NASHUA RIVER WATERSHED

2003 Periphyton Technical Memorandum

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Introduction

During the summer of 2003, personnel of the MassDEP conducted a biomonitoring survey of the north branch of the Nashua River. Samples were collected 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 (reported separately). Estimates were made of the percent algal cover within the riffle of the sampling reach and algal type and abundance were recorded.

Objectives of the periphyton sampling were to provide additional information for 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 information to aid in determining if the designated uses, as described in the Surface Water Quality Standards (MassDEP 1996), are being supported, threatened or lost in particular segments.

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, which is 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 and compromise the aquatic life use support.

The algal data are also used to determine if aesthetics have been impacted. Floating rafts of previously attached benthic mats can make a waterbody visually unappealing. Long streamers of filamentous algae attached to the bottom substrates also discourage swimmers and hinder fishermen by making the substrata slippery for walking and can snag their fishing lines. Observations made by wading in the stream and viewing the periphyton on rocks or cobbles provide evidence for determining if nuisance algal growth is present. As part of the habitat assessment, a visual evaluation is made to determine if the algal covering is 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. The macroalgal filaments are usually representatives of the Chlorophyceae (the green algae) and are typically 2-3 cm or longer. If 40% or more of the riffle/run substrata is covered by macroalgae the aesthetics of the stream may be threatened and organic enrichment indicated (Barbour, 1999). Thus, to gain information on the likely impacts that algal growth is having on the benthic community, estimates are made of the areal coverage of the micro or macroalgae on the substrates within the sampling reach (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 is made and samples are collected for algal identification. Periphyton samples are typically scrapes collected from 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 evaluate if excessive algal growth may be threatening the uses of the river (Aquatic Life Support and Aesthetics).

Methods

Periphyton samples were obtained along with the macroinvertebrate samples and habitat information using methods described in Barbour (1999). Sampling was done by the macroinvertebrate sampling crew and consisted of scraping randomly gathered rocks and cobbles from the riffle area or, occasionally, other habitats. Material was removed with a knife or by hand from rock substrata and then added to labeled glass vials containing sample water. The samples were transported to the lab at MassDEP-Worcester in one-liter plastic jars containing stream water to keep them cool. Table 1 contains descriptions of the station locations where periphyton samples were collected and presents the percent canopy cover, percent algal cover and the relative abundance of the dominant algae at each site.

Once at the lab, the vials were refrigerated until identifications were completed. Samples held longer than a 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 to get uniform samples before subsampling. Filamentous algae were removed first and identified separately before the remainder of the sample was examined. An Olympus BH2 compound microscope with Nomarski optics was used for the taxonomic identifications. Ten fields were typically examined for each slide at a power of 200x. References used for the taxonomic identifications are listed at the end of this memorandum.

A modified method for periphyton analysis developed by Bahls (1993) was used. The scheme developed by Bahls (1993) for determining abundance on a slide is as follows:

R (rare)	fewer than one cell per field of view at 200x, on the average;
C (common)	at least one, but fewer than five cells per field of view;
VC (very common)	between 5 and 25 cells per field;
A (abundant)	more than 25 cells per field, but countable;
VA (very abundant)	number of cells per field too numerous to count.

Table 1. 2003 Periphyton samples from the North Nashua River

Station	Location	% Canopy Cover	% Algal Cover	Dominant Algae
NN03	Downstream from Mill #9 bridge, Fitchburg-approximately 0.8 miles downstream from West Fitchburg WWTF (MA0101281)	50	50	Pennate diatoms
NN09	Airport Rd. (Falulah Rd. on USGS quads), Fitchburg - approximately 2.2 miles upstream from East Fitchburg WWTF (MA0100986)	5	75	*Mougeotia*, brown floc
NN10A	Approximately 600 feet downstream from Rte. 2, Leominster - approx. 0.9 miles downstream of East Fitchburg WWTF (MA0100986) and 0.7 miles upstream of Leominster WWTP (MA0100617)	5	70	*Lyngbya*, fungal hyphae
NN13	Upstream from abandoned bridge @ Ponakin Mill, Lancaster	50	40	Green coccoid

Results and Discussion

Station NN03 is located on the North Branch of the Nashua River downstream from the West Fitchburg WWTF outfall in Fitchburg, MA. The riffle area sampled had 50 % canopy cover and 50

% algal coverage. Floc composed of pennate diatoms covered large portions of the stream bed in the riffle zone. Similar to station NN10A downstream, the substrata were also covered with abundant fungal hyphae and cyanobacteria (*Lyngbya* sp.). Many planktonic lake algae were present such as *Actinastrum, Closterium, Cosmarium, Pediastrum, Sphaerocystis* and *Scenedesmus* (Appendix A).

Station NN09, located downstream from Airport Rd, Fitchburg, was mostly unshaded (5% canopy cover) and nuisance levels of the filamentous green alga *Mougeotia* sp covered 75 % of the substrata in the riffle. The full sunlight at this site likely contributed to this abundant growth. Along with the *Mougeotia* sp. a brown floc, composed of amorphous organic matter, covered 100% of the surfaces within the riffle. Long streamers of *Mougeotia* sp were also present when the station was sampled in 1998 (Beskenis 2000).

Microscopic examination of the sample from NN10A, did not reveal representative genera in the Chlorophyceae (green algae) in abundant amounts; instead, Lyngbya (cyanobacteria) and fungal hyphae were abundant. The influence of the organic and nutrient enrichment from the East Fitchburg Wastewater Treatment Facility (located less than 1 mile upstream) on the periphyton community is indicated by the dominance of fungi in the periphyton (Table 1 and Appendix A). The fungi are active in the decomposition of proteins as well as different forms of carbohydrates (Bartsch and Ingram 1967).

Stations NN09 and NN10A both exhibited primarily open canopies and 70% – 75% periphyton cover, but the composition of the algal assemblages at each site was vastly different. Water quality data from NN09 and NN10A (Connors 2005) indicate similar nutrient and dissolved oxygen levels, but turbidity and TSS were higher at NN10A. Decrease in light levels caused by the turbidity at NN10A may have led to the loss of the *Mougeotia* sp (green filamentous algae) that was dominant at NN09. Also, water sampled from this segment has been found to be toxic in the past leading to its listing in Category 5 (“303d List”) of the Integrated List of Waters (MassDEP 2005) as needing an investigation to determine the cause of this toxicity and how to reduce it. Therefore, the impact on algal life stages is not known at this time.

Field notes indicated that an effluent odor could be detected in the air at station NN13, but the water column was free from any odor. Canopy cover at this location was 50% (Table 1) created by a mixed canopy dominated by trees. Periphyton in the form of a thin film of pseudoparenchymatous algae (Table 1 and Appendix A) covered 40% of the riffle substrata and shared the available habitat with mosses which were the dominant aquatic vegetation in the riffle. As observed during the 1998 survey the algal cover was provided by a film of compressed, green algae (Beskenis 2000).

Conclusions

A nuisance algal bloom of *Mougeotia* sp was found at station NN09 that could impair the beneficial uses of this segment of the North Nashua River. In general, however, the stations sampled along the North Nashua did not exhibit extensive algal growth.

Growth at two stations (NN03, NN10A) was dominated by heterotrophic organisms that use organic carbon rather than inorganic carbon for growth. Since heterotrophic organisms utilize oxygen to break down compounds instead of producing oxygen like algae do during photosynthesis, in-stream oxygen levels can be adversely affected.

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Appendix A: 2003 North Nashua River Periphyton - Algal Taxonomic Identifications and Abundance Data *All samples collected on September 3, 2003*					
Station	**Location**	**Habitat**	**Class**	**Genera**	**Relative Abundance***
NN03 *Sample 1*	Downstream from Mill #9 bridge, Fitchburg- approximately 0.8 miles downstream from West Fitchburg WWTF (MA0101281)	rock/riffle	**Bacillariophyceae**	diatoms	R
				Fragilaria	R
			Chlorophyceae	*Oedogonium*	R
				Spirogyra	R
			Cyanophyceae	*Lyngbya*	C
				fungal hyphae	A
NN03 *Sample 2*		moss	**Bacillariophyceae**	*Fragilaria*	R
				pennate diatoms	VA
				Synedra	R
			Chlorophyceae	*Actinastrum*	R
				Closterium	R
				Cosmarium	R
				Dictyosphaerium	R
				Oedogonium	A
				Pediastrum	R
				Scenedesmus	R
				Sphaerocystis	R
				Spirogyra	R
				Trachelomonas	R
			Cyanophyceae	*Anabaena*	R
				Lyngbya	A
NN09 *Sample 1*	Airport Rd. (Falulah Rd. on USGS quads), Fitchburg - approximately 2.2 miles upstream from East Fitchburg WWTF (MA0100986)	riffle/rock	**Chlorophyceae**	*Rhizoclonium*	R
				Spirogyra	C
NN09 *Sample 2*		riffle/rock	**Chlorophyceae**	*Mougeotia*	VA
NN10A *Sample 1*	Approximately 600 feet downstream from Rte. 2, Leominster - approx. 0.9 miles downstream of East Fitchburg WWTF (MA0100986) and 0.7 miles upstream of Leominster WWTP (MA0100617)	riffle/rock	**Bacillariophyceae**	diatoms	R
			Chlorophyceae	coccoid greens	R
			Cyanophyceae	*Lyngbya*	C
			Filamentous bacteria	*Flexibacter*	C
				fungal hyphae	C

NN10A *Sample 2*		floc from pool	**Bacillariophyceae**	diatoms	R
			Chlorophyceae	*Coleochaete*	R
			Cyanophyceae	*Lyngbya*	A
				fungal hyphae	A
NN13 *Sample 1*	Upstream from abandoned bridge @ Ponakin Mill, Lancaster	riffle/rock	**Chlorophyceae**	*Chaetophora ?*	C
				pseudoparachymatous-coccoid	A
NN13 *Sample 2*		riffle/moss	**Bacillariophyceae**	*Cocconeis*	VA
				Cymbella	VA
				diatoms	A
				Fragilaria	VA
				Melosira	VA
				Synedra	VA
				Phormidium	C

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