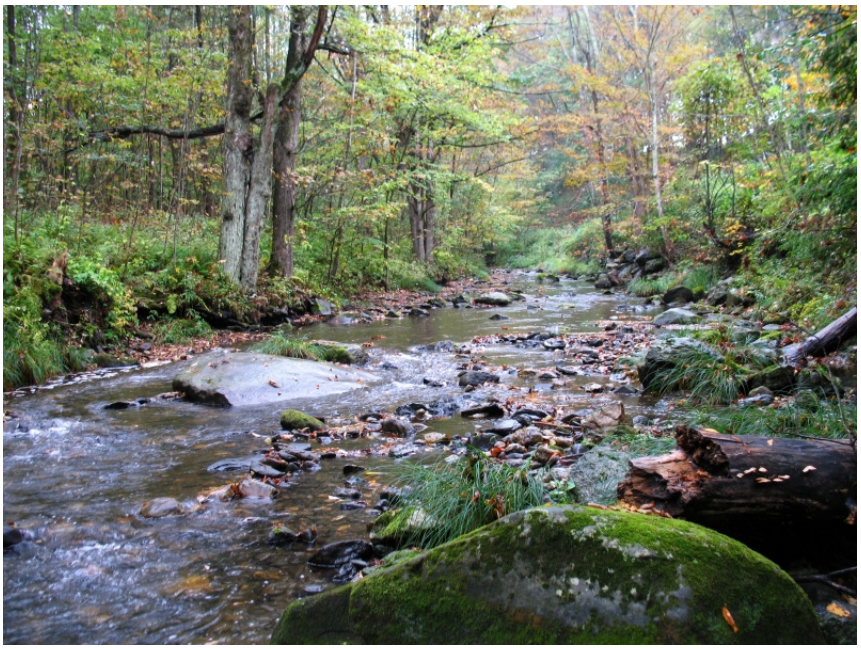
SORM02 – South River Upstream of Reed's Bridge just below gaging station

SORM03 – South River ~100 m upstream of Emerson Hollow Rd & Shelburne Falls Rd intersection.



SORM04 –South River ~75 m above the confluence with Pumpkin Hollow Brook

SORM05 – South River 250 m above the Rt. 116 bridge at Eldridge Road.



SORM06 – South River 1/6 mile below the Bullitt Road crossing.

SORM07 – South River on the upstream side of the Emmett Road crossing in Ashfield

SORM08 – South River on the upstream side of Baptist Corner Road crossing in Ashfield.