Charles River Watershed Year 2002 Water Quality Monitoring Survey

Results of Periphyton Sampling

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CHARLES RIVER WATERSHED PERIPHYTON COMMUNITY ASSESSMENT - 2002

INTRODUCTION

During July, 2002, MassDEP-DWM personnel collected periphyton (attached microalgae, bacteria and fungi) for qualitative analyses from river and stream stations in the Charles River basin. The sampling was conducted as part of the macroinvertebrate/habitat assessment. One objective of the benthic algal sampling was to document areas with excessive growth of green and yellow-green macroalgae. This information, along with percent algal cover, can be used to determine if the aesthetic value of stream segments was compromised. Another objective was to document the dominant genera in the riffle zones for comparison with other streams or historical sampling results.

Algae are good indicators of water quality conditions since they absorb nutrients and contaminants solely from the water column. The algal community composition, growth rates and biomass production can be altered following exposure to different kinds or amounts of nutrients or toxic substances. Other environmental factors including: stream velocity, substrata, sunlight and biological factors, e.g. the number and kind of grazers present and strategies for resource competition, all affect the success of the algal community. The microalgae are typically represented by diatoms and cyanobacteria (also referred to as blue-green algae) and the macroalgae refer primarily to the green and yellow-green algae. The algal periphyton are further described by the substrata to which they are attached, such as epilithic algae on gravel, cobbles and boulders; epiphytic algae on plants; and episammic algae on sand.

Benthic algal samples are typically collected in the riffle zone from scrapes of a single type of substrata e.g. cobbles or rocks. In order to determine locations with algal problems, information obtained from the algal identifications is combined with percent canopy cover and percent algal cover from the habitat assessment. The estimation of the percent cover of green macroalgae is used to determine if nuisance algal growth is impacting the Aesthetics or Aquatic Life use as described in the Massachusetts Surface Water Quality Standards (SWQS)(MassDEP 1996). Excessive algal growth (Barbour et al., 1999) is defined as an area where the percent algal cover of macroalgae is greater than 40% in a riffle or run. This cover may be considered a threat to the aesthetic quality of the stream segment (Biggs 1996). Aquatic Life can also be impacted by excessive growth of macroalgae. Breakdown of the algal biomass or exudates can lead to lowered dissolved oxygen concentrations. Detrital particles can clog interstitial areas on the substratum that are used by the meiofauna. Macroinvertebrates with low tolerance for these reduced oxygen levels are replaced by more tolerant organisms that are indicative of reduced water quality.

MATERIALS AND METHODS

Site Selection

The locations for the biological sampling (Table 1, Figure 1) were determined by the monitoring coordinator for the Charles River Basin, in conjunction with DWM biologists. The Quality Assurance Project Plan (QAPP) for the Charles River Basin contains the rationale for the selection of the sampling stations (MassDEP 2002).

Field Methods

Periphyton data were gathered along with the macroinvertebrate and habitat data using methods described in Barbour (1999). Periphyton samples were collected within the riffle used for the macroinvertebrate kick samples. The algae were gathered from rock and cobble substrata by scraping the top surface with a knife and rinsing the collected material into a labeled glass vial.

Laboratory Methods

The samples were transported to the lab at DEP-DWM-Worcester where they were refrigerated until taxonomic identifications were completed or they were preserved with M^3 Mix (Reinke, 1984).

Following arrival at the laboratory, the sample vials were logged in and given a unique laboratory number (MassDEP 2000). An Olympus BH2 compound microscope with Nomarski optics was used for identifications. Headspace was left in sample jars or vials so that vigorous shaking of the sample jar can release diatoms and other algae from filamentous algae or moss. The filamentous algae or moss were then removed from the jar for identification and the remainder of the sample was examined separately. A modified version of a scheme devised by Bahls (1993) was used for determining periphyton abundance on the slides. Abundance was described as:

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.

CHARLES RIVER WATERSHED - 2002 BIOMONITORING STATIONS

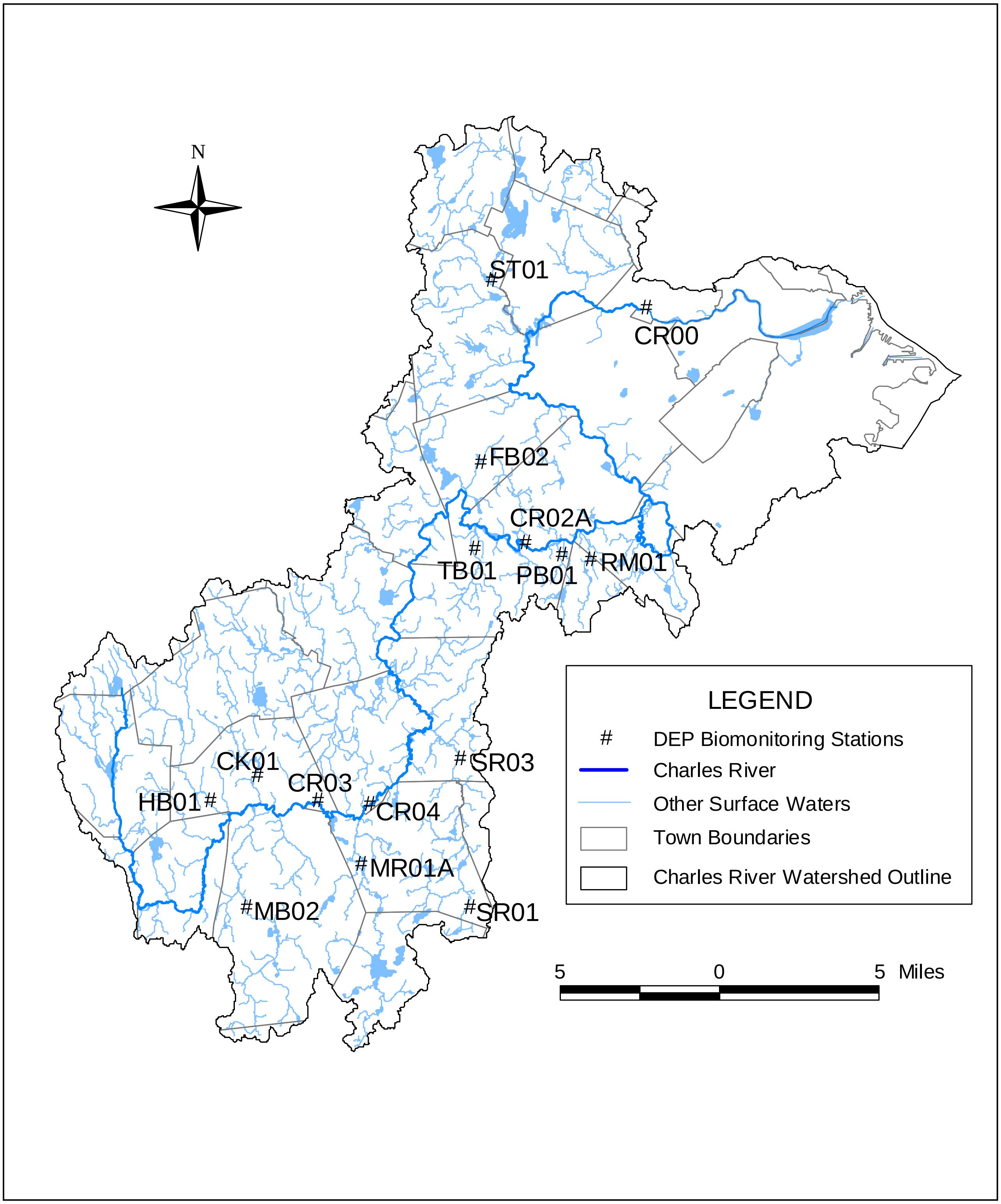

Figure 1. Location of MassDEP/DWM biomonitoring stations for the 2002 Charles River watershed survey.
from Fiorentino 2005

RESULTS

Table 1 contains descriptions of the station locations where periphyton was collected, estimates of percent algal cover, a listing of the most abundant genera, and the common name of their family grouping (green, yellow-green, diatoms, golden-brown, blue-green). Green and yellow-green groups represent taxa that do have filamentous macroalgal representatives. Appendix A lists genera found at each station as well as their abundance in the sample.

Three stations included in this survey of the Charles River and selected tributaries had macroalgal growth greater than 40 % (Table 1). Varying characteristics of the dominant algal genera at each location (Appendix A) made their impacts on the aesthetics of a particular segment unique.

At the Watertown Dam (CR00) the algal cover was described as 100% and the canopy cover as 0% (Table 1). The macroalgae *Cladophora* (A) and *Ulothrix* (VA) were found in clumps, particularly along the edges. Most substrata were covered with a thick biofilm composed primarily of the cyanobacteria *Lyngbya* sp. that was contained within mucilaginous material. The biofilm made the substrata appear to be covered by a “greenish brown “ floc.

At South St (CR02A), below the Dover Dam, Dover, the macroalgal growth was represented by attached filaments of *Cladophora* sp. that trailed in long streamers off of available substrata. The metaphyton *Spirogyra* sp. and *Rhizoclonium* sp. formed large floating clumps that tangled in the vegetation and built up behind any obstructions. Much greater amounts of algal biomass appeared to be present here compared to other stations.

At Dean St. (CR04),located below the Charles River Pollution Control District (CRPCD) sewage treatment plant in Medway, moss and macrophytes dominated the riffle area while metaphyton (drift algae) was present along the margins tangled in vegetation and in pooled areas, or on the protected side of rocks and other obstructions. The metaphyton is present as large semi-buoyant clouds of algae. The macrophytes at this location did not have secondary growth of green filamentous algae on them, so that more of the bottom substrata was visible compared to CR02A.

At three stations (CR03, CK01, and SR03), the percent canopy cover was low allowing abundant sunlight for photosynthesis, but the algal cover remained low; always <5% (Table 1).

Table 1: **CHARLES RIVER BENTHIC ALGAL ANALYSIS-2002**

Station Number, Location, % Canopy Cover, % Algal Cover and Dominant Algal Genera in rock/riffle habitat

Station number	Location	% Canopy cover	% Algal Cover	Dominant Genera
CR03	Charles River-downstream from Walker Street (upst. from CRPCD), Medway	30	<5	Chlorophyceae-*Mougeotia* sp. *Ulothrix* sp.
CR04	Charles River-downstream from Dean Street (dnst. from CRPCD), Millis	<5	In areas with reduced flow>40	Chlorophyceae-*Ulothrix* sp. Chlorophyceae-*Mougeotia* sp.
			In riffle <5	Bacillariophyceae-*Melosira* sp. Bacillariophyceae-*Fragilaria* sp.
CR02A	Charles River- downstream from South St. Dam, Dover	0	95	Chlorophyceae-*Microspora* sp. Chlorophyceae-*Rhizoclonium heiroglyphicum* Chlorophyceae-*Oedogonium* sp.
CR00	Charles River-downstream from Watertown Dam, Watertown	0	100	Cyanophyceae-*Lyngbya* sp.
HB01	Hopping Brook-downstream from West Street, Medway	90	<1	Not collected
MB02	Mine Brook- downstream from Rte 140, Franklin	90	<5	Chlorophyceae-*Rhizoclonium* sp.
CK01	Chicken Brook- downstream from Milk Pond at Winthrop St., Medway	30	<5	Chlorophyceae-siphonous filamentous
MR01A	Mill River- downstream from Main St., Norfolk	75	<1	Chlorophyceae-*Microspora* sp.
SR01	Stop River-downstream from Pond St. Street, Norfolk	30	<5	Not collected
SR03	Stop River-upstream from Noon Hill Avenue, Norfolk,	0	<1	Bacillariophyceae-*Melosira varians*
TB01	Trout Brook- downstream from Haven St., Dover reference station	100	<1	Not collected

DISCUSSION

Stations CR04, CR02A and CR00 are locations on the mainstem of the Charles River where dense algal growth was present (Table 1). They exhibited open canopies that allowed energy from the sun to both drive photosynthesis and heat the surrounding water. Algal production occurs where nutrients and other resources (e.g. sunlight) are not limited (Borchardt1996), as was the situation at these locations that received nonpoint sources of pollution. Station CR04 is downstream of the point source discharge from the CRPCD Wastewater Treatment Plant in Millis (MassDEP 2002).

The amount of algal coverage by filamentous green algae (macroalgae) was greater than 40% at CR04, CR02A and CR00. The substrates of the two stations below the dams (CR02A and

CR00), were almost completely covered by filamentous algae which may have a deleterious effect on the use of these segments for aesthetic purposes or by aquatic life (Barbour 1999).

The mainstem station CR03 and the two tributary stations CK01 on Chicken Brook and SR03 on the Stop River were open to sunlight, but the algal production was low. If resources (nutrients) are available under these conditions, algal growth will likely result. However, if nutrients are not available, or if another stressor such as low flow, scouring, toxicity, degraded water quality, grazing pressures, turbidity or colored water, or lack of suitable habitat are present, algal growth potential may still not be realized. At the three stations listed there may be varying reasons for the lack of algal growth, and since no specific testing was done to determine the cause they can only be proposed based upon other sources of information regarding these sites.

The biological assessment report (Fiorentino 2005) included an evaluation for each of these sites and described significant environmental factors that may be affecting the macroinvertebrate community as well as algal productivity. CR03 was the reference station for the macroinvertebrate assessment. The benthic community was described as healthy and it represented what would likely be present in a “least-impacted” stream; flow was also found to be suitable without large sections of exposed substrata. No immediate explanation for the lack of algal growth is evident. One factor may be the type of sampling for periphyton that was employed. Basically, one substratum (cobbles) and one flow regime (riffles) were sampled. Since the sampling reach had 50% in-stream aquatic vegetation - arrowhead and moss - a major habitat for attached algae was not included in this sampling method. Microalgae may have been present along arrowhead stems or filtered from the water column by the moss. There was no mention of filamentous macroalgae on the submerged stems of the arrowhead, but since multihabitat sampling was not done, it cannot be discounted.

The same issue with sampling methods may be relevant at SR03 since *Sparganium* sp.covered the “majority” of the reach and there was limited riffle present. The *Sparganium* sp.may have been the most suitable habitat for epiphytes. SR03 differs from CR03 however, because it had a bioassessment of “slightly impacted” possibly relating to water quality issues. Water quality data from 2002 (MassDEP 2002) indicate that, except for June 4, the remaining sampling dates consistently exhibited low dissolved oxygen (DO) values and percent saturation values that did not meet Massachusetts water quality standards (MassDEP 1996). The low mid-day DO values (mean = 4.2 mg/l), provided another indication that no significant microalgal or macroalgal population existed in this reach since algal production would likely have led to higher oxygen levels.

CK01 also received a “slightly impacted” biological assessment, but it differed from the other two stations with low algal production since it lacked the macrophytes that may have provided an additional substratum for algal growth. At this time no explanation can be given for the lack of algae, but a recommendation by Fiorentino (2005) includes water quality sampling at this location during the next sampling round that may provide further insight.

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Appendix A: PERIPHYTON-Charles River Watershed 2002 Periphyton Survey Data						
Location		Date	Habitat	Family	Genus	Abundance
Charles River						
CR03						
Charles River Downstream from Walker St., (upst. from CRPCD), Medway		15-Jul	rock, riffle	Chlorophyceae	*Mougeotia capucina*	VA
				Chlorophyceae	*Ulothrix* sp.	A
CR03						
		6-Aug	mat	Bacillariophyceae	*Melosira* sp.	R
				Chlorophyceae	*Scenedesmus* sp.	R
				Cyanophyceae	*Oscillatoria* sp.	A
				Cyanophyceae	*Cocconeis* sp.	C
				Cyanophyceae	*Lyngbya* sp.	VA
					lots of diatoms, naviculoids	VA
CR04						
Charles River Downstream from Dean St. (dnst. from CRPCD), Millis		15-Jul	rock, riffle	Chlorophyceae	*Ulothrix* sp.	VA
				Chlorophyceae	*Mougeotia* sp.	VA
CR04		29-Jul	rock, riffle	Bacillariophyceae	*Melosira* sp.	VA
				Bacillariophyceae	*Synedra* sp.	C
				Bacillariophyceae	*Fragilaria* sp.	VA
CR02A						
Charles River Downstream of Dover Dam, Dover		17-Jul	entangled in vegetation	Chlorophyceae	*Spirogyra* sp.	C
				Chlorophyceae	*Rhizoclonium* sp.	VA
CR02A						
Charles River Downstream of Dover Dam, Dover		17-Jul	sand, pool	Cyanophyceae	*Lyngbya versicolor*	VA
CR02A						
Charles River Downstream of Dover Dam, Dover		17-Jul	rock, riffle	Chlorophyceae	*Microspora* sp.	VA
				Chlorophyceae	*Rhizoclonium heiroglyphicum*	VA
				Chlorophyceae	*Oedogonium* sp.	VA
CR02A						
Charles River Downstream of Dover Dam, Dover		17-Jul	pool, rock	Chlorophyceae	*Coleochaete* sp.	
CR02A				Chlorophyceae	*Spirogyra* sp.	C
Charles River Downstream of Dover Dam, Dover		29-Jul	on vegetation			
				Bacillariophyceae	*Melosira* sp.	R
				Chlorophyceae	*Cladophora* sp.	R
				Chlorophyceae	*Coelastrum* sp.	R
				Chlorophyceae	*Oedogonium* sp.	A
				Chlorophyceae	*Pediastrum* sp.	R

Appendix A: PERIPHYTON-Charles River Watershed 2002 Periphyton Survey Data

Location		Date	Habitat	Family	Genus	Abundance
CR02A						
Charles River Downstream of Dover Dam, Dover		29-Jul	rock, riffle	Bacillariophyceae	*Cocconeis* sp.	VA
				Chlorophyceae	*Cladophora* sp.	C
				Chlorophyceae	*Rhizoclonium* sp.	A
				Chlorophyceae	*Spirogyra* sp.	R
				Cyanophyceae	*Lyngbya* sp.	R
CR00						
Charles River Downstream from Watertown Dam, Watertown		16-Jul	Entangled in vegetation	Chlorophyceae	*Cladophora* sp.	A
				Chlorophyceae	*Ulothrix* sp.	VA
				Bacillariophyceae	*Cocconeis* sp.	VA
				Bacillariophyceae	*Melosira* sp.	R
CR00						
		16-Jul	rock, riffle	Bacillariophyceae	*Melosira granulate var. angustissima*	R
				Bacillariophyceae	*ui diatoms*	C
				Cyanophyceae	*Rivularia* sp.	A
				Cyanophyceae	*Lyngbya* sp.	VA
MR01A						
Mill River-Downstream from Main St., Norfolk		18-Jul	rock, riffle	Chlorophyceae	*Microspora* sp.	R
MR01A						
Mill River-Downstream from Main St., Norfolk		18-Jul	pool, pebble-gravel	Cyanophyceae	*Phormidium favosum*	VA
SR03						
Stop River- At Noon Hill St., Medfield		16-Jul	rock, riffle	Bacillariophyceae	*Melosira varians*	VA
				Bacillariophyceae	*Synedra* sp.	C
SR03						
		22-Jul	rock, riffle	Bacillariophyceae	*Cocconeis* sp.	R
				Bacillariophyceae	*Cymbella* sp.	C
				Bacillariophyceae	*Melosira* sp.	A
				Bacillariophyceae	*Synedra* sp.	R
				Bacillariophyceae	*naviculoids*	R
					fungal hyphae	A
					sewage fungus	R
				Cyanophyceae	*Lyngbya* sp.	R
FB02						
Fuller Brook- Upstream from Cameron St., Wellesley		17-Jul		Bacillariophyceae	*Melosira* sp.	R
				Chlorophyceae	*Stigeoclonium lubricum*	VA
				Chlorophyceae	*ui-green*	R
				Chlorophyceae	*Ulothrix* sp.	VA