MONITORING AQUATIC BENTHIC ECOSYSTEMS OF THE BRUCE PENINSULA

NANCY M^{c}AFEE
BRUCE PENINSULA BIOSPHERE ASSOCIATION
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INTRODUCTION

The Ontario Benthos Biomonitoring Network (OBBN) uses benthic invertebrates, otherwise known as benthos, as indicator species of aquatic ecosystem health (Jones *et al.*, 2004). These organisms can provide early warning signs if the ecosystem is under stress because they are sensitive to minute changes in chemical and biological factors. Additionally, benthos are relatively sedentary, inexpensively sampled, and easily identified (Jones *et al.*, 2004).

Since the protocol for monitoring benthos is relatively new, the focus to date has been to establish 'normal' standards for aquatic ecosystems (Jones *et al.*, 2004). To do this, the OBBN has used a reference condition approach (RCA). Essentially, the RCA approach takes into account natural variability among minimally impacted sites in order to account for any differences in impacted sites. Reference sites are being established in a wide range of ecosystem types across Ontario to provide baseline information and act as an experimental control (Jones *et al.*, 2004).

To monitor benthos in the Northern Bruce Peninsula, 4 reference sites were established in 2003 (Boyle, 2003). The purpose of this study is to resample the established sites and to implement the Marchant Box Method as described in Jones *et al.*, 2004.

METHODS

Location and design

In 2003, 4 reference sites were established (Figure 1) (Crane River, Spring Creek Site 1, Spring Creek Site 2, and Willow Creek). Due to time constraints, only 2 of these sites (Willow Creek and Spring Creek 1 Site 2) were resampled this year. For more information regarding these sites, including location maps and UTMs, refer to Boyle 2003.

Several changes have been made to the OBBN protocol since 2003. The most prominent of these changes include, adjustments to the way in which the traveling kick and sweep technique is performed, the number of samples collected at each replicate and the time required to do so. Also, the data sheet has become more concise, requiring fewer measurements per replicate (Appendix).

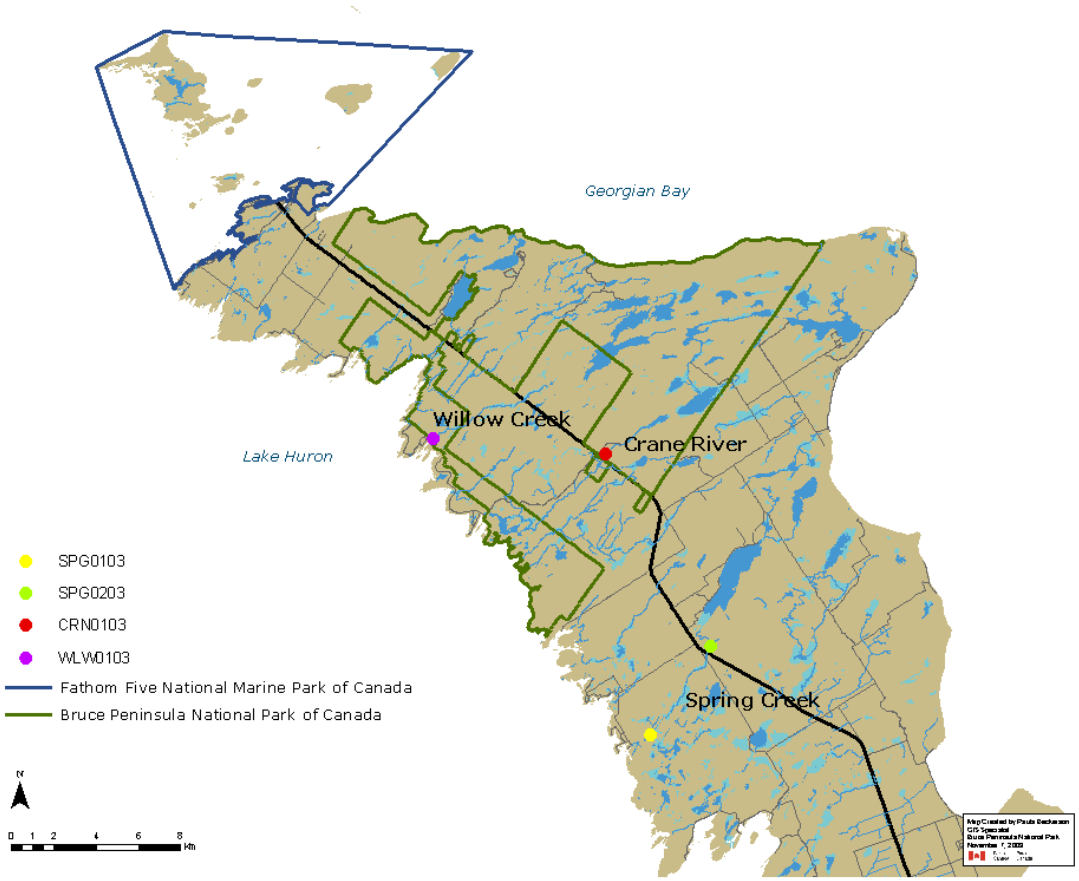


Figure 1: Location of the 4 benthic monitoring sites in the Northern Bruce Peninsula, Ontario, Canada .

The traveling kick and sweep was previously performed in a zig-zag fashion and is now done in straight, repeated transects until a distance of 10 m is reached, in no more than 3 minutes. Three samples (riffle, pool, riffle) are collected in this manner and pooled at each of 3 replicates per site. Thus, 3 buckets containing 3 samples each are collected from each site. A small amount of water is added to the buckets and they are stored with the lid partially open in the laboratory until the samples can be processed the following day.

Water quality (pH, temperature, dissolved oxygen) was assessed at each replicate this year. These measurements were taken at the first sample location (transect) for each replicate, as well as bank-full width. Hydraulic head and maximum depth were measured at each transect.

Marchant Box Method

To process the samples, the Marchant Box (sub-sampling box consisting of 100 cells) Method was used as opposed to the Teaspoon Method used last year. Samples were sieved by washing large debris thoroughly, while collecting all wash water in a large bucket. This water was then passed through a 600 µm mesh sieve and anything remaining on the sieve was placed in the Marchant Box. The majority of the sample, including soil, was added to the Marchant Box. Once the lid was in place the contents were mixed by flipping the box, shaking, and returning the box to the upright position. When the contents were evenly distributed a small amount of water was added if needed, depending on how full each cell was at this point. Ideally, the cells should not be full to the point where the organisms can swim to adjacent cells easily.

Cells were then chosen randomly using the phone-book method. Two numbers were selected to locate a cell using a grid system (Figure 2). The contents of this cell were removed using a vacuum apparatus (Figure 3), in which they arrive in a flask. To collect the larger debris from the bottom of the cell, water was added while vacuuming, ensuring that the water did not overflow the cell. Once the cell contents were in the flask they were placed in a tray where organisms could be removed easily and identified using a dissecting microscope. This process was repeated until 100 organisms were identified and tallied. The last cell sampled may have provided enough organisms to reach a final tally of 100, however, all organisms present in this sample must be identified and included in the tally.

For a more detailed description of stream sampling and the Marchant Box Method, as well as the tally sheet for recording the number of animals, refer to the most recent version of the OBBN protocol.

Data analysis

From the raw data, the mean proportion of animals for each taxonomic group was determined and grouped into combined categories. Two taxonomic groups, Nematoda and Oligochaeta, are commonly confused when processing samples, and as a result were combined into Worms. The category Diptera represents the taxonomic groups Chironimidae, Culicidae, Tipulidae, and Simuliidae, as well as Misc. Diptera. Several taxonomic groups were not present in the collected samples (Colenterata, Turbellaria, Coleoptera, Gastropoda, Tabanidae, Ceratopogonidae, and Hirudinea), and therefore were excluded from the combined list.

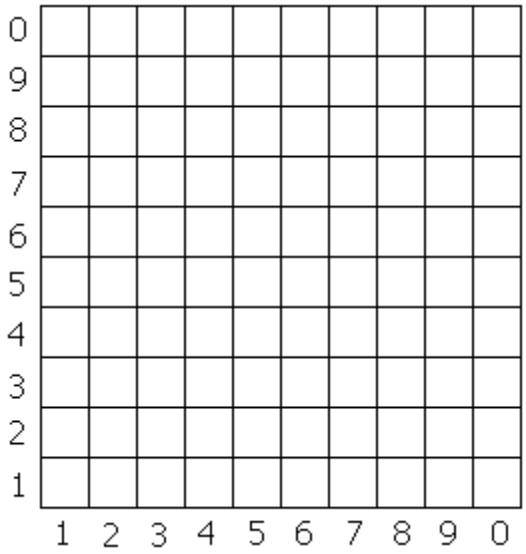


Figure 2: Marchant Box layout with grid for randomizing sample selection.

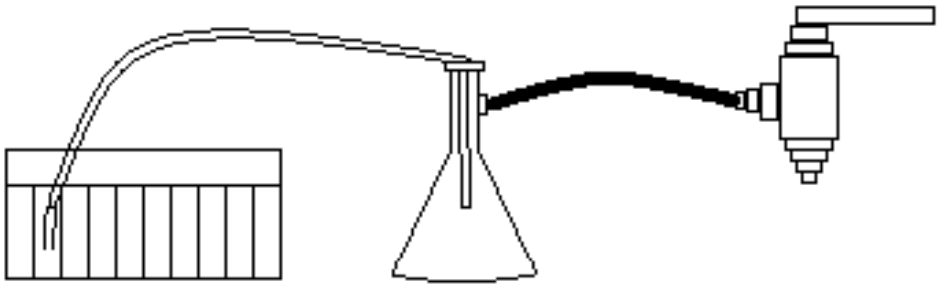


Figure 3: Sampling apparatus including Marchant Box, 2 L flask, and aspirator (left to right).

RESULTS

The most prominent animals in the samples collected from each site were scuds, caddisflies and mayflies. Scuds represented approximately half of the animals sampled in each site. Caddisflies had a mean proportion of 13.8 and 11.1% in Willow and Spring Creek sites, respectively. Mayflies had a mean proportion of 12.7 and 7.4% in Willow and Spring Creek sites, respectively. Ultimately, the data collected from these reference sites will be combined with several others to provide a basis for 'normal' conditions. Test sites can then be compared to these criteria by using numerous indices.

	Willow Creek			Spring Creek (Site 2)		
Taxonomic Group	**Rep 1**	**Rep 2**	**Rep 3**	**Rep 1**	**Rep 2**	**Rep 3**
Coelenterata (Hydras)	0	0	0	0	0	0
Turbellaria (Flatworms)	0	0	0	0	0	0
Nematoda (Roundworms)	0	0	1	1	0	0
Oligochaeta (Aquatic Earthworms)	1	1	1	13	4	0
Hirudinea (Leeches)	0	0	0	0	0	0
Isopoda (Sow Bugs)	7	8	0	0	0	1
Pelecypoda (Clams)	0	2	1	0	0	0
Amphipoda (Scuds)	60	65	20	20	95	51
Decapoda (Crayfish)	0	0	1	1	0	0
Trombidiformes-Hydracarina (Mites)	0	3	2	0	0	0
Ephemeroptera (Mayflies)	1	0	42	0	0	24
Anisoptera (Dragonflies)	2	1	9	1	2	1
Zygoptera (Damselflies)	0	0	0	1	0	0
Plecoptera (Stoneflies)	5	4	9	9	2	0
Hemiptera (True Bugs)	0	1	1	0	0	0
Megaloptera (Fishflies, Alderflies)	13	1	4	2	1	0
Trichoptera (Caddisflies)	15	9	23	20	0	16
Lepidoptera (Aquatic Moths)	0	0	0	0	1	0
Coleoptera (Beetles)	0	0	0	0	0	0
Gastropoda (Snails, limpets)	0	0	0	0	0	0
Chironomidae (Midges)	0	4	16	23	8	6
Tabanidae (Horse and Deer Flies)	0	0	0	0	0	0
Culicidae (Mosquitos)	0	0	0	0	1	0
Ceratopogonidae (No-see-ums)	0	0	0	0	0	0
Tipulidae (Crane Flies)	0	0	0	0	0	1
Simuliidae (Black Flies)	0	0	0	4	0	2
Misc. Diptera (Misc. True Flies)	1	1	5	7	0	5
Total Count	105	100	135	102	114	107

Table 1: Raw taxa abundance for each replicate at Willow Creek and Spring Creek (Site 2).

Taxa Group	Willow Creek	Spring Creek (Site 2)
Worms	0.6	2.8
Sowbugs	4.4	0.3
Clams	0.9	0.0
Scuds	42.7	51.4
Crayfish	0.3	0.3
Mites	1.5	0.0
Mayflies	12.7	7.4
Dragonflies	3.5	1.2
Damselflies	0.0	0.3
Stoneflies	5.3	3.4
Bugs	0.6	0.0
Alderflies	5.3	0.9
Caddisflies	13.8	11.1
Moths	0.0	0.3
Diptera	1.6	3.5

Table 2: Mean percentage of taxonomic groups at Willow Creek and Spring Creek (Site 2).

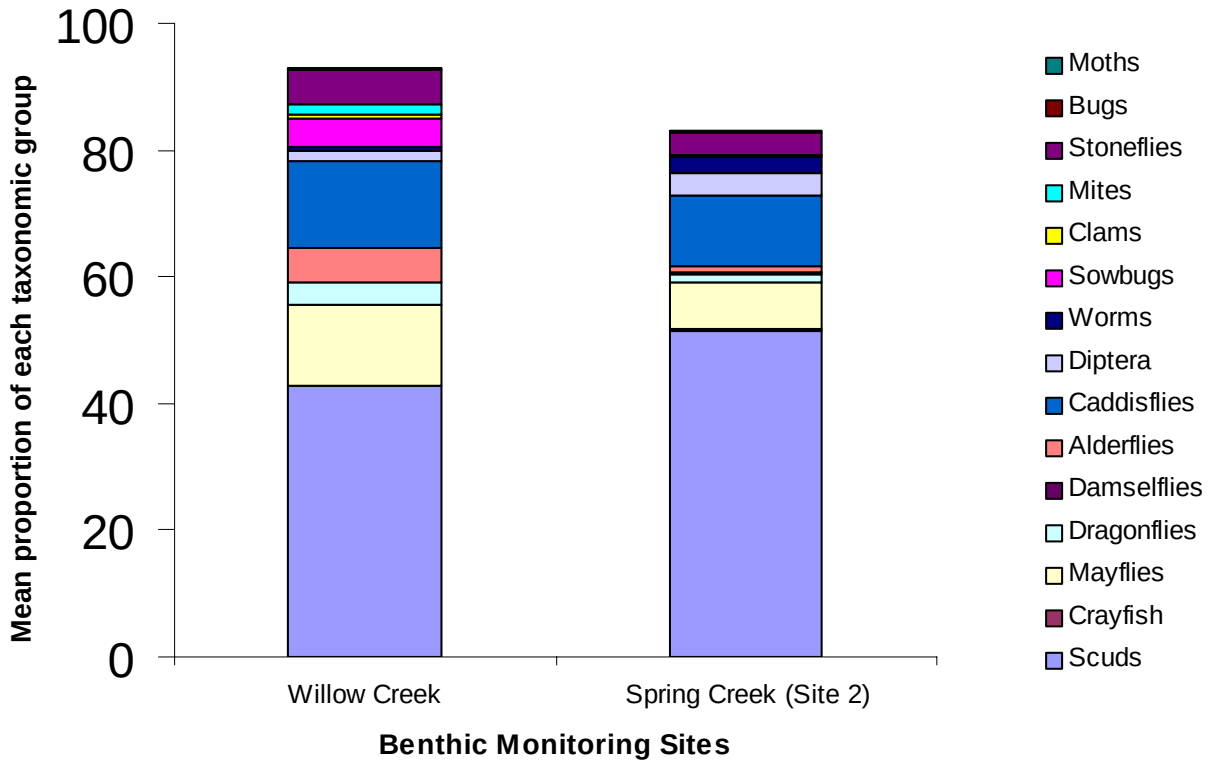


Figure 4: Mean proportion of each taxonomic group from Willow Creek and Spring Creek (Site 2).

DISCUSSION

The establishment of more reference sites is required in order to draw any conclusions as far as what can be considered 'normal' in a benthic ecosystem. Test (impacted) sites can then be examined and existing problems within the ecosystem can be addressed (Jones *et al.*, 2004). Boyle (2003), has provided a list of suggested sites that may be used as either reference or test sites.

The Marchant Box Method was successful and is the recommended technique for processing samples (Jones *et al.*, 2004). This method, if conducted within 24 hours of collecting the sample, still has the advantage of viewing the animals while still alive. Additionally, this method has been shown to be more accurate (Jones *et al.*, 2004). The use of a microscope allows for greater attention to detail, as several taxonomic groups have very similar features. The only drawback to the Marchant Box Method is the time required to process the samples. Depending on the number of animals collected in one sample, this method can consume 2 to 6 hours.

REFERENCES

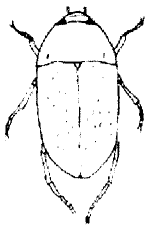
Boyle, T. 2003. Monitoring aquatic benthic ecosystems of the Bruce Peninsula. Bruce Peninsula Biosphere Association.

Jones, C., Somers, K.M., Craig, B. and Reynoldson, T. 2004. Ontario Benthos Biomonitoring Network protocol manual. Version 1. Ontario Ministry of the Environment, Environment Canada, Acadia Centre for Estuarine Research: Ontario.

APPENDIX

Updated field sheet (2004)

Ontario Benthos Biomonitoring Network Field Sheet: STREAMS



Date:	Stream name:
Time	Site #:
Agency:	Location (Sampling reach centroid, use deg./min./sec. or specify other)
Investigators:	Latitude: Elevation (m asl):
Water Quality	Longitude:
Water Temperature (°C):	Conductivity (uS/cm): pH:
DO (mg/l):	Alkalinity (mg/l as $CaCO_3$):

Site Description and Map

Draw a map of the site (with landmarks) and indicate areas sampled. Attach photograph (optional)
Show north arrow.

Benthos Collection Method (circle one):

- Traveling Kick & Sweep
- Grab Sample
- Other (specify):

Gear Type (circle one)

- D-net
- Ponar
- Other (*specify*):
- Ekman
- Rock Baskets

Mesh Size: 500 micron (or specify)

Sub-samples	Sampling distance covered (m)	Time (min.)	Max. Depth (m)	Wetted Width (m)	Max. Hydraulic Head (mm)	# Grabs pooled per sample
Sample 1: Riffle (cross-over)						
Sample 2: Pool						
Sample 3: Riffle (cross-over)						

Substrate

Enter dominant substrate class and second dominant class for each sub-sample

	Sample 1	Sample 2	Sample 3
Dominant			
2nd Dominant			

Class	Description
1	Clay (hard pan)
2	Silt (gritty, < 0.06 mm particle diameter)
3	Sand (grainy, 0.06 - 2 mm)
4	Gravel (2 - 65 mm)
5	Cobble (65 - 250 mm)
6	Boulder (> 250 mm)
7	Bed Rock

Substrate Notes

Organic Matter-Areal Coverage

Use 1: Abundant, 2: Present, 3: Absent

	Sample 1	Sample 2	Sample 3
Woody Debris			
Detritis			

Riparian Vegetative Community

Use: 1 (None), 2 (cultivated), 3 (meadow), 4 (scrubland), 5 (forest, mainly coniferous), 6 (forest, mainly deciduous)

Zone (dist. From water's edge)	Left Bank	Right Bank (facing downstream)
1.5-10 m		
10-30 m		
30-100 m		

% Canopy Cover (circle one)

0-24 25-49 50-74 75-100

If instrument used, record type:

Aquatic Macrophytes and Algae (Use: 1 (Abundant), 2 (Present), 3 (Absent). Circle dominant type.

Macrophytes	Sample 1	Sample 2	Sample 3
Emergent			
Rooted Floating			
Submergent			
Free Floating			

Algae	Sample 1	Sample 2	Sample 3
Floating Algae			
Filaments			
Attached Algae			
Slimes or Crusts			

Stream Size/Flow

Bank Full Width (m): Discharge (m^3/s, optional, indicate method):

River Characterisation (*circle one*) Perennial Intermittent Unknown

Notes (esp. related to land-use, habitat, obvious stressors)

Candidate reference Site - Minimally Impacted? (circle one) Yes No

General Comments

Stream Sheet-Pg. 2