Mactaquac Aquatic Ecosystem Study
Report Series 2015-002

METHODS PAPER: Benthic Macroinvertebrate Sampling in the Saint John River Downstream of the Mactaquac Generating Station

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DISCLAIMER

Intended use and technical limitations of the report, "Benthic Macroinvertebrate Sampling in the Saint John River Downstream of the Mactaquac Generating Station". This interim report describes the first summer of benthic macroinvertebrate community sampling in the Saint John River downstream of the Mactaquac Generating Station. This programme is continuously evolving as sites are tested, added, and excluded, and the following report is summary of the 2014 sampling. The CRI doesn't assume liability for any use of the included data and analyses outside the stated scope.

Introduction

Benthic macroinvertebrate (BMI) were sampled as part of the biological monitoring programme to establish baseline conditions in the Mactaquac Aquatic Ecosystem Study (MAES). A total of 15 core (Figure 1) sites were established in the study reach with an additional two sample sites identified outside the influence of direct human impacts (mainstem at Claire, NB and Nashwaak River; Table 1). The BMI community structure (identified to genus-level) as well as samples for stable isotope and DNA analyses are targeted for each site beginning in 2014 and occurring annual for the duration of the MAES longer term project. The methodology for sampling follows Canadian Aquatic Biomonitoring Network (CABIN) protocols adjusted for large river sampling (www.ec.gc.ca/rcba-cabin/; CABIN manual, 2012).

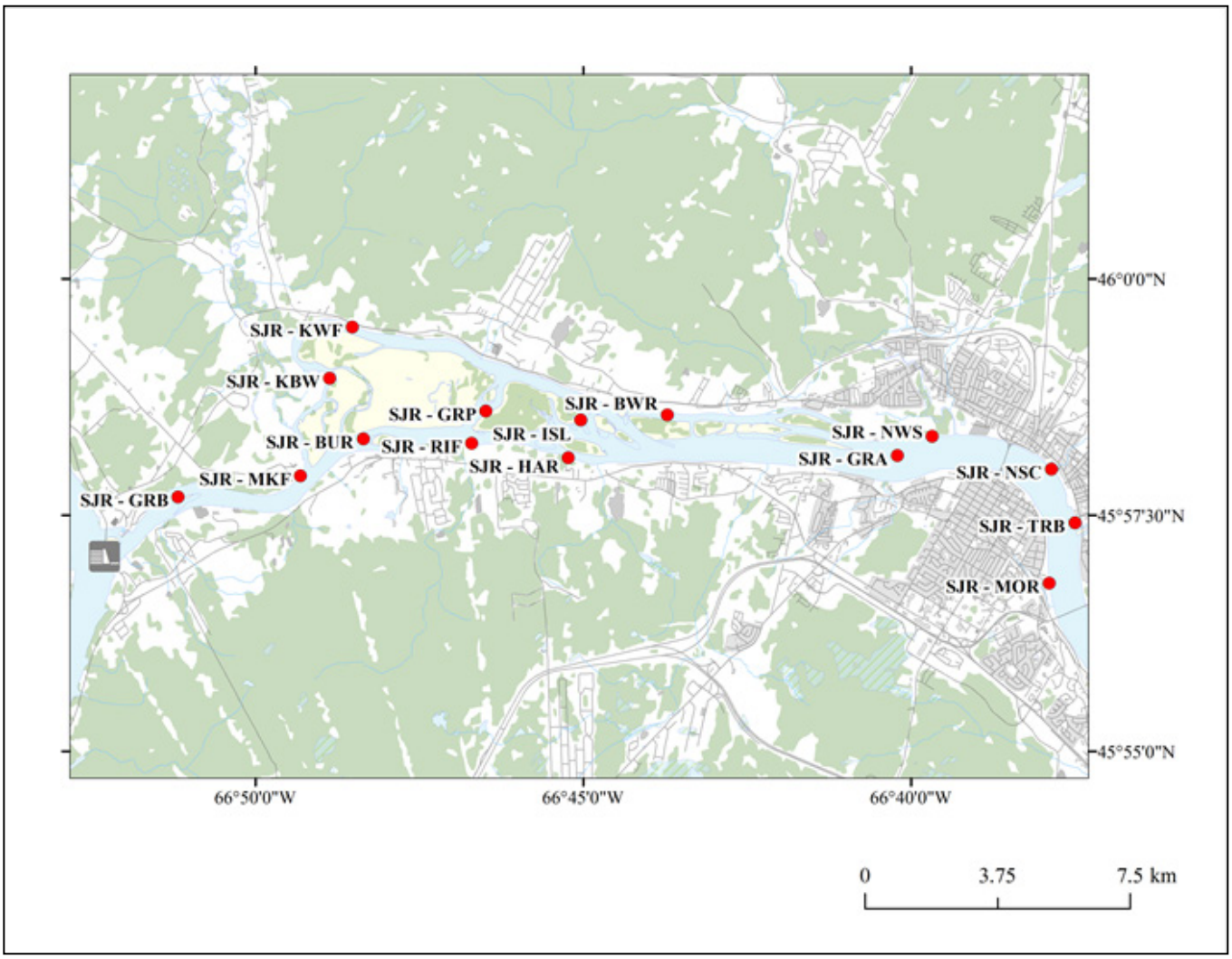

Figure 1. The BMI sampling sites for the Mactaquac Aquatic Ecosystem Study (see Table 1).

Site Selection and Timing of Sampling

The BMI samples are to be collected in early fall to maximize taxa encountered (CABIN manual, 2012). This is typically September. Two crews of two people with formal CABIN training and certification are employed.

The Saint John River below the Mactaquac Generating Station is subject to frequent changes in water levels caused both by the operation of the Mactaquac Generating Station and the nature of the area as the head of tide along the Saint John River. As such, it was important to select areas that were not exposed on a periodic basis due to changing water levels as these would not have representative BMI communities. Sites were also selected to represent the variety of substrates, macrophyte communities, and flow conditions (channel location) in this section of the river. Site types were riffles-gravel/sand substrate, edge/backwater-depositional soft bottom substrates (Table 1). Each sample site was identified as an ~100m reach. The MAES Biological Team selected these as core sites to be sampled each year. It is anticipated that additional sites will be added in each year as maps of habitats improve.

Table 1*:* The BMI sampling sites, collection method, date of collection in 2014, and habitat for the Mactaquac Aquatic Ecosystem Study

Site ID number	Site name	Latitude	Longitude	Collection method	Habitat	Date of 2014 sample collection
SJR-BUR	Saint John River at Burpee Bar riffle	45.97171	-66.8053	CABIN kick	Riffle	25/09/2014
SJR-BWR	Saint John River backwater	45.97583	-66.7277	CABIN kick	Riffle	24/09/2014
SJR-CON*	Saint John River headwaters	47.18426	-68.88361	CABIN kick	Riffle	29/09/2014
SJR-GRA	Saint John River on mid-channel gravel bar	45.9688	-66.6687	CABIN kick	Riffle	23/09/2014
SJR-GRB	Saint John River on gravel bar below dam	45.96179	-66.8519	CABIN kick	Riffle	25/09/2014
SJR-GRP	Saint John River in Grand Pass	45.97628	-66.7749	CABIN kick	Riffle	26/09/2014
SJR-HAR	Saint John River upstream of Hartts Island	45.9682	-66.7527	CABIN kick	Edge	24/09/2014
SJR-ISL	Saint John River island	45.97453	-66.7508	CABIN kick/sweep	Edge/ riffle	24/09/2014
SJR-KBW	Saint John River on Keswick backwater	45.98293	-66.8183	CABIN kick/sweep	Edge/ pool	26/09/2014

Site ID number	Site name	Latitude	Longitude	Collection method	Habitat	Date of 2014 sample collection
SJR-KWF	Saint John River above Keswick Ferry	45.99136	-66.810	CABIN kick/sweep	Edge	26/09/2014
SJR-MKF	Saint John River at old McKinney Ferry site	45.96475	-66.8226	CABIN kick/sweep	Edge/ riffle	25/09/2014
SJR-MOR	Saint John River below Morell Park	45.94556	-66.2631	CABIN kick/sweep	Edge	23/09/2014
SJR-NAS*	Nashwaak River	46.2962	-66.7809	CABIN kick	Riffle	30/09/2014
SJR-NSC	Saint John River northside bank	45.96709	-66.6316	CABIN kick/sweep	Edge	23/09/2014
SJR-NWS	Saint John River above Nashwaaksis	45.97224	-66.6598	CABIN kick/sweep	Edge	24/09/2014
SJR-RIF	Saint John River mainstem riffle	45.97131	-66.7783	CABIN kick	Riffle	25/09/2014
SJR-TRB	Saint John River below train bridge	45.95621	-66.6252	CABIN kick/sweep	Edge	23/09/2014

* Reference sites

Standardized Sampling Sheets and Site Description

All data were recorded on standardized CABIN sampling sheets modified for large river sampling (see Appendix 1). Each sheet is completed in full and always checked prior to leaving a site to ensure that no data were omitted. The field sheets include a geographical description of the site and surrounding land uses, physical location (i.e., GPS coordinates), and a sketch of the sampling reach. Photos are taken of the sampling sheets and the sample reach including a representative photo of the substrate.

Benthic Macroinvertebrate Sampling

BMI sampling followed CABIN protocols and was completed prior to the collection of physical habitat variables (CABIN manual, 2012). Samples were collected using a 400µm mesh kick net using a traveling kick over a period of 3 minutes. The crew member moved backward upstream with the kick net positioned downstream and moved in a zigzag pattern through the reach, kicking and grinding the substrate. The sample area was defined by the proportion of the different habitats present within the sample reach. A second crew member timed the kick using a stopwatch.

For sites with minimum flow or high macrophyte coverage, the sample was collected using a standard kick and sweep protocol involving the crew member disturbing the

substrate/macrophyte bed with their foot while sweeping the net through the disturbed area. The type of habitat sampled (e.g. riffle, rapids, straight run, etc.) was recorded as was the typical depth of the kick area. The kick area was also indicated in the sketch on the CABIN field sheet.

If there was only a small amount of collected material then it was transferred to a white tray before being transferred to a labeled 500ml sample jar and preserved with 95% ethanol (ETOH). Larger volume samples or those with high amounts of organic matter/plant material were sorted using the standard "Bucket Swirling Method" (CABIN manual, 2012) and sieved (250um) to remove all of the fine sediment and large organic material. Sample jars were labeled with the site code and date of sample using a permanent marker in addition a piece of paper with the same site information was placed in the sample jar. Where more than one sample jar was required due to the volume of material, the jars were also numbered.

Physical Habitat Characterization

Physical habitat is characterized following protocols as set out in the CABIN sampling methodology and all data were recorded on the CABIN field sheets (CABIN manual, 2012; Appendix 1 and 2). Water and air temperature, pH, conductance, and dissolved oxygen using a YSI multimeter is recorded. Slope for the ~100m study reach is measured using a survey level, tripod and survey rod where height measurements are recorded at the start and end of the sample reach.

A 100-pebble count is conducted in the sample reach. The intermediate axis (*b*-axis) of the 100 substrate particles is measured (mm) and used to calculate the Wolman D50 (median diameter), the Wolman Dg (geometric mean diameter), and the % of substrate in each class, i.e., pebble, cobble, rock, etc. (CABIN manual, 2012). The *b*-axis was measured *in situ* (without removing it from the substrate matrix) if the substrate particle could not be removed due to size or embeddedness. Visual estimates of the smallest particles, i.e., sand, silt, and/or clay, were recorded. The percent (%) embeddedness of 10 of the particles was recorded by estimating the amount of the particle below the substrate surface (CABIN manual, 2012).

As the cross section at the sample site was not wadeable, flow velocity was recorded using the standard CABIN approach for larger rivers where 10 random measurements of depth and velocity (measured at 0.6*d* or the average of 0.2*d* and 0.8*d*) are recorded (CABIN manual, 2012).

Data Management

Biological samples have been sent to a Society for Freshwater Science-certified taxonomist (EcoAnalysts, Ltd) for processing, sorting, and identification to genus-level following the standard CABIN protocols (CABIN manual, 2012). Field data sheets have been inputted into a central spreadsheet and the biological data will be paired once the samples are complete.

Appendix A. MAES BMI Field Sheet (adapted from CABIN, September 2014)

Field Crew: _____ Site Code: _____

Sampling Date: (DD/MM/YYYY) _____

☐ **Occupational Health & Safety: Site Inspection Sheet completed**

PRIMARY SITE DATA

CABIN Study Name: CABIN Research - Atlantic Local Basin Name: SJR

River/Stream Name: SJR Stream Order: (map scale 1:50,000) _____

Select one: ☐ Test Site ☐ Potential Reference Site

Geographical Description/Notes:

Surrounding Land Use: (check those present) Information Source: _____

☐ Forest ☐ Field/Pasture ☐ Agriculture ☐ Residential/Urban

☐ Logging ☐ Mining ☐ Commercial/Industrial ☐ Other _____

Dominant Surrounding Land Use: (check one) Information Source: _____

☐ Forest ☐ Field/Pasture ☐ Agriculture ☐ Residential/Urban

☐ Logging ☐ Mining ☐ Commercial/Industrial ☐ Other _____

Location Data

Latitude: ____ N Longitude: - ____ W (DMS or DD)

Elevation: ____ (masl) GPS Datum: ☐ GRS80 (NAD83/WGS84) ☐ Other: _____

Site Location Map Drawing

Note: Indicate North

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Field Crew: _____ Site Code: _____

Sampling Date: (DD/MM/YYYY) _____

Photos

☐ Field Sheet ☐ Upstream ☐ Downstream ☐ Across Site ☐ Aerial View

☐ Substrate (exposed) ☐ Substrate (aquatic) ☐ Other _____

REACH DATA *(~100m in length)*

Additional notes about reach

1. Habitat Types: *(check those present)*

☐ Riffle ☐ Rapids ☐ Straight run ☐ Pool/Back Eddy

2. Canopy Coverage: *(stand in middle of stream and look up, check one)*

☐ 0 % ☐ 1-25 % ☐ 26-50 % ☐ 51-75 % ☐ 76-100 %

3. Macrophyte Coverage: *(not algae or moss, check one)*

☐ 0 % ☐ 1-25 % ☐ 26-50 % ☐ 51-75 % ☐ 76-100 %

4. Streamside Vegetation: (*check those present)*

☐ ferns/grasses ☐ shrubs ☐ deciduous trees ☐ coniferous trees

5. Dominant Streamside Vegetation: *(check one)*

☐ ferns/grasses ☐ shrubs ☐ deciduous trees ☐ coniferous trees

6. Periphyton Coverage on Substrate: *(benthic algae, not moss, check one)*

☐ **1** - Rocks are not slippery, no obvious colour (thin layer < 0.5 mm thick)

☐ **2** - Rocks are slightly slippery, yellow-brown to light green colour (0.5-1 mm thick)

☐ 3 - Rocks have a noticeable slippery feel (footing is slippery), with patches of thicker green to brown algae (1-5 mm thick)

☐ **4** - Rocks are very slippery (algae can be removed with thumbnail), numerous large clumps of green to dark brown algae (5 mm -20 mm thick)

☐ 5 - Rocks are mostly obscured by algal mat, extensive green, brown to black algal mass may have long strands (> 20 mm thick)

BENTHIC MACROINVERTEBRATE DATA

Note: Indicate if a sampling method other than the recommended 400 µm mesh kick net is used.

Habitat sampled: (*check one*) ☐ riffle ☐ rapids ☐ straight run

400 µm mesh Kick Net	
Person sampling	
Sampling time (i.e. 3 min.)	
No. of sample jars	
Typical depth in kick area (cm)	

Preservative used: _____

Sampled sieved on site using "Bucket Swirling Method":

☐ YES ☐ NO

If YES, debris collected for QA/QC ☐

Additional notes about sample

Field Crew: _____ Site Code: _____

Sampling Date: (DD/MM/YYYY) _____

WATER CHEMISTRY DATA **Time:** (24 hr clock) **Time zone:**

Air Temp: _____ (ºC) Water Temp: _____ (ºC) pH: _____

Specific Conductance: _____(µs/cm) DO: _____ (mg/L) Turbidity: _____ (NTU)

CHANNEL DATA

Slope - Indicate how slope was measured: (check one)

☐ **Calculated from map**

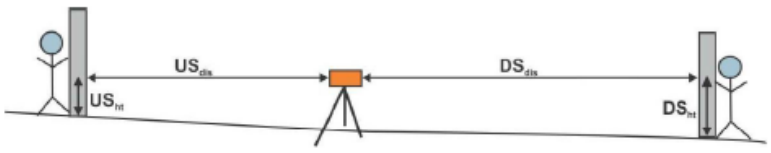
Scale: _____ (Note: small scale map recommended if field measurement is not possible - i.e. 1:20,000).
contour interval (vertical distance) _____ (m),
distance between contour intervals (horizontal distance) _____ (m)
slope = vertical distance/horizontal distance =_____

OR

☐ **Measured in field**

Circle device used and fill out table according to device:
a. Survey Equipment b. Hand Level & Measuring Tape

Measurements	Upstream (U/S)	Downstream(D/S)	Calculation
[a]Top Hairline (T)			
[a]Mid Hairline (ht) OR [b]Height of rod			
[a]Bottom Hairline (B)			
[b]Distance (dis) OR [a]T-B x 100	[a]US_{dis}=T-B	[a]DS_{dis}=T-B	$US_{dis}+DS_{dis}$=
Change in height (Δht)			$DS_{ht}-US_{ht}$=
Slope (Δht/total dis)			



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Field Crew: _____ Site Code: _____

Sampling Date: (DD/MM/YYYY) _____

Velocity and Depth

Check appropriate velocity measuring device and fill out the appropriate section in chart below. Distance from shore and depth are required regardless of method:

☐ **Velocity Head Rod (or ruler)**: Velocity Equation (m/s) = $\sqrt{[\ 2(\Delta D/100) * 9.81]}$

☐ **Rotary meters**: Gurley/Price/Mini-Price/Propeller (Refer to specific meter conversion chart for calculation)

☐ **Direct velocity measurements**: ☐ Marsh-McBirney ☐ Sontek or ☐ Other_____

	1	2	3	4	5	6	AVG
Distance from Shore (m)							
Depth (**D**) (cm)							
Flowing water Depth (D_1) (cm)							
Depth of Stagnation (D_2) (cm)							
Change in depth ($\Delta D=D_2-D_1$) (cm)							
Revolutions							
Time (minimum 40 seconds)							

For direct velocity measurements

	1	2	3	4	5	6	7	8	9	10
Depth (D) (cm)										
Distance from shore (m)										
Velocity (m/s) at 0.6D										
Velocity (m/s) at 0.2D										
Velocity (m/s) at 0.8D										

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Field Crew: _____ Site Code: _____

Sampling Date: (DD/MM/YYYY) _____

SUBSTRATE DATA

Surrounding/Interstitial Material

Circle the substrate size category for the surrounding material.

100 Pebble Count & Substrate Embeddedness

- Measure the intermediate axis (100 rocks) and embeddedness (10 rocks) of substrate in the stream bed.
- Indicate B for bedrock, S for sand/silt/clay (particles < 0.2 cm) and O for organic material.
- Embededness categories (E): Completely embedded = 1, 3/4 embedded, 1/2 embedded, 1/4 embedded, unembedded = 0

Substrate Size Class	Category
Organic Cover	0
< 0.1 cm (fine sand, silt or clay)	1
0.1-0.2 cm (coarse sand)	2
0.2-1.6 cm (gravel)	3
1.6-3.2 cm (small pebble)	4
3.2-6.4 cm (large pebble)	5
6.4-12.8 cm (small cobble)	6
12.8-25.6 cm (cobble)	7
> 25.6 cm (boulder)	8
Bedrock	9

	Diameter (cm)	E		Diameter (cm)	E		Diameter (cm)	E		Diameter (cm)	E
1			26			51			76		
2			27			52			77		
3			28			53			78		
4			29			54			79		
5			30			55			80		
6			31			56			81		
7			32			57			82		
8			33			58			83		
9			34			59			84		
10			35			60			85		
11			36			61			86		
12			37			62			87		
13			38			63			88		
14			39			64			89		
15			40			65			90		
16			41			66			91		
17			42			67			92		
18			43			68			93		
19			44			69			94		
20			45			70			95		
21			46			71			96		
22			47			72			97		
23			48			73			98		
24			49			74			99		
25			50			75			100		

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Field Crew: _____ Site Code: _____

Sampling Date: (DD/MM/YYYY) _____

SITE INSPECTION

Site Inspected by: _____

Communication Information

☐ Itinerary left with contact person (include contact numbers)

Contact Person: _____ Time checked-in: _____

Form of communication: ☐ radio ☐ cell ☐ satellite ☐ hotel/pay phone ☐ SPOT

Phone number: ( ) _____

Vehicle Safety

☐ Safety equipment (first aid, fire extinguisher, blanket, emergency kit in vehicle)

☐ Equipment and chemicals safely secured for transport

☐ Vehicle parked in safe location; pylons, hazard light, reflective vests if necessary Notes:

Shore & Wading Safety

☐ Wading Task Hazard Analysis read by all field staff

☐ Wading Safe Work Procedures read by all field staff

☐ Instream hazards identified (i.e. log jams, deep pools, slippery rocks)

☐ PFD worn

☐ Appropriate footwear, waders, wading belt

☐ Belay used

Notes:

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