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Deerfield River Watershed
2005 Benthic Macroinvertebrate Assessment

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INTRODUCTION

Biological monitoring is a useful, cost-effective method 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 (Barbour et al. 1999, Barbour et al. 1995). Surveying and assessing these sentinel species and their habitats are the principle tools of biomonitoring.

As part of the Massachusetts Department of Environmental Protection/Division of Watershed Management's (MassDEP/DWM) 2005 Deerfield River watershed assessments, aquatic benthic macroinvertebrate biomonitoring and habitat assessment were conducted to evaluate the biological health of selected portions of the watershed. A total of 15 benthic stations were sampled to obtain evidence of potential stressor effects on resident biological communities. Biomonitoring station locations, along with station identification numbers, watershed areas and sampling dates, are noted in Table 1. Biomonitoring stations also appear in Figure 1.

The selected sampling stations are located in a variety of streams throughout the Massachusetts portion of the watershed. All of the stations have riffle-zones - riffle-zones are noted as containing the greatest abundance and diversity of lotic benthic fauna (Plafkin et al. 1989); yet, these high velocity areas are located in streams of a variety of sizes. For the purpose of more precise comparison, the benthic stations have been divided by the size of their contributing watersheds into two categories (using GIS data and USGS StreamStats--USGS 2007). Streams with watershed areas less than 40 km^2 were considered "Small Watersheds", while those with greater than 40 km^2 were considered "Large Watersheds". Basin slope (aka stream gradient) was also included in Table 1. This variable measures the decline in elevation from the stream's headwaters to the biomonitoring station. Although there is no clearly defined rule as to what basin slope percentage is indicative of a high-gradient stream, values above 6% should be considered as having a significant gradient. Stream gradient can be used as a predictor of sediment transport and deposition, and may influence distribution of aquatic organisms. Stream length (headwaters to biomonitoring station) is also included in the table as this measure was required to define basin slope.

Collection and analysis of macroinvertebrate data provide information necessary for making basin-wide aquatic life use-support determinations required by Section 305(b) of the Clean Water Act. All Deerfield River watershed biomonitoring stations were compared to reference stations representing "least disturbed conditions" (Stoddard; et al. 2006). Hinsdale Brook (HI02) was the reference station for Small Watershed stations and the Cold River (CR02) served as the reference site for Large Watershed stations. The choice of reference station to use for comparison to a study site was based on comparability of stream morphology, flow regimes, and drainage area. Use of watershed reference stations is particularly useful in assessing nonpoint source pollution originating from multiple and/or unknown sources in a watershed (Hughes 1989). Both the quality and quantity of available habitat affect the structure and composition of resident biological communities. Effects of habitat features can be minimized by comparing collected data to reference stations with similar habitats (Barbour et al. 1999). Sampling highly similar habitats also reduces metric variability attributable to factors such as current speed and substrate type.

During winter 2004-2005, problem areas, potential problem areas, and areas lacking historical data within the Deerfield River watershed were better defined through such activities as communicating with knowledgeable and interested parties (MA DEP, USGS, EPA, and watershed associations), examining historical data, identifying "unassessed" waters, conducting site visits, examining GIS datalayers, and reviewing NPDES and water withdrawal permits. Table 2 includes a summary of the perceived problems identified in the Deerfield River watershed (MassDEP 2004a).

The main objectives of the 2005 biomonitoring in the Deerfield River watershed were: (a) to determine the biological health of streams within the watershed by conducting assessments based on aquatic macroinvertebrate communities; and (b) to identify problem stream segments so that efforts can be focused on developing NPDES permits, Water Management Act (WMA) permits, stormwater management, and control of other nonpoint source (NPS) pollution. Specific tasks were:

1. Conduct benthic macroinvertebrate sampling and habitat assessments at locations throughout the Deerfield River watershed;

2. Based upon the macroinvertebrate data, identify river segments within the watershed with potential point/nonpoint source pollution problems; and

3. Using the benthic macroinvertebrate data and supporting field/habitat data:

   - Assess the types of water quality and/or water quantity problems that are present, and
   - If possible, make recommendations for remedial actions or additional monitoring and assessment.
   - Provide macroinvertebrate and habitat data to MassDEP/DWM's Environmental Monitoring and Assessment Program for assessments of aquatic life use-support status required by Section 305(b) of the Federal Clean Water Act (CWA).
   - Provide macroinvertebrate and habitat data for other informational needs of Massachusetts regulatory and resource agencies.

Table 1. List of 2005 Deerfield River Watershed Biomonitoring Stations in Massachusetts
List of benthic biomonitoring stations sampled during the 2005 Deerfield River watershed survey, including station identification number, kilometer point (distance from mouth), upstream gradient and drainage area, station description, and sampling date. Stream and watershed statistics derived from USGS (2007).

Station ID	km Point	Basin Slope (%)	Basin Area (km^2)	Station Description	Sampling Date
Small Watersheds <40 km^2					
WH02	0.98	9.2	3.37	**Wheeler Brook.** Shelburne Road West, ~0.16 km upstream of Route 2, Greenfield	27-Sep-05
DM00	0.21	11.4	7.93	**Davis Mine Brook.** ~100 m upstream of confluence with Mill Brook, Charlemont	27-Sep-05
CE01	0.38	8.86	9.45	**Creamery Brook.** ~20 m upstream of Williamsburg Road, Ashfield	28-Sep-05
HI02*	0.42	9.28	13.65	**Hinsdale Brook.** West of Plain Road, ~60 m upstream of confluence with Punch Brook, Greenfield	26-Sep-05
PL01	1.15	8.25	14.76	**Poland Brook.** Upstream of North Poland Road, Conway	28-Sep-05
MB09	3	11.2	20.49	**Mill Brook.** Southeast of Route 8A, ~0.6 km upstream of confluence with Maxwell Brook, Charlemont	27-Sep-05
VP11BEA	3.7	8.73	25.82	**Bear River.** ~100 m upstream of Shelburne Falls Road, Conway	28-Sep-05
Large Watersheds >40 km^2					
CL01	0.93	11.2	46.88	**Clesson Brook.** Upstream of Route 112, Buckland	26-Sep-05
CR02*	3.99	10.1	73.3	**Cold River.** ~1.9 km downstream of Wheeler Brook, North of Route 2, Savoy	26-Sep-05
GR02	1.09	9.29	96.87	**Green River.** ~150 m upstream of Thorne Brook confluence, Leyden/Colrain	22-Sep-05
BBA-UP	4.33	9.54	221.19	**North River.** ~300 m downstream of Adamsville Road, Colrain	27-Sep-05
BBA-DN	3.69	9.56	221.96	**North River.** ~350 m downstream of Route 112, Colrain	27-Sep-05
GR01	1.53	8.89	231.03	**Green River.** ~150 m downstream of Petty Plain Road footbridge, Greenfield	26-Sep-05
UDR01	50.36	10.9	681.17	**Deerfield River.** ~300 m upstream of Florida Bridge, Florida	22-Sep-05
LDR01	12.53	11	1455.57	**Deerfield River.** ~100 m upstream of I-91 Bridge, Greenfield	28-Sep-05

*Reference Station

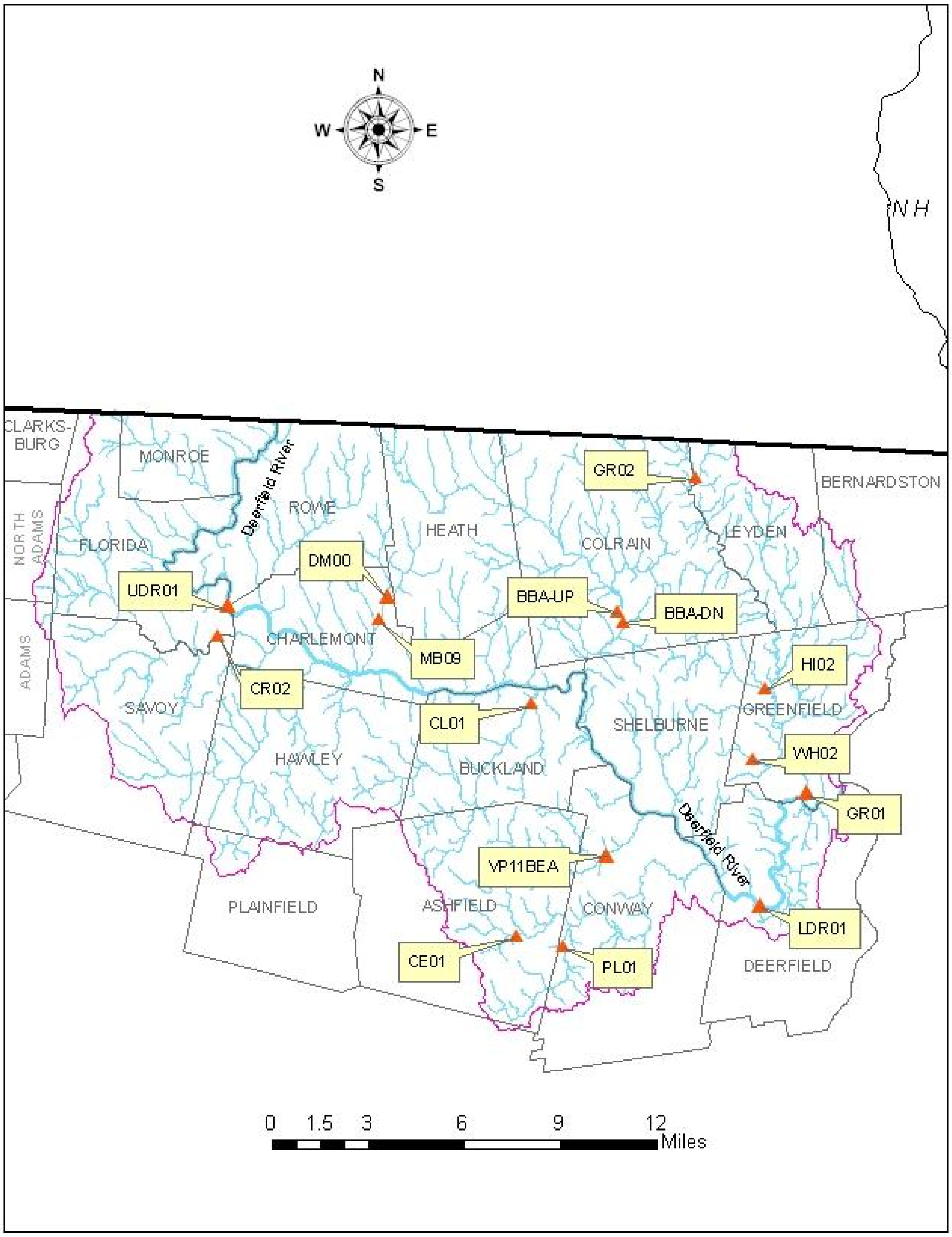

Figure 1. Location of 2005 Deerfield River Watershed Biomonitoring Stations

Table 2. List of Perceived Problems
List of Issues/Problems identified in Deerfield River Watershed 2000 Water Quality Assessment Report (MassDEP 2004a) prior to the 2005 Deerfield River Watershed biomonitoring survey.

Stream Name (Station Number)	Issues/Problems
Wheeler Brook (WH02)	Potential NPS (road runoff). Unassessed for aquatic life
Davis Mine Brook (DM00)	Acid mine drainage/pH impairment Habitat alteration Unassessed for aquatic life
Creamery Brook (CE01)	Potential NPS (road runoff, agriculture) Unassessed for aquatic life
Hinsdale Brook (HI02)*	Suboptimal habitat quality Unassessed for aquatic life Served as "Small Watershed" Reference
Poland Brook (PL01)	Unassessed for aquatic life
Mill Brook (MB09)	Acid mine drainage from Davis Mine Brook Alert status for Aquatic Life
Bear River (VP11BEA)	No potential problems
Clesson Brook (CL01)	Potential NPS (road runoff, agriculture)
Cold River (CR02)*	Potential NPS (road runoff) Served as "Large Watershed" Reference
Green River (GR02)	Miscellaneous NPS (road runoff)
North River (BBA-UP)	Continued monitoring recommended Agriculture, Other NPS
North River (BBA-DN)	Continued monitoring recommended BBA Non-wovens
Green River (GR01)	Urban runoff (stormwater, road runoff) Potential illicit sewer connections/dry-weather discharges Habitat degradation
Deerfield River (UDR01)	Flow regulation/alteration Potential NPS impacts (road and railroad runoff)
Deerfield River (LDR01)	Flow regulation/alteration Unknown NPS impacts Upstream point source discharges

* Reference Station

METHODS

MACROINVERTEBRATE SAMPLING

The macroinvertebrate sampling procedures employed during the 2005 Deerfield River watershed biomonitoring survey are described in Nuzzo (2002), and are based on US EPA Rapid Bioassessment Protocols (RBPs) for wadeable streams and rivers (Barbour et al. 1999). 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 activities were conducted in accordance with the Quality Assurance Project Plan (QAPP) for benthic macroinvertebrate biomonitoring (MassDEP 2004b). Sampling was conducted by MassDEP/DWM biologists throughout a 100 m reach, in riffle/run areas with fast currents and rocky (boulder, cobble, pebble, and gravel) substrates—generally the most productive habitats, supporting the most diverse communities in the stream system. Ten kicks in squares approximately 0.46 m x 0.46 m were composited for a total sample area of about 2 m^2. Samples were labeled and preserved in the field with denatured 95% ethanol, then brought to the MassDEP/DWM lab for further processing.

MACROINVERTEBRATE SAMPLE PROCESSING AND ANALYSIS

The macroinvertebrate sample processing and analysis procedures employed for the 2005 Deerfield River watershed biomonitoring samples are described in the standard operating procedures (Nuzzo 2002) and were conducted in accordance with the Quality Assurance Project Plan (QAPP) for benthic macroinvertebrate biomonitoring (MassDEP 2004). Macroinvertebrate sample processing entailed random selection of specimens from the other materials in the sample until approximately 100 organisms (±10%) were extracted. Specimens were identified to family (RBPII) as allowed by available keys, specimen condition, and specimen maturity. While a RBPIII level of effort (genus/species level taxonomy) provides more accurate information on ecological/ environmental relationships and sensitivity to impairment, family level provides a higher degree of precision among samples and taxonomists, requires less expertise to perform, and accelerates assessment results (Plafkin et al. 1989). Taxonomic data were analyzed using a modification of Rapid Bioassessment Protocol II (RBP II) metrics and scores (Plafkin et al. 1989). 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 a selected “least disturbed condition” reference station yields an impairment score for each site. The analysis separates sites into three categories: *Non-Impacted, Moderately Impacted*, and *Severely Impacted*. Each impact category corresponds to a specific aquatic life use-support determination used in the Clean Water Act (CWA) Section 305(b) water quality reporting process—*Non-Impacted* communities are assessed as “Support” in the 305(b) report; *Moderately Impacted* and *Severely Impacted* communities are assessed as “Non-support.” A description of the *Aquatic Life* use designation is outlined in the *Massachusetts Surface Water Quality Standards* (SWQS) (MassDEP 2006). 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 Taxa Richness; or shifts in community composition relative to the reference station (Barbour et al. 1999). Those biological metrics calculated and used in the analysis of 2005 Deerfield River watershed macroinvertebrate data are listed and defined below (For a more detailed description of metrics used to evaluate benthos data, and the predicted response of these metrics to increasing perturbation, see Barbour et al. 1999):

1) Taxa Richness—a measure based on the number of taxa present. Generally increases with increasing water quality, habitat diversity, and habitat suitability.

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

3) Hilsenhoff Biotic Index (HBI)—an index designed to produce a numerical value to indicate the level of organic pollution (Hilsenhoff 1987). Organisms have been assigned a value ranging from zero to

ten based on their tolerance to organic pollution. Tolerance values (TV) currently used by MassDEP/DWM biologists were originally developed by Hilsenhoff and have since been supplemented by Bode et al. (1991) and Lenat (1993). 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 (EPT/Chironomidae)—a ratio using relative abundance of these indicator groups as a measure of community balance. Skewed populations having a disproportionate number of the generally tolerant Chironomidae (“midges”) relative to the more sensitive insect groups may indicate environmental stress.

5) Percent Dominant Taxon—the percent contribution of the numerically dominant taxon to the total numbers of organisms. A community dominated by few species indicates environmental stress. Conversely, more balance among species indicates a healthier community.

6) Ratio of Scraper and Filtering Collector (SC/FC) Functional Feeding Groups—a ratio reflecting 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) Reference Affinity—a comparison of a study site community 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 RBPII scores as follows: <35% receives 0 points; 3 points in the range from 35 to 64%; and 6 points for $\geq$64%.

HABITAT ASSESSMENT

An evaluation of physical habitat quality is critical to any assessment of ecological integrity (Karr et al. 1986; Barbour et al. 1999). 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). Before leaving the sampling reach during the 2005 Deerfield River watershed macroinvertebrate biosurveys, habitat qualities were assessed using a modification of the evaluation procedure in Barbour et al. (1999). The matrix used to assess habitat quality is based on key physical characteristics of the water body and related streamside features. Most of the parameters related to instream physical attributes are influenced by overall land use and are potential sources of limitation to the aquatic biota (Barbour et al. 1999). The ten habitat parameters are as follow: 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 a reference station to judge the probable magnitude of the influence of any detected habitat differences on the RBP outcome.

QUALITY CONTROL

Field and laboratory Quality Control (QC) activities were conducted in accordance with the Quality Assurance Project Plan (QAPP) for biomonitoring and habitat assessment (MassDEP 2004b). Quality Control procedures are further detailed in the standard operating procedures (Nuzzo 2002).

RESULTS AND DISCUSSION

Results of the 2005 Deerfield River Watershed macroinvertebrate monitoring study, including taxonomic lists (tables 4 and 5), habitat assessment results (Table 9) and summaries of the RBP analyses (tables 6-8) can be found in the appendix to this memorandum. Based on USGS surface-water runoff data (USGS 2006), streamflow conditions appeared "normal" (neither drought, nor flood conditions) during the month prior to benthic sample collection (September, 2005). As a result, the resident benthic communities were not under excessive stress from either drought conditions or flood conditions during the sampling period.

Small Watersheds (<40 km^2)

HI02 – HINSDALE BROOK (REFERENCE STATION)

West of Plain Road, approximately 60 m upstream of confluence with Punch Brook, Greenfield

Habitat

Hinsdale Brook is Class B water as defined in the Massachusetts Surface Water Quality Standards (MassDEP 2006). The watershed contributing to HI02 (13.65 km^2) lies within the towns of Shelburne, Colrain, and the city of Greenfield. Hinsdale Brook becomes a named stream at the confluence of two unnamed second-order streams west of Fiske Mill Road in Shelburne. Hence, Hinsdale Brook is third-order along its course through the sampled reach and on to its confluence with the Green River. The gradient of Hinsdale Brook is steep (9.28%) from its point of inception to HI02, but decreases downstream as the stream flows on to the Connecticut River valley floor. Much of the land use in the contributing headwaters is dominated by no-till agriculture such as, hay fields, orchards, and pasture land. The high gradient portion of the river flows through a heavily forested land use. Residential land use increases in the city of Greenfield, but an adequate, forested riparian buffer zone remains in place.

The within-reach habitat conditions at HI02 (146/200) suffered slightly due to low base flow (Table 9). Other habitat impacts included instream sediment deposition and an unstable left bank. While the bank vegetative protection and riparian widths were optimal along both banks, the high densities of non-native, invasive species [>90%: Japanese knotweed (*Polygonum cuspidatum)*, bittersweet (*Celastrus sp.*)] were a concern as they made up a majority of the thick understory. The dominant tree species was sycamore (*Platanus occidentalis*). The canopy cover was 100%.

The stream width within the sampling reach was estimated at 6.5 m. The depth of the riffle and run habitat was estimated at 0.1 m. Pools were not present within the sampled area. No occurrences of NPS pollution were observed, and the water appeared clear and colorless. The inorganic substrate components included 40% cobble, 10% pebble, 10% gravel, and 40% sand. The organic substrate components were entirely CPOM. Approximately 5% of the substrate was covered with brown floc.

Benthos

Hinsdale Brook was chosen as the reference station for test sites in small watersheds based on the undeveloped nature (e.g. minimal urban runoff and other NPS pollution, lack of point sources, etc.) of its watershed. The combination of good macroinvertebrate habitat quality and metric values corroborate its designation as a reference station. The HI02 benthos showed good diversity and optimal community balance (a Percent Dominant Taxon metric value of 17% was the lowest of all biomonitoring stations in the survey) typically encountered in a "least-disturbed" stream (Table 6).

Fish by-catch at HI02 included four longnose dace (*Rhinicthys cataractae*), 11 slimy sculpin (*Cottus cognatus*), and one blacknose dace (*Rhinichthys atratulus*). The presence of slimy sculpin is indicative of a cold-water fishery, and this brook is stocked with Atlantic salmon (*Salmo salar*). Nonetheless, this brook is not presently designated as a cold-water fishery.

WH02 – WHEELER BROOK

Shelburne Road West, approximately 0.16 km upstream of Route 2, Greenfield

Habitat

Wheeler Brook is designated as Class B water in the Massachusetts Surface Water Quality Standards (MassDEP 2006). The watershed contributing to WH02 is 3.37 km^2, and lies within the town of Shelburne and the city of Greenfield. Wheeler Brook becomes a named stream at the confluence of an unnamed second-order stream and an unnamed first-order stream (~380 m downstream from the Shelburne/Greenfield border). Wheeler Brook begins, and ends, as a second-order stream – terminating at its confluence with Smead Brook (at the northeast edge of the Route 91/2 rotary). Wheeler Brook's gradient is 9.20%, and quite comparable to that of Hinsdale Brook (9.28%) – the reference station. The sampling location was within the high gradient area, upstream of the Connecticut Valley floor. The primary land use within the watershed is forest; although, there do exist some pastures and widely separated residences. As was the case with Hinsdale Brook, the high gradient portion of the stream is heavily forested, and follows a road (Old Greenfield Road) into the City of Greenfield. There exists an extensive forested buffer on both sides of the stream and road.

The within-reach habitat conditions at WH02 were the worst of all assessed Deerfield River watershed benthic stations (Table 9). Lack of sufficient instream cover, channel alteration (due to the abutting road), sediment deposition, lack of deep habitats, reduced channel flow, reduced bank stability, and a very abbreviated riparian zone (also attributable to the road), contributed to the reduction in the total habitat score (108/200). Also, a great deal of trash was observed in the stream.

The bank vegetation was limited along the left bank, due to the proximity of the road. This unstable, small, area was vegetated with grasses and wildflowers. The right bank understory was sparsely vegetated with grasses and shrubs due to the dominance of eastern hemlock (*Tsuga canadensis*). The riparian zone was extensive along the right bank, and sloped steeply up from the stream. The canopy cover was estimated at 70%.

The stream width within the 100 m sampling reach was estimated at two meters. The depth over both the riffle and run habitat was estimated at 0.1 m. The depth of the small pools within the reach were approximately 0. 3 m. There was a potential source of NPS pollution from the nearby road, and obvious sources of NPS pollution from the amounts of trash observed within the stream. The water was not turbid, and appeared colorless. The inorganic substrate components consisted of 20% boulder, 30% cobble, 10% pebble, 10% gravel, and 30% sand. The organic substrates were entirely Coarse Particulate Organic Matter (CPOM). There was no algal coverage observed within the reach.

Benthos

The benthic sample from WH02 exhibited no signs of detrimental impact (Table 6). In some respects, the benthic community was slightly better than that at the reference station. There were two more families collected at WH02 than at HI02, and the Biotic Index was slightly lower (better). However, the Scraper/Filterer ratio, and reference affinity metric values were reduced. The Plecoptera (often considered one of the most pollution sensitive insect orders) were represented by four different families at WH02, whereas three Plecoptera families were represented in the sample obtained from HI02. WH02 received a total metric score of 36 (out of a possible 42). This condition is representative of *Non-Impacted* conditions.

Occasionally, other organisms are unintentionally captured during a benthic invertebrate survey (by-catch). Two brook trout (*Salvelinus fontinalis*) were captured in the net. The presence of this species is indicative of cold-water conditions within Wheeler Brook.

DM00 – DAVIS MINE BROOK

Approximately 100 m upstream of confluence with Mill Brook, Charlemont

Habitat

Davis Mine Brook is designated as Class B water as defined in the Massachusetts Surface Water Quality Standards (MassDEP 2006). However, it was listed in Category 5 (i.e., waters requiring a TMDL) of the Massachusetts Year 2006 Integrated List of Waters (MassDEP 2007) as the result of impairment (low pH) from acid mine drainage emanating from Davis Mine. The watershed contributing to DM00 (7.93 km^2) lies primarily within the towns of Rowe and Charlemont (USGS 2007). Davis Mine Brook becomes a named stream at the confluence of two unnamed first-order streams in the town of Rowe. Davis Mine Brook receives the flow from two more unnamed first-order streams in Rowe and then enters the town of Charlemont where it conjoins with Mill Brook. The gradient of Davis Mine Brook above the sampling site is 11.4%. That is the steepest gradient of all sites examined, and is reflected in the topology of the surrounding area. The upstream land use is primarily forest. Aside from the discontinued mine, there do exist some small agricultural concerns. These are “no-till” in nature, and appear to be pastures and hay fields. There are a few residences in the proximal watershed, but there exists a large (>200 m) forested buffer between these houses and Davis Mine Brook.

The within-reach habitat score for Davis Mine Brook (180/200) was quite good (Table 9). All habitat measures scored in the “optimal” range with the exceptions of velocity-depth combinations (“suboptimal” - there were no Fast and Deep habitats), and channel flow status (“suboptimal” – there was reduced flow at this station). The reduced flows observed at DM00 were potentially caused by a naturally occurring seasonal reduction in rainfall, and the diminutive size of the contributing watershed. An orange coloration was observed on most of the rocks within the stream. It is believed that this is flocculence from an iron reducing bacteria responding to the seepage from the Davis Mine. The bank vegetative protection and riparian widths were optimal on both sides of the brook. Naturally occurring vegetation appeared undisturbed within the riparian zone. However, the predominance of eastern hemlock (*Tsuga canadensis*) restricted the growth of the understory. The narrow width of the brook (four meters), and the many trees, resulted in a 90% canopy cover.

The depths within the riffles and the runs were estimated at 0.2 m. There was one pool that reached an estimated depth of 0.6 m. No nonpoint sources of pollution (NPS) were evident within the sampled reach. However, a large collection of rusted automotive parts and household appliances downstream of the reach remains a concern. The water was not turbid or colored, nor did it evince any odor. The inorganic substrate components included 40% boulder, 50% cobble, 5% pebble, and 5% gravel. The organic substrates were entirely composed of CPOM. The lack of finer / smaller substrates points to the very high gradient (and consequent high velocities) at this station. Green filamentous algae coverage was estimated at 5%, and brown floc was also observed.

Benthos

Results of the 2005 benthic survey of Davis Mine Brook suggest substantial improvement in the structure of the resident benthos when compared to the benthos encountered at this station in 2000. The 2000 assemblage was characterized by an extreme paucity of organisms (<100 organisms observed in the sample) and an impairment designation of *Severely Impacted*. The sample collected in 2005 yielded an ample number of specimens (>100) including 25 individual mayflies (Ephemeroptera) representing

Baetidae, Ephemerellidae, and Heptageniidae. This was in stark contrast with the 2000 sample which completely lacked mayflies, an insect order that is very sensitive to acidification (Wiederholm 1984).

The caddisfly (Trichoptera) family Lepidostomatidae, highly sensitive to organic pollution, was absent in the 2000 survey, but 14 were collected in 2005. The new occurrence of Lepidostomatidae suggests improvements in water quality at DM00. This insect was found to be one of the early colonizers in a post-disturbance (pesticide application) stream (Whiles, et al. 1980). Although future examinations of the biota within this stream are warranted, it appears that conditions favorable to the support of aquatic life are improving. Davis Mine Brook (DM00) received a determination of *Non-Impacted*.

CE01 – CREAMERY BROOK

Approximately 20 m upstream of Williamsburg Road, Ashfield

Habitat

Creamery Brook is a Class B, Cold Water Fishery resource (MassDEP 2006). The 9.45 km^2 watershed contributing to CE01 lies entirely within the town of Ashfield. Creamery Brook becomes a second-order, named stream below the confluence of two unnamed streams, at the Steady Lane Bridge. It flows adjacent to Creamery Road, receiving flow from unnamed first- and second-order tributary streams, becoming a third-order stream approximately 300 m upstream from the sampling station. The stream is considered "high-gradient," with an 8.86% slope upstream of the sampled location. Although the gradient is high in the headwaters of Creamery Brook, there appears to be a decrease in slope as the brook flows through the village of South Ashfield. Here, near the sampling station, the stream forms several small meanders. The land use within the contributing watershed is a patchwork of forest and mostly non-tilled fields. In some areas, there exists a reduced buffer zone between these fields and the stream.

The within-reach habitat scored somewhat poorly (151/200) (Table 9). Bank stability was poor along both banks throughout the reach. Increased sediment deposition, and marginal riparian zone width along the right bank were also noted. Bank vegetative protection was "optimal", as naturally occurring vegetation covered more than 90% of both banks. Trees and other vegetation provided 70% canopy cover to the reach. The instream cover was considered adequate, but not optimal, for the maintenance of fish populations.

The stream width within the 100 m reach was estimated at two meters. The depth at the riffles and the runs measured 0.2 m and 0.3 m, respectively. The depth of the pools reached 0.5 m. Potential sources of NPS pollution included residences atop the steep banks. The water was not turbid and was without odor or color. The inorganic substrate components were 10% boulder, 60% cobble, 15% pebble, 10% gravel, and 5% sand. All substrates were notably "loose" under foot, and easily shifted. The organic substrate was entirely CPOM. Algal coverage was estimated at 1%.

Benthos

The benthos collected at Creamery Brook (CE01) closely resembled the benthos from the Hinsdale Brook reference station (93% comparability) (Table 6). This observation is indicative of "least-disturbed" conditions (*Non-Impacted*). Only the scraper/filterer metric deviated significantly from that of the reference site. The cold-water classification of Creamery Brook was corroborated during kick-sampling with the by-catch of the obligate cold-water species, slimy sculpin (*Cottus cognatus*).

PL01 – POLAND BROOK

Upstream of North Poland Road, Conway

Habitat

Poland Brook is designated as a Class B Cold Water Fishery resource (MassDEP 2006). The 14.76 km^2 watershed contributing to PL01 comprises the towns of Ashfield and Conway. Poland Brook becomes a named stream at the confluence of Chapel Brook and an unnamed stream east of North Poland Road in

Conway. Poland Brook originates as a second-order stream, and remains such throughout the sampling reach. It becomes a third-order stream approximately 200 m upstream from its confluence with the South River in Conway. The stream gradient upstream of the sampling reach is 8.25% and, although it is the lowest gradient stream sampled during the 2005 benthic survey, it is classified as a high-gradient stream. Nonetheless, there exists a small valley upstream of the sampled reach. Within this valley there is a zone of low gradient, and a large wetland. The wetland has been modified, and a pond has been developed within this area. The claimed land, next to the pond, appears to be used as hayfield, and appears to flood in the spring. The land use within the contributing watershed is a mix of forest and agriculture. There are a few residences within the watershed, as well. Much of the contributing watershed is Wildlife Management Area.

The total habitat score for PL01 was 153/200 (Table 9). There was extensive sediment deposition throughout the reach, much of it silt. There appeared to be little refugia available for fish species within the examined reach and instream cover (for fish) was rated as "marginal". The streambanks were more than 90% covered with naturally occurring vegetation. The riparian zone was greater than 18 m and contained a mix of native tree species (60%), shrubs and vines (60%), and herbaceous vegetation (100%).

The stream width was estimated at six meters. The riffles and runs were 0.2 m deep, and the pools were 0.5 m deep. There was no evidence of NPS pollution, but the upstream wetland, pond and fields were not observed at the time of this survey. The water exhibited no turbidity, odor or color. The inorganic substrates included 10% boulder, 80% cobble, 5% pebble, and 5% silt. The organic substrate was entirely CPOM (although the "silt" actually may have been FPOM).

Benthos

Due to the broad range of scores encompassed by the middle category of the RBP II analysis, RBP III analysis was applied to the PL01 benthic data. The RBP III analysis is based on genus/species taxonomic data and thus gives a more detailed characterization of the benthic macroinvertebrate community than the family-level taxonomy used for RBP II analysis. The increased taxonomic resolution allows detection of more subtle degrees of impairment and the discrimination of four impact categories: *Non-Impacted, Slightly Impacted, Moderately Impacted,* and *Severely Impacted*.

After recalculating the metrics (for both PL01 and the reference station HI02) based on genus/species taxonomy (Table 5), the PL01 benthic community was found to be *Slightly Impacted* (Table 8). The preponderance of filtering collectors (80% of assemblage) and the hyperdominance by *Hydropsyche morosa* gr. (42% of the assemblage) resulted in metric scores of zero for both the Scraper/Filtering Collector ratio and Percent Dominant Taxon, respectively. Subsequently, the RBP III result fell in the range for *Slightly Impacted*. This indicates the presence of a high loading of suspended organic particulates, suggesting the sediment fraction characterized as "silt" in the field likely is FPOM and may well reflect high productivity in the upstream pond/wetland.

MB09 – MILL BROOK

Southeast of Route 8A, approximately 0.6 km upstream of confluence with Maxwell Brook, Charlemont

Habitat

Mill Brook is designated a Class B, Cold Water Fishery according to the Massachusetts Water Quality Standards (MassDEP 2006). The watershed contributing to benthic station MB09 (20.49 km^2) is encompassed by the towns of Rowe, Heath, and Charlemont. Mill Brook becomes a named, second-order stream below the village of Dell (in Heath). It flows into Charlemont, receives the flow from Davis Mine Brook, and becomes a third-order stream. It continues its course through Charlemont, receiving the flow from Maxwell Brook, and remains a third-order stream as it empties into the Deerfield River. The majority of the land use is forest. There is some small non-till agriculture (hay fields and pasture), and a sparse number of homes. The stream gradient is 11.2% which is considered high-gradient.

The within-reach habitat conditions were quite good (173/200) (Table 9). Some slight reductions in the total habitat score were due to the proximity of Route 8A (along the right bank) which had the effect of reducing the riparian zone width. There was also some potential for erosion along this right bank which reduced “bank stability” to a suboptimal rating. Despite the adjacent road, the riparian zone width and the bank vegetative protection scored in the “optimal” range. Eastern hemlock (*Tsuga canadensis*) was the dominant tree species, and the trees provided 90% canopy cover to the stream. Due to the year-round shading and acidic nature of eastern hemlock stands, the understory was quite thin. Shrubs – mostly mountain laurel (*Kalmia latifolia*) – and vines were reduced to 50% coverage. The herbaceous growth was reduced to 25% coverage and consisted primarily of grasses, ferns, and moss.

The stream width within the 100 m sampling reach was estimated at five meters. The depth at both the riffles and runs was estimated at 0.3 m, and there were no well-defined pools. There was no evidence of any NPS pollution. The water was not turbid, nor did it have any color or odor. The inorganic substrate components included 50% boulder, 40% cobble, 5% pebble, and 5% gravel. The organic substrate components were entirely CPOM. The lack of finer grained substrates is indicative of the high gradient and subsequent high velocities within this stream reach. There was no algal coverage within this reach.

Benthos

The benthic community at MB09 appeared quite diverse, with sensitive taxa well represented in the sample. In comparison to the reference station (HI02), Mill Brook (MB09) was *Non-Impacted* (Table 6). In fact, the Taxa Richness, Biotic Index and EPT/Chironomidae Ratio were all slightly better at MB09 than at the reference station.

Seven Lepidostomatidae were collected from MB09. As noted earlier, these sensitive insects were also present at the upstream Davis Mine Brook station. Nine Chloroperlidae were also collected from MB09. These insects have displayed some tolerance to reduced pH (Davy-Bowker et al. 2005) such as that associated with acid mine drainage, and their presence may point to the influence that Davis Mine Brook has on Mill Brook.

The resident benthic community of Mill Brook was previously assessed (2000) as *Slightly Impacted* at a location downstream from the confluence with Maxwell Brook (MassDEP 2002). At that time, “metrics for Taxa Richness, EPT/Chironomidae, and Percent Dominant Taxon all performed worse than the reference station” (MassDEP 2002). Impacts to the benthos were largely attributed to water quality degradation originating from Davis Mine Brook. The 2005 Mill Brook station (MB09) was located about 1300 m farther upstream, placing it upstream from any influence from Maxwell Brook, and thus better isolating the impact of Davis Mine Brook on Mill Brook. The 2005 results indicated that Mill Brook was healthy and not adversely impacted by Davis Mine Brook.

VP11BEA – BEAR RIVER

Approximately 100 m upstream of Shelburne Falls Road, Conway

The Bear River is classified as a Class B, Cold Water Fishery resource (MassDEP 2006). The 25.82 km^2 watershed contributing to VP11BEA lies within the towns of Ashfield, Buckland and Conway. The Bear River becomes a named stream at the confluence of two unnamed streams just east of Barnes Road in the town of Ashfield, and is a third-order, high-gradient (slope=8.73%) stream when it reaches the sampling station.

The Bear River at VP11BEA drains a landscape that is hilly and dominated by forest. While there are agricultural activities within the watershed as well, these practices are mostly no-till, and consist of hay fields and pasture. It is not until after it flows through the sampling reach that the Bear River loses most of its elevation, well over 100 m before it joins the Deerfield River in the South River State Forest in the town of Conway.

The total habitat score for VP11BEA was 155/200 (Table 9). Reductions in this score were primarily due to bank erosion and sediment deposition. Areas of erosion, and high potential for erosion during floods were observed along both banks. Sediment deposition was rated as “suboptimal”, with between 5% and 30% of the bottom affected. Channel flow status was rated as “marginal”, with many of the substrates in the riffles exposed. The bank vegetative protection was “optimal”, and the dense cover of trees consisted of both coniferous and deciduous species. These trees provided 80% canopy cover to the stream.

The stream width at VP11BEA was estimated at seven meters. The depth at the riffles and runs was 0.3 m, and the depth at the pools was 0.5 m. There was no evidence of any NPS pollution within, or near, the sampling reach. The water was clear, and had no color or odor. The inorganic substrates included 50% boulder, 35% cobble, 10% gravel, and 5% sand. The organic substrate was entirely CPOM. Algal coverage was less than 1%, and a brown film was noted on the rocks within the riffles.

Benthos

The Bear River is one of the least-impacted streams in the entire Deerfield River watershed (Fiorentino 1997; MassDEP 2002). It was not used as the reference station for the 2005 small-watersheds due to its larger watershed area. The VP11BEA benthic sample represents an exceptionally healthy aquatic community (*Non-Impacted*), with most metrics outperforming the HI02 reference station, as well as all other small-stream stations in the 2005 biosurvey (Table 6). One slimy sculpin (*Cottus cognatus*) was captured as by-catch in 2005. The presence of this fish lends credence to the cold-water fishery designation of this stream.

<u>Large Watersheds (>40 km^2)</u>

CR02 – COLD RIVER (REFERENCE STATION)
Approximately 1.9 km downstream from Wheeler Brook, North of Route 2, Savoy/Florida

Habitat

The Cold River is designated in the Massachusetts Surface Water Quality Standards as a Class B, Cold Water Fishery resource (MassDEP 2006). The watershed area contributing to CR02 is 73.30 km^2. This watershed encompasses portions of four towns (Florida, North Adams, Adams, and Savoy). The Cold River rises north of Blackstone Road in the town of Florida. It soon becomes a second-order stream, augmented by the flow from the Green River (in Florida). It becomes a third-order stream 1.2 km farther downstream when it receives the flow from an unnamed second-order stream. The stream order of the Cold River increases again 3 m farther downstream when it joins Tower Brook. It remains a fourth-order stream through the sampled reach. The high gradient of the Cold River (10.1% upstream of CR02) is maintained through the sampling reach and on to its confluence with the Deerfield River in Charlemont. Most of the land use within the contributing watershed is forested, and too steep for development. Also, the watershed contains parts of Florida State Forest, Savoy Mountain State Forest, and Mohawk Trail State Forest. There are few residences within the watershed. Potential anthropogenic stressors within the watershed include Route 2, and the Mohawk Trail State Park. However, the majority of the park is situated downstream from the sampled reach.

The CR02 within-reach habitat variables totaled 170/200 (Table 9). All parameters scored within the “optimal” range except for channel flow status and velocity-depth combinations which fell within the “marginal” range due to the decreased flows encountered during the survey. As mentioned above, the Cold River is a high-gradient stream and quickly drains water through its system. Also, most high-gradient systems are prone to “flash” flow events – flow levels that quickly change from low-flow to high-flow in a short period of time. This results in an enlarged streambed that is capable of handling the high flow event, yet is not often filled to capacity. At the time of the survey, the stream channel was approximately 25% full, and deep pools were absent from the reach. The vegetation along the immediate banks, and within the highly sloped riparian zone, consisted of a dense stand of deciduous trees (100% cover) whose shade severely limited the growth of shrubs, vines, and herbaceous plants (~5% cover). Despite the dense population of trees along the banks, the wide character of the streambed (see below) limited the canopy cover over the stream reach to approximately 50%.

The streambed at CR02 was wide (15 m), having formed in response to the “flash” flows associated with the steep watershed. The water depth over both the riffles and runs was estimated at 0.2 m and the pools were an estimated at 0.35 m. The water was clear in color and without odor. The proximity of Route 2 (along the right bank) was the only potential source of NPS pollution. The inorganic portion of the substrates included <5% bedrock, 60% boulder, 30% cobble, ~5% pebble, and ~5% gravel. The large proportion of boulder is indicative of the high energy of the water flowing through this reach. The organic substrates were entirely made up of CPOM. Algal coverage was estimated at 68%, and was made up of thin film green algae attached to rocks. The large amounts of periphyton are potentially attributable to the large amount of sunlight reaching the streambed.

Benthos

The Cold River historically has been used as a least-disturbed-condition reference station due to the very limited anthropogenic perturbation within the contributing watershed (Fiorentino 1997; Nuzzo 2002). However, the 2005 Cold River sampling station (CR02) was established at a point 2.7 km upstream from the 2000 station (CR01) to avoid any potential influence of the campground (NPS, latrines, showers).

The 2005 benthic sample obtained from CR02 appeared comparable to the one collected at CR01 in 2000. Both samples were indicative of healthy aquatic communities. Interestingly, Chironomidae comprised 38% and 40% of the total sample at CR01 and CR02, respectively. The 2000 sample was identified to the genus/species level, and it was determined that the dominant taxon was *Polypedilum aviceps* – "a clean water indicator" (Nuzzo 2002, Bode and Novak 1998). However, the 2005 sample was identified to the family level only, and the Percent Dominant Taxon increased from 18% (*Polypedilum aviceps*) in 2000 to 40% (all Chironomidae) in 2005. A cursory examination of the midges observed in the CR02 benthic sample once again found good representation by *Polypedilum aviceps.*

A single Atlantic salmon parr (*Salmo salar*) was accidentally captured during collection of the 2005 benthic sample. The fish was returned to the stream, but its occurrence is indicative of suitable habitat and cold water in this river.

CL01 – CLESSON BROOK
Upstream of Route 112, Buckland

Clesson Brook is Class B water as defined in the Massachusetts Surface Water Quality Standards (MassDEP 2006). The watershed contributing to CL02 (46.88 km^2) lies within the towns of Hawley, Ashfield and Buckland, and is high gradient (11.20%). Clesson Brook begins its course as a named stream at three unnamed ponds east of East Hawley Road in the town of Hawley. The stream follows Clesson Brook Road and enters the town of Buckland. In Buckland, the stream parallels Route 112, and flows eastward through a narrow valley that has been agriculturally developed (and contains Buckland town center). Clesson Brook enters the sampled reach just upstream of Route 112 as a fourth-order stream. From station CL02, Clesson Brook flows under Route 112 and enters the Deerfield River in its final kilometer of flow. Much of the land use in the headwaters is forested, including a portion of Hawley State Forest. The land use changes as the brook flows along Route 112. Here, the narrow valley is used for hay fields, cornfields, dairy, and livestock. Also, the steep gradient found in the headwaters is diminished, yet the stream is still considered high gradient throughout its course.

The total habitat score at CL01 was 148/200 (Table 9). Some of the reductions in scoring were due to diminished instream flow. The channel flow status was rated as "marginal", and most of the substrates were exposed. Some sediment deposition was also noted, reducing this habitat metric to the "suboptimal" level. Instream cover for fish was reduced to "suboptimal", as well. This was due to a lack of adequate refugia – partially due to low flow conditions. Bank stability (along both banks) was "suboptimal", with between 5-30% of the stream banks exhibiting areas of erosion. Finally, the riparian vegetative zone width along the left bank was reduced to less than 6 meters, and was assessed as "poor". The left riparian zone has been developed as a "backyard" for an adjacent residence.

While the bank vegetative protection was "optimal", some Japanese knotweed (non-native, invasive) was observed within the reach. The trees were a mix of deciduous and conifers, and provided only 10% canopy coverage to the reach.

The stream width was estimated at six meters. The depth at the riffles and runs was 0.1 m and 0.2 m, respectively, and the pools were up to 0.4 m deep. There was some potential NPS pollution in the form of road runoff due to the proximity of Route 112. The water was clear and without color or odor. The inorganic substrates included 5% boulder, 70% cobble, 10% pebble, 5% gravel, and 10% sand. The organic substrates were entirely CPOM. Algae coverage was quite high at 60%. Algal types included green filamentous, brown filamentous, and brown “hard balls”. Also, brown floc was observed.

Benthos

Clesson Brook received a determination of *Non-Impacted* when compared to the reference station (Table 7). All community assessment metrics performed better than those at the reference station. The most striking improvement over reference conditions was the Taxa Richness – six more families were represented at CL01 than at CR02. Among the families found at Clesson Brook (but not at the Cold River) were Pteronarcyidae (a stonefly with a tolerance value of 0), and Glossosomatidae (a caddisfly with a tolerance value of 0). The presence of these two pollution-sensitive insects indicates a very healthy aquatic community.

There were two slimy sculpin (*Cottus cognatus*) captured as by-catch. The presence of this obligatory cold-water species suggests that Clesson Brook may be a cold-water fishery. However, this determination cannot be made from the incidental collection of two fish. Both fish were returned to the stream.

GR02 – GREEN RIVER

Approximately 150 m upstream from the confluence with Thorne Brook, Leyden/Colrain

Habitat

The Green River is designated as Class A, Cold Water Fishery, High Quality Water as defined in the Massachusetts Surface Water Quality Standards (MassDEP 2006). GR02 was located 2.1 km downstream from the Vermont border. The 96.87 km^2 watershed contributing to GR02 is high-gradient (9.29%) and comprises portions of the towns of Colrain and Leyden. The Green River is a third-order stream at this location. The majority of land use in the contributing watershed is forest and sparse residential. There are very few potential sources of human impact to this portion of the Green River. The total habitat score for GR02 was 166/200 (Table 9). The decrease in habitat score was primarily due to flow-related issues. The channel flow status was rated “marginal”, and instream cover for fish, and the velocity-depth combinations (there were no fast/deep habitats) were “suboptimal”. Bank stability and vegetative zone width were compromised along the right bank, potentially due to road maintenance along Green River Road.

The trees, mostly eastern hemlock (*Tsuga canadensis*), only provided 10% canopy cover to the reach due to the width of the stream channel (7.5 m). There were no signs of non-native or invasive plant species within the reach. The depth over the riffles and runs was 0.3 m and 0.4 m, respectively, and pools were approximately 0.5 m deep. There was no evidence of any NPS pollution. The water was clear, and without odor or color. The inorganic substrates included 40% boulder, 25% cobble, 15% pebble, 15% gravel, and 5% sand. The organic substrate was entirely CPOM. Green thin-film algae covered 8% of the substrates in the riffles.

Benthos

The benthic sample collected from GR02 exemplified a very healthy aquatic community (*Non-Impacted*). The Taxa Richness, Biotic Index and EPT Index metrics performed better at GR02 than at any other large-stream station during the 2005 Deerfield River watershed biomonitoring survey (Table 7).

In addition to excellent water quality, it is likely that the natural flow and habitat conditions present at this station are responsible for the healthy benthic community at GR02. While these natural conditions lead to a highly variable flow regime, it is this variability that creates conditions amenable to a highly diverse community, such as that encountered at GR02.

Very little human impact exists within the Massachusetts portion of this watershed. That lack of human disturbance, and exceptional water quality conditions, are primary reasons why this stream is being utilized as a public drinking water supply. Continued protection of this resource is highly recommended. MassDEP/DWM may wish to use GR02 as an alternate reference station for future biological investigations of large rivers/streams in the Deerfield River watershed.

BBA-UP – NORTH RIVER
Approximately 300 m downstream of Adamsville Road, Colrain

Habitat

The North River (at BBA-UP) is classified as a Class B, Cold Water Fishery, High Quality Water resource (MassDEP 2006). The watershed contributing to BBA-UP (221.19 km^2) is situated in the Massachusetts towns of Rowe, Heath, and Colrain, and extends northward into Vermont. The North River is formed in the village of Griswoldville (Colrain) by the confluence of the East Branch (3rd order) and West Branch (4th order) North River. This confluence is 0.9 km upstream from the sampled reach. The gradient of the North River upstream of BBA-UP is considered high (9.54%), but the slope decreases somewhat as the river flows through the sampled reach. Much of the land use within this large watershed is forested. However, in the narrow valleys nearer the river, development of residences, small farms, and small industrial facilities has taken place. The greatest amount of development, and most proximal to the sampled station, is at the confluence of the two branches. Much of the valley floor has been developed with pastures, lawns, cornfields and residences.

The total habitat score at BBA-UP was 177/200 (Table 9). All habitat measures scored within the "optimal" range except Channel Flow Status ("suboptimal") and Riparian Vegetative Zone Width. The proximity of the BBA Nonwoven mill buildings along the left bank, and an expansive residential lawn along the right bank, reduced the width of the riparian vegetative zone to "marginal". Also, approximately 20% of the vegetation along the banks was the non-native Japanese knotweed. The canopy coverage supplied by nearby trees and vegetation was only 2%.

The stream width at BBA-UP was estimated at 14 m. The depth of the riffles and runs was estimated at 0.3 m, and the depth in the pools was estimated at 0.4 m. The water was clear and without color or odor. Potential NPS pollution included runoff from the BBA parking lot and the adjacent lawn. Substrates were quite coarse at this station. The inorganic substrates included 40% boulder, 40% cobble, 15% pebble, and 5% gravel. The organic substrates were entirely CPOM. There were no observed algae within the reach.

Benthos

The benthic sample collected from BBA-UP indicated that there was no impact (*Non-Impacted*) to the resident macroinvertebrate community (Table 7). A diverse and healthy community that displayed optimum structure characterized the benthos.

By-catch included one slimy sculpin (*Cottus cognatus*) and one longnose dace (*Rhinichthys cataractae*). The presence of slimy sculpin corroborates the classification of this stream as a cold water fishery.

BBA-DN – NORTH RIVER
Approximately 350 m downstream of Route 112, Griswoldville (Colrain)

Habitat

The North River at BBA-DN is designated a Class B, Cold Water Fishery in the Massachusetts Surface Water Quality Standards (MassDEP 2006). BBA-DN was located ~670 m downstream from BBA-UP and approximately 400 m downstream from the effluent discharge from BBA Nonwovens Simpsonville Incorporated Wastewater Treatment Facility (1.35 MGD of treated industrial and domestic wastewater—MassDEP 2004a). Because of the proximity to BBA-UP, many of the watershed features described above are identical for both stations. The watershed servicing BBA-DN is 221.96 km^2, and the gradient upstream of BBA-DN is 9.56%. Although this is well within the definition of "high-gradient", the sampled reach did not evince the high velocities and coarse substrates that were found at BBA-UP.

The total habitat score at BBA-DN was 141/200 (Table 9). This reduction in score, when compared to the upstream BBA-UP station, is due to reduced instream cover for fish, increases in sediment deposition, lack of deep-water habitats, decreased stability of both banks, and a reduced riparian vegetative zone width along the left bank. The high stream velocities in evidence at BBA-UP do not exist at this downstream station. As a result, smaller substrates (e.g. sand, gravel) are not transported further downstream and are deposited within the reach. Also, these smaller substrates may also be entering the river from the moderately unstable banks along both stream margins. The canopy cover was 10%.

The stream width within the sampled reach was estimated at 12 m. The depth in the riffles and runs was estimated at 0.3 m and the depth in the pools was estimated at 0.4 m. The water was without turbidity, color or odor. One potential nonpoint source of pollution observed during the survey was runoff from ongoing road and bridge repairs upstream at Route 112. The inorganic substrates were dominated by cobble, but of much smaller size than those encountered upstream. Substrates comprised 10% boulder, 50% cobble, 20% pebble, 10% gravel, and 10% sand. The organic substrates were entirely CPOM. There were no observed algae within the reach.

Benthos

The benthic sample collected from BBA-DN was determined to be healthy and showed no signs of impairment (*Non-Impacted*) when compared to the large-stream reference station in the Cold River (Table 7). Although this station is downstream of an industrial discharge, there appeared to be no difference between the upstream sample (BBA-UP) and this downstream sample (BBA-DN). In fact, most metrics calculated for BBA-DN performed better than those for BBA-UP (Table 7).

GR01 – GREEN RIVER

Approximately 150 m downstream of Petty Plain footbridge, Greenfield

Habitat

The Green River is a Class B, Cold Water Fishery resource (MassDEP 2006). The Massachusetts portion of the watershed contributing to GR01 (231.03 km^2) encompasses the towns of Colrain, Leyden and the City of Greenfield. The Green River becomes a named stream at the confluence of unnamed second-order and first-order streams in Halifax, VT. The Green River enters Colrain, Massachusetts as a third-order stream where it forms the border with Leyden. After flowing into Greenfield, the river becomes fourth-order when it receives flow from Glen Brook, and remains so to its confluence with the Deerfield River. The overall gradient from the headwaters to this station is 8.89%. Although the upper Green River watershed land use is dominated by forest, the lower watershed (more proximal to GR01) is heavily urbanized. The lower watershed is marked by a variety of industrial, commercial, and residential land uses in Greenfield, much of which abuts the banks of the Green River.

The total habitat score for GR01 was 131/200 (Table 9). The habitat was limited by marginal instream cover for fish, slight embeddedness of substrates, channel alteration due to Route 5/10, the lack of deep habitats, marginal channel flow, suboptimal bank stability along the left bank, and reduced riparian zone width along both banks. Human development immediately adjacent to, and upstream from, this station seems to be adversely affecting instream habitat. The banks and riparian zones were sparsely covered with vegetation, and much of that vegetation was non-native and invasive (bittersweet, Japanese knotweed). The trees and taller vegetation provided a 60% canopy cover to the sampling reach.

The stream width was estimated at 18 m. The depth at the riffles was 0.1 m, and the depth at the runs and pools was 0.4 m. There was obvious NPS pollution in the form of litter within and along the stream. There was also potential NPS pollution via the roadways and lawns. The water was slightly grey and turbid, and smelled of chemicals and sewage. The inorganic substrates included <5% boulder, 45% cobble, 30% pebble, 10% gravel, and 10% sand. The organic substrates were entirely CPOM. There was a brown floc on the top of the rocks in the pools and riffles.

Benthos

The Green River, at this station, is highly urbanized. Historically, this segment of the river received industrial discharges that affected adversely the resident fauna (Fiorentino 1997). Today, the health of the resident benthos is much improved (*Non-Impacted*) (Table 7). Curtailment of discharges, improved stormwater management, and remediation of industrial sites have eliminated some documented and potential impacts to the resident biota at GR01 (Fiorentino 1997).

The 2005 benthic data revealed a *Non-Impacted* benthic community. This was also the case when this station was sampled in 2000. The remaining hurdle for improvement to this station may be habitat restoration, as riparian habitat degradation remains a concern in this portion of the Green River. This may always be the case, as several houses, roads, and business are located within this zone. However, instream habitat can be improved through the establishment of instream cover and the removal of dysfunctional dams, and trash.

UDR01 – DEERFIELD RIVER

Approximately 300 m upstream of Florida Bridge, Florida

Habitat

The Deerfield River at this station location is designated as a Class B, Cold Water Fishery resource as defined in the Massachusetts Surface Water Quality Standards (MassDEP 2006). The watershed contributing to UDR01 covers 681.17 km^2 and drains portions of the Massachusetts towns of Monroe, Rowe, and Florida. The majority of this watershed, however, lies within Vermont (UDR01 was 18.3 km downstream from the Vermont border). The watershed slope (10.9%) is considered “high-gradient”. The flow regime of the Deerfield River is highly modified by the presence of large impoundments and hydroelectric project operations. In fact, sampling at UDR01 and LDR01 was limited to times of “no release” from the hydroelectric projects in order to access the river by wading. The majority of the land within the watershed is forested; however, several towns in the Vermont portion of the watershed (e.g., Wilmington, Whittingham, and Readsboro) have modified the landscape. While such land use changes can lead to water quality degradation, the presence of several large impoundments upstream from UDR01 likely attenuate any localized water quality problems originating in these towns.

The total habitat score at UDR01 was 155/200 (Table 9). The reductions in score were primarily due to low flow conditions. The instream cover for fish was rated as “marginal”, as were the velocity-depth combinations (there were no deep habitats), and the channel flow status. Low-flow events affecting habitat are frequent due to the extensive regulation of this river. The riparian vegetative zone widths were rated as “suboptimal” due to the presence of a road along the right bank and railroad tracks along the left bank. However, no non-native or invasive plants were observed at UDR01. The vegetation provided only 2% canopy cover to the sampling reach due to the wide nature of the river.

The stream width was estimated at 20 m. The depth at the riffles was 0.4 m, and there were no runs or pools. Potential sources of NPS pollution were the adjacent road and railroad. The water was clear and without odor or color. The inorganic substrates included 75% boulder, 20% cobble, and 5% pebble. The organic substrate was entirely CPOM. Green filamentous algae covered 20% of the substrates. A brown thin film coated the rock substrates.

Benthos

The assessment of the benthos collected from this station resulted in a rating of *Non-Impacted* (Table 7). In fact the total metric score (42) out-performed that of the reference site (39). The Taxa Richness (18 families represented) was high relative to most of the large-stream stations, including the reference. The sample from UDR01 also yielded one of the lowest (best) Percent Dominant Taxon (23%) metric values of all the large-stream stations sampled. These measures are all indicative of a diverse, “healthy” resident macroinvertebrate community.

LDR01 – DEERFIELD RIVER
Approximately 100 m upstream of the Route 91 bridge, Greenfield

Habitat

The Deerfield River, at station LDR01, is a designated Class B Warm Water Fishery resource (MassDEP 2006). The Massachusetts portion of the contributing watershed (1456 km^2) drains all, or portions of, the towns of Monroe, Rowe, Florida, Savoy, Heath, Charlemont, Hawley, Plainfield, Ashfield, Buckland, Colrain, Leyden, Shelburne, Conway, Deerfield and the city of Greenfield. The watershed is considered high-gradient (slope = 11%). Much of the land use within the extensive Deerfield watershed is forest and residential with several small farms. However, the majority of farming practices are no-till hay fields.

The total habitat score for LDR01 was 182/200 (Table 9), the highest total habitat score observed during the 2005 Deerfield River watershed benthic survey. All habitat measures were within "optimal" ranges, except for instream cover for fish and channel flow status (both were "suboptimal"). The existing fish cover was too exposed to allow for suitable refugia, and the regulated nature of the Deerfield River at this station led to less than optimal flows. The banks and riparian zones were covered with a mix of deciduous trees, and supported a relatively dense (80%) understory of herbaceous vegetation. Some non-native, invasive species were observed (bittersweet, Japanese knotweed). There was no canopy cover to the river at LDR01.

The stream width was estimated at 22 m. The depth at the riffles was 0.2 m. The depth through the runs was 0.5 m, and the depth in the pools was 1 m. The upstream road crossings were the only noted potential sources of NPS pollution. The water was not turbid, and without color or odor. The inorganic substrate components included 50% boulder, 30% cobble, 10% pebble, 5% gravel, and 5% sand. The organic portion of the substrates was entirely CPOM. The algae coverage was estimated at only 1%, and consisted of green filamentous algae attached to the rocky substrates.

Benthos

As was the case in 2000 (MassDEP 2002), the benthic community sampled at LDR01 in 2005 received a determination of *Non-Impacted* (Table 7). Again, habitat conditions were determined to be the best attainable in the watershed. This is reflected in the resident macroinvertebrate community. The Taxa Richness was 17, which is greater than the number of families collected at the reference station (CR02). Also, Percent Dominant Taxon was reduced (better) at LDR01 (26%) compared to the reference station (40%), indicating less extreme hyperdominance. In addition, the abundance of EPTs (n = 88) relative to CR01, indicates that pollution-sensitive taxa are well represented in the LDR01 benthos assemblage. Furthermore, the low Biotic Index (3.42 – second lowest of all the large watershed stations) indicates relatively low organic enrichment.

SUMMARY AND RECOMMENDATIONS

Benthic macroinvertebrate biomonitoring stations within the Deerfield River watershed included wadeable streams that were sampled using DWM kick-sampling methodologies (Nuzzo 2002). Reference stations in Hinsdale Brook (HI02), and the Cold River (CR02) were chosen as representatives of "least disturbed conditions" for Small Watersheds (<40 km^2) and Large Watersheds (>40 km^2), respectively. This determination was based on the lack of development within the contributing watershed, the lack of significant water withdrawals, historically designated reference-quality stations (Cold River), high-scoring metric values for resident biota, and good riparian and instream habitats.

Habitat scores ranged from 108/200 in Wheeler Brook (WH02) to 182/200 in the Deerfield River (LDR01). The 74-point spread was affected by a variety of habitat conditions ranging from extensive anthropogenic impacts, to the presence of protected conservation areas. On average, habitat quality was compromised most by the status of channel flow and the width and stability of the riparian zone.

Fourteen of the 15 benthic stations were determined to be *Non-Impacted*. This is a reflection of the general "good health" of the Deerfield River watershed as a whole. The benthic site on Poland Brook (PL01) received an initial RBP II determination of *Moderately Impacted.* Poland Brook appeared to exhibit a pollution-stress signal, as evidenced by extreme hyperdominance (a single taxon represented 42% of community) and community structure heavily biased toward filter-feeders (80% of assemblage). Follow-up RBP III analysis found the benthic community to be *Slightly Impacted* at PL01.

The schematic presented in Figure 2 is based on a proposed conceptual model that predicts the response of aquatic communities to increasing human disturbance. It incorporates both the biological condition impact categories outlined in the RBP biological assessment methodology currently used by MassDEP and the Tiered Aquatic Life Use (TALU) conceptual model developed by the US EPA and refined by various state environmental agencies (US EPA 2003). The model summarizes the main attributes of an aquatic community (in this case the benthic macroinvertebrate community only) that can be expected at each level of the biological condition gradient, and how these metric-based bioassessments can then be used to make aquatic life use determinations as part of the 305(b) reporting process. *Slightly* or *Non-Impacted* benthic communities *support* the Massachusetts SWQS designated *Aquatic Life* use in addition to meeting the objective of the Clean Water Act (CWA), to restore and maintain the chemical, physical, and biological integrity of the Nation's waters (Environmental Law Reporter 1988). All of the 2005 Deerfield River watershed biomonitoring stations support the *Aquatic Life* use goal of the CWA. This is not to say that stations achieving a designation of *Non-Impacted* (or *Slightly Impacted*) should be considered pristine. There may be stressors affecting water quality, aesthetics, and other biota that have minimal impact upon the benthic community.

While the RBP analysis of benthic macroinvertebrate communities is an effective means of determining the severity of water quality impacts, it is less effective in determining what kinds of pollution are causing the impact (i.e., ascertaining cause and effect relationships between potential stressors and affected biota). Nevertheless, in some situations a close examination of individual metric performance, taxon absence or presence, habitat evaluations, or other supporting field data can lead to inferences of potential anthropogenic causes of perturbation. Fortunately, all of the streams assessed in 2005 were found to be supporting the *Aquatic Life* use. Nonetheless, Table 3 lists potential threats to the stream habitat and resident benthos that were observed at the biomonitoring stations during the survey. The table also includes recommendations for lessening the various threats and improving the general conditions observed. The list is by no means exhaustive, but rather a summary of suggestions for additional monitoring efforts, BMP implementation, and other recommendations for follow-up activities while still working within the framework of the "5-Year Basin Cycle" and using the resources routinely available to DWM personnel.

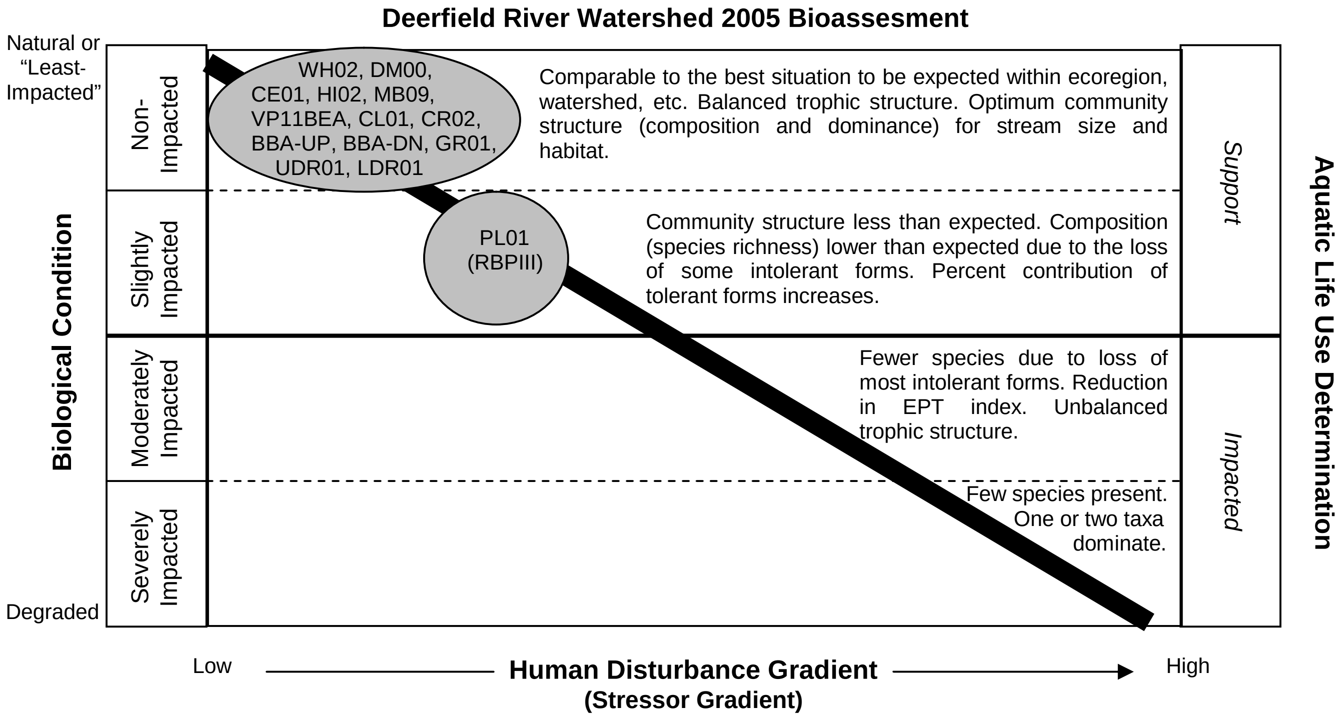

Figure 2. Aquatic Life Use and Stressor Gradient Schematic

This figure presents a schematic of the predictive response of aquatic communities to increasing human disturbance. Included is the performance (Biological Condition and Aquatic Life Use determinations) of the Deerfield River watershed 2005 biomonitoring stations along the Human Disturbance Gradient. NOTE: reference stations HI02 and CR01 are considered to represent the "least disturbed" conditions and to be supportive of the *Aquatic Life* use.

Table 3. Summary of Potential Threats to Benthos and Habitat
A summary of potential threats to benthos and habitat observed at each biomonitoring station during the 2005 Deerfield River watershed survey. Where applicable, recommendations have been made.

Site	Possible Causes of Impairment	Recommendations
WH02	Instream trash. Potential road runoff.	Stream clean-up. Increased buffering between road and stream.
DM00	Acid Mine Drainage	Continued monitoring of instream benthic conditions. Support for ongoing research into acid mine mitigation.
CE01	Reduced riparian zone width	Increase width of riparian zone. Education regarding impacts to stream from various land use activities.
HI02	No observed impacts	Continued protection of this resource.
PL01	Nutrients. Upstream habitat modification.	Implementation of BMPs for upstream habitat restoration.
MB09	Acid Mine Drainage	Continued monitoring of instream benthic conditions. Support for ongoing research into acid mine mitigation.
VP11BEA	Slight increase in sedimentation	Establishment of BMPs for mitigation of road sand entering stream
CL01	Reduced riparian vegetative zone width	Increase width of riparian zone. Education regarding impacts to stream from various land use activities.
CR02	Potential road runoff	Establishment of BMPs for mitigation of road sand entering stream
GR02	Road runoff	Establishment of BMPs for mitigation of road sand entering stream
BBA-UP	No observed impacts	None
BBA-DN	Reduced instream habitat. Increased sediment input. Reduced bank stability.	Establishment of BMPs for mitigation of road sand entering stream. Establishment of Bank stability projects.
GR01	Riparian development. Trash. Stream bed and bank modification.	Stream clean up. BMPs for mitigation of stormwater runoff.
UDR01	Flow modification. Road and railroad runoff.	Implementation of runoff mitigation BMPs.
LDR01	Flow modification.	Implementation of regulated releases to mimic natural flow conditions.

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APPENDIX

Table 4. RBP II Taxa List

RBP II taxa list and counts, functional feeding groups (FFG), and tolerance values (TV) for macroinvertebrates collected from stream sites during the 2005 Deerfield River watershed survey.

Station ID/Stream Name-town: GR02/Green River-Leyden, UDR01/Deerfield River-Florida, GR01/Green River-Greenfield, HI02/Hinsdale Brook-Greenfield, CR02/Cold River-Savoy, CL01/Clesson Brook-Buckland, WH02/Wheeler Brook-Greenfield, DM00/Davis Mine Brook-Charlemont, MB09/Mill Brook-Charlemont, BBA-UP/North River-Colrain, BBA-DN/North River-Colrain, PL01/Poland Brook-Conway, LDR01/Deerfield River-Greenfield, VP11BEA/Bear River-Conway, CE01/Creamery Brook-Ashfield.

Taxon	FFG[1]	TV[2]	GR02	UDR01	GR01	HI02*	CR02*	CL01	WH02	DM00	MB09	BBA-UP	BBA-DN	PL01	LDR01	VP11BEA	CE01
Ancylidae	SC	6			8			1									
Pisidiidae	FC	6		1													
Lumbricina	GC	8							2								
Enchytraeidae	GC	10							3							1	
Naididae	GC	9				3	2	2								1	
Lumbriculidae	GC	7			8	6			9			1			2	1	1
Hydrachnidia	PR	6		2									1				
Baetidae	GC	4	2	2	8	18	2	3	1	9	9				15	7	9
Ephemerellidae	GC	1	8	1		7	3	3	1	4	8	5	3		10	29	13
Heptageniidae	SC	4	16	2	7	2	8	10		12	7	11	2	1	12	14	6
Isonychiidae	GC	2	9		9		1	1			1	6	1	6	1	1	
Leptophlebiidae	GC	2	3	3		2	3	1	2			7				8	2
Cordulegastridae	PR	3							1								
Gomphidae	PR	5	1	1							1		1				
Chloroperlidae	PR	1	2	1		1		5	4	8	9	1				2	1
Leuctridae	SH	0										1				1	1
Peltoperlidae	SH	0							10					1			2
Perlidae	PR	1	1	3	2	3	1	1	6			4	3	2	2	4	4
Perlodidae	PR	2	5			2					3						
Pteronarcyidae	SH	0	1					1	7							1	1
Corydalidae	PR	5	1										1	2	1	1	
Sialidae	PR	4									1						
Brachycentridae	FC	1			1					1			1	1			
Glossosomatidae	SC	0	2		12	8		8					12		1	1	
Helicopsychidae	SC	3													3	2	
Hydropsychidae	FC	4	30	21	29	18	32	24	30	7	7	14	36	50	14	5	28
Hydroptilidae	GC	4												1			
Lepidostomatidae	SH	1	1	3			4	1		14	7	2			2	1	
Leptoceridae	PR	4											1				
Limnephilidae	SH	4					1		2							1	1
Philopotamidae	FC	3	6	22	4	9	4	11	14	14	21	13	5	28	28	7	7
Polycentropodidae	FC	6	1								1					1	
Rhyacophilidae	PR	0	2	4		1	1	1	5	3	2		3			8	3
Elmidae	SC	4	4	5	18	1		4	6	3	3	3	11	1	9	3	
Psephenidae	SC	4	1	1	1				1			2	2				
Athericidae	PR	2	1		1					2	6			1		1	
Ceratopogonidae	PR	6	1						2					1		1	
Chironomidae	GC	6	5	18	2	18	41	24	4	18	14	33	16	12	7	2	16
Empididae	PR	6		3				4							1		
Simuliidae	FC	6	1			1					1			1	1	1	
Tipulidae	SH	5	1	1		4		2		4	4	4	10	1	1	4	8
TOTAL	**-**	**-**	**105**	**94**	**110**	**104**	**103**	**107**	**110**	**99**	**105**	**107**	**109**	**109**	**110**	**109**	**103**

[1]Functional Feeding Group (FFG). The feeding habit of each taxon. SH-Shredder; GC-Gathering Collector; FC-Filtering Collector; SC-Scraper; PR-Predator.

[2]Tolerance Value (TV). An assigned value used to calculate the biotic index. Tolerance values range from 0 for organisms very intolerant of organic wastes to 10 for organisms very tolerant.

*Reference station

Table 5. RBP III Taxa List: Station HI02 and PL01
RBP III taxa list and counts, functional feeding groups (FFG), and tolerance values (TV) for macroinvertebrates collected from stream sites during the 2005 Deerfield River watershed survey.

Taxon	FFG[1]	TV[2]	HI02*	PL01
Nais sp.	GC	9	3	
Lumbriculidae	GC	7	6	
Baetidae (cerci only)	GC	6	12	
Baetidae (subequal filament)	GC	6	6	
Ephemerella sp.	GC	1	7	
Heptageniidae	SC	4		1
Rithrogena sp.	GC	0	2	
Isonychia sp.	FC	2		6
Leptophlebiidae	GC	2	2	
Sweltsa sp.	PR	0	2	
Leuctridae/Capniidae	SH	2	1	
Tallaperla maria	SH	0		1
Acroneuria abnormis	PR	0	3	1
Agnetina capitata	PR	2		1
Nigronia serricornis	PR	5		2
Brachycentrus sp.	FC	1		1
Glossosoma sp.	SC	0	8	
Hydropsyche betteni	FC	6		4
Hydropsyche morosa gr.	FC	6	17	46
Chuematopsyche sp.	FC	5	1	
Hydroptila sp.	GC	6		1
Dolophilodes sp.	FC	0	9	12
Chimarra obscura	FC	4		16
Rhyacophila sp.	PR	1	1	
Promoresia sp.	SC	2		1
Optioservus sp.	SC	4	1	
Atherix sp.	PR	4		1
Probezzia sp.	PR	6		1
Polypedilum sp.	SH	6		1
Polypedilum aviceps	SH	4	2	
Tanytarsus sp.	FC	6		1
Robackia demeijerei	GC	4		1
Thienemanniella sp.	GC	6	1	
Cricotopus sp.	SH	7	7	
Cricotopus cylidraceus gr.	GC	7		1
Eukiefferiella sp.	GC	6	3	
Tvetenia paucunca	GC	5	5	6
Thienemannimyia gr.	PR	6		2
Simulium sp.	FC	5	1	1
Antocha sp.	PR	3	2	1
Dicranota sp.	PR	3	2	
TOTAL	-	-	104	109

[1]Functional Feeding Group (FFG). The feeding habit of each taxon. SH-Shredder; GC-Gathering Collector; FC-Filtering Collector; SC-Scraper; PR-Predator
[2]Tolerance Value (TV). An assigned value used to calculate the biotic index. Tolerance values range from 0 for organisms very intolerant of organic wastes to 10 for organisms very tolerant.
*Reference station

Table 6. RBP II Benthic Metric Scores - Small Watersheds

Summary of RBP II data analysis for macroinvertebrate communities sampled during the 2005 Deerfield River watershed survey. Shown are the calculated metric values, metric scores (underlined), and the corresponding assessment designation for each biomonitoring station relative to the small watershed least-disturbed-conditon reference station (HI02), Refer to Table 1 for a complete listing and description of sampling stations.

STATION	HI02*		DM00		CE01		WH02		PL01		MB09		VP11BEA	
STREAM	Hinsdale Brook		Davis Mine Brook		Creamery Brook		Wheeler Brook		Poland Brook		Mill Brook		Bear River	
HABITAT SCORE	146		180		151		108		153		173		155	
TAXA RICHNESS	17	6	13	3	16	6	19	6	15	6	18	6	27	6
BIOTIC INDEX	3.89	6	3.28	6	3.51	6	3.32	6	3.78	6	3.2	6	2.6	6
EPT INDEX	11	6	9	3	13	6	11	6	8	3	11	0	17	6
EPT/CHIRONOMIDAE	3.94	6	4	6	4.88	6	20.5	6	7.5	6	5.36	6	46.5	6
SCRAPER/FILTERER	0.39	6	0.68	6	0.17	3	0.16	3	0.03	0	0.33	6	1.43	6
% DOMINANT TAXON	17%	6	18%	6	27%	6	27%	6	46%	3	20%	6	27%	6
REFERENCE AFFINITY	100	6	89	6	90	6	60	3	61	3	83	6	68	6
TOTAL METRIC SCORE	*42*		*36*		*39*		*36*		*27*		*36*		*42*	
% COMPARABILITY TO REFERENCE	100%		86%		93%		86%		64%		83%		100%	
BIOLOGICAL CONDITION -DEGREE IMPACTED	Reference Station		*Non-Impacted*		*Non-Impacted*		*Non-Impacted*		*Moderate Impact*		*Non-Impacted*		*Non-Impacted*	

*=Reference Station

Table 7. RBP II Benthic Metric Scores - Large Watersheds

Summary of RBP II data analysis for macroinvertebrate communities sampled during the 2005 Deerfield River watershed survey. Shown are the calculated metric values, metric scores (underlined), and the corresponding assessment designation for each biomonitoring station relative to the large watershed least-disturbed-condition reference station (CR02). Refer to Table 1 for a complete listing and description of sampling stations.

STATION	CR02*		CL01		GR02		BBA-UP		BBA-DN		GR01		UDR01		LDR01	
STREAM	Cold River		Clesson Brook		Green River		North River		North River		Green River		Deerfield River		Deerfield River	
HABITAT SCORE	170		148		166		177		141		131		155		182	
TAXA RICHNESS	13	6	19	6	24	6	15	6	17	6	14	6	18	6	17	6
BIOTIC INDEX	4.5	6	3.86	6	3.25	6	3.94	6	3.62	6	3.66	6	3.8	6	3.52	6
EPT INDEX	11	6	13	6	15	6	10	6	10	6	8	3	10	6	10	6
EPT/CHIRONOMIDAE	1.46	6	2.92	6	17.8	6	1.94	6	4.19	6	36	6	3.44	6	12.6	6
SCRAPER/FILTERER	0.22	6	0.66	6	0.61	6	0.59	6	0.64	6	1.35	6	0.18	6	0.58	6
% DOMINANT TAXON	40%	3	22%	6	29%	6	33%	3	33%	3	26%	6	23%	6	26%	6
REFERENCE AFFINITY	100	6	82	6	62	3	62	3	62	3	62	3	69	6	66	6
TOTAL METRIC SCORE	*39*		*42*		*39*		*36*		*36*		*36*		*42*		*42*	
% COMPARABILITY TO REFERENCE	100%		108%		100%		92%		92%		92%		108%		108%	
BIOLOGICAL CONDITION -DEGREE IMPACTED	Reference Station		*Non-Impacted*		*Non-Impacted*		*Non-Impacted*		*Non-Impacted*		*Non-Impacted*		*Non-Impacted*		*Non-Impacted*	

*=Reference Station

Table 8. RBP III Benthic Metric Scores: Station HI02 and PL01
Summary of RBP III data analysis for macroinvertebrate communities sampled during the 2005 Deerfield River watershed survey. Shown are the calculated metric values, metric scores (underlined), and the corresponding assessment designation for PL01 relative to the small watershed least-disturbed-condition reference station (HI02). Refer to Table 1 for a complete listing and description of sampling stations.

STATION	HI02*		PL01	
STREAM	Hinsdale Brook		Poland Brook	
HABITAT SCORE	146		153	
TAXA RICHNESS	24	6	22	6
BIOTIC INDEX	4.08	6	4.43	6
EPT INDEX	13	6	11	4
EPT/CHIRONOMIDAE	3.94	6	7.5	6
SCRAPER/FILTERER	0.32	6	0.02	0
% DOMINANT TAXON	16%	6	42%	0
REFERENCE AFFINITY	100	6	61	4
TOTAL METRIC SCORE	*42*		*26*	
% COMPARABILITY TO REFERENCE	100%		62%	
BIOLOGICAL CONDITION -DEGREE IMPACTED	Reference Station		*Slightly Impacted*	

Table 9. Habitat Assessment Parameters and Scores

Habitat assessment summary for biomonitoring stations sampled during the Deerfield River watershed survey – September 2005. For instream parameters, scores ranging from 16-20 = optimal; 11-15 = suboptimal; 6-10 = marginal; 0-5 = poor. For bank and riparian zone parameters, scores ranging from 9-10 = optimal; 6-8 = suboptimal; 3-5 = marginal; 0-2 = poor. Refer to Table 1 for a complete listing and description of sampling stations.

Habitat Parameter	WH02	DM00	CE01	HI02*	PL01	MB09	VP11BEA	CL01	CR02*	GR02	BBA-UP	BBA-DN	GR01	UDR01	LDR01
STREAM	Wheeler Brook	Davis Mine Brook	Creamery Brook	Hinsdale Brook	Poland Brook	Mill Brook	Bear River	Clesson Brook	Cold River	Green River	North River	North River	Green River	Deerfield River	Deerfield River
Instream Cover	6	16	14	17	10	18	19	12	16	11	18	11	10	10	13
Epifaunal Substrate	16	19	19	16	17	19	19	18	19	20	20	17	17	19	20
Embeddedness	18	19	19	14	13	20	18	16	20	19	20	16	14	19	18
Channel Alteration	11	20	20	20	20	20	20	19	20	19	20	19	14	19	20
Sediment Deposition	9	19	11	10	10	19	12	14	19	19	19	12	18	19	19
Velocity-Depth Combinations	8	15	14	10	12	15	15	17	10	15	16	9	10	10	17
Channel Flow Status	8	15	15	9	15	8	8	10	6	12	15	17	9	9	15
Bank Vegetative Protection	6[L] / 10[R]	10 / 9	10 / 9	10 / 10	10 / 10	10 / 10	9 / 9	10 / 9	10 / 10	9 / 9	10 / 10	10 / 10	8 / 10	9 / 9	10 / 10
Bank Stability	3 / 2	9 / 9	2 / 2	3 / 7	6 / 10	9 / 8	3 / 6	6 / 6	10 / 10	10 / 6	10 / 10	4 / 4	7 / 9	9 / 8	10 / 10
Riparian Vegetative Zone Width	1 / 10	10 / 10	10 / 5	10 / 10	10 / 10	10 / 7	10 / 7	1 / 10	10 / 10	10 / 7	4 / 5	2 / 10	1 / 4	8 / 7	10 / 10
TOTAL SCORE	108	180	151	146	153	173	155	148	170	166	177	141	131	155	182

L = Left Bank
R = Right Bank
* = Reference Station