Monitoring Aquatic Benthic Ecosystems of the Bruce Peninsula

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Acknowledgements

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Introduction

Long term ecological monitoring is a term used to describe the observation and documentation of changes and trends in ecosystem health over a long period of time. This type of monitoring is useful because it provides early warning signs of potential ecological problems resulting from natural or anthropogenic stressors. From this information, proper ecosystem management strategies can be established. In an aquatic setting, long term monitoring programs can be useful in evaluating changes and trends in water quality, as well as habitat quality. (Jones et al., 2005)

The Ontario Benthos Biomonitoring Network (OBBN) is a provincial organization which develops and promotes the use of standardized protocols for the ecological monitoring of lakes, rivers and wetlands. These protocols involve using benthic invertebrates, which are bottom dwelling organisms, as indicators of aquatic ecosystem health. These organisms are considered good indicators of ecosystem health for many reasons, including their widespread distribution, ease of collection and identification, relatively long life cycles, limited mobility, varying tolerances to chemical and physical changes, and their tendency to respond to ecological stressors after short exposure periods. (Boyle, 2003)

The OBBN recommends using a reference condition approach (RCA) which involves using biological data from a set of minimally impacted reference sites to evaluate the impairment levels of impacted test sites. The establishment of reference sites throughout the province provides information regarding normal standards for various aquatic habitats. As reference sites become established at a provincial level, this baseline data can be used to evaluate impacted test sites throughout the province. (Jones et al., 2005)

The Bruce Peninsula Biosphere Association is a non-profit, community-based organization, which addresses local environmental concerns and promotes sustainability through informed decision making while maintaining a balance between local development and ecological sustainability. The benthic monitoring program that has been set up on the Northern Bruce Peninsula meets the objectives of the Biosphere Association as it provides localized ecological monitoring of various streams within the community. In addition, the monitoring program contributes to the establishment of reference sites, which can be used to evaluate impacted test sites at both the provincial and local community level. (Boyle, 2003)

In 2003, four reference sites were established on the Northern Bruce Peninsula on three different streams. Two of these sites are located on Spring Creek, one is located on Willow Creek, and one is located on Crane River. This year's monitoring activities involved re-sampling the existing sites using OBBN protocols, as well as establishing three new monitoring sites. One of these new sites is located on Crane River and two are located on Willow Creek.

Methods

Location and Design

Initially, four reference sites were established in 2003. Two of these sites are located on Spring Creek, one is located on Willow Creek, and one is located on Crane River. The site names and numbers with the respective site codes of these original sites are listed below in Table 1.

Table 1: Site names and codes for the original four benthic monitoring sites.

Site Name	Site Code
Willow Creek (Site 1)	WLW0103
Crane River (Site 1)	CRN0103
Spring Creek (Site 1)	SPG0103
Spring Creek (Site 2)	SPG0203

In addition to these original sites, three additional sites were established this monitoring year. One new site was established on Crane River and two sites were established on Willow Creek. The site names and codes for the newly established sites are listed below in Table 2. The locations of the original sites, as well as the new sites, can be seen in Figure 1. The establishment of these new sites will provide additional information regarding benthos abundance and diversity in the selected streams so that the overall health of these streams can be evaluated over time using more detailed information.

Originally, at Crane River Site 1, the replicate configuration was such that replicates 1 and 2 were within close proximity to one another and replicate 3 was a significant distance further upstream. This original replicate configuration can be seen in Boyle, 2003. Since replicate 3 was so much further upstream and not necessarily similar in stream characteristics to the other two replicates, these two stream areas were segmented into two separate sites. The replicate configuration after the formation of the second site can be seen in Figure 2. The replicate configurations for Willow Creek Site 2 and Willow Creek Site 3 can been seen below in Figures 3 and 4, respectively. For replicate configurations of the sites at Spring Creek, refer to Boyle, 2003.

Table 2: Site names and codes for the additional benthic monitoring sites established this year.

Site Name	Site Code
Crane River (Site 2)	CRN0205
Willow Creek (Site 2)	WLW0205
Willow Creek (Site 3)	WLW0305

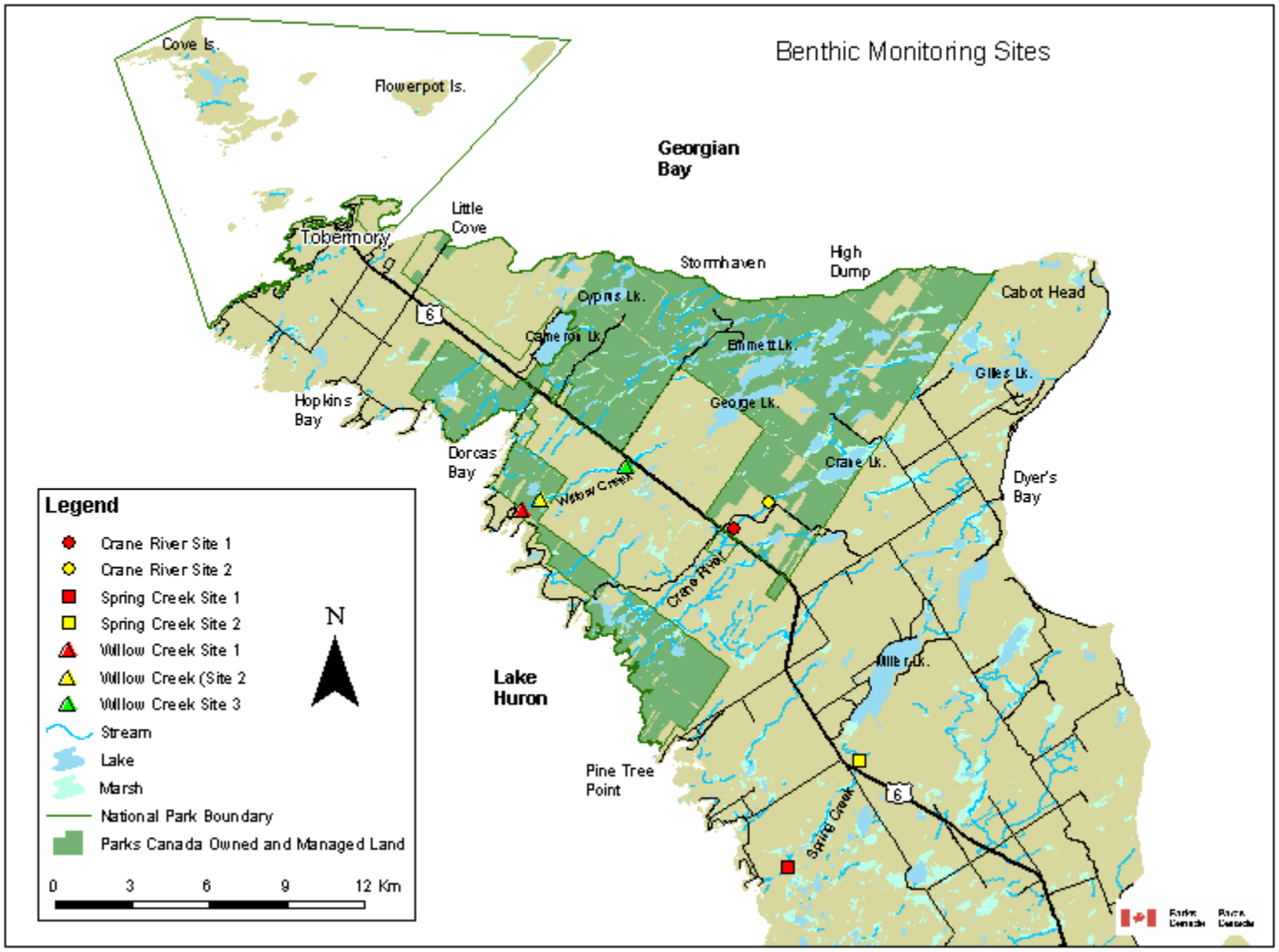

Figure 1: Location of the seven benthic monitoring sites established in the Municipality of Northern Bruce Peninsula, located in Ontario, Canada.

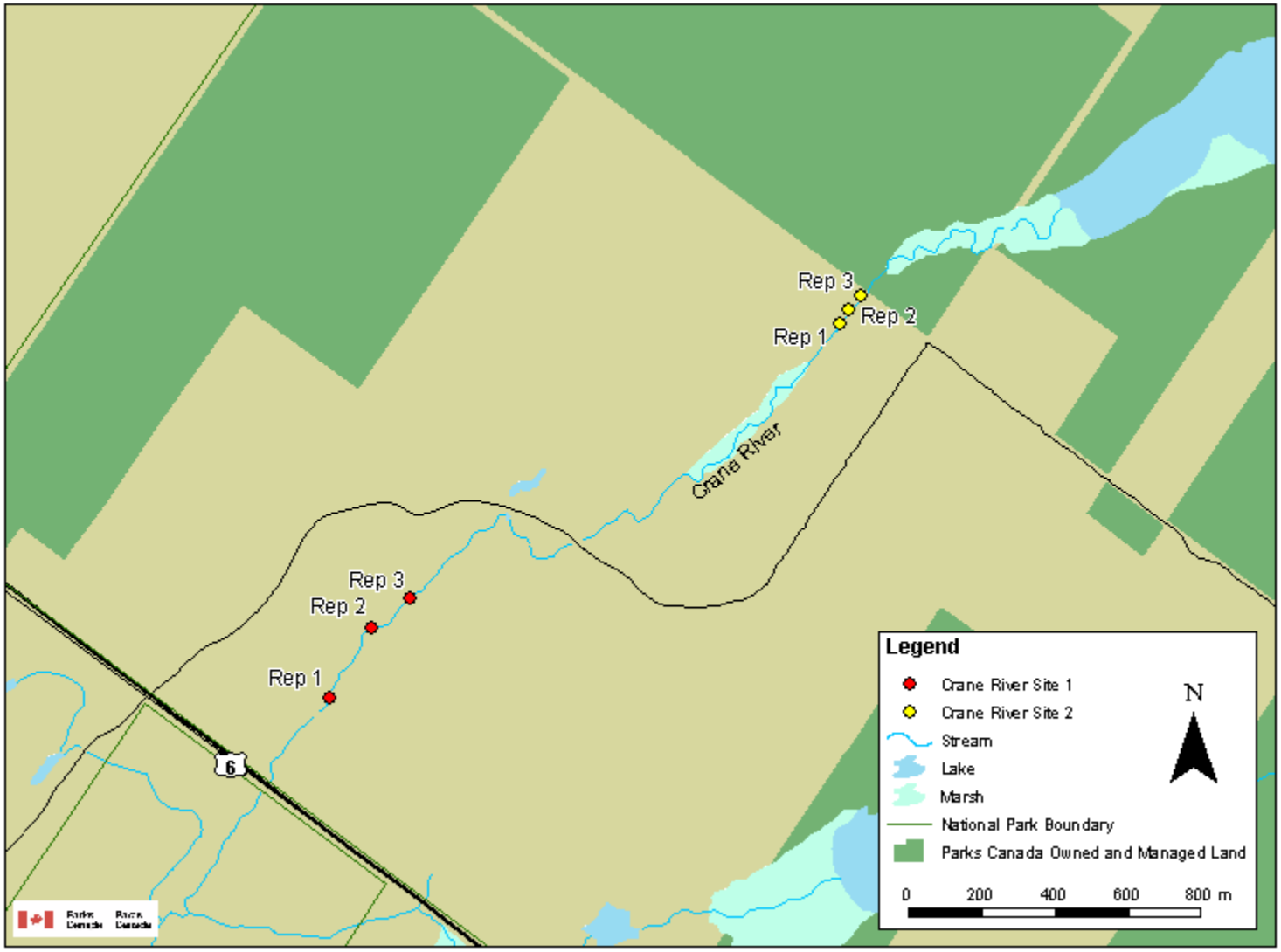

Figure 2: Replicate configurations for Crane River Site 1 and Crane River Site 2.

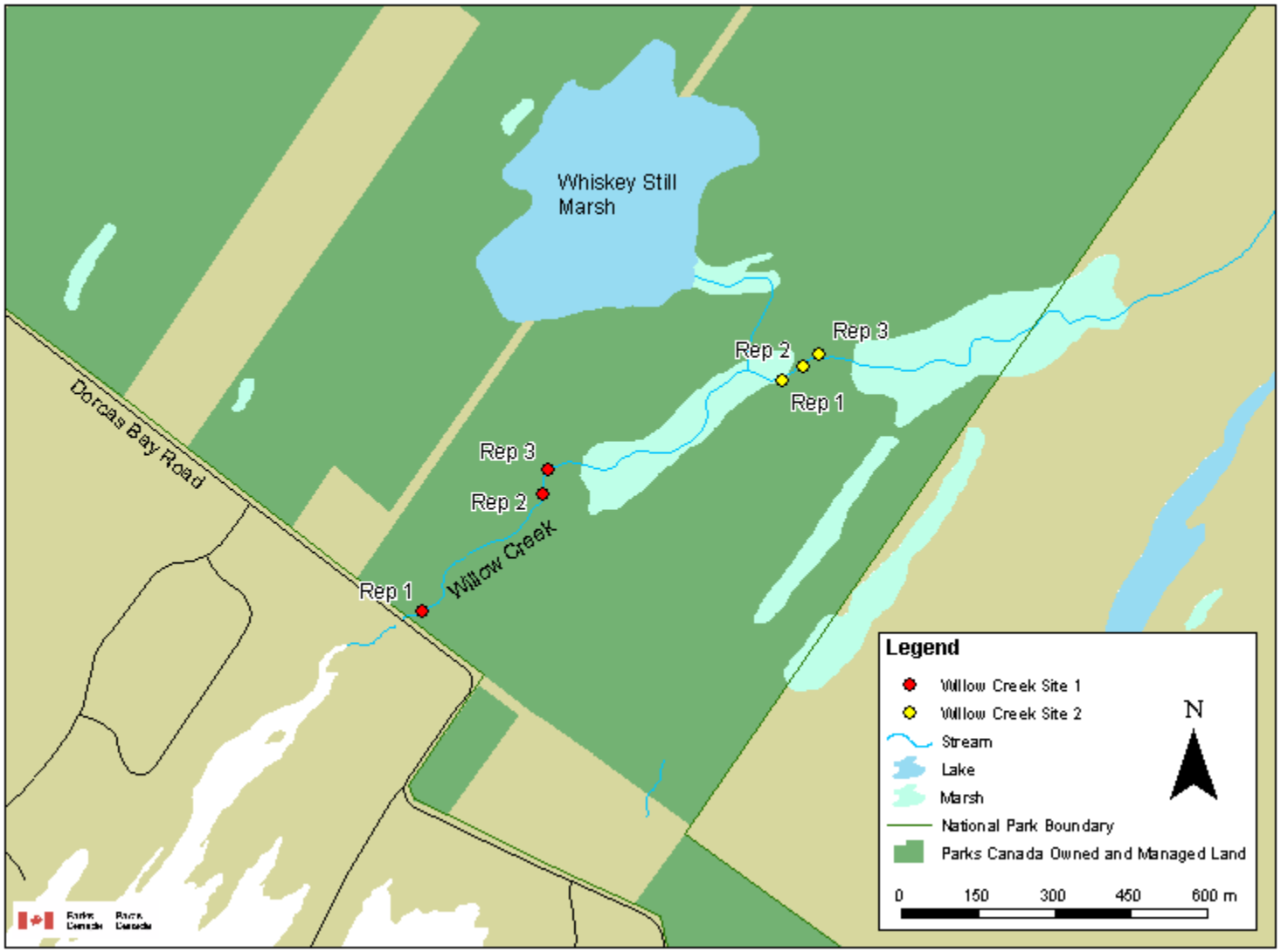

Figure 3: Replicate configurations for Willow Creek Site 1 and Willow Creek Site 2.

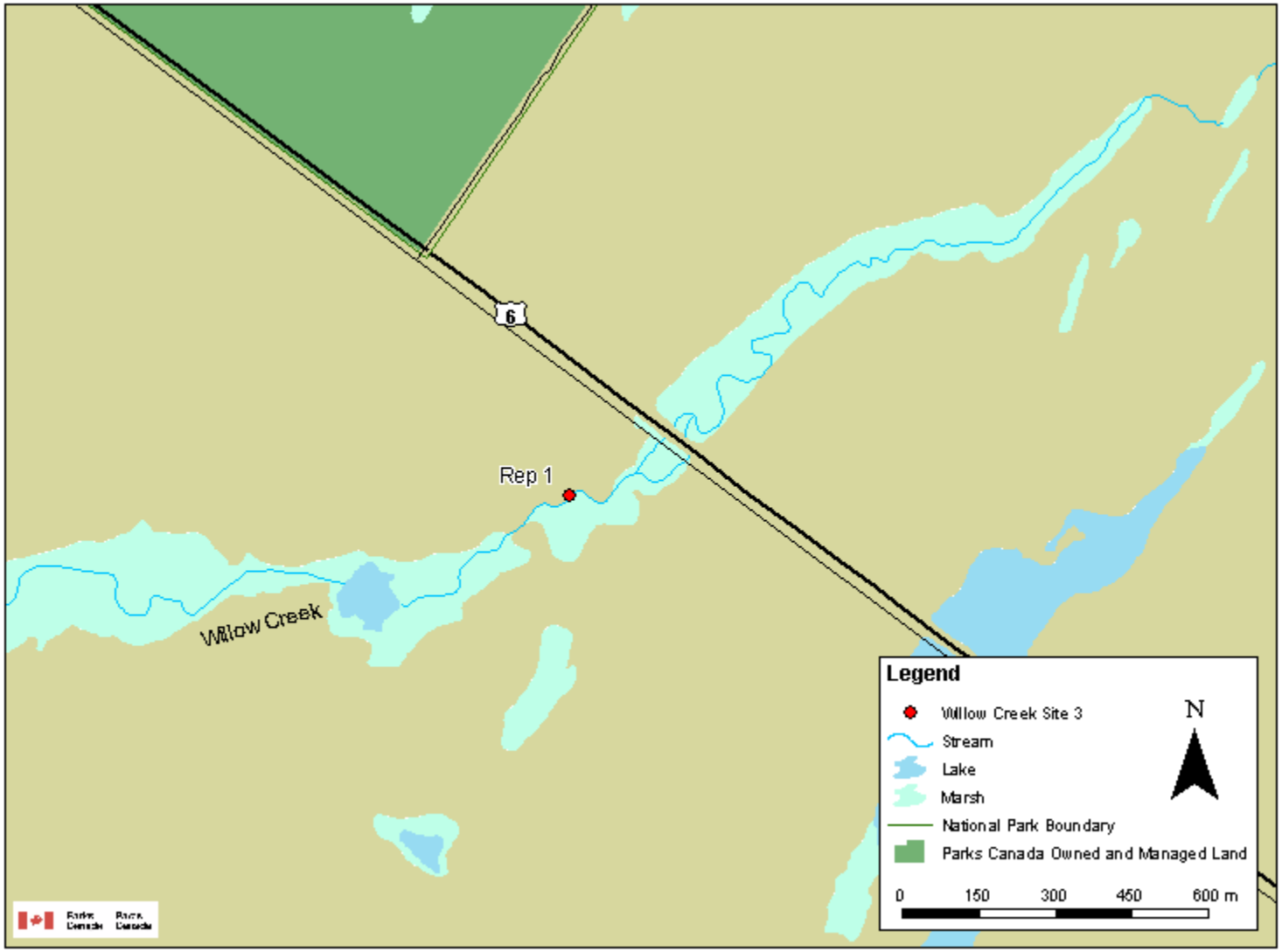

Figure 4: Replicate configuration for Willow Creek Site 3.

Sample Collection

Sample collection and processing were performed using the latest methods put forth by the OBBN. The methods used this year were the same as the methods that were performed in 2004 for this monitoring program. Sample collection involved using a travelling kick and sweep method. Three straight transects were established within each site replicate with two transects being located in riffle areas and one transect being located in a pool area. Beginning at the transect furthest downstream, the kick and sweep was performed along each of these transects until a distance of ten metres was reached in approximately three minutes. In areas where the wetted width of the stream was less than 10 metres, the kick and sweep was performed back and forth along the transect until a distance of ten metres was achieved. The samples collected along each of these transects were then pooled at each of the replicates. For each site, three replicates were sampled with the exception of Willow Creek Site 3. Only one replicate was sampled at this site because the stream characteristics were not suitable for additional replicates. A generous amount of water was added to each sample bucket. The samples were then transported and stored in the lab where they were processed the following day. In addition to sample collection, information was taken regarding substrate type and the presence or absence of riparian and aquatic vegetation for each replicate. Hydraulic head, maximum depth, bank full width and wetted width were recorded for each transect. Water quality data was also collected at each of the sites this year. Parameters measured were temperature, dissolved oxygen, conductivity, alkalinity, pH, total dissolved solids, phosphates, calcium and magnesium hardness, colour, ammonia, and nitrates. These measurements were taken at the first transect of each replicate. Monitoring of these parameters provide additional data on water quality and may be useful in observing future trends in ecosystem health at the monitoring locations.

For more detailed information regarding sample collection, refer to Jones et al., 2005.

Sample Processing

The Marchant Box method was used this year as the sample processing method. Each replicate sample was processed individually. For a detailed description of the Marchant Box sample processing method, refer to Jones et al., 2005 and McAfee, 2004.

Data Analysis

In last years report (McAfee, 2004), the mean percentages of some of the taxonomic groups at each site were calculated incorrectly. In the results, the category Diptera included the taxonomic groups Chironomidae, Culicidae, Tipulidae, Simulidae, and Misc. Diptera. The mean percentage of Diptera at

each site was calculated by averaging all of the raw data results of the applicable taxonomic groups as one result. The mean percentage for the group Diptera should have been calculated by averaging the results of the applicable taxonomic groups separately and then summing these results as a total proportionate value. Similarly, the group Worms included the taxonomic groups Oligochaeta and Nematoda. These mean percentage of Worms was calculated in the same way that the mean percentage of Diptera was calculated. These results have been corrected and the revised mean percentages of taxonomic groups can be seen in Table 3 and Figure 5.

From the raw taxonomic tallies, the mean abundance of each taxonomic group was calculated for each site this year. The mean percentage of each taxonomic group was then calculated. Several taxonomic groups were combined in the displayed results. Diptera includes the taxonomic groups Chironomidae, Culicidae, Tipulidae, Simulidae, and Misc, Diptera. Nematoda and Oligochaeta were grouped into the category called worms. These taxonomic groups were combined in much the same way that previous year's results were combined. The combination of these taxonomic groups was done again this year to allow for easy comparison of this year's abundance results to previous year's results. Taxonomic groups that were not present in the samples were not displayed in the results indicating mean abundance at each of the sites. These groups were Coelenterata, Lepidoptera, Tabanidae, Culicidae, Ceratopogonidae, and Tipulidae. Other groups were only present in miniscule amounts and were therefore not displayed on the results. These groups were Gastropoda and Hirudinea.

To this point in the monitoring program, only two of the sites have been monitored for more than two years (Willow Creek Site 1 and Spring Creek Site 2). Each of these sites have been monitored for a period of three years. A year-to-year comparison of the results at each of these sites can be seen below in Figure 7. As monitoring continues, year-to-year comparisons of the results at each of the sites will indicate any trends in benthic abundance and diversity at each of the sites.

Results

The revised results displaying the mean percentage of each taxonomic group found last year can be seen below in Table 3 and Figure 5.

This year's raw taxonomic abundance for each replicate at the seven sites is displayed below in Table 4. The mean percentage of each taxonomic group is displayed in Table 5 and Figure 6. A year-to-year comparison of the mean percentage of each taxonomic group found at Willow Creek Site 1 and Spring Creek Site 2 can be seen in Figure 7.

Table 3: Revised mean proportion of each taxonomic group found at each of the sampling locations in 2004.

Taxa Group	Willow Creek	Spring Creek (Site 2)
Worms	1.2	5.6
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	7.9	17.6

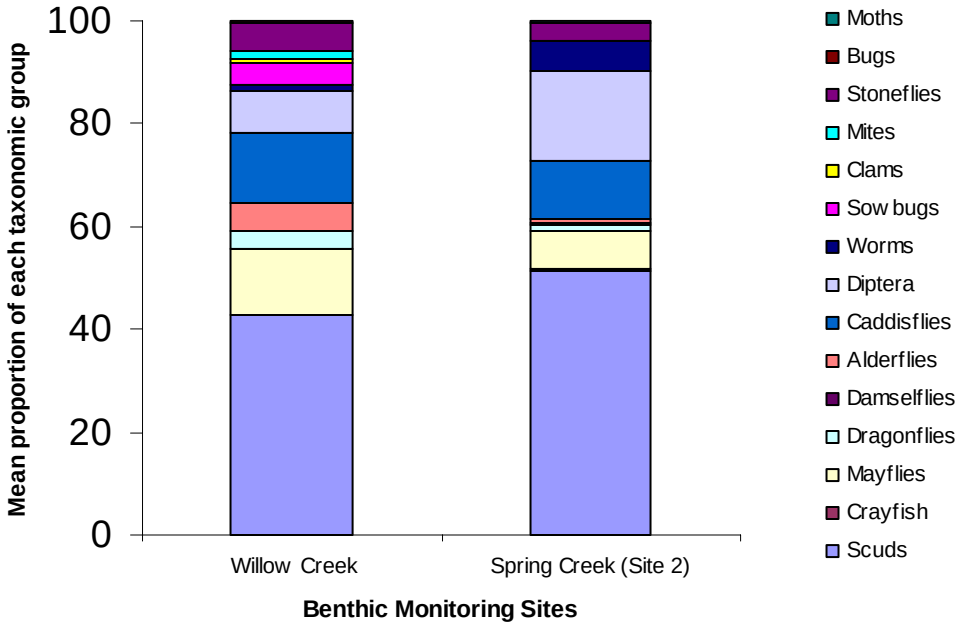

Figure 5: Revised mean proportion of each taxonomic group found at each of the sampling locations in 2004

Table 4: Raw taxonomic abundance for each replicate at each of the seven sampling locations (2005)

	Willow Cr. (01)			Willow Cr. (02)			Willow Cr. (03)	Crane R. (01)			Crane R. (02)			Spring Cr. (01)			Spring Cr. (02)		
Replicate #	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**
Taxonomic Group																			
Coelenterata (Hydras)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Turbellaria (Flatworms)	0	0	0	0	0	0	0	0	0	0	0	5	3	0	0	0	0	0	0
Nematoda (Roundworms)	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
Oligochaeta (Aquatic Earthworms)	5	0	1	1	0	0	2	0	0	2	0	2	4	0	1	0	5	4	1
Hirudinea (Leeches)	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0
Isopoda (Sow Bugs)	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pelecypoda (Clams)	0	0	0	0	0	0	0	0	1	2	44	28	45	0	0	0	0	0	0
Amphipoda (Scuds)	29	59	32	0	7	4	101	1	3	31	0	0	0	8	5	1	11	10	10
Decapoda (Crayfish)	1	2	2	0	1	0	0	12	0	1	0	0	1	2	0	0	0	1	0
Trombidiformes-Hydracarina (Mites)	1	0	2	5	2	8	1	0	0	0	0	3	6	0	0	0	1	0	0
Ephemeroptera (Mayflies)	2	0	2	14	4	18	0	2	3	6	2	1	2	1	0	3	1	7	5
Anisoptera (Dragonflies)	8	12	3	2	0	1	0	4	2	0	4	1	5	0	3	0	1	0	1
Zygoptera (Damselflies)	0	1	0	1	1	1	0	1	0	0	0	0	0	1	0	0	0	0	0
Plecoptera (Stoneflies)	16	4	15	6	6	2	0	0	5	0	0	0	0	2	1	2	14	16	7
Hemiptera (True Bugs)	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0
Megaloptera (Fishflies, Alderflies)	7	4	5	11	6	6	0	0	6	5	0	1	1	3	7	0	2	5	3
Trichoptera (Caddisflies)	0	17	8	15	42	43	2	1	22	16	7	4	2	28	15	58	29	16	22
Lepidoptera (Aquatic Moths)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Coleoptera (Beetles)	6	3	2	1	5	0	0	10	16	28	10	6	15	16	8	3	0	0	0
Gastropoda (Snails, limpets)	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0
Chironomidae (Midges)	26	13	27	42	30	26	6	68	46	15	37	46	24	60	63	36	21	38	46
Tabanidae (Horse and Deer Flies)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Culicidae (Mosquitos)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ceratopogonidae (No-see-ums)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tipulidae (Crane Flies)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Simuliidae (Black Flies)	0	0	1	3	1	1	0	0	0	0	0	0	0	0	1	0	14	7	11
Misc. Diptera (Misc. True Flies)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Total Count	101	119	100	101	105	111	112	100	104	106	104	101	109	121	104	103	100	104	107

Table 5: Mean percentage of taxonomic groups found at each site in 2005

Taxa Group	Willow (1)	Willow (2)	Willow (3)	Crane (1)	Crane (2)	Spring (1)	Spring (2)
Scuds	37.5	3.5	90.2	11.3	0.0	4.3	10.0
Crayfish	1.6	0.3	0.0	4.2	0.3	0.6	0.3
Mayflies	1.3	11.4	0.0	3.5	1.6	1.2	4.2
Dragonflies	7.2	0.9	0.0	1.9	3.2	0.9	0.6
Damselflies	0.3	0.9	0.0	0.3	0.0	0.3	0.0
Alderflies	5.0	7.3	0.0	3.5	0.6	3.0	3.2
Caddisflies	7.8	31.5	1.8	12.6	4.1	30.8	21.5
Diptera	20.9	32.5	5.4	41.6	34.1	48.8	44.4
Worms	1.9	0.3	1.8	0.6	2.5	0.3	3.2
Sowbugs	1.3	0.0	0.0	0.0	0.0	0.0	0.0
Clams	0.0	0.0	0.0	1.0	37.3	0.0	0.0
Mites	0.9	4.7	0.9	0.0	2.9	0.0	0.3
Stoneflies	10.9	4.4	0.0	1.6	0.0	1.5	11.9
Beetles	3.4	1.9	0.0	17.4	9.9	8.2	0.0
Flatworms	0.0	0.0	0.0	0.0	2.5	0.0	0.0

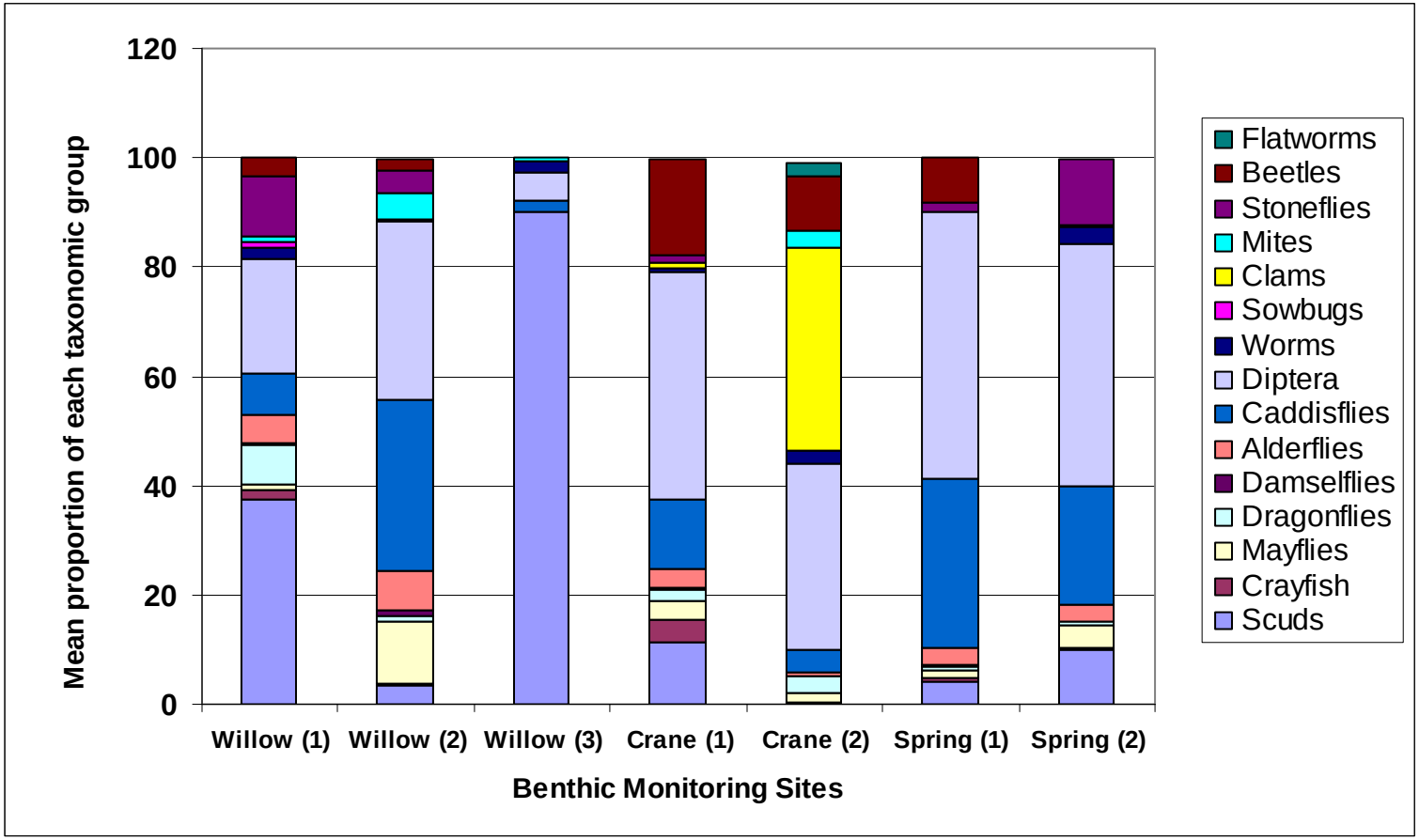

Figure 6: Mean proportion of each taxonomic group found at each of the benthic sampling locations in 2005.

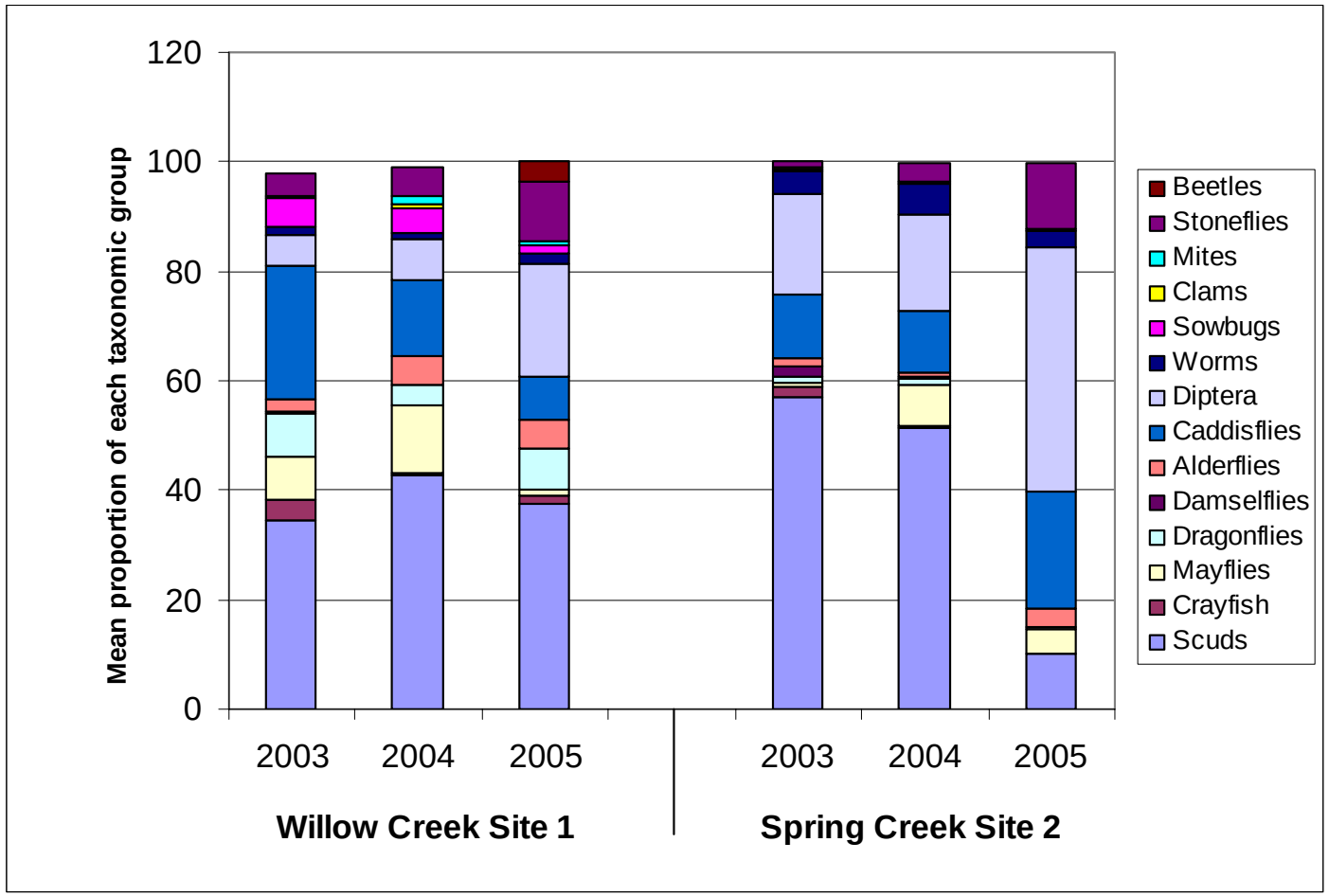

Figure 7: Mean proportion of each taxonomic group found at Willow Creek Site 1 and Spring Creek Site 2 in 2003, 2004, and 2005.

Discussion

This year represents the third year since the establishment of the benthic monitoring program on the Northern Bruce Peninsula. A total of seven benthic monitoring sites have been established and monitored using protocols provided by the OBBN. These sites are located on three different streams within the Municipality of Northern Bruce Peninsula with the purpose of monitoring the health of these streams over an extended period of time.

This monitoring program began with the establishment of four sites, with two being located on Spring Creek, one on Crane River, and one on Willow Creek. Three additional sites were established this year, with two located on Willow Creek and one on Crane River. The addition of these new sites will allow for more extensive data to be collected regarding benthic diversity and abundance on these three streams. In addition, the data collected from these new sites will allow for comparisons between different areas of each stream so that potential sources of impact can be pin pointed and the effects of these sources can be examined.

Through utilization of the Reference Condition Approach, the seven sites located on the Northern Bruce Peninsula can be categorized as reference sites. The biological data taken from these sites can be used to evaluate impairment levels of impacted test sites at both the local and provincial level. At this point, this was only the first or second year of sampling for many of the sites. This was the third year of sampling for two of the sites (Willow Creek Site 1 and Spring Creek Site 2). Additional monitoring data is required from these sites in order to establish reference conditions within each of the sampling streams. After additional years of baseline data is documented, reference conditions can be established in order to evaluate selected test sites.

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