Technical Memorandum CN 235.3

SOUTH SHORE COASTAL WATERSHEDS
2006 BENTHIC MACROINVERTEBRATE BIOASSESSMENT

Division of Watershed Management
Watershed Planning Program
Worcester, MA

March 2013

Commonwealth of Massachusetts
Executive Office of Energy and Environmental Affairs
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INTRODUCTION

The Massachusetts Department of Environmental Protection/Division of Watershed Management (MassDEP/DWM) utilizes biological monitoring techniques to detect anthropogenic impacts to aquatic communities. Aquatic communities (e.g., benthic macroinvertebrates, fish, periphyton) are natural indicators of environmental quality and can reveal the effects of episodic and cumulative pollution and habitat alteration (Barbour et al. 1995, Plafkin et al. 1989).

As part of the DWM 2006 surface water monitoring program for the South Shore Coastal Watersheds, aquatic benthic macroinvertebrate biomonitoring was conducted to evaluate the biological health of selected streams and determine their status with respect to the support of the *Aquatic Life Use*, as designated in the *Massachusetts Surface Water Quality Standards* (SWQS) (MassDEP 2006a). These assessments form the basis for reporting and listing waters pursuant to sections 305(b) and 303(d) of the Clean Water Act (CWA). All monitoring activities, including water quality sampling and biomonitoring, were guided by the *South Coastal Watershed Sampling and Analysis Plan 2006* (MassDEP 2006b). The macroinvertebrate community was sampled at a total of fourteen locations during July 25-27, 2006. The sampling site descriptions, along with station identification numbers and sampling dates are presented in Table 1.

In the past the MassDEP has carried out very little macroinvertebrate biomonitoring in these watersheds. A classification survey of the North River was conducted in 1983, for which the primary objective was to "characterize the surface water courses and related aquatic habitats chemically and hydrophysically, and to qualitatively document the dominant flora and fauna of the river system." (DEQE 1983, 1986). Szal (1992) investigated the effects of the effluent from the Rockland Wastewater Treatment Plant on the macroinvertebrate community of the receiving water, French Stream. Finally, the Jones River Watershed Association (JRWA) included macroinvertebrate sampling as part of an effort to establish a baseline of current conditions in the Jones River and selected tributaries (Teal Ltd. 2000). Monitoring locations, sampling protocols, and the taxonomic levels to which invertebrate specimens were identified all differed among these investigations, as well as from the 2006 biomonitoring surveys described here, so direct comparisons of the results from these studies are not appropriate for assessing whether the biological condition of these streams has changed over time. Nonetheless, where applicable, earlier data were reviewed to provide some historical context with respect to the presence or absence of macroinvertebrate species populations in the streams studied in 2006, but this effort yielded little additional information.

The benthic community data from an unnamed tributary flowing through Forge Pond in Plymouth (Station ER07) was considered by DWM biologists to be the most representative of "least-disturbed" conditions in the South Shore Coastal Watersheds and, therefore, was selected to serve as the reference condition to which the other "test" sites were compared. The stream was not affected by point sources of water pollution, and assumed (based on historical water quality data, topographic map examinations, and field reconnaissance) to be minimally impacted (relative to other portions of the South Shore Coastal Watersheds) by nonpoint sources. To provide information for making *Aquatic Life* use-support determinations, macroinvertebrate communities present at biomonitoring stations in the South Shore Coastal Watersheds were compared with the community occurring at this regional reference station. Deleterious effects on the benthic community are typically indicated by the absence of generally pollution-sensitive macroinvertebrate taxa, such as Ephemeroptera, Plecoptera, and Trichoptera (EPT); dominance of a particular taxon, especially a representative of the pollution-tolerant Chironomidae and Oligochaeta; low total taxa richness; or shifts in community composition relative to the reference station (Plafkin et al. 1989).

METHODS

Macroinvertebrate Sampling - RBPIII

Macroinvertebrate sampling methods employed for the 2006 surveys of the South Shore Coastal Watersheds are described in the standard operating procedures *Water Quality Monitoring in Streams Using Aquatic Macroinvertebrates* (Nuzzo 2003) and are based on the United States Environmental

Protection Agency (USEPA) Rapid Bioassessment Protocols (RBPs) for wadeable streams and rivers (Plafkin et al. 1989). 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 was conducted by MassDEP/DWM biologists throughout a 100 m reach in riffle/run areas with fast currents and rocky (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 before transport to the MassDEP/DWM lab for further processing.

Table 1. List of biomonitoring stations sampled during the DWM 2006 surveys of the South Shore Coastal Watersheds, including station and unique identification numbers, drainage areas, sampling site descriptions, and sampling dates.

Station ID	Unique ID	Drainage Area (mi^2)	Sampling Site Description	Sampling Date
Plymouth Bay Subwatershed				
ER07[1]	B0590	3.08	Unnamed Tributary through Forge Pond, ~500m upstream from Forge Pond, Plymouth	27-Jul-2006
ER015	B0588	3.83	Eel River, ~100m upstream from Russell Millpond, Plymouth	27-Jul-2006
ER02	B0589	5.71	Eel River, ~100m downstream from Russell Mills Road, Plymouth	27-Jul-2006
JR102	B0593	20.1	Jones River, ~150m downstream from Elm Street, Kingston	27-Jul-2006
TB01	B0594	8.97	Town Brook, at footbridge upstream from Summer Street / Pleasant Street, Plymouth	27-Jul-2006
North and South River Subwatersheds				
FS102	B0591	4.99	French Stream, upstream at Summer Street, Rockland	26-Jul-2006
SH02	B0592	3.15	Second Herring Brook, ~100m downstream from Norris Pond Dam, Norwell	25-Jul-2006
DW101	B0595	11.1	Drinkwater River, ~150m downstream from Circuit Street, Hanover	26-Jul-2006
IM101	B0596	0.88	Iron Mine Brook, ~100m downstream from Broadway, Hanover	26-Jul-2006
IH102	B0597	28.8	Indian Head River, ~200m downstream from Cross Street / State Street, Hanover / Hanson	26-Jul-2006
SR102	B0598	11.4	South River, ~100m downstream from Main Street, Marshfield.	26-Jul-2006
HR01	B0599	4.6	Herring River, ~50m upstream from New Driftway, Scituate	27-Jul-2006
FH02	B0600	1.75	First Herring Brook, ~5 upstream from Grove Street, Scituate	25-Jul-2006
TH02	B0601	9.65	Third Herring Brook, ~120m downstream from Broadway / River Street, Hanover / Norwell	25-Jul-2006

[1] Reference site

Macroinvertebrate Sample Processing and Data Analysis

The macroinvertebrate sample processing and analysis procedures employed for the 2006 South Shore Coastal Watersheds are described in the standard operating procedures (Nuzzo 2003). Macroinvertebrate sample processing entailed distributing whole samples in pans, randomly selecting grids within the pans, and sorting specimens from the other materials in the sample until approximately 100 organisms (±10%) were extracted. Specimens were identified to genus or species as allowed by available keys, specimen condition, and specimen maturity.

Based on the taxonomy, various community, population, and functional parameters, or "metrics", were calculated to allow measurement of important aspects of the biological integrity of the macroinvertebrate community. This integrated approach provides more assurance of a valid assessment because a variety of biological parameters are evaluated, and the deficiency of any one metric should not invalidate the entire approach (Plafkin et al. 1989). Taxonomic data were analyzed using a modification of Rapid Bioassessment Protocol III (RBP III) metrics and scores (Plafkin et al. 1989). The modifications were: substitution of "Reference Site Affinity" (RSA) for the Community Loss Index and elimination of the shredder/total ratio (no separate leaf-pack material was collected). The RSA metric is a modification of Percent Model Affinity (Novak and Bode 1992). Instead of using the model's percentages for Oligochaeta, Ephemeroptera, Plecoptera, Trichoptera, Coleoptera, Chironomidae, and "other," these percentages were taken from the reference site data. The RSA score is then 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 RBP III scores as follows: 0 points for <35%; 2 points in the range from 35 to 49%; 4 points for 50 to 64%; and 6 points if ≥65%. The entire suite of metrics used for the analysis was as follows.

- Richness—the total number of different species present in the subsample plus those detected from a "large/rare" search of the whole sample (those taxa missed in subsampling).

- HBI—Hilsenhoff Biotic Index (Hilsenhoff 1982), as modified in Nuzzo (2003); the HBI is the sum of the products of each taxon's abundance and its corresponding pollution tolerance value, divided by the total count in the subsample.

- EPT—the sum of richness among the orders Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies) as determined from the specimens in the subsample plus those detected in a "large/rare" search of the whole sample; these orders tend to be dominated by species generally considered to be pollution sensitive.

- $EPT_a/Chiro_a$—the ratio of total abundance among EPT taxa to total abundance among Chironomidae taxa.

- SC/FC—the ratio of the proportion of sample that is represented by individuals that predominantly feed by scraping to those that are primarily filter-feeders.

- % Dominant Taxon—the most abundant taxon as a percent of the assemblage; >20% is generally considered hyperdominant and indicative of a stressor impact.

- RSA—Reference Site Affinity (described above).

Metric values for each station were scored based on comparability to the reference station, and then scores were totaled. The percent comparability of total metric scores for each study site to those for the selected "least-disturbed" reference station yielded an impairment score for each site. RBP III analysis separates sites into four categories: "non-impaired", "slightly impaired", "moderately impaired", and "severely impaired". Each

impairment category corresponds to a specific *Aquatic Life* use-support determination currently used by DWM analysts in the CWA Section 305(b) water quality reporting process—non-impaired and slightly impaired benthic invertebrate communities are generally indicative of conditions supporting the *Aquatic Life Use*, whereas water bodies exhibiting moderately or severely impaired communities are generally assessed as "not supporting."

Habitat Assessment

Habitat qualities were scored for each sampling reach using the assessment procedure in Plafkin et al. (1989), as modified in Barbour et al. (1999). An evaluation of physical and biological habitat quality is critical to any assessment of ecological integrity (Karr et al. 1986; Plafkin et al. 1989). 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). The matrix used to assess habitat quality is based on key physical characteristics of the water body and the immediate riverfront area. Most parameters evaluated are instream physical attributes that are potential sources of limitation to the aquatic biota (Plafkin et al. 1989). The ten habitat parameters are as follows: instream cover, epifaunal substrate, embeddedness, sediment deposition, channel alteration, velocity/depth combinations, channel flow status, right and left (when facing downstream) bank vegetative protection, right and left bank stability, right and left bank riparian vegetative zone width. Habitat parameters are scored, totaled, and compared to the reference station to infer the extent to which the condition of the habitat, rather than water quality effects, may account for differences in macroinvertebrate community structure at the study sites.

RESULTS AND DISCUSSION

Despite the presence of some sediment deposition, which affected the habitat score the most, the overall habitat quality was very good at Station ER07 on the unnamed tributary through Forge Pond, scoring 83% of the maximum attainable value of 200 and validating further its use as the reference condition (Appendix 1). The mean habitat score for the remaining sites was 149, and habitat scores for all but two sites compared favorably with, or even exceeded, that of the reference site (Table 2). The habitat quality at Station SR102 on the South River was described as "partially supporting", losing the most points in instream cover, channel alteration, velocity-depth combinations and riparian vegetative zone width (both banks). Only Station HR01 on the Herring River in Scituate exhibited habitat degraded to a level considered "not supporting." Channel alteration, instream cover, embeddedness, bank vegetative protection (both banks), bank stability (both banks) and riparian vegetative zone width (both banks) all scored marginally or poorly in the habitat assessment of the Herring River (Appendix 1).

A taxonomic list of the macroinvertebrate organisms collected at each sampling station during the 2006 biomonitoring survey is provided in Appendix 2. Included in the list are total organism counts, the functional feeding group designation (FG) for each macroinvertebrate taxon, and the tolerance value (TV) of each taxon. Table 2 presents summaries of the habitat and RBP III macroinvertebrate data analyses for all of the sites. Included for each sampling site are the habitat comparability to the reference condition, biological metric calculations, metric scores, and impairment designations.

The benthic macroinvertebrate community at Station ER07 on the unnamed tributary through Forge Pond in Plymouth outperformed all of the sites investigated in several key metrics (e.g., Total and EPT Richness, Biotic Index, % Dominant Taxon), and the values of these metrics were typical of what might be expected from a reference site (Table 2).

Although the macroinvertebrate communities present at all thirteen "test" sites in the South Coastal Watersheds exhibited reductions in the Total and EPT Richness metrics and higher Biotic Index values when compared to the reference site at ER07, eleven sites rated only "slightly impaired" and, as such, were considered to be supporting the designated *Aquatic Life Use* (Table 2). The macroinvertebrate communities in the Eel River downstream from Russell Mills Road (ER02) and the Herring River in

Scituate (HR01) were “moderately impaired” and “severely impaired”, respectively, leading to the determination that the *Aquatic Life Use* was not supported in these two water bodies.

The invertebrate communities in all of the streams in the South Coastal Watersheds were structured in response to varying degrees of organic enrichment, though habitat factors also likely contributed to the conditions in the Herring River and Town Brook. A review of the taxa list (Appendix 2) reveals the prevalence of filtering collectors in the invertebrate communities inhabiting all of these sites. Three genera alone – *Hydropsyche*, *Cheumatopsyche* and *Chimarra* – comprised from one-third to one-half of the specimens collected from most of the “test” sites. These caddisflies construct silken capture nets that strain food particles from the stream current. Their predominance at most “test” sites is indicative of the abundant supply of particulate organic matter that is typical of the low-gradient, impounded streams found in southeastern Massachusetts. The low scraper/filterer ratios exhibited at all of the sampling sites are further evidence of the availability of this rich food supply.

Despite 91% habitat comparability, the benthic macroinvertebrate community in the Eel River downstream from Russell Mills Road, Plymouth (Station ER02) was only 25% comparable to the reference community, thus leading to an assessment of “moderately impaired” for this site. The Taxa Richness, EPT Index and % Dominant Taxon metrics contributed to the largest reductions in the total metric score. Furthermore, the Biotic Index value was the highest of any station sampled. Since habitat characteristics did not appear to limit the biological potential at this site, adverse impacts on the macroinvertebrate community can be attributed primarily to water quality conditions. Once again, filtering collectors (i.e., *Hydropsyche betteni, Cheumatopsyche* sp. and the “fingernail clam” family Pisidiidae) dominated the macroinvertebrate community at this site. Unlike all but one of the other sites, however, the RBP III analysis of this location indicates enriched conditions resulting in a benthic invertebrate community impaired to the degree that the *Aquatic Life Use* is not supported.

Station HR01, located on the Herring River in Scituate, was the only site that received a “severely impaired” RBP III designation. The entire sample of invertebrate organisms consisted of 103 amphipods representing the family Gammaridae, and a single specimen each of caddisfly larva and segmented worm. This site also exhibited the poorest habitat quality of the 14 sites examined in this investigation. For this reason it is difficult to distinguish the effects of habitat factors and water quality conditions on the biological potential of the Herring River at this location. Examination of DWM field sheets and a review of water quality data suggest that this site is tidally influenced. Although much lower during other visits, a specific conductance value of 963 µS/cm was recorded here on October 11, 2006 (Carr and Reardon 2012). The observed tidal effects and associated fluctuations in salinity call into question the validity of employing the RBP III protocols to assess the biological status of the Herring River at this sampling station. Certainly deviations from the reference community would be expected from differences in salinity alone. Nonetheless, the poor habitat quality and complete lack of diversity reflected in the macroinvertebrate community suggest that the *Aquatic Life Use* is not supported in this reach of the Herring River.

SUMMARY

Sampling of the benthic macroinvertebrate community was carried out in July, 2006 at fourteen sites in the South Shore Coastal Watersheds to evaluate the biological health of selected streams and to determine their status with respect to the support of the *Aquatic Life Use*, as designated in Massachusetts’ Surface Water Quality Standards. Results of these assessments form the basis for reporting and listing waters under sections 305(b) and 303(d) of the Clean Water Act. Field and laboratory methods and data analysis were based on the USEPA’s Rapid Biomonitoring Protocols. The unnamed stream through Forge Pond in Plymouth (Station ER07) served as the reference site. The macroinvertebrate community structure at twelve sampling stations was rated as “slightly impaired” and the water bodies represented by these sites were considered to be supporting the *Aquatic Life Use.* At two sites the benthic macroinvertebrate community was degraded to the point where the *Aquatic Life Use* was not supported. The low EPT richness and high Biotic Index score at a site on the Eel River was characteristic of invertebrate communities structured in response to organic enrichment. While the macroinvertebrate community was severely impaired at the Herring River site in Scituate, tidal effects and

habitat characteristics appeared to limit the biological potential of this stream the most. Therefore, for the purpose of reporting in accordance with section 305(b) of the CWA, the *Aquatic Life Use* status of this reach can be considered "non-support" due to habitat factors.

Table 2. Summary of habitat analysis (i.e., comparability to the reference habitat condition) and RBP III analysis of macroinvertebrate communities sampled during the South Shore Coastal Watersheds survey between 25 and 27 July 2006. Shown are the calculated metric values, metric scores (in italics) based on comparability to the reference station (ER07) and the corresponding assessment designation for each biomonitoring station. Complete habitat evaluations are presented in Appendix 1. Refer to Table 1 for a listing and description of sampling stations.

SAMPLING STATION	ER07		ER015		ER02		JR102		TB01		FS102		SH02		DW101	
STREAM	Unnamed Tributary		Eel River		Eel River		Jones River		Town Brook		French Stream		Second Herring Brook		Drinkwater River	
HABITAT SCORE	166		171		151		131		114		145		177		156	
HABITAT % REFERENCE	--		103%		91%		79%		69%		87%		107%		94%	
HABITAT COMPARABILITY	--		Comparable		Comparable		Supporting		Partially supporting		Supporting		Comparable		Comparable	
TAXA RICHNESS	32	*6*	17	*2*	8	*0*	22	*4*	20	*4*	14	*2*	17	*2*	16	*2*
BIOTIC INDEX	3.65	*6*	5.75	*2*	6.50	*2*	5.32	*2*	5.44	*2*	5.13	*4*	4.30	*4*	5.10	*4*
EPT INDEX	11	*6*	3	*0*	2	*0*	7	*0*	4	*0*	5	*0*	6	*0*	3	*0*
EPT/CHIRONOMIDAE	2.21	*6*	1.24	*4*	26	*6*	6.43	*6*	2.86	*6*	7.25	*6*	5.50	*6*	1.94	*6*
SCRAPER/FILTERER	0.35	*6*	0.42	*6*	--	--	0.64	*6*	0.77	*6*	0.67	*6*	0.65	*6*	0.98	*6*
REFERENCE AFFINITY	100%	*6*	67%	*6*	44%	*2*	63%	*4*	61%	*4*	42%	*2*	65%	*6*	61%	*4*
% DOMINANT TAXON	21%	*4*	23%	*4*	55%	*0*	23%	*4*	23%	*4*	33%	*2*	25%	*4*	19%	*6*
TOTAL METRIC SCORE	*40*		*24*		*10*		*26*		*26*		*22*		*28*		*28*	
% COMPARABILITY TO REFERENCE	100%		60%		25%		65%		65%		55%		70%		70%	
BIOLOGICAL CONDITION -DEGREE IMPACTED	**NOT IMPAIRED**		**SLIGHTLY IMPAIRED**		**MODERATELY IMPAIRED**		**SLIGHTLY IMPAIRED**		**SLIGHTLY IMPAIRED**		**SLIGHTLY IMPAIRED**		**SLIGHTLY IMPAIRED**		**SLIGHTLY IMPAIRED**	

Table 2 (continued). Summary of habitat analysis (i.e., comparability to the reference habitat condition) and RBP III analysis of macroinvertebrate communities sampled during the South Shore Coastal Watersheds survey between 25 and 27 July 2006. Shown are the calculated metric values, metric scores (in italics) based on comparability to the reference station (ER07), and the corresponding assessment designation for each biomonitoring station. Complete habitat evaluations are presented in Appendix 1. Refer to Table 1 for a listing and description of sampling stations.

SAMPLING STATION	ER07		IM101		IH102		SR102		HR01		FH02		TH02	
STREAM	Unnamed Tributary		Iron Mine Brook		Indian Head River		South River		Herring River		First Herring Brook		Third Herring Brook	
HABITAT SCORE	166		149		182		124		91		166		183	
HABITAT % REFERENCE	--		90%		110%		75%		55%		100%		110%	
HABITAT COMPARABILITY	--		Comparable		Comparable		Supporting		Not Supporting		Comparable		Comparable	
TAXA RICHNESS	32	*6*	21	*4*	14	*2*	19	*4*	3	*0*	21	*4*	18	*2*
BIOTIC INDEX	3.65	*6*	5.08	*4*	4.90	*4*	4.99	*4*	6.00	*2*	4.46	*4*	5.69	*2*
EPT INDEX	11	*6*	5	*0*	5	*0*	5	*0*	1	*0*	6	*0*	4	*0*
EPT/CHIRONOMIDAE	2.21	*6*	1.05	*2*	26.5	*6*	1.54	*4*	--	*0*	1.87	*6*	3.19	*6*
SCRAPER/FILTERER	0.35	*6*	0.40	*6*	0.62	*6*	0.89	*6*	--	*0*	0.02	*0*	0.19	*6*
REFERENCE AFFINITY	100%	*6*	65%	*6*	42%	*2*	63%	*4*	20%	*0*	79%	*6*	66%	*6*
% DOMINANT TAXON	21%	*4*	31%	*2*	27%	*4*	21%	*4*	98%	*0*	19%	*6*	37%	*2*
TOTAL METRIC SCORE	*40*		*24*		*24*		*26*		*2*		*26*		*24*	
% COMPARABILITY TO REFERENCE	100%		60%		60%		65%		5%		65%		60%	
BIOLOGICAL CONDITION -DEGREE IMPACTED	**NOT IMPAIRED**		**SLIGHTLY IMPAIRED**		**SLIGHTLY IMPAIRED**		**SLIGHTLY IMPAIRED**		**SEVERELY IMPAIRED**		**SLIGHTLY IMPAIRED**		**SLIGHTLY IMPAIRED**	

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Appendix 1. Habitat assessment summary for biomonitoring stations sampled during the 2006 South Shore Coastal Watersheds survey. For within-reach parameters, scores ranging from 16-20 = optimal; 11-15 = suboptimal; 6-10 = marginal; 0-5 = poor. For riparian parameters, scores ranging from 9-10 = optimal; 6-8 = suboptimal; 3-5 = marginal; 0-2 = poor. Maximum habitat score for any site = 200. Refer to Table 1 for a listing and description of sampling stations.

STATION	ER07	ER015	ER02	JR102	TB01	FS102	SH02	DW101	IM101	IH102	SR102	HR01	FH02	TH02
PRIMARY PARAMETERS (range is 0-20)	**SCORE**													
INSTREAM COVER	20	19	17	7	7	10	18	9	8	19	8	4	14	17
EPIFAUNAL SUBSTRATE	15	17	12	14	16	15	17	18	16	19	17	14	17	18
EMBEDDEDNESS	11	16	14	14	16	13	16	16	16	20	13	10	19	19
CHANNEL ALTERATION	20	15	18	8	9	18	19	16	15	14	4	3	15	15
SEDIMENT DEPOSITION	6	10	11	17	11	10	17	18	14	20	14	13	20	18
VELOCITY-DEPTH COMBINATIONS	16	17	15	10	19	10	16	10	12	19	8	11	10	17
CHANNEL FLOW STATUS	20	19	20	19	20	17	19	19	14	19	19	17	18	19
SECONDARY PARAMETERS (range is 0-10 for each bank)	**SCORE**													
BANK VEGETATIVE PROTECTION left	10	10	5	9	3	9	10	10	10	9	9	3	9	10
BANK VEGETATIVE PROTECTION right	10	10	10	2	1	9	10	8	10	10	9	3	9	10
BANK STABILITY left	9	9	7	9	5	7	8	7	8	9	10	4	10	10
BANK STABILITY right	9	10	9	10	4	7	8	8	8	10	10	5	10	10
RIPARIAN VEGETATIVE ZONE WIDTH left	10	10	3	10	2	10	10	10	10	4	1	3	5	10
RIPARIAN VEGETATIVE ZONE WIDTH right	10	9	10	2	1	10	9	7	8	10	2	1	10	10
TOTAL SCORE	**166**	**171**	**151**	**131**	**114**	**145**	**177**	**156**	**149**	**182**	**124**	**91**	**166**	**183**

Appendix 2. Species-level taxa list and counts, functional feeding groups (FG), and tolerance values (TV) for macroinvertebrates collected from stream sites during the 2006 South Shore Coastal Watersheds survey from 25 to 27 July 2006. Refer to Table 1 for a listing and description of sampling stations.

TAXON	FFG[1]	TV[2]	Sampling Stations													
			ER07[3]	ER015	ER02	JR102	TB01	FS102	SH02	DW101	IM101	IH102	SR102	HR01	FH02	TH02
Gastropoda		7		1												
Hydrobiidae	SC	8				6										
Pseudosuccinea columella	GC	6	1													
Planorbidae	SC	6	1			1										
Pisidiidae	FC	6	3	5	17	17	1	1	5		1	5			4	1
Oligochaeta	GC	8												1		
Enchytraeidae	GC	10		2												
Nais behningi	GC	6														1
Nais communis	GC	8											1			1
Tubificidae IWB	GC	10			3											
Lumbriculidae	GC	7						1			17		2		2	14
Erpobdella punctata	PR	8	1										1			1
Caecidotea sp.	GC	8				1			1	2	1	1	1			
Caecidotea communis	GC	8	2	8			2								9	
Gammaridae	GC	6												103		
Gammarus sp.	GC	6			2	5	4			9	30					6
Hyalella azteca	GC	8	1			1	1									
Hydrachnidia	PR	6				3										
Lebertia sp.	PR	6	1													
Sperchon sp.	PR	6					1	1								
Baetis flavistriga	GC	4						1								
Heterocloeon anoka	SC	2	1													
Plauditus sp.	GC	4				3										
Eurylophella funeralis	GC	0	4													
Heptageniidae	SC	4										1	2			
Maccaffertium sp.	SC	3				11	2		4				6			1
Maccaffertium pudicum	SC	2	1													
Aeschnidae	PR	3	1													
Boyeria vinosa	PR	2													1	
Calopterygidae	PR	5									1					
Calopteryx sp.	PR	6													1	
Hetaerina sp.	PR	6	1													
Leuctra sp.	SH	0	23						11		5				19	8
Leuctridae/Capniidae	SH	2											1			
Nemouridae	SH	2									1					
Nigronia serricornis	PR	0	3							1					2	
Glossosoma sp.	SC	0	1													
Hydropsychidae	FC	4										2		1	5	
Cheumatopsyche sp.	FC	5	3	2	21	23	11	11	3	11		7	15			
Diplectrona modesta	FC	0									9				6	
Hydropsyche sp.	FC	4								1						
Hydropsyche betteni	FC	7	10	18	57	3	24	18	11	18	4	11	11		21	38
Hydropsyche morosa gr.	FC	6				3										
Hydropsyche sparna	FC	6										5				
Hydroptilidae	GC	4													1	
Lepidostoma sp.	SH	1									1					
Oecetis sp.	PR	5		1												
Oecetis avara	PR	5	2													
Chimarra aterrima	FC	4	4					3	25	1					5	4
Chimarra obscura	FC	4				1	3	25				27	8			
Rhyacophila sp.	PR	1							1						1	
Rhyacophila carolina gr.	PR	1	2													
Rhyacophila fuscula	PR	0	2													
Neophylax sp.	SC	3				1										
Elmidae	SC	4					1						3			
Macronychus glabratus	SH	5					1									

TAXON	FFG[1]	TV[2]	Sampling Stations													
			ER07[3]	ER015	ER02	JR102	TB01	FS102	SH02	DW101	IM101	IH102	SR102	HR01	FH02	TH02
Microcylloepus pusillus	GC	3					2					2				
Optioservus sp.	SC	4				2					3	3	2			4
Optioservus ovalis	SC	4						3	10	19					1	
Oulimnius latiusculus	SC	4	9	18			16						1			
Promoresia tardella	SC	2							2	6						
Stenelmis sp.	SC	5		2		10					3	23	15			5
Stenelmis crenata	SC	5					15	36	14	16						
Psephenus herricki	SC	4				1						9	2			
Anchytarsus bicolor	SH	4	1													
Glyptotendipes sp.	SH	10			1											
Microtendipes pedellus gr.	FC	6													1	
Polypedilum sp.	SH	6								2						
Polypedilum flavum	SH	6	1	1			5	2	6			1				
Polypedilum illinoense gr.	SH	6						1			8				2	
Micropsectra sp.	GC	7		5											3	
Rheotanytarsus exiguus gr.	FC	6	1			1				3						1
Rheotanytarsus pellucidus	FC	5	8				2			7			1		3	5
Tanytarsus sp.	FC	6	3			1										2
Orthocladiinae	GC	5														1
Brillia sp.	SH	5									1					
Brillia flavifrons	SH	5		1												
Cardiocladius albiplumus	PR	5			1											
Cardiocladius obscurus	PR	5					3									
Corynoneura sp.	GC	4											2			
Cricotopus/Orthocladius sp.	GC	7					1									
Eukiefferiella claripennis gr.	GC	8						1			1					
Eukiefferiella devonica gr.	GC	4											3			
Orthocladius sp.	GC	6					1									
Parametriocnemus sp.	GC	5	5						2		1					
Thienemanniella xena	GC	6											1		1	
Tvetenia paucunca	GC	5	2	7			2	4	1	2	6				12	
Tvetenia vitracies	GC	5		1		5				2		1	21			7
Thienemannimyia gr.	PR	6	4	2	1				1		2				9	
Empididae	PR	6				1			1							
Hemerodromia sp.	PR	6		2			3						1			1
Neoplasta sp.	PR	6									1					
Simuliidae	FC	6				1										
Simulium sp.	FC	5	5	23			3		2	1	1	1				3
Dicranota sp.	PR	3								1	1				1	
Tipula sp.	SH	6	1													
TOTAL			**108**	**99**	**103**	**101**	**104**	**108**	**100**	**102**	**98**	**99**	**100**	**105**	**110**	**104**

[1]Functional Feeding Group (FG) lists the primary feeding habit of each species and follows the abbreviations: SH-Shredder; GC-Gathering Collector; FC-Filtering Collector; SC-Scraper; PR-Predator.

[2]Tolerance Value (TV) is an assigned value used in the calculation of the Biotic Index. Tolerance values range from 0 for organisms very intolerant of organic wastes to 10 for very tolerant organisms.

[3] Reference station