Technical Memorandum

2005 Deerfield River Watershed Periphyton Study

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Worcester, MA

May 2010

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Introduction

Biological assessment was performed by personnel from the Massachusetts Department of Environmental Protection (MassDEP) at several stations in the Deerfield River Watershed during the summer of 2005. Samples were collected at two Deerfield River and seven tributary sites for the identification of periphyton, described here as including the attached microscopic and macroscopic algae. Periphyton sampling was limited to sites chosen for macroinvertebrate/habitat investigations.

Objectives of the periphyton sampling were to provide additional information for use assessment by adding another biological community to the macroinvertebrate and habitat information, and to examine temporal changes in the amount and type of algae present in the assemblage. The periphyton assessment provides supportive information to aid in determining if the designated uses, as described in the Surface Water Quality Standards (MassDEP 2006), are being supported, threatened or lost in particular segments. Periphyton data can be used to evaluate two designated uses, Aquatic Life and Aesthetics.

Aquatic life evaluations determine if suitable habitat is available for “sustaining a native, naturally diverse, community of aquatic flora and fauna.” Natural diversity and the presence of native species may not be sustained when there are dense growths of a monoculture of a particular alga. This alteration of the community structure may indicate that the aquatic life use support is lost or threatened. Loss of parts of the food web - vital for aquatic life use support - may result from this alteration. In addition, the die-off and decomposition of large amounts of biomass from macroalgae can fill in the interstitial sites in the substrate and destroy this habitat for the benthic invertebrates, further compromising aquatic life.

The algal data are also used to determine if the aesthetic quality of the waterbody has been impacted. Floating rafts of previously attached benthic algal mats can make a waterbody visually unappealing, as can large areas of the bottom substrates covered with long streamers of algae that can discourage waders and hinder fishermen by making the substrata slippery for walking. Fishermen can also snag their fishing lines on the filamentous algae. A determination of whether or not the aesthetic quality of a waterbody is compromised by algal growth can be made by measuring the percent macroalgal cover in a particular habitat (e.g. riffles or pool). Forty percent or greater coverage by filamentous green algae is typically considered a nuisance level of algae (Biggs 1996, Barbour et al. 1999).

Periphyton sampling is typically done on first, second or third order streams and rivers that are small, shallow, and often fast-moving. At each of the stations an estimate of the percent cover of the periphyton and benthic algae is made and samples are collected for algal identification. Periphyton samples are typically scrapes of one type of substrata in the riffle zone. The algal scrapes are used in the qualitative microscopic examination to determine the presence and relative abundance of the phyla that contributes the most to the biomass in the riffle or pool habitats. The estimate of percent cover of the filamentous algae (macroalgae) is used in conjunction with the microscopic examination to determine if uses of the river (Aquatic Life Support and Aesthetics) are lost or threatened because of excessive algal growth.

Materials and Methods

Periphyton Identifications and Relative Abundance

Periphyton samples were gathered, along with macroinvertebrate samples and habitat information, from nine sites on the Deerfield River and selected tributaries (Table 1) using methods described in Barbour et al (1999). Sampling was performed by the macroinvertebrate sampling crew and consisted of randomly scraping rocks and cobble substrates, typically within the riffle area, but other habitats were occasionally sampled. Material was removed with a knife or by hand from rock substrata, added to labeled glass vials containing sample water, and transported to the laboratory at MassDEP-Worcester in one-liter plastic jars containing stream water to keep them cool. Once at the laboratory, samples were refrigerated until taxonomic identifications were completed. Samples held longer than one week were preserved using M^3 with a dose rate of 2 ml of preservative per 100 ml of sample (Reinke 1984).

Vials were shaken before subsampling. Filamentous algae were removed first, identified separately, and then the remainder of the sample was examined. An Olympus BH2 compound microscope with Nomarski optics was used for the identifications. (References used for the taxonomic identifications are listed at the end of this memorandum). Slides were typically examined under 200x power. A scheme developed by Bahls (1993) was employed to determining periphyton abundance on a microscope slide at 200x power as follows:

Rare – Fewer than one cell per field of view at 200x, on the average;
Common – At least one, but fewer than five cells per field of view;
Very common – Between 5 and 25 cells per field;
Abundant – More than 25 cells per field, but countable;
Very abundant – Number of cells per field too numerous to count.

A visual determination was also made of whether or not the algal covering was composed of micro or macroalgae, in particular, the green filamentous algae. The microalgae typically appear as a thin film, often green or blue-green, or as a brown floc. Macroalgal (green filamentous algae) that covers greater than 40% of the substrata in the riffle/run is considered to be indicative of organic enrichment (Barbour et al. 1999) and may indicate that the aesthetic quality of the stream is compromised.

Results

Canopy cover and percent algal cover at the stations included in the periphyton sampling are presented in Table 1. A taxonomic list of the periphyton collected, along with their relative abundance, can be found in the Appendix.

Table 1. 2005 Deerfield River Watershed Periphyton Study. Canopy cover (%) and within-reach algal cover (%).

Station No.	Station Description	Canopy cover (%)	Within-reach algal cover (%)
HI02*	Hinsdale Brook, west of Plain Rd. ~60 m upstream of confluence with Punch Brook, Greenfield	100	<5
DM00	Davis Mine Brook~100 m upstream of confluence with Mill Brook, Charlemont	90	5
CR02*	Cold River ~1.9 km downstream of Wheeler Brook. North of Route 2, Savoy	50	60-70
LDR01	Deerfield River~100 m upstream of I-91 Bridge, Deerfield	0	1
UDR01	Deerfield R ~300 m upstream of Florida Bridge, Florida	2	20
VP11BEA	Bear River, ~100 m upstream of Shelburne Falls Road, Conway	80	<1
BBA-DN	North River~350 m downstream of Route 112, Colrain	10	Not recorded
CE01	Creamery Brook~20 m upstream of Williamsburg Rd, Ashfield	70	1
GR02	Green River~150 m upstream of Thorne Brook confluence, Leyden	10	100

* Reference stations

Observations

The canopy over Station HI02 on Hinsdale Brook in Greenfield was completely closed and benthic algal coverage was less than 5% (Table 1). Nonetheless, light levels were adequate for the development of a diatom community as evidenced by a brown floc on the bottom surfaces. Hinsdale Brook was designated by the macroinvertebrate sampling crew as a reference stream for small watersheds (i.e., < 40 km).

The land use surrounding Davis Mine Brook in Charlemont was 100% forested and Station DM00 exhibited a closed canopy resulting in low light levels. Algal growth was predominantly in the form of unidentified cyanobacteria filaments.

Despite serving as a reference site for streams with watersheds greater than 40 km (Mitchell 2009), Cold River (CR02) in Savoy supported significant algal growth (Table 1). This watershed is also 100% forested, but the canopy cover was 50% in the vicinity of the sampling location. Both the diatom *Gomphonema* sp. and the filamentous yellow-green *Vaucheria* sp. (see Appendix) were found in very abundant amounts in the sample. The growth habit was described as a thin green film and not the long strands of "nuisance algae", such as the green alga *Cladophora* sp.

In terms of substrate cover, almost no algae (1%) were observed at LDR01 on the main-stem Deerfield River in Deerfield despite a completely open canopy. A sample of the algae present, however, yielded "very abundant" amounts of *Spirogyra* sp. according to the scheme developed by Bahls (1993). *Spirogyra* sp. is a filamentous green alga that can grow to nuisance levels under favorable conditions of light, stream velocity, and nutrient availability, but may actually occur in the Deerfield River as part of the drift algae or tychoplankton community.

Upstream of LDR01 is UDR01 which also had an open canopy. Algal coverage within the reach was higher here at 20% (Table 1) and included some filamentous green algae. Nuisance amounts of algae, however, were not present at this station.

VP11BEA was located on the Bear River in Colrain and once again this small watershed had a closed canopy (80%) that contributed to <1% algal cover. There were some *Melosira* sp. (centric diatom) cells present.

CE01, Creamery Brook, Ashfield exhibited a closed canopy and reduced algal growth.

Green River in Leyden (GR02) had an open canopy and 100% algal coverage in the reach. The algal cover was described as a thin green film, and the primary alga recovered in the sample was cyanobacteria (*Phormidium* sp.).

Conclusions

Most stations in the Deerfield River watershed drained forested landscapes and exhibited closed canopies. The shaded character of the headwater streams limited the development of nuisance filamentous forms that typically respond to higher light intensity and elevated nutrient levels. The thin green algal film evident in the Cold and Green rivers may have developed in response to nutrient enrichment, but loss of aesthetic value due to abundant filamentous algal growth was not apparent at the sampling sites.

Biggs et al. (1998) found that headwater sites were dominated by filamentous cyanobacteria and diatoms. This observation was also made by Rounick and Winterbourn (1983) who studied two experimental channels located in a forested area, with one exposed to light and the other kept in the dark. The shaded stream supported the development of an organic layer consisting of slime, fine particles, bacteria and fungi that was replaced by the growth of diatoms and filamentous algae when exposed to natural light intensities. The open-canopy headwater stations followed this pattern in this study while closed-canopy sites were more likely dominated by heterotrophic organisms. In summary, assessments of the waterbodies included in this investigation should highlight the scarceness of filamentous algal growth.

Literature Cited

Bahls, L. L. 1993. *Periphyton Bioassessment Methods for Montana Streams*. Water Quality Bureau, Dept. of Health and Environmental Sciences. Helena, Montana.

Barbour, M., Gerritsen, J, Synder, B. D. and J. B. Stribling. 1999. *Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates and Fish*, 2nd edition. EPA 841-B-99-002. U.S. Environmental Protection Agency, Office of Water, Washington, D.C.

Biggs, B. J. F. 1996. Patterns of benthic algae in streams. IN: *Algal Ecology: Freshwater Benthic Ecosystems*. R. J. Stevenson, M. Bothwell, and R. L. Lowe. Pp 31-55. Academic Press, San Diego, California.

Biggs, B. J. F., Kilroy, C. and R. Lowe. 1998. Periphyton development in three valley segments of a New Zealand grassland river: test of a habitat matrix conceptual model within a catchment. *Arch. Hydrobiol*. 143: 147-177.

MassDEP. 2006. *Massachusetts Surface Water Quality Standards (Revision of 314 CMR 4.00, effective December 29, 2006)*. Massachusetts Department of Environmental Protection, Boston, MA.

Mitchell. Peter. 2009. *Deerfield River Watershed 2005 Benthic Macroinvertebrate Assessment Report*. Massachusetts Department of Environmental Protection. Division of Watershed Management. Worcester, MA. 35 p.

Reinke, D. C.1984. *Algal Identification Workshop*. Kansas Biological Survey. Manhattan, Kansas.276 p.

Rounick, J. S. and M. J. Winterbourn. 1983. Leaf processing in two contrasting beech forests stream: effect of physical and biotic factors in leaf litter breakdown. *Archiv für Hydrobiologie* 96: 448-474.

References Used for Taxonomic Identifications of the Algae

Collins, F. S. 1970. *Green Algae of North America*. Bibliotheca Phycologica, Band 11. Verlag von J. Cramer. New York. 106 p., 11 plates

Cox, E. J. 1996. *Identification of Freshwater Diatoms from Live Material*. Chapman and Hall. London. 158 p.

Dodd, J. J. 1987. *The Illustrated Flora of Illinois*. Southern Illinois University Press. Carbondale. 477 p.

Hansmann, E. W. 1973. *Diatoms of the Streams of Eastern Connecticut*. State Geological and Natural History Survey of Connecticut. Dept. Of Environmental Protection. Hartford.119 p.

Prescott, G. W. 1982. *Algae of the Western Great Lakes Area*. Otto Koeltz Science Publishers. Koenigstein/West Germany. 977 p.

Prescott, G. W. 1982. *How to Know the Freshwater Algae*. Wm C. Brown. New York. 293 p.

Smith, G. M. 1950. *The Fresh-water Algae of the United States*. 2 nd edit. McGraw Hill Publishers. New York. 719 p.

VanLandingham, S. L. 1982. *Guide to the Identification, Environmental Requirements and Pollution Tolerance of Freshwater Blue-green Algae (Cyanophyta).* Environmental Monitoring and Support Laboratory. U.S. Environmental Protection Agency. Cincinnati.

Weber, C.I. 1971. *A Guide to the Common Diatoms at Water Pollution Surveillance System Stations*. U. S. Environmental Protection Agency. Cincinnati. 101 p.

Whitford, L. A. and G. J. Schumacher. 1984. *A Manual of Fresh-Water Algae*. Sparks Press. Raleigh. 337 p

Appendix.
2005 Deerfield River Watershed Periphyton Study – Algal Taxa and Relative Abundance

Station No.	Station Description	Date	Class	Genus	Relative Abundance*
HI02**	Hinsdale Brook, west of Plain Rd. ~60 m upstream of confluence with Punch Brook, Greenfield	26-Sept	Bacillariophyceae Bacillariophyceae Bacillariophyceae Bacillariophyceae Chlorophyceae	*Cymbella* sp. *Melosira* sp. *Synedra* sp. Unid. pennate diatoms *Cosmarium* sp.	VA VA VA VA R
DM00	Davis Mine Brook ~100 m upstream of confluence with Mill Brook, Charlemont	27-Sept	Cyanophyceae	Unid. blue-green filaments	VA
CR02**	Cold River ~1.9 km downstream of Wheeler Brook. North of Route 2, Savoy	26-Sept	Bacillariophyceae Chlorophyceae Xanthophyceae	Pennate diatoms (incl. *Synedra, Fragilaria,* *Tabellaria* *Gomphonema* *Mougeotia* sp. *Vaucheria* sp.	 VA R VA
LDR01	Deerfield River ~100 m upstream of 191 Bridge, Greenfield	28-Sept	Chlorophyceae Chlorophyceae	Unid. green filaments *Spirogyra* sp.	R VA
UDR01	Deerfield R ~300 m upstream of Florida Bridge, Florida	22-Sept	Bacillariophyceae Chlorophyceae Chlorophyceae Xanthophyceae	*Tabellaria* sp. *Mougeotia* sp. *Bulbochaete* sp. Unid. filamentous	C VA VA R
VP11BEA	Bear River, ~100 m upstream of Shelburne Falls Road, Conway	28-Sept	Bacillariophyceae Chlorophyceae	*Melosira* sp. *Cladophora* sp.	C R
BBA-DN	North River ~350 m downstream of Route 112, Colrain	27-Sept	Chlorophyceae	*Cladophora glomerata*	A

CE01	Creamery Brook ~20 m upstream of Williamsburg Road, Ashfield	28-Sept	Chlorophyceae Chlorophyceae	Unid. green filaments *Cladophora* sp.?	R R
GR02	Green River ~150 m upstream of Thorne Brook confluence, Leyden	22-Sept	Cyanophyceae	*Phormidium* sp.	VA

* Abundance measures (see text for definitions):

R (rare)
C (common)
VC (very common)
A (abundant)
VA (very abundant)

** Reference station