GULL (KEEYASK) PROJECT

Generating Station

January 2004

Report # 01-06

Aquatic Macrophyte and Associated Epiphytic Invertebrate Data Collected in Gull Lake and Portions of the Nelson River between Birthday Rapids and Gull Rapids, Manitoba, Fall 2001

Draft

ENVIRONMENTAL STUDIES PROGRAM

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AQUATIC MACROPHYTE AND ASSOCIATED EPIPHYTIC INVERTEBRATE DATA COLLECTED IN GULL LAKE AND PORTIONS OF THE NELSON RIVER BETWEEN BIRTHDAY RAPIDS AND GULL RAPIDS, MANITOBA, FALL 2001

Draft Report Prepared for Manitoba Hydro

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OVERVIEW

Manitoba Hydro and its potential partners (Tataskweyak Cree Nation, War Lake First Nation, Fox Lake Cree Nation, and York Factory First Nation) are currently looking into building a hydroelectric generating station at Gull Rapids on the Nelson River. Studies are being done to support predictions of possible effects of this generating station on the environment. This information is required to prepare an Environmental Impact Statement (EIS), a document required by government for its consideration when deciding about licensing the generating station. The aquatic part of these studies is looking at the water, algae (microscopic plants in the water), weeds, bugs, and fish. The area being studied includes Split, Stephens, Clark, Gull, and Assean lakes and adjoining parts of the rivers (Burntwood, Nelson, Aiken, and Assean) and the streams that flow into them. Separate reports are being issued on each topic and for each different area.

This report presents the results of the first year of macrophyte and epiphytic invertebrate sampling in Gull Lake, including portions of the Nelson River between Birthday and Gull rapids during the 2001 open-water season. Macrophytes are plants that grow in shallow water and provide shelter for fish. Epiphytic invertebrates are small animals that live among the plants and are an important food source for many fish. Macrophyte and epiphytic invertebrate sampling was also conducted in Gull Lake in 2002 and 2003.

TECHNICAL SUMMARY

Manitoba Hydro and its potential partners (Tataskweyak Cree Nation, War Lake First Nation, Fox Lake Cree Nation, and York Factory First Nation) are currently investigating the feasibility of developing a **hydroelectric generating station*** at Gull Rapids located at the upstream end of Stephens Lake on the Nelson River (Figure 1). An Environmental Studies Program has been developed to provide the data and information required for an **environmental impact assessment** of the above-mentioned hydroelectric **Project**, should a decision be made to proceed with a licensing submission to **regulatory authorities**. Manitoba Hydro and the potential partners have established a cooperative approach to assessing the potential effects of future development on the **environment** and for producing the information required for regulatory review and impact **monitoring**.

The Gull (Keeyask) **aquatic monitoring** and impact assessment program was designed to investigate and document interrelated components of the Burntwood, Nelson, Aiken, and Assean rivers as well as the associated lake (Split, Stephens, Clark, Gull, and Assean) aquatic **ecosystems**. Investigations of physical **habitat**, **water quality**, **detritus**, **algae**, aquatic **macrophytes**, **aquatic invertebrates**, and fish were to be undertaken. Individual reports are being prepared and issued on each topic and for specific waterbodies.

The following report presents information collected from macrophytes and **epiphytic invertebrate** sampling conducted in Gull Lake, and portions of the Nelson River between Birthday and Gull rapids, during the 2001 open-water season. Specific objectives of the program were to provide a description of the aquatic macrophyte and epiphytic invertebrate communities in terms of abundance, composition, and distribution within the Gull Lake area.

Aquatic macrophyte samples were collected from five areas in Gull Lake and portions of the Nelson River between Birthday and Gull rapids during the fall 2001 sampling period. Within each area, sites were selected to represent specific aquatic habitats, including a shoreline, a mid-bay, and an outer-bay site. Epiphytic invertebrates were collected in conjunction with aquatic macrophyte sampling.

Eight macrophyte taxa and thirteen epiphytic invertebrate taxa were identified from samples collected in Area 1 of the Gull Lake area during the fall 2001 sampling period. The dominant macrophyte taxa within Area 1 were *Myriophyllum sibiricum* and *Stuckenia vaginatus*. Insects, particularly chironomid larvae, accounted for the majority of invertebrates associated with macrophytes collected at that time.

* *Definitions for words appearing in bold are provided in the glossary (see Section 5.0).*

Ten macrophyte taxa and eleven epiphytic invertebrate taxa were identified from samples collected in Area 2 of the Gull Lake area during the fall 2001 sampling period. *Lemna trisulca* and *Potamogeton* sp. 1 composed the majority of aquatic macrophytes collected from samples in Area 2. Unlike the other areas sampled, Crustacea, particularly amphipods, accounted for the majority of the epiphytic invertebrates associated with aquatic macrophytes collected during the fall 2001.

Nine macrophyte taxa and fifteen epiphytic invertebrate taxa were identified from samples collected in Area 3 of the Gull Lake area during the fall 2001 sampling period. The dominant macrophyte taxa identified in Area 3 included *L. trisulca*, *M. sibiricum*, and *Potamogeton* sp. 3. Insects, primarily chironomid larvae, accounted for the majority of epiphytic invertebrates associated with aquatic macrophytes collected during the fall 2001.

Ten macrophyte taxa and eleven epiphytic invertebrate taxa were identified from samples collected in Area 4 of the Gull Lake area during the fall 2001 sampling period. Macrophyte samples collected in Area four were comprised primarily of *Polygonum amphibium* and a variety of *Potamogeton* **species**. Similar to Area 1 and 2, insects, particularly chironomid larvae, accounted for the majority of epiphytic invertebrates associated with aquatic macrophytes during the fall 2001.

Seven macrophyte taxa and twelve epiphytic invertebrate taxa were identified from samples collected in Area 5 of the Gull Lake area during the fall 2001 sampling period. The genus *Potamogeton* composed the majority of macrophyte samples collected in Area 5, though species varied between sites. Insects, particularly chironomid larvae, accounted for the majority of epiphytic invertebrates associated with aquatic macrophytes collected during the fall 2001.

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1.0 INTRODUCTION

Manitoba Hydro and its potential partners (Tataskweyak Cree Nation [TCN], War Lake First Nation [WLFN], Fox Lake Cree Nation [FLCN], and York Factory First Nation [YFFN]) are currently investigating the feasibility of developing a **hydroelectric generating station**[*] at Gull Rapids located at the upstream end of Stephens Lake on the Nelson River (Figure 1). An Environmental Studies Program has been developed to provide the data and information required for an **environmental impact assessment** of the above-mentioned hydroelectric **Project** (hereafter referred to as the Project), should a decision be made to proceed with a licensing submission to **regulatory authorities**. Manitoba Hydro and the potential partners have established a cooperative approach to assessing the potential effects of the Project on the **environment** and for producing the information required for regulatory review and impact **monitoring**.

The broad objectives of the Environmental Studies Program are the following:

- to describe the **existing environment** of the Study Area using an **ecosystem**-based approach;
- to provide data and information to assist in the planning of the Project;
- to provide data and information to enable assessment of the potential adverse effects that may result from the Project; and
- to provide the basis for monitoring environmental change resulting from development, should the Project proceed.

The following report presents the results of aquatic **macrophyte** and **epiphytic invertebrate** sampling in Gull Lake and from portions of the Nelson River between Birthday and Gull rapids (herein referred to as the Gull Lake area) and is one of a series of reports produced from the Gull (Keeyask) Environmental Studies Program.

1.1 AQUATIC ECOSYSTEMS MONITORING AND ASSESSMENT

The collection of **baseline information** on the **aquatic environment** was initiated at the Project site in 1999. Manitoba Hydro expanded the program in 2001, and again in 2002, in response to concerns raised by the Cree Nations to include a broader geographic area to better characterize all aspects of the environment that may be affected by development at Gull Rapids. This included the **reach** of the Nelson River between, and including, Split Lake

[*] *Definitions for words appearing in bold are provided in the glossary (see Section 5.0).*

to Stephens Lake, the Burntwood, Aiken, and Assean rivers, as well as the associated lake (Split, Clark, Gull, and Assean) aquatic ecosystems. Biological investigations included measurements of physical **habitat**, **water quality**, **detritus**, **algae**, aquatic macrophytes, **aquatic invertebrates**, and fish.

Individual reports are being prepared and issued on each of these topics and for specific waterbodies. These reports will describe the existing environment, provide information to assist in Project planning, and provide the basis for predicting and assessing the significance of potential adverse effects that may result from construction and operation of the Project.

This report presents the results of the aquatic macrophyte and associated epiphytic invertebrate sampling program conducted in Gull Lake, and portions of the Nelson River between Birthday and Gull rapids, during the 2001 open-water season. The specific objective is as follows:

- to provide a description of the aquatic macrophyte and epiphytic invertebrate communities in terms of abundance, composition, and distribution within the Gull Lake area.

2.0 THE GULL (KEEYASK) STUDY SETTING

2.1 STUDY AREA

The Gull (Keeyask) Study Area includes the reach of the Nelson River from Kelsey Generating Station (GS) to Kettle GS, including Split, Clark, Gull, and Stephens lakes; the Burntwood River downstream of First Rapids; the Grass River downstream of Witchai Lake Falls; the Assean River **watershed**, including Assean Lake; and all other tributaries to the above stated reach of the Nelson River (Figure 1).

The entire Study Area lies within the High **Boreal** Land Region characterized by a mean annual temperature of –3.4ºC and annual precipitation range of 415 to 560 mm. **Topography** is bedrock controlled overlain with fine-grained **glacio-lacustrine deposits** of clays and gravels. Depressional areas have **peat** plateaus and patterned **fens** with **permafrost** present. Black spruce/moss/sedge associations are the dominant vegetation (Canada-Manitoba Soil Survey 1976).

Split Lake, which is immediately downstream of the Kelsey GS at the **confluence** of the Burntwood and Nelson rivers, is the second largest waterbody in the Study Area. Due to the large inflows from the Nelson and Burntwood rivers, the lake has detectable current in several locations. Split Lake has maximum and mean depths of 28.0 m and 3.9 m, respectively, at a water surface elevation of 167.0 m **ASL** (Lawrence et al. 1999). The surface area of Split Lake was determined to be 26,100 ha (excluding islands), with a total shoreline length, including islands, of 940.0 km (Lawrence et al. 1999). The numerous islands in Split Lake represent 411.6 km of the total shoreline.

The reach of the Nelson River between Split Lake and Stephens Lake is characterized by: i) narrow sections with swiftly flowing water (including Birthday and Gull rapids); and ii) wider more **lacustrine** sections, including Clark and Gull lakes. Mean winter flow in the reach is 3,006 m^3/s and mean summer flow is 2,812 m^3/s (Manitoba Hydro 1996a).

The Assean River system is north of Split Lake and drains into Clark Lake (Figure 1). Except for the mouth of the Assean River, the **hydrology** of the watershed has not been affected by hydroelectric development.

Stephens Lake, the largest lake in the Study Area, is located downstream of Gull Rapids and was created through the development of the Kettle GS. Stephens Lake has a surface area of 29,930 ha (excluding islands) and a total shoreline length, including islands, of 740.8 km. The numerous islands encompass an area of 3,340 ha and 336.2 km of shoreline. There is no

detectable current throughout most of this large lake, except for the old Nelson River channel.

Communities in the Study Area include the First Nations communities of Split Lake (TCN) and York Landing (YFFN), both located on Split Lake (Figure 1). Members of WLFN reside in Ilford south of the Nelson River and while some members of FLCN reside in Gillam on the south shore of Stephens Lake. Gillam, the largest community in the Study Area; is the regional headquarters for Manitoba Hydro's northern operations.

The names assigned to some of the features described in Section 2.3 and illustrated in Figure 1 may be inconsistent with local names, topographic maps, and/or the Gazetteer of Canada. When field programs were initiated in spring, 2001, names of several features within the Study Area were unknown to North/South Consultants Inc. (NSC) biologists and First Nation assistants. Therefore, some features for which no name was known were assigned names by field personnel. Chief and council of TCN, YFFN, WLFN, and FLCN or the Canadian Permanent Committee on Geographical Names have not approved names of features described within this document.

2.2 PREVIOUS HYDROELECTRIC DEVELOPMENT

The Study Area is bounded by two Manitoba Hydro hydroelectric generating stations on the Nelson River; the Kelsey GS just upstream of Split Lake and Kettle GS downstream of Stephens Lake. The Kelsey GS came into service in 1961 and is operated as a **run-of river plant** with very little storage or re-regulation of flows (Manitoba Hydro 1996a).

The Kettle GS was completed in 1974, which raised the water level at the structures by 30.0 m and created a backwater effect upstream to Gull Rapids. Approximately 22,055 ha of land were flooded in creating Stephens Lake (Manitoba Hydro 1996a). Kettle GS is operated as a **peaking-type plant**, cycling its **forebay** on a daily, weekly, and seasonal basis. The forebay is operated within an annual water level range from 141.1 m to 139.5 m ASL (Manitoba Hydro 1996a).

Since 1976, two water management projects, the Churchill River Diversion (CRD) and Lake Winnipeg Regulation (LWR), have influenced water levels and flows within the Study Area. These two projects augment and alter flows to generating stations on the lower Nelson River by diverting additional water into the drainage from the Churchill River (CRD) (Manitoba Hydro 1996b) and managing outflow from Lake Winnipeg (LWR). The CRD and LWR projects reversed the Nelson River pre-Project seasonal water level and flow patterns in the Gull (Keeyask) Study Area by increasing water levels and flow during periods of ice cover

and reducing flows during the open-water period. Overall, there has been a net increase of 246 m^3/s in average annual flow at Gull Rapids since CRD and LWR (Manitoba Hydro 1996a). The historic and current flow regimes are described in "History and First Order Effects, Split Lake Cree Post-Project Environmental Review", Volume Two (Manitoba Hydro 1996a).

2.3 REPORT-SPECIFIC STUDY AREA

The majority of the reach of the Nelson River between Birthday Rapids and Gull Rapids lies within a landscape of well-drained mineral **soils**, dominated by black spruce forest. Immediately upstream of Gull Lake, the land adjacent to the south shore of the Nelson River is generally poorly drained, and is dominated by **organic** soils, and black spruce **bogs**, peatlands, and fens. Trembling aspen occurs occasionally along the shores of the Nelson River in areas that are well-drained. Exposed bedrock occurs along the north shore and upstream portions of the south shore of the Nelson River, particularly within the first 2 km downstream of Birthday Rapids. Permafrost is **discontinuous** to **sporadic** adjacent this section of the river (Agriculture and Agri-Food Canada 2003).

Birthday Rapids is located approximately 10 km downstream of Clark Lake and 30 km upstream of Gull Rapids on the Nelson River (Figure 1). The drop in elevation from the upstream to downstream side of Birthday Rapids is approximately 5 m. The 14 km reach of the Nelson River between Birthday Rapids and Gull Lake is characterized as a large, somewhat uniform channel with medium to high water **velocity**. A series of exposed shoals and boulders are located within the first 7 km downstream of Birthday Rapids, after which **run** habitat dominates the river. There are a few large bays with reduced water velocity and a number of small tributaries that drain into the Nelson River between Birthday Rapids and Gull Lake. River **substrates** are typically bedrock, boulder, cobble, and sand, with some fine **sediment** in areas with reduced current. The shoreline in this section of the river contains large sections of bedrock and some areas of fine sediments. **Riparian** vegetation includes willow and alder, black spruce, tamarack, and trembling aspen. Aquatic vegetation is restricted to bays that are removed from the major river current.

Gull Lake is a section of the Nelson River where the river widens and is lacustrine in nature with moderate to low water velocity featuring numerous bays. Gull Lake is herein defined as the reach of the Nelson River beginning approximately 17 km upstream of Gull Rapids and 14 km downstream of Birthday Rapids, where the river widens to the north into a bay around a large point of land (Figure 1), and extending downstream to the downstream end of Caribou Island, approximately 3 km upstream of Gull Rapids. Gull Lake has three distinct **basins**, the first extending from the upstream end of the lake downstream approximately 6

km to a large island; the second extending from the large island to Morris Point (a constriction in the river immediately upstream of Caribou Island); and the third extending from Morris Point to the downstream end of Caribou Island. Water velocity in the third basin is somewhat faster than in the first two, particularly under low flow scenarios, as the river channel flows around Caribou Island. Gull Lake has numerous small tributaries, with the majority being **ephemeral**. Lake substrates are predominantly **silt** and sand with some cobble and boulder in the first two basins where current is slow, and predominantly cobble, boulder, and bedrock in the third basin, with soft substrates in off-current areas. Riparian vegetation includes willow and alder, black spruce, tamarack, and trembling aspen. Aquatic vegetation is restricted to bays that are removed from the major river channel.

The 3 km reach of the Nelson River between Gull Lake and Gull Rapids is characterized by a steep gradient with high water velocity. The river channel is separated into two by a large island at the upstream end of Gull Rapids (Figure 1). The substrate is bedrock, boulder, and cobble with small amounts of clay and silt in off-current bays. Aquatic vegetation is restricted to a bay on the south shore.

3.0 METHODS

3.1 MACROPHYTE SAMPLING LOCATIONS

Aquatic macrophyte and associated epiphytic invertebrate sampling was conducted between Birthday and Gull rapids, including Gull Lake, from 02 to 07 September, 2001, within the following five areas (Figure 2):

- Area 1: Pahwaybanic Bay, located approximately 8.2 km downstream of Birthday Rapids, off the mainstem of the Nelson River;
- Area 2: John Garson Bay, located approximately 11.4 km upstream of Gull Rapids, off the mainstem of the Nelson River;
- Area 3: Kahpowinic Bay, located approximately 15.5 km downstream of Birthday Rapids, off the mainstem of the Nelson River;
- Area 4: Tub Bay, located approximately 4.6 km upstream of Gull Rapids, off the mainstem of the Nelson River; and
- Area 5: Gull Lake at Caribou Island, located approximately 8.0 km upstream of Gull Rapids.

Within each area, three sites were selected to represent specific aquatic habitats, including a shoreline site, a mid-bay site, and an outer-bay site; the exception was Area 2 where only two sites were sampled. Within each site, random locations with abundant aquatic vegetation and water depth no greater than 2 m were sampled in replicate; one sample was taken from the left side of the boat and one from the right. At each site, UTM coordinates were taken with a navigation quality Global Positioning System unit and water depth was measured using a weighted rope graduated to the nearest 10 cm.

3.2 MACROPHYTE FIELD SAMPLING

Aquatic macrophytes and associated epiphytic invertebrates were collected with a custom-designed sampler constructed of industrial ABS grade material. The frame measured 0.6 x 0.7 m in depth, 1.4 m in height, with a surface area of 0.42 m^2, and had an attached 1.5 m cod-end. The sampler was placed into the water with the retractable cutter blade engaged and lowered to the bottom, disturbing the aquatic vegetation as little as possible. The cutter blade and attached cod-end were then pulled across the bottom of the sampler, severing the rooted macrophytes above the sediment surface. All plants and associated invertebrates were retained within the sampler.

Once the sampler was pulled to the surface, macrophytes were thoroughly rinsed. Replicate samples were kept separated and macrophytes were put into labelled bags. The rinse water was sieved through a 500 µm sieve to collect epiphytic invertebrates, which were then preserved in 10% formalin. Macrophyte samples were frozen immediately and transported to North/South Consultants Inc. laboratory in Winnipeg for further processing.

3.3 LABORATORY AND DATA ANALYSIS

Macrophytes were thawed in the laboratory in cold water, identified to the lowest **taxonomic** group (usually genus or **species**), and sorted. Macrophyte samples were sorted and identified based on Fassett 1957, Flora of North America Editorial Committee 2000, Johnson et al. 1999, and Scoggan 1978.

Species level identification of certain aquatic macrophyte samples was difficult due to the time of year samples were collected (i.e., lack of flowering parts in early fall). Consequently, these macrophytes were sorted into groups with similar appearances and are referred to as *Potamogeton* sp. 1, *Potamogeton* sp. 2, and *Potamogeton* sp. 3. Any macrophyte material that could not be identified was grouped as unidentified.

The wet weight (g) of macrophyte samples was determined by weighing plant material in pre-weighed aluminum pans. Samples were subsequently dried in a Fisher Scientific Isotemp drying oven for approximately 24 hours at a temperature of 106°C and a dry-weight (g) was determined for each plant group (g; dry-weight/group). Dried samples were discarded. Aquatic macrophyte biomass (g; dry-weight of group/m^2) was determined using the following formula:

dry-weight of groups per sample (g) / surface area of sampler (0.42 m^2).

In the laboratory, epiphytic invertebrate samples were transferred to 70% ethanol, sorted under a magnifying lamp, identified to major groups, and enumerated. Any remaining invertebrates found on macrophytes in the lab that were not initially rinsed off in the field were included in the analysis. Epiphytic invertebrate abundance (individuals/m^2) was determined using the following formula:

individuals per sample / surface area of sampler (0.42 m^2).

4.0 RESULTS

Sampling sites for each of the five areas in Gull Lake and portions of the Nelson River between Birthday and Gull rapids are presented in Figure 2. Site-specific location, sampling date, and water depth is presented for each area in Table 1.

4.1 AREA 1

Six taxa of **vascular** macrophytes were identified from samples collected at three sites in Area 1 of the Gull Lake area during fall 2001. Dry weights of macrophyte samples are presented in Table 2 and Figure 3. Taxa found at all three sites included *Myriophyllum sibiricum* and *Lemna trisulca*. *M. sibiricum* was the dominant **taxon** at both sites 1 (mid-bay) and 2 (shoreline), having a mean percent dry weight of 49.9% and 73.1%, respectively (Table 2; Figure 3). At Site 3 (outer-bay), *Stuckenia vaginatus* dominated, with a mean percent dry weight of 62.4%. *L. trisulca* contributed notably to the overall biomass of each site within Area 1, having mean percent dry weight values of 32.9%, 19.4%, and 20.2% for sites 1, 2, and 3, respectively (Table 2). **Nonvascular** macrophytes collected in Area 1 included aquatic moss and epiphytic algae/cyanophytes, each contributing less than 10.0% of the total dry weight collected at each site (Table 2). Overall, samples collected in Area 1 during the fall 2001 indicated that sites 1 and 3 had a greater diversity of aquatic macrophytes than Site 2 (Table 2; Figure 3).

Thirteen epiphytic invertebrate taxa were identified from samples collected in Area 1of the Gull Lake area during the fall 2001. Mean invertebrate abundance and percent composition are summarized in Table 3 and Figure 4. Overall, the most common invertebrate taxon in the samples was Insecta (predominantly chironomid larvae), followed by Crustacea (exclusively amphipods) and Mollusca (Pisidiidae and Gastropoda) (Table 3; Figure 4). Mean total epiphytic invertebrate abundance varied between and within sites sampled in Area 1. Overall, the mean total invertebrate abundance was 1,257 individuals/m^2, with samples collected at sites 2 and 3 having higher abundances (1,466 and 1,562 individuals/m^2, respectively) than Site 1 (745 individuals/m^2) (Table 3).

At Site 1, Crustacea (Amphipoda) dominated as the most abundant invertebrate taxon associated with aquatic macrophyte samples, followed by Mollusca (Gastropoda and Pisidiidae) and Insecta, with average abundances of 344, 219, and 181 individuals/m^2, respectively (Table 3; Appendix 1). At sites 2 and 3, Insecta dominated as the most abundant invertebrate taxon with average abundances of 1,117 and 1,300 individuals/m^2, respectively. The particularly high abundance of chironomid larvae at sites 2 and 3 (1,069 and 1,237

individuals/m^2, respectively) accounted for these sites having higher mean total invertebrate abundances within Area 1 (Table 3; Appendix 1).

4.2 AREA 2

Eight taxa of vascular macrophytes were identified from samples collected in Area 2 of the Gull Lake area during fall 2001. Because of sparse vegetation, only two habitat types were sampled; an outer-bay site was not sampled. Dry weight of macrophyte samples are presented in Table 2 and Figure 3. Taxa found at both Site 4 (mid-bay) and Site 5 (shoreline) included *Lemna trisulca*, *Potamogeton* sp. 1, and *Potamogeton* sp. 2. A total of eight vascular macrophyte taxa were identified from samples collected at Site 4, with *Potamogeton* sp. 1 dominating in mean percent dry weight (52.2%) (Table 2; Figure 3). At Site 5, four taxa of vascular macrophytes were identified, with the dominant taxon, *L. trisulca*, having a mean percent dry weight of 79.4% (Table 2). In addition to vascular macrophytes, aquatic moss and ephiphytic algae/cyanophytes were collected in Area 2, each contributing less than 15% of the total dry weight at each site (Table 2). Overall, sampling in Area 2 during fall 2001 revealed that although Site 4 had a more diverse assemblage of aquatic macrophytes than Site 5, a greater quantity of macrophytes was collected at Site 5 than at Site 4 (73.4 g/m^2 versus 22.3 g/m^2) (Table 2).

Eleven epiphytic invertebrate taxa were identified from samples collected in Area 2 of the Gull Lake area during fall 2001. Mean invertebrate abundance and percent composition are summarized in Table 3 and Figure 4. Overall, the most common invertebrate taxon in the samples was Crustacea (exclusively Amphipoda), followed by Mollusca (Pisidiidae and Gastropoda) and Insecta (predominantly chironomid larvae) (Table 3; Figure 4). Mean total epiphytic invertebrate abundance varied between and within sites sampled in Area 2. Overall mean total invertebrate abundance was 1,356 individuals/m^2, with Site 5 dominating in total mean invertebrate abundance compared to Site 4 (2,151 and 563 individuals/m^2, respectively) (Table 3).

At Site 4, Crustacea (exclusively Amphipoda) was the most abundant invertebrate taxa associated with aquatic macrophyte samples, followed by Insecta and Mollusca (Gastropoda and Pisidiidae), with average abundances of 293, 151, and 114 individuals/m^2, respectively (Table 3; Appendix 1). At Site 5, Mollusca (predominantly Gastropoda) and Crustacea (exclusively Amphipoda) were the most abundant epiphytic invertebrate taxa identified, with average abundances of 932 and 926 individuals/m^2, respectively (Table 3; Appendix 1).

4.3 AREA 3

Eight taxa of vascular macrophytes were identified from samples collected at sites 7 (mid-bay), 8 (shoreline), and 9 (outer-bay) in Area 3 of the Gull Lake area during fall 2001. Dry weights of macrophyte samples are presented in Table 2 and Figure 3. *Lemna trisulca* and *Ceratophyllum demersum* were the only taxa found throughout Area 3. *L. trisulca* was the dominant taxon at Site 7, with a mean percent dry weight of 88.0% (Table 2). Six vascular macrophytes were identified from samples collected at Site 8, with *Myriophyllum sibiricum* dominating in mean percent dry weight, followed by *L. trisulca*, and *Equisetum fluviatile* (55.7, 20.4, and 19.3%, respectively) (Table 2; Figure 3). At Site 9, *Potamogeton* sp. 3 was the dominant vascular macrophyte of the six identified from samples (46.5%, respectively) (Table 2). Epiphytic algae/cyantobacteria were also collected at sites 8 and 9 (4.2 and 25.4%, respectively) (Table 2). Overall, aquatic macrophyte sampling in Area 3 during the fall 2001 indicated that Site 8 had a greater density of aquatic macrophytes (53.4 g/m^2) than sites 7 and 9 (29.4 and 12.9 g/m^2, respectively) (Table 2).

Fifteen epiphytic invertebrate taxa were identified from samples collected in Area 3 of the Gull Lake area during the fall 2001. Mean invertebrate abundance and percent composition are summarized in Table 3 and Figure 4. Overall, the most common invertebrate taxon in the samples was Insecta (predominantly chironomid larvae), followed by Crustacea (specifically amphipods), Mollusca (Pisidiidae and Gastropoda), and Annelida (Table 3; Figure 4). Mean total epiphytic invertebrate abundance varied between and within sites sampled in Area 3. Overall mean total invertebrate abundance was 1,600 individuals/m^2, with samples collected at Site 8 dominating in total invertebrate abundance (2,695 individuals/m^2) compared to sites 7 and 8 (1,041 and 1,068 individuals/m^2, respectively) (Table 3).

At Site 7, Insecta (principally chironomid larvae) was the most abundant invertebrate taxon associated with aquatic macrophyte samples, followed by Mollusca (predominately Gastropoda) and Crustacea (exclusively Amphipoda), with a mean abundance of 631, 264, and 136 individuals/m^2, respectively (Table 3; Appendix 1). At Site 8, epiphytic invertebrate samples were composed primarily of Insecta, with a mean abundance of 1,753 individuals/m^2 (Table 3; Appendix 1). The particularly high abundance of chironomid larvae at this site (1,606 individuals/m^2) accounted for Site 8 having the highest mean total invertebrate abundance within Area 3. Less abundant taxa within Site 8 included Crustacea (comprised of Amphipoda and Conchostraca), Mollusca (largely Gastropoda), and Annelida, with mean invertebrate abundances per site of 543, 295, and 88 individuals/m^2) (Table 3; Appendix 1). At Site 9, Insecta was again the most abundant epiphytic invertebrate taxa

identified, followed by Annelida (exclusively Oligochaeta), with mean abundances of 733 and 225 individuals/m^2, respectively (Table 3; Appendix 1).

4.4 AREA 4

Eight taxa of vascular macrophytes were identified from samples collected at sites 10 (shoreline), 11 (mid-bay), and 12 (outer-bay) in Area 4 of the Gull Lake area during fall 2001. Dry weights of macrophyte samples are presented in Table 2 and Figure 3. None of the taxa identified were present at all three sites. Three vascular macrophytes were identified at Site 10, with *Polygonum amphibium* dominating in mean percent dry weight (95.8%) (Table 2). Aquatic moss was also collected at Site 10 (Table 2). Samples collected from Site 11 contained two taxa, *Potamogeton richardsonii* and *Potamogeton zosteriformis*, each having comparable mean percent dry weights (32.1 and 32.4%, respectively) (Table 2). At Site 12, three vascular macrophytes were identified, with *Potamogeton sp.* 1 dominating in mean percent dry weight (66.9%) (Table 2; Figure 3). Epiphytic algae/cyanobacteria were also identified at sites 11 and 12, contributing as much as 34.6% of the total dry weight collected (Table 2). Overall, macrophyte sampling in Area 4 during the fall 2001 indicated that sites 10 and 12 had a greater density of aquatic macrophytes (25.7 and 20.2 g/m^2, respectively) compared to Site 11 (4.5 g/m^2) (Table 2).

Eleven epiphytic invertebrate taxa were identified from samples collected in Area 4 of the Gull Lake area during the fall 2001. Mean invertebrate abundance and percent composition are summarized in Table 3 and Figure 4. Overall, the most common invertebrate taxon in the samples was Insecta (predominantly chironomid larvae), followed by Hydrozoa, Mollusca (primarily Gastropoda), Annelida (exclusively Oligochaeta), and Crustacea (exclusively Amphipoda) (Table 3; Figure 4). Mean total epiphytic invertebrate abundance varied between and within sites sampled in Area 4. Overall mean total invertebrate abundance was 615 individuals/m^2, with samples collected at Site 12 dominating in total invertebrate abundance (1,379 individuals/m^2) compared to sites 10 and 11 (314 and 153 individuals/m^2, respectively) (Table 3).

At Site 10, Crustacea and Insecta dominated as the most abundant invertebrate taxa associated with aquatic macrophyte samples, with mean abundances of 136 and 131 individuals/m^2, respectively (Table 3; Appendix 1). At Site 11, epiphytic invertebrate samples were largely composed of Insecta (124 individuals/m^2), with all other taxa having minimal representation ($\leq$ 13 individuals/m^2) (Table 3; Appendix 1). Hydrozoa dominated as the most abundant epiphytic invertebrate at Site 12, with a mean abundance per site of 432 individuals/m^2, followed by Insecta, Annelida (exclusively Oligochaeta), and Mollusca

(predominantly Gastropoda) (357, 282, and 273 individuals/m^2, respectively) (Table 3; Appendix 1).

4.5 AREA 5

Six taxa of vascular macrophytes were identified from samples collected at three sites in Area 5 of the Gull Lake area during fall 2001. Dry weights of macrophyte samples are presented in Table 2 and Figure 3. All of the vascular macrophytes identified in samples collected from Area 5 belonged to the *Potamogeton* genus, although none of the species identified were present at all three sites. Three unidentified species of *Potamogeton* (1, 2, and 3) accounted for the majority of samples collected at Site 13, with mean percent dry weights of 25.6, 31.8, and 29.0%, respectively (Table 2). At Site 14, *Potamogeton praelongus* dominated in mean percent dry weight (43.5%), followed by *Potamogeton zosteriformis* (23.2%). *P. zosteriformis* dominated the macrophyte samples collected at Site 15, followed by *P. praelongus*, and *Potamogeton richardsonii* (38.7, 19.1, and 17.1%, respectively) (Table 2; Figure 3). In addition, epiphytic algae/cyanobacteria were identified at all three sites, with the percent dry weight ranging from 11.3% at Site 13 to 32.9% at Site 14 (Table 2). Overall, the macrophyte samples collected in Area 5 during the fall 2001 identified sites 13 and 15 as having a greater density of aquatic macrophytes (32.8 and 30.0 g/m^2, respectively) compared to Site 14 (16.3 g/m^2) (Table 2).

Twelve epiphytic invertebrate taxa were identified from samples collected in Area 5 of the Gull Lake area during the fall 2001. Mean invertebrate abundance and percent composition are summarized in Table 3 and Figure 4. Overall, the most common invertebrate taxon in the samples was Insecta (predominantly chironomid larvae and hemipterans), followed by Annelida (specifically Oligochaeta), and Mollusca (primarily Gastropoda) (Table 3; Figure 4). Mean total epiphytic invertebrate abundance varied between and within sites sampled in Area 5. Overall mean total invertebrate abundance was 1,960 individuals/m^2, with samples collected at Site 14 having a greater abundance (2,611 individuals/m^2) compared to sites 13 and 15 (1,642 and 1,625 individuals/m^2, respectively) (Table 3).

At Site 13, Insecta (mainly chironomid larvae, trichopterans, and hemipterans) was the most abundant invertebrate taxa associated with aquatic macrophyte samples, followed by Annelida and Mollusca (primarily gastropods) (992, 455, and 142 individuals/m^2, respectively) (Table 3; Appendix 1). The particularly high abundance of Annelida (specifically Oligochaeta) (1,513 individuals/m^2) at Site 14 contributed to this site having the highest mean total invertebrate abundance within Area 5. Less abundant taxa collected at Site 14 included Insecta (mainly chironomid larvae and hemipterans) and Mollusca (primarily gastropods), with mean abundances of 833 and 232 individuals/m^2, respectively

(Table 3; Appendix 1). At Site 15, Insecta (predominately chironomid larvae), followed by Mollusca (exclusively Gastropoda) and Annelida (specifically Oligochaeta), dominated the samples, with mean total invertebrate abundances of 800, 554, and 257 individuals/m^2, respectively (Table 3; Appendix 1).

5.0 GLOSSARY

Algae − a group of simple plant-like aquatic ***organisms*** possessing ***chlorophyll*** and capable of ***photosynthesis***; they may be attached to surfaces or free-floating; most freshwater ***species*** are very small in size.

Aquatic – living or found in water.

Aquatic environment − areas that are permanently under water, or that are under water for a sufficient period to support ***organisms*** that remain for their entire lives, or a significant portion of their lives, totally immersed in water.

Aquatic invertebrate (s) − an animal lacking a backbone that lives, at least part of its life, in the water (e.g., aquatic insect, mayfly, clam, aquatic earthworm, crayfish).

Aquatic monitoring – the primary goal of long term ***monitoring*** of lakes and rivers is to understand how ***aquatic*** communities and ***habitats*** respond to natural processes and to be able to distinguish differences between human-induced disturbance effects to aquatic ***ecosystems*** and those caused by natural processes.

Aquatic plants – multi-celled plants living in the water.

ASL – Above Sea Level.

Baseline information − information about an area, over a period of time, that is used as background for detecting and/or comparing potential future changes.

Basin (s) – a distinct section of a lake, separated from the remainder of the lake by a constriction.

Bog (s) – wetland ***ecosystem*** characterized by an accumulation of ***peat***, acid conditions, and a plant community dominated by sphagnum moss.

Boreal – of or relating to the forest areas of the North Temperate Zone, dominated by

Chlorophyll - a group of green pigments present in plant and algal cells that are necessary in the trapping of light energy during ***photosynthesis***.

Confluence – the meeting place of two streams or rivers.

Detritus – particulate and dissolved ***organic*** matter that is produced by the decomposition of plant and animal matter.

Discontinuous – the occurrence of ***permafrost*** in 35-85% of a geographic area.

Ecosystem − all living ***organisms*** in an area and the non-living parts of the ***environment*** upon which they depend, as well as all interactions, both among living and non-living components of the ecosystem.

Environment − 1) the total of all the surrounding natural conditions that affect the existence of living ***organisms*** on earth, including air, water, soil, minerals, climate, and the organisms themselves; and, 2) the local complex of such conditions that affects a particular organism and ultimately determines its physiology and survival.

Environmental impact assessment − an evaluation of the likely adverse environmental effects of a project that will contribute to decisions about whether to proceed with a project.

Epiphytic invertebrate – an insect found on ***aquatic plants***, using the plant for food or shelter.

Ephemeral − a stream that flows only in direct response to precipitation, and thus discontinues its flow during dry seasons.

Existing environment − the present condition of a particular area; generally assessed prior to the construction of a proposed project.

Fen (s) – a peatland with the water table usually at or just above the surface; often stagnant and alkaline.

Forebay – the portion of a reservoir immediately upstream of a hydroelectric facility.

Glacio-lacustrine deposits − ***soil*** that originates from lakes that were formed by melting glaciers.

Habitat − the place where a plant or animal lives; often related to a function such as spawning, feeding, etc.

Hydroelectric generating station − a generating station that converts the potential energy of elevated water or the kinetic energy of flowing water into electricity.

Hydrology- the branch of physical geography that deals with the waters of the Earth, their distribution, characteristics, and effects relative to human activities.

Lacustrine − referring to freshwater lakes; ***sediments*** generally consisting of stratified fine sand, ***silt***, and clay deposits on a lake bed.

Macrophyte (s) − multi-celled ***aquatic*** and ***terrestrial*** plants.

Monitoring − measurement or collection of data to determine whether change is occurring in something of interest.

Nonvascular – referring to the lower plants (e.g., moss and ***algae***).

Organic – the compounds formed by living ***organisms***.

Organism(s) – an individual living thing.

Peaking-type plant – a ***hydroelectric generating station*** that is designed to supply power during high demand periods and is generally operated to serve that purpose.

Peat − material consisting of non-decomposed and only slightly decomposed ***organic*** matter found in extremely moist areas.

Permafrost – subsoil that remains below the freezing point throughout the year, as in an Arctic environment.

Photosynthesis – a process which occurs in plants and ***algae*** where, in the presence of light, carbon dioxide and water are turned into a useable form of energy (sugar) and oxygen.

Project − proposed ***hydroelectric generating station*** on the Nelson River, upstream of Stephens Lake.

Reach − any length of stream or river under study, often with similar features along its length.

Regulatory authorities − a decision-making body such as a government department.

Riparian – along the banks of rivers and streams.

Run – an area of a stream or river with uniform, swiftly flowing water without surface breaks.

Run-of-river plant − a ***hydroelectric generating station*** that has no upstream storage capacity and must pass all water flows as they come.

Sediment (s) – material, usually soil or ***organic detritus***, which is deposited in the bottom of a waterbody.

Silt – a very small rock fragment or mineral particle, smaller than a very fine grain of sand and larger than coarse clay; usually having a diameter of 0.002 to 0.06 mm; the smallest soil material that can be seen with the naked eye.

Soil – 1) all loose, unconsolidated, weathered, or otherwise altered rock material above bedrock; and 2) a natural accumulation of ***organic*** matter and inorganic rock material that is capable of supporting the growth of vegetation.

Species - a group of ***organisms*** that can interbreed to produce fertile offspring.

Sporadic(ally) – the occurrence of isolated patches of ***permafrost***, 10-35% of a geographic region.

Substrate – the material forming the streambed; also solid material upon which an ***organism*** lives or to which it is attached.

Taxon – any valid taxonomic category (e.g., order, family, genus, species) defined according to hierarchical level.

Taxonomic – pertaining to the classification of plants and animals into groups.

Terrestrial – belonging to, or inhabiting, the land or ground.

Topography − the general configuration of the land surface including relief and position of natural and man-made features.

Vascular – referring to the higher plants (e.g., flowering plants).

Velocity – a measurement of speed of flow.

Water quality − measures of substances in the water such as nitrogen, phosphorus, oxygen, and carbon.

Watershed − the area within which all water drains to collect in a common channel or lake.

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6.1 PERSONAL COMMUNICATION

KRINDLE, J. Calyx Consulting, Winnipeg, Manitoba. Aquatic/Terrestrial Botanist, October – November, 2002.

TABLES AND FIGURES

Table 1. Survey information of sampling locations within Gull Lake and portions of the Nelson River between Birthday and Gull rapids, fall 2001.

Date	Area	Site	Replicate	Habitat	Location (UTM/Datum WGS 84)			Water
					Zone	Easting	Northing	Depth (m)
02-Sep-01	1	1	A	mid-bay	15V	0339693	6244942	1.50
02-Sep-01	1	1	B	mid-bay	15V	0339693	6244942	1.50
02-Sep-01	1	2	A	shoreline	15V	0339790	6245123	1.20
02-Sep-01	1	2	B	shoreline	15V	0339790	6245123	1.20
02-Sep-01	1	3	A	outer-bay	15V	0339300	6245393	1.50
02-Sep-01	1	3	B	outer-bay	15V	0339300	6245393	1.50
04-Sep-01	2	4	A	mid-bay	15V	0355848	6243325	0.90
04-Sep-01	2	4	B	mid-bay	15V	0355848	6243325	0.90
04-Sep-01	2	5	A	shoreline	15V	0355632	6243456	1.30
04-Sep-01	2	5	B	shoreline	15V	0355632	6243456	1.30
05-Sep-01	3	7	A	mid-bay	15V	0344668	6245390	1.30
05-Sep-01	3	7	B	mid-bay	15V	0344668	6245390	1.30
05-Sep-01	3	8	A	shoreline	15V	0345128	6245575	1.30
05-Sep-01	3	8	B	shoreline	15V	0345128	6245575	1.30
05-Sep-01	3	9	A	outer-bay	15V	0345469	6245276	1.60
05-Sep-01	3	9	B	outer-bay	15V	0345469	6245276	1.60
05-Sep-01	4	10	A	shoreline	15V	0360168	6245342	0.50
05-Sep-01	4	10	B	shoreline	15V	0360168	6245342	0.50
06-Sep-01	4	11	A	mid-bay	15V	0360227	6245418	1.70
06-Sep-01	4	11	B	mid-bay	15V	0360227	6245418	1.70
06-Sep-01	4	12	A	outer-bay	15V	0360265	6245492	1.60
06-Sep-01	4	12	B	outer-bay	15V	0360265	6245492	1.60
07-Sep-01	5	13	A	mid-bay	15V	0356724	6247506	1.50
07-Sep-01	5	13	B	mid-bay	15V	0356724	6247506	1.50
07-Sep-01	5	14	A	shoreline	15V	0356743	6247703	1.30
07-Sep-01	5	14	B	shoreline	15V	0356743	6247703	1.30
07-Sep-01	5	15	A	outer-bay	15V	0356775	6247883	1.50
07-Sep-01	5	15	B	outer-bay	15V	0356775	6247883	1.50

Table 2. Total dry weight (g/m^2) and percent dry weight (%) of vascular and non-vascular macrophyte samples collected in Gull Lake and portions of the Nelson River between Birthday and Gull rapids, fall 2001. Individual abundances may not add up to totals due to rounding.

Area	**1**											
Site	**1**				**2**				**3**			
	Dry Weight			**%**	**Dry Weight**			**%**	**Dry Weight**			**%**
Replicate Samples	**A**	**B**	**Mean**	**Mean**	**A**	**B**	**Mean**	**Mean**	**A**	**B**	**Mean**	**Mean**
Lemna trisulca	9.452	16.102	12.8	32.9	8.798	4.800	6.8	19.4	5.421	9.938	7.7	20.2
Myriophyllum sibiricum	15.362	23.364	19.4	49.9	28.712	22.424	25.6	73.1	0.336	0.000	0.2	0.4
Potamogeton richardsonii	0.000	2.260	1.1	2.9	0.000	0.000	0.0	0.0	0.000	0.000	0.0	0.0
Potamogeton sp. 1	0.000	0.000	0.0	0.0	0.000	0.000	0.0	0.0	11.374	0.000	5.7	14.9
Stuckenia vaginatus	0.000	0.000	0.0	0.0	0.000	0.000	0.0	0.0	47.540	0.000	23.8	62.4
Utricularia macrorhiza	0.424	0.000	0.2	0.5	0.000	0.000	0.0	0.0	0.000	0.000	0.0	0.0
Vascular Plant Sub-total	**25.238**	**41.726**	**33.5**	**86.3**	**37.510**	**27.224**	**32.4**	**92.6**	**64.671**	**9.938**	**37.3**	**97.9**
aquatic moss	0.000	0.000	0.0	0.0	3.705	1.052	2.4	6.8	0.000	0.000	0.0	0.0
epiphytic algae / cyanophytes	6.217	1.557	3.9	10.0	0.443	0.000	0.2	0.6	1.010	0.000	0.5	1.3
unidentified macrophytes	1.410	1.471	1.4	3.7	0.000	0.000	0.0	0.0	0.000	0.562	0.3	0.7
TOTAL	**32.864**	**44.755**	**38.8**	**100**	**41.657**	**28.276**	**35.0**	**100**	**65.681**	**10.500**	**38.1**	**100**

Table 2. Continued.

Area	**2**							
Site	**4**				**5**			
	Dry Weight			**%**	**Dry Weight**			**%**
Replicate Samples	**A**	**B**	**Mean**	**Mean**	**A**	**B**	**Mean**	**Mean**
Lemna trisulca	1.164	0.060	0.6	2.7	19.736	96.850	58.3	79.4
Myriophyllum sibiricum	0.495	0.000	0.2	1.1	0.000	0.000	0.0	0.0
Potamogeton gramineus	0.000	3.507	1.8	7.8	0.000	0.000	0.0	0.0
Potamogeton richardsonii	0.000	1.836	0.9	4.1	0.000	0.000	0.0	0.0
Potamogeton sp. 1	5.443	17.879	11.7	52.2	0.817	13.286	7.1	9.6
Potamogeton sp. 2	1.514	0.000	0.8	3.4	9.362	0.588	5.0	6.8
Polygonum amphibium	0.000	5.440	2.7	12.2	0.000	0.000	0.0	0.0
Utricularia macrorhiza	0.207	0.000	0.1	0.5	0.000	0.000	0.0	0.0
Vascular Plant Sub-total	**8.824**	**28.721**	**18.8**	**84.0**	**29.914**	**110.724**	**70.3**	**95.8**
aquatic moss	1.698	4.636	3.2	14.2	1.257	0.805	1.0	1.4
epiphytic algae / cyanophytes	0.164	0.000	0.1	0.4	0.000	0.000	0.0	0.0
unidentified macrophytes	0.033	0.610	0.3	1.4	2.967	1.093	2.0	2.8
TOTAL	**10.719**	**33.967**	**22.3**	**100**	**34.138**	**112.621**	**73.4**	**100**

Table 2. Continued.

Area	3											
Site	7				8				9			
	Dry Weight			%	Dry Weight			%	Dry Weight			%
Replicate Samples	A	B	Mean	Mean	A	B	Mean	Mean	A	B	Mean	Mean
Ceratophyllum demersum	0.017	0.000	0.0	0.0	0.028	0.028	0.0	0.0	0.028	0.028	0.0	0.0
Equisetum fluviatile	0.000	0.000	0.0	0.0	3.167	17.424	10.3	19.3	0.000	0.000	0.0	0.0
Lemna trisulca	20.262	31.445	25.9	88.0	10.831	10.924	10.9	20.4	0.036	0.000	0.0	0.1
Myriophyllum sibiricum	1.717	4.281	3.0	10.2	40.914	18.479	29.7	55.7	0.028	0.028	0.0	0.0
Potamogeton richardsonii	0.028	0.028	0.0	0.0	0.028	0.028	0.0	0.0	0.000	2.488	1.2	9.7
Potamogeton sp. 1	0.000	0.864	0.4	1.5	0.028	0.028	0.0	0.0	0.500	0.838	0.7	5.2
Potamogeton sp. 2	0.000	0.000	0.0	0.0	0.000	0.000	0.0	0.0	3.055	0.143	1.6	12.5
Potamogeton sp. 3	0.000	0.000	0.0	0.0	0.000	0.000	0.0	0.0	11.921	0.000	6.0	46.5
Vascular Plant Sub-total	**22.024**	**36.619**	**29.3**	**99.8**	**54.997**	**46.911**	**51.0**	**95.3**	**15.569**	**3.526**	**9.5**	**74.2**
epiphytic algae / cyanophytes	0.000	0.000	0.0	0.0	3.636	0.852	2.2	4.2	6.310	0.233	3.3	25.4
unidentified macrophytes	0.112	0.033	0.1	0.2	0.390	0.107	0.2	0.5	0.095	0.000	0.0	0.4
TOTAL	**22.136**	**36.652**	**29.4**	**100**	**59.023**	**47.871**	**53.4**	**100**	**21.973**	**3.759**	**12.9**	**100**

Table 2. Continued.

Area	4											
Site	10				11				12			
	Dry Weight			%	Dry Weight			%	Dry Weight			%
Replicate Samples	A	B	Mean	Mean	A	B	Mean	Mean	A	B	Mean	Mean
Carex spp.	0.557	0.000	0.3	1.1	0.000	0.000	0.0	0.0	0.000	0.000	0.0	0.0
Myriophyllum sibiricum	0.071	0.867	0.5	1.8	0.000	0.000	0.0	0.0	0.000	0.000	0.0	0.0
Potamogeton richardsonii	0.000	0.000	0.0	0.0	2.900	0.000	1.5	32.1	0.000	0.000	0.0	0.0
Potamogeton zosteriformis	0.000	0.000	0.0	0.0	0.000	2.924	1.5	32.4	0.000	0.000	0.0	0.0
Potamogeton sp. 1	0.000	0.000	0.0	0.0	0.000	0.000	0.0	0.0	8.869	18.990	13.9	66.9
Potamogeton sp. 2	0.000	0.000	0.0	0.0	0.000	0.000	0.0	0.0	1.612	1.071	1.3	6.4
Potamogeton sp. 3	0.000	0.000	0.0	0.0	0.000	0.000	0.0	0.0	1.417	0.000	0.7	3.4
Polygonum amphibium	45.036	4.248	24.6	95.8	0.000	0.000	0.0	0.0	0.000	0.000	0.0	0.0
Vascular Plant Sub-total	**45.664**	**5.114**	**25.4**	**98.7**	**2.900**	**2.924**	**2.9**	**64.5**	**11.898**	**20.062**	**16.0**	**79.0**
aquatic moss	0.121	0.000	0.1	0.2	0.000	0.000	0.0	0.0	0.000	0.000	0.0	0.0
epiphytic algae / cyanophytes	0.000	0.000	0.0	0.0	0.000	3.129	1.6	34.6	2.236	6.202	4.2	20.9
unidentified macrophytes	0.086	0.457	0.3	1.1	0.031	0.050	0.0	0.9	0.000	0.062	0.0	0.2
TOTAL	**45.871**	**5.571**	**25.7**	**100**	**2.931**	**6.102**	**4.5**	**100**	**14.133**	**26.326**	**20.2**	**100**

Table 2. Continued.

Area	5											
Site	13				14				15			
	Dry Weight			%	Dry Weight			%	Dry Weight			%
Replicate Samples	A	B	Mean	Mean	A	B	Mean	Mean	A	B	Mean	Mean
Potamogeton praelongus	0.000	0.000	0.0	0.0	4.117	10.007	7.1	43.5	11.438	0.000	5.7	19.1
Potamogeton richardsonii	0.000	0.000	0.0	0.0	0.000	0.000	0.0	0.0	1.864	8.424	5.1	17.1
Potamogeton zosteriformis	0.000	0.000	0.0	0.0	6.012	1.517	3.8	23.2	20.881	2.345	11.6	38.7
Potamogeton sp. 1	8.888	7.886	8.4	25.6	0.000	0.000	0.0	0.0	0.000	3.167	1.6	5.3
Potamogeton sp. 2	3.714	17.124	10.4	31.8	0.000	0.000	0.0	0.0	0.000	0.000	0.0	0.0
Potamogeton sp. 3	18.533	0.500	9.5	29.0	0.000	0.000	0.0	0.0	0.000	0.000	0.0	0.0
Vascular Plant Sub-total	**31.136**	**25.510**	**28.3**	**86.3**	**10.129**	**11.524**	**10.8**	**66.6**	**34.183**	**13.936**	**24.1**	**80.2**
epiphytic algae / cyanophytes	3.836	3.548	3.7	11.3	3.736	6.952	5.3	32.9	10.286	1.617	6.0	19.8
unidentified macrophytes	1.593	0.000	0.8	2.4	0.114	0.048	0.1	0.5	0.000	0.000	0.0	0.0
TOTAL	**36.564**	**29.057**	**32.8**	**100**	**13.979**	**18.524**	**16.3**	**100**	**44.469**	**15.552**	**30.0**	**100**

Table 3. Summary of mean abundance (individuals/m^2) and percent composition (%) of major epiphytic invertebrate groups collected in association with macrophytes from Gull Lake and portions of the Nelson River between Birthday and Gull rapids, fall 2001. Individual abundances may not add up to totals due to rounding.

Area	1							
Site	1		2		3		OVERALL	
	Individuals/m^2	%	Individuals/m^2	%	Individuals/m^2	%	Individuals/m^2	%
Annelida	1	0.2	48	3.3	46	3.0	**32**	**2.6**
Crustacea	344	46.2	133	9.1	145	9.3	**208**	**16.5**
Arachnida	0	0.0	0	0.0	1	0.1	**0**	**0.0**
Insecta	181	24.3	1117	76.1	1300	83.2	**865**	**68.8**
Mollusca	219	29.4	168	11.4	69	4.4	**152**	**12.1**
Nemata	0	0.0	0	0.0	0	0.0	**0**	**0.0**
Platyhelminthes	0	0.0	0	0.0	0	0.0	**0**	**0.0**
Hydrozoa	0	0.0	0	0.0	0	0.0	**0**	**0.0**
TOTAL INVERTEBRATES	**745**	**100**	**1466**	**100**	**1562**	**100**	**1257**	**100**

Table 3. Continued.

Area	2					
Site	4		5		OVERALL	
	Individuals/m^2	%	Individuals/m^2	%	Individuals/m^2	%
Annelida	5	0.8	18	0.8	**11**	**0.8**
Crustacea	293	52.1	926	43.1	**610**	**45.0**
Arachnida	0	0.0	4	0.2	**2**	**0.1**
Insecta	151	26.7	271	12.6	**210**	**15.5**
Mollusca	114	20.3	932	43.3	**523**	**38.6**
Nemata	0	0.0	0	0.0	**0**	**0.0**
Platyhelminthes	0	0.0	0	0.0	**0**	**0.0**
Hydrozoa	0	0.0	0	0.0	**0**	**0.0**
TOTAL INVERTEBRATES	**563**	**100**	**2151**	**100**	**1356**	**100**

Table 3. Continued.

Area	3							
Site	7		8		9		Overall	
	Individuals/m^2	%	Individuals/m^2	%	Individuals/m^2	%	Individuals/m^2	%
Annelida	7	0.7	88	3.3	225	21.1	**107**	**6.7**
Crustacea	136	13.1	543	20.1	26	2.5	**235**	**14.7**
Arachnida	2	0.2	14	0.5	1	0.1	**6**	**0.4**
Insecta	631	60.6	1753	65.1	733	68.6	**1038**	**64.9**
Mollusca	264	25.3	295	11.0	68	6.4	**209**	**13.0**
Nemata	1	0.1	1	0.0	0	0.0	**1**	**0.0**
Platyhelminthes	0	0.0	0	0.0	0	0.0	**0**	**0.0**
Hydrozoa	0	0.0	0	0.0	14	1.3	**5**	**0.3**
TOTAL INVERTEBRATES	**1041**	**100**	**2695**	**100**	**1068**	**100**	**1600**	**100**

Table 3. Continued.

Area	4							
Site	10		11		12		Overall	
	Individuals/m^2	%	Individuals/m^2	%	Individuals/m^2	%	Individuals/m^2	%
Annelida	7	2.3	7	4.7	282	20.5	**99**	**16.1**
Crustacea	136	43.0	8	5.5	35	2.5	**60**	**9.7**
Arachnida	0	0.0	0	0.0	0	0.0	**0**	**0.0**
Insecta	131	41.9	124	81.1	357	25.9	**204**	**33.2**
Mollusca	40	12.8	13	8.7	273	19.8	**109**	**17.7**
Nemata	0	0.0	0	0.0	0	0.0	**0**	**0.0**
Platyhelminthes	0	0.0	0	0.0	0	0.0	**0**	**0.0**
Hydrozoa	0	0.0	0	0.0	432	31.3	**144**	**23.4**
TOTAL INVERTEBRATES	**314**	**100**	**153**	**100**	**1379**	**100**	**615**	**100**

Table 3. Continued.

Area	5							
Site	13		14		15		Overall	
	Individuals/m^2	%	Individuals/m^2	%	Individuals/m^2	%	Individuals/m^2	%
Annelida	455	27.7	1513	58.0	257	15.8	**742**	**37.9**
Crustacea	10	0.6	8	0.3	1	0.1	**6**	**0.3**
Arachnida	0	0.0	0	0.0	0	0.0	**0**	**0.0**
Insecta	992	60.4	833	31.9	800	49.2	**875**	**44.7**
Mollusca	142	8.6	232	8.9	554	34.1	**309**	**15.8**
Nemata	5	0.3	0	0.0	1	0.1	**2**	**0.1**
Platyhelminthes	0	0.0	0	0.0	0	0.0	**0**	**0.0**
Hydrozoa	39	2.4	24	0.9	12	0.7	**25**	**1.3**
TOTAL INVERTEBRATES	**1642**	**100**	**2611**	**100**	**1625**	**100**	**1960**	**100**

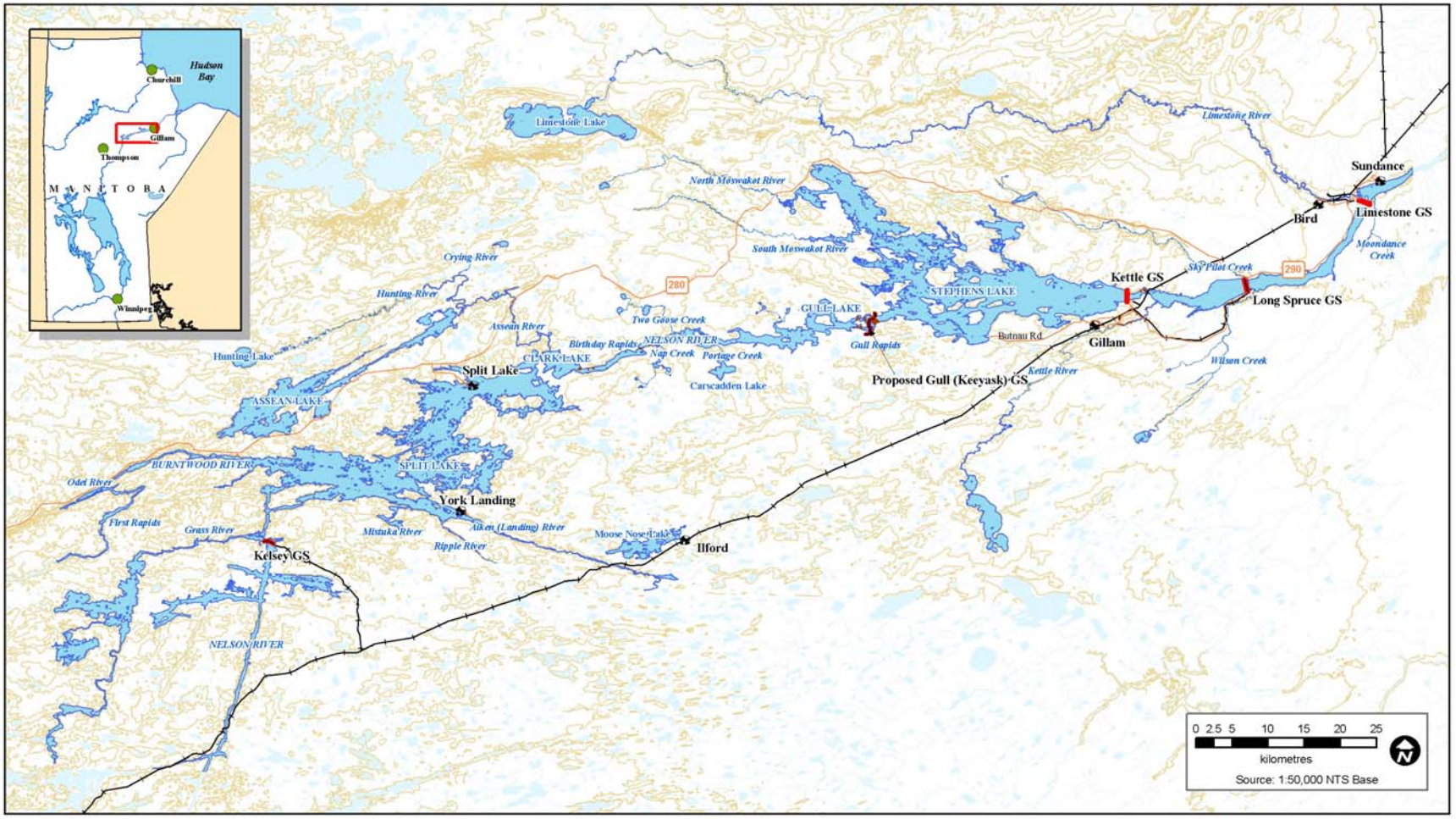

Figure 1. Map of the Gull (Keeyask) Study Area showing proposed and existing hydroelectric development.

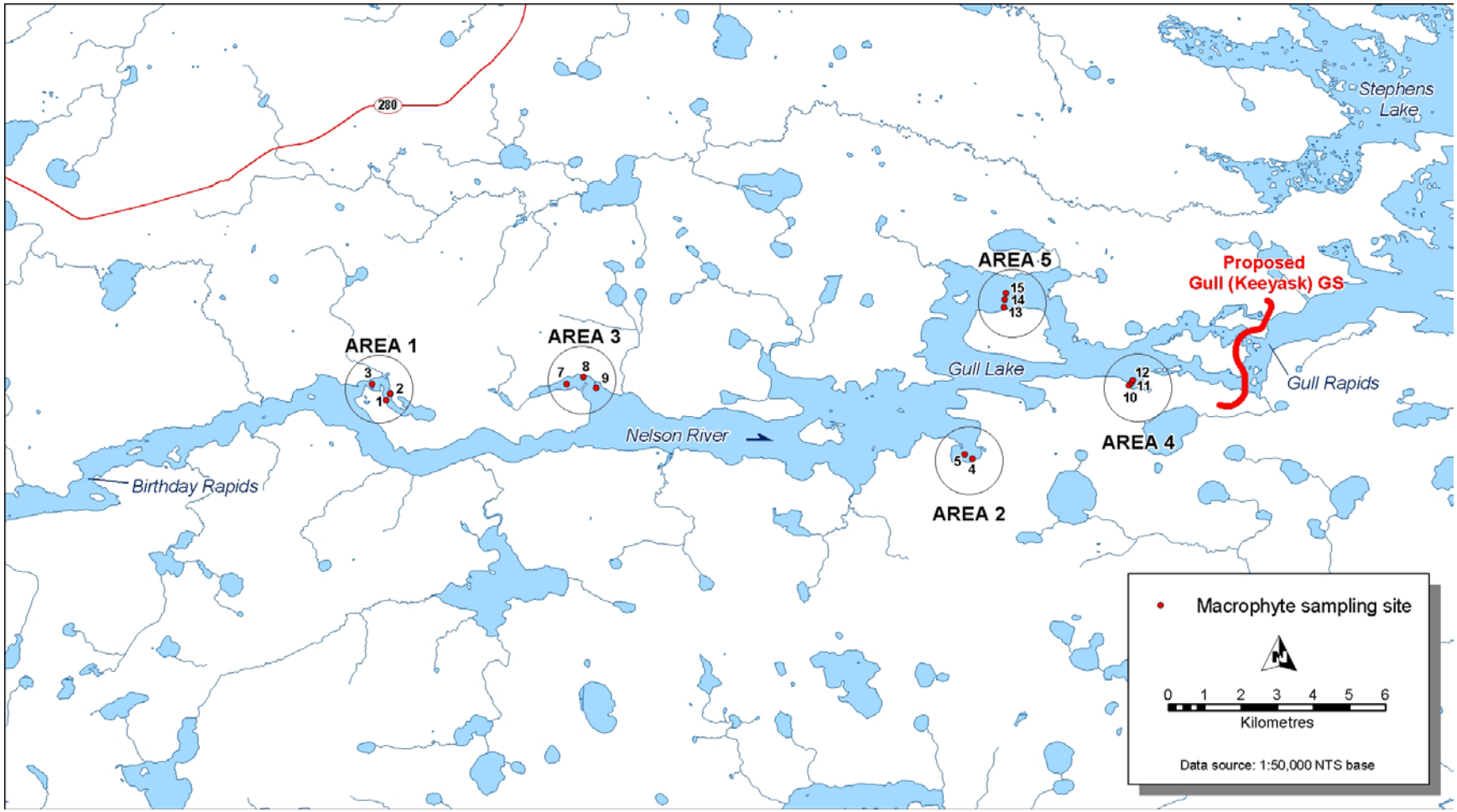

Figure 2. Aquatic macrophyte and associated epiphytic invertebrate sampling sites in Gull Lake and portions of the Nelson River between Birthday and Gull rapids, fall 2001.

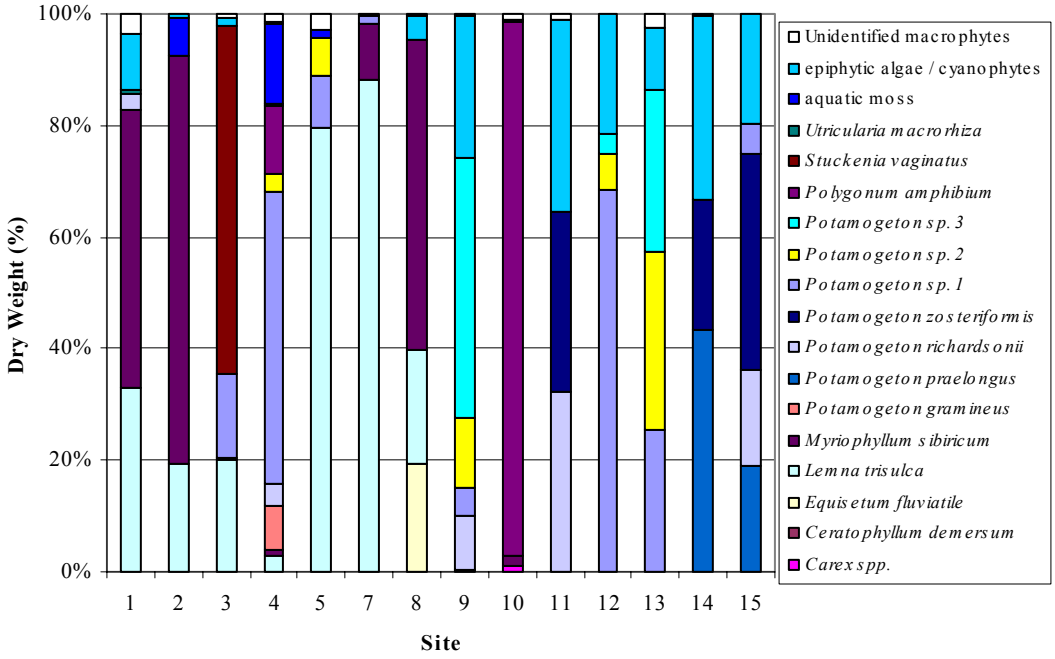

Figure 3. Percent dry weight (%) of vascular and non-vascular macrophyte samples collected in Gull Lake and portions of the Nelson River between Birthday and Gull rapids, 2001.

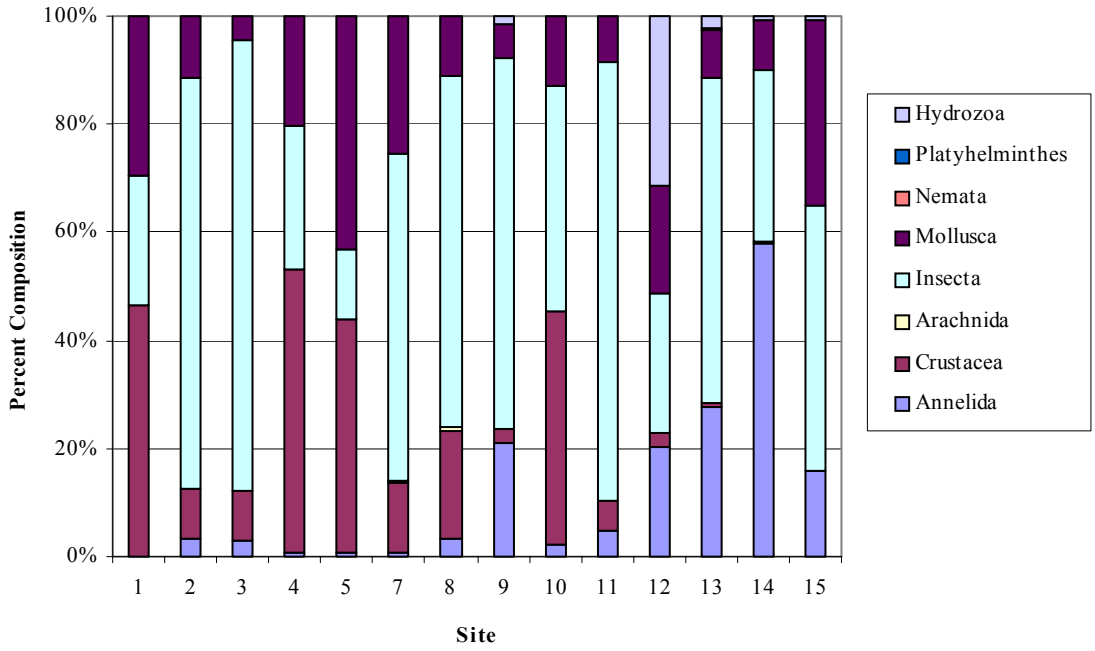

Figure 4. Percent composition (%) of major epiphytic invertebrate groups collected in association with macrophytes from Gull Lake and portions of the Nelson River between Birthday and Gull rapids, fall 2001.

APPENDIX 1.
DETAILED ABUNDANCE AND COMPOSITION OF EPIPHYTIC INVERTEBRATE DATA COLLECTED IN GULL LAKE AND PORTIONS OF THE NELSON RIVER BETWEEN BIRTHDAY AND GULL RAPIDS, FALL 2001.

Table A1-1. Abundance (individuals/m^2) and percent composition (%) of epiphytic invertebrates collected in Gull Lake and portions of the Nelson River between Birthday and Gull rapids, fall 2001. Individual abundances may not add up to totals due to rounding.

Area	**1**													
Site	**1**				**2**				**3**				**Overall**	
	Individuals/m^2			**%**	**Individuals/m^2**			**%**	**Individuals/m^2**			**%**	**Individuals/m^2**	**%**
Replicate Samples	**A**	**B**	**Mean**	**Mean**	**A**	**B**	**Mean**	**Mean**	**A**	**B**	**Mean**	**Mean**	**Mean**	**Mean**
Annelida														
Oligochaeta	0	2	1	0.2	12	69	40	2.8	81	10	45	2.9	29	2.3
Hirudinea	0	0	0	0.0	7	10	8	0.6	2	0	1	0.1	3	0.3
Total Annelida	**0**	**2**	**1**	**0.2**	**19**	**79**	**48**	**3.3**	**83**	**10**	**46**	**3.0**	**32**	**2.6**
Crustacea														
Ostracoda	0	0	0	0.0	0	0	0	0.0	0	0	0	0.0	0	0.0
Amphipoda	195	493	344	46.2	240	26	133	9.1	169	121	145	9.3	208	16.5
Conchostraca	0	0	0	0.0	0	0	0	0.0	0	0	0	0.0	0	0.0
Mysida	0	0	0	0.0	0	0	0	0.0	0	0	0	0.0	0	0.0
Decapoda	0	0	0	0.0	0	0	0	0.0	0	0	0	0.0	0	0.0
Cyclopoida	0	0	0	0.0	0	0	0	0.0	0	0	0	0.0	0	0.0
Calanoida	0	0	0	0.0	0	0	0	0.0	0	0	0	0.0	0	0.0
Cladocera	0	0	0	0.0	0	0	0	0.0	0	0	0	0.0	0	0.0
Total Crustacea	**195**	**493**	**344**	**46.2**	**240**	**26**	**133**	**9.1**	**169**	**121**	**145**	**9.3**	**208**	**16.5**
Arachnida														
Acarina	0	0	0	0.0	0	0	0	0.0	0	2	1	0.1	0	0.0
Insecta														
Megaloptera	0	0	0	0.0	0	0	0	0.0	0	0	0	0.0	0	0.0
Odonata														
Anisoptera	0	0	0	0.0	0	0	0	0.0	0	0	0	0.0	0	0.0
Zygoptera	2	0	1	0.2	10	2	6	0.4	2	7	5	0.3	4	0.3
Coleoptera	7	12	10	1.3	2	5	4	0.2	2	0	1	0.1	5	0.4

Table A1-1. Continued.

Area	1													
Site	1				2				3				Overall	
	Individuals/m^2			%	Individuals/m^2			%	Individuals/m^2			%	Individuals/m^2	%
Replicate Samples	A	B	Mean	Mean	A	B	Mean	Mean	A	B	Mean	Mean	Mean	Mean
Hemiptera	45	24	35	4.6	7	10	8	0.6	2	0	1	0.1	15	1.2
Ephemeroptera	2	0	1	0.2	5	2	4	0.2	7	12	10	0.6	5	0.4
Trichoptera	12	19	15	2.1	14	7	11	0.7	38	7	23	1.4	16	1.3
Plecoptera	2	0	1	0.2	0	0	0	0.0	0	0	0	0.0	0	0.0
Diptera														
Chironomidae														
larva	83	152	118	15.8	1424	714	1069	72.9	2188	286	1237	79.3	808	64.3
pupa	0	0	0	0.0	24	7	15	1.1	45	0	23	1.4	13	1.0
Ceratopogonidae	0	0	0	0.0	0	0	0	0.0	0	0	0	0.0	0	0.0
Tipulidae	0	0	0	0.0	0	0	0	0.0	0	0	0	0.0	0	0.0
Chaoboridae	0	0	0	0.0	0	0	0	0.0	0	0	0	0.0	0	0.0
Total Insecta	**153**	**207**	**181**	**24.3**	**1486**	**748**	**1117**	**76.1**	**2284**	**312**	**1300**	**83.2**	**865**	**68.8**
Mollusca														
Bivalvia														
Unionidae	0	0	0	0.0	0	0	0	0.0	0	0	0	0.0	0	0.0
Pisidiidae	40	38	39	5.3	36	10	23	1.5	21	24	23	1.4	28	2.2
Gastropoda	112	248	180	24.1	183	107	145	9.9	31	62	46	3.0	124	9.9
Total Mollusca	**152**	**286**	**219**	**29.4**	**219**	**117**	**168**	**11.4**	**52**	**86**	**69**	**4.4**	**152**	**12.1**
Nemata	**0**	**0**	**0**	**0.0**	**0**	**0**	**0**	**0.0**	**0**	**0**	**0**	**0.0**	**0**	**0.0**
Platyhelminthes	**0**	**0**	**0**	**0.0**	**0**	**0**	**0**	**0.0**	**0**	**0**	**0**	**0.0**	**0**	**0.0**
Hydrozoa	**0**	**0**	**0**	**0.0**	**0**	**0**	**0**	**0.0**	**0**	**0**	**0**	**0.0**	**0**	**0.0**
TOTAL INVERTEBRATES	**501**	**988**	**745**	**100**	**1964**	**969**	**1466**	**100**	**2589**	**531**	**1562**	**100**	**1257**	**100**

Table A1-1. Continued.

Area	2									
Site	4				5				Overall	
	Individuals/m^2			%	Individuals/m^2			%	Individuals/m^2	%
Replicate Samples	A	B	Mean	Mean	A	B	Mean	Mean	Mean	Mean
Annelida										
Oligochaeta	2	7	5	0.8	14	21	18	0.8	11	0.8
Hirudinea	0	0	0	0.0	0	0	0	0.0	0	0.0
Total Annelida	**2**	**7**	**5**	**0.8**	**14**	**21**	**18**	**0.8**	**11**	**0.8**
Crustacea										
Ostracoda	0	0	0	0.0	0	0	0	0.0	0	0.0
Amphipoda	205	381	293	52.1	936	917	926	43.1	610	45.0
Conchostraca	0	0	0	0.0	0	0	0	0.0	0	0.0
Mysida	0	0	0	0.0	0	0	0	0.0	0	0.0
Decapoda	0	0	0	0.0	0	0	0	0.0	0	0.0
Cyclopoida	0	0	0	0.0	0	0	0	0.0	0	0.0
Calanoida	0	0	0	0.0	0	0	0	0.0	0	0.0
Cladocera	0	0	0	0.0	0	0	0	0.0	0	0.0
Total Crustacea	**205**	**381**	**293**	**52.1**	**936**	**917**	**926**	**43.1**	**610**	**45.0**
Arachnida										
Acarina	0	0	0	0.0	7	0	4	0.2	2	0.1
Insecta										
Megaloptera	0	0	0	0.0	0	0	0	0.0	0	0.0
Odonata										
Anisoptera	0	0	0	0.0	0	0	0	0.0	0	0.0
Zygoptera	7	0	4	0.6	17	0	8	0.4	6	0.4
Coleoptera	0	2	1	0.2	0	0	0	0.0	1	0.0
Hemiptera	10	40	25	4.4	2	5	4	0.2	14	1.1

Table A1-1. Continued.

Area	2									
Site	4				5				Overall	
	Individuals/m^2			%	Individuals/m^2			%	Individuals/m^2	%
Replicate Samples	A	B	Mean	Mean	A	B	Mean	Mean	Mean	Mean
Ephemeroptera	14	26	20	3.6	52	2	27	1.3	24	1.8
Trichoptera	2	7	5	0.8	17	5	11	0.5	8	0.6
Plecoptera	0	0	0	0.0	0	0	0	0.0	0	0.0
Diptera										
Chironomidae										
larva	48	136	92	16.3	214	226	220	10.2	156	11.5
pupa	5	2	4	0.6	2	0	1	0.1	2	0.2
Ceratopogonidae	0	0	0	0.0	0	0	0	0.0	0	0.0
Tipulidae	0	0	0	0.0	0	0	0	0.0	0	0.0
Chaoboridae	0	0	0	0.0	0	0	0	0.0	0	0.0
Total Insecta	**86**	**213**	**151**	**26.7**	**304**	**238**	**271**	**12.6**	**210**	**15.5**
Mollusca										
Bivalvia										
Unionidae	0	0	0	0.0	0	0	0	0.0	0	0.0
Pisidiidae	0	5	2	0.4	364	207	286	13.3	144	10.6
Gastropoda	67	157	112	19.9	607	686	646	30.0	379	28.0
Total Mollusca	**67**	**162**	**114**	**20.3**	**971**	**893**	**932**	**43.3**	**523**	**38.6**
Nemata	**0**	**0**	**0**	**0.0**	**0**	**0**	**0**	**0.0**	**0**	**0.0**
Platyhelminthes	**0**	**0**	**0**	**0.0**	**0**	**0**	**0**	**0.0**	**0**	**0.0**
Hydrozoa	**0**	**0**	**0**	**0.0**	**0**	**0**	**0**	**0.0**	**0**	**0.0**
TOTAL INVERTEBRATES	**360**	**763**	**563**	**100**	**2233**	**2069**	**2151**	**100**	**1356**	**100**

Table A1-1. Continued.

Area	3													
Site	7				8				9				Overall	
	Individuals/m^2			%	Individuals/m^2			%	Individuals/m^2			%	Individuals/m^2	%
Replicate Samples	A	B	Mean	Mean	A	B	Mean	Mean	A	B	Mean	Mean	Mean	Mean
Annelida														
Oligochaeta	10	2	6	0.6	131	45	88	3.3	436	14	225	21.1	106	6.6
Hirudinea	2	0	1	0.1	0	0	0	0.0	0	0	0	0.0	0	0.0
Total Annelida	**12**	**2**	**7**	**0.7**	**131**	**45**	**88**	**3.3**	**436**	**14**	**225**	**21.1**	**107**	**6.7**
Crustacea														
Ostracoda	0	0	0	0.0	0	0	0	0.0	0	0	0	0.0	0	0.0
Amphipoda	148	124	136	13.1	507	571	539	20.0	52	0	26	2.5	234	14.6
Conchostraca	0	0	0	0.0	5	2	4	0.1	0	0	0	0.0	1	0.1
Mysida	0	0	0	0.0	0	0	0	0.0	0	0	0	0.0	0	0.0
Decapoda	0	0	0	0.0	0	0	0	0.0	0	0	0	0.0	0	0.0
Cyclopoida	0	0	0	0.0	0	0	0	0.0	0	0	0	0.0	0	0.0
Calanoida	0	0	0	0.0	0	0	0	0.0	0	0	0	0.0	0	0.0
Cladocera	0	0	0	0.0	0	0	0	0.0	0	0	0	0.0	0	0.0
Total Crustacea	**148**	**124**	**136**	**13.1**	**512**	**573**	**543**	**20.1**	**52**	**0**	**26**	**2.5**	**235**	**14.7**
Arachnida														
Acarina	2	2	2	0.2	0	29	14	0.5	2	0	1	0.1	6	0.4
Insecta														
Megaloptera	0	0	0	0.0	0	0	0	0.0	0	0	0	0.0	0	0.0
Odonata														
Anisoptera	0	0	0	0.0	0	0	0	0.0	0	0	0	0.0	0	0.0
Zygoptera	14	7	11	1.0	21	24	23	0.8	2	0	1	0.1	12	0.7
Coleoptera	2	7	5	0.5	21	10	15	0.6	0	0	0	0.0	7	0.4
Hemiptera	7	17	12	1.1	19	31	25	0.9	2	0	1	0.1	13	0.8

Table A1-1. Continued.

Area	3													
Site	7				8				9				Overall	
	Individuals/m^2			%	Individuals/m^2			%	Individuals/m^2			%	Individuals/m^2	%
Replicate Samples	A	B	Mean	Mean	A	B	Mean	Mean	A	B	Mean	Mean	Mean	Mean
Ephemeroptera	0	10	5	0.5	2	14	8	0.3	10	0	5	0.4	6	0.4
Trichoptera	5	19	12	1.1	45	19	32	1.2	5	2	4	0.3	16	1.0
Plecoptera	0	0	0	0.0	0	0	0	0.0	0	0	0	0.0	0	0.0
Diptera														
Chironomidae														
larva	236	936	586	56.4	1821	1390	1606	59.6	1238	157	698	65.4	963	60.2
pupa	0	0	0	0.0	45	43	44	1.6	40	7	24	2.2	23	1.4
Ceratopogonidae	0	0	0	0.0	0	0	0	0.0	0	0	0	0.0	0	0.0
Tipulidae	0	0	0	0.0	0	0	0	0.0	0	0	0	0.0	0	0.0
Chaoboridae	0	0	0	0.0	0	0	0	0.0	0	0	0	0.0	0	0.0
Total Insecta	**264**	**996**	**631**	**60.6**	**1974**	**1531**	**1753**	**65.1**	**1297**	**166**	**733**	**68.6**	**1038**	**64.9**
Mollusca														
Bivalvia														
Unionidae	0	0	0	0.0	0	0	0	0.0	0	0	0	0.0	0	0.0
Pisidiidae	2	17	10	0.9	5	7	6	0.2	0	0	0	0.0	5	0.3
Gastropoda	231	276	254	24.4	350	229	289	10.7	102	33	68	6.4	204	12.7
Total Mollusca	**233**	**293**	**264**	**25.3**	**355**	**236**	**295**	**11.0**	**102**	**33**	**68**	**6.4**	**209**	**13.0**
Nemata	**0**	**2**	**1**	**0.1**	**0**	**2**	**1**	**0.0**	**0**	**0**	**0**	**0.0**	**1**	**0.0**
Platyhelminthes	**0**	**0**	**0**	**0.0**	**0**	**0**	**0**	**0.0**	**0**	**0**	**0**	**0.0**	**0**	**0.0**
Hydrozoa	**0**	**0**	**0**	**0.0**	**0**	**0**	**0**	**0.0**	**0**	**29**	**14**	**1.3**	**5**	**0.3**
TOTAL INVERTEBRATES	**660**	**1420**	**1041**	**100**	**2972**	**2416**	**2695**	**100**	**1890**	**242**	**1068**	**100**	**1600**	**100**

Table A1-1. Continued.

Area	4													
Site	10				11				12				Overall	
	Individuals/m^2			%	Individuals/m^2			%	Individuals/m^2			%	Individuals/m^2	%
Replicate Samples	A	B	Mean	Mean	A	B	Mean	Mean	A	B	Mean	Mean	Mean	Mean
Annelida														
Oligochaeta	12	2	7	2.3	5	10	7	4.7	362	202	282	20.5	99	16.1
Hirudinea	0	0	0	0.0	0	0	0	0.0	0	0	0	0.0	0	0.0
Total Annelida	**12**	**2**	**7**	**2.3**	**5**	**10**	**7**	**4.7**	**362**	**202**	**282**	**20.5**	**99**	**16.1**
Crustacea														
Ostracoda	0	0	0	0.0	0	0	0	0.0	0	0	0	0.0	0	0.0
Amphipoda	181	90	136	43.0	10	7	8	5.5	36	33	35	2.5	60	9.7
Conchostraca	0	0	0	0.0	0	0	0	0.0	0	0	0	0.0	0	0.0
Mysida	0	0	0	0.0	0	0	0	0.0	0	0	0	0.0	0	0.0
Decapoda	0	0	0	0.0	0	0	0	0.0	0	0	0	0.0	0	0.0
Cyclopoida	0	0	0	0.0	0	0	0	0.0	0	0	0	0.0	0	0.0
Calanoida	0	0	0	0.0	0	0	0	0.0	0	0	0	0.0	0	0.0
Cladocera	0	0	0	0.0	0	0	0	0.0	0	0	0	0.0	0	0.0
Total Crustacea	**181**	**90**	**136**	**43.0**	**10**	**7**	**8**	**5.5**	**36**	**33**	**35**	**2.5**	**60**	**9.7**
Arachnida														
Acarina	0	0	0	0.0	0	0	0	0.0	0	0	0	0.0	0	0.0
Insecta														
Megaloptera	0	0	0	0.0	0	0	0	0.0	0	0	0	0.0	0	0.0
Odonata														
Anisoptera	5	0	2	0.8	0	0	0	0.0	0	0	0	0.0	1	0.1
Zygoptera	0	0	0	0.0	0	0	0	0.0	0	0	0	0.0	0	0.0
Coleoptera	2	0	1	0.4	0	0	0	0.0	0	0	0	0.0	0	0.1
Hemiptera	105	45	75	23.8	7	14	11	7.1	52	48	50	3.6	45	7.4

Table A1-1. Continued.

Area	4													
Site	10				11				12				Overall	
	Individuals/m^2			%	Individuals/m^2			%	Individuals/m^2			%	Individuals/m^2	%
Replicate Samples	A	B	Mean	Mean	A	B	Mean	Mean	A	B	Mean	Mean	Mean	Mean
Ephemeroptera	2	0	1	0.4	0	0	0	0.0	7	5	6	0.4	2	0.4
Trichoptera	0	2	1	0.4	33	0	17	11.0	26	21	24	1.7	14	2.3
Plecoptera	0	0	0	0.0	0	0	0	0.0	0	0	0	0.0	0	0.0
Diptera														
Chironomidae														
larva	69	24	46	14.7	40	129	85	55.9	205	324	264	19.2	132	21.4
pupa	10	0	5	1.5	0	21	11	7.1	12	14	13	0.9	10	1.5
Ceratopogonidae	0	0	0	0.0	0	0	0	0.0	0	0	0	0.0	0	0.0
Tipulidae	0	0	0	0.0	0	0	0	0.0	0	0	0	0.0	0	0.0
Chaoboridae	0	0	0	0.0	0	0	0	0.0	0	0	0	0.0	0	0.0
Total Insecta	**193**	**71**	**131**	**41.9**	**80**	**164**	**124**	**81.1**	**302**	**412**	**357**	**25.9**	**204**	**33.2**
Mollusca														
Bivalvia														
Unionidae	0	0	0	0.0	0	0	0	0.0	0	0	0	0.0	0	0.0
Pisidiidae	0	0	0	0.0	0	0	0	0.0	0	2	1	0.1	0	0.1
Gastropoda	64	17	40	12.8	7	19	13	8.7	202	340	271	19.7	108	17.6
Total Mollusca	**64**	**17**	**40**	**12.8**	**7**	**19**	**13**	**8.7**	**202**	**342**	**273**	**19.8**	**109**	**17.7**
Nemata	**0**	**0**	**0**	**0.0**	**0**	**0**	**0**	**0.0**	**0**	**0**	**0**	**0.0**	**0**	**0.0**
Platyhelminthes	**0**	**0**	**0**	**0.0**	**0**	**0**	**0**	**0.0**	**0**	**0**	**0**	**0.0**	**0**	**0.0**
Hydrozoa	**0**	**0**	**0**	**0.0**	**0**	**0**	**0**	**0.0**	**302**	**562**	**432**	**31.3**	**144**	**23.4**
TOTAL INVERTEBRATES	**450**	**181**	**314**	**100**	**101**	**200**	**153**	**100**	**1205**	**1552**	**1379**	**100**	**615**	**100**

Table A1-1. Continued.

Area	5													
Site	13				14				15				Overall	
	Individuals/m^2			%	Individuals/m^2			%	Individuals/m^2			%	Individuals/m^2	%
Replicate Samples	A	B	Mean	Mean	A	B	Mean	Mean	A	B	Mean	Mean	Mean	Mean
Annelida														
Oligochaeta	329	574	451	27.5	207	2817	1512	57.9	176	338	257	15.8	740	37.8
Hirudinea	2	5	4	0.2	0	2	1	0.0	0	0	0	0.0	2	0.1
Total Annelida	**331**	**579**	**455**	**27.7**	**207**	**2819**	**1513**	**58.0**	**176**	**338**	**257**	**15.8**	**742**	**37.9**
Crustacea														
Ostracoda	0	0	0	0.0	0	0	0	0.0	0	0	0	0.0	0	0.0
Amphipoda	12	7	10	0.6	5	12	8	0.3	2	0	1	0.1	6	0.3
Conchostraca	0	0	0	0.0	0	0	0	0.0	0	0	0	0.0	0	0.0
Mysida	0	0	0	0.0	0	0	0	0.0	0	0	0	0.0	0	0.0
Decapoda	0	0	0	0.0	0	0	0	0.0	0	0	0	0.0	0	0.0
Cyclopoida	0	0	0	0.0	0	0	0	0.0	0	0	0	0.0	0	0.0
Calanoida	0	0	0	0.0	0	0	0	0.0	0	0	0	0.0	0	0.0
Cladocera	0	0	0	0.0	0	0	0	0.0	0	0	0	0.0	0	0.0
Total Crustacea	**12**	**7**	**10**	**0.6**	**5**	**12**	**8**	**0.3**	**2**	**0**	**1**	**0.1**	**6**	**0.3**
Arachnida														
Acarina	0	0	0	0.0	0	0	0	0.0	0	0	0	0.0	0	0.0
Insecta														
Megaloptera	0	0	0	0.0	0	0	0	0.0	0	0	0	0.0	0	0.0
Odonata														
Anisoptera	0	0	0	0.0	0	0	0	0.0	0	0	0	0.0	0	0.0
Zygoptera	0	0	0	0.0	0	0	0	0.0	0	0	0	0.0	0	0.0
Coleoptera	0	0	0	0.0	0	0	0	0.0	0	0	0	0.0	0	0.0
Hemiptera	93	162	127	7.8	202	286	244	9.3	140	98	119	7.3	163	8.3

Table A1-1. Continued.

Area	5													
Site	13				14				15				Overall	
	Individuals/m^2			%	Individuals/m^2			%	Individuals/m^2			%	Individuals/m^2	%
Replicate Samples	A	B	Mean	Mean	A	B	Mean	Mean	A	B	Mean	Mean	Mean	Mean
Ephemeroptera	7	12	10	0.6	0	12	6	0.2	7	5	6	0.4	7	0.4
Trichoptera	257	129	193	11.7	24	98	61	2.3	36	7	21	1.3	92	4.7
Plecoptera	12	5	8	0.5	0	2	1	0.0	0	0	0	0.0	3	0.2
Diptera														
Chironomidae														
larva	624	598	611	37.2	590	412	501	19.2	1043	145	594	36.6	569	29.0
pupa	48	38	43	2.6	17	24	20	0.8	117	2	60	3.7	41	2.1
Ceratopogonidae	0	0	0	0.0	0	0	0	0.0	0	0	0	0.0	0	0.0
Tipulidae	0	0	0	0.0	0	0	0	0.0	0	0	0	0.0	0	0.0
Chaoboridae	0	0	0	0.0	0	0	0	0.0	0	0	0	0.0	0	0.0
Total Insecta	**1041**	**944**	**992**	**60.4**	**833**	**834**	**833**	**31.9**	**1343**	**257**	**800**	**49.2**	**875**	**44.7**
Mollusca														
Bivalvia														
Unionidae	0	0	0	0.0	0	0	0	0.0	0	0	0	0.0	0	0.0
Pisidiidae	0	0	0	0.0	0	2	1	0.0	0	0	0	0.0	0	0.0
Gastropoda	255	29	142	8.6	45	417	231	8.8	605	502	554	34.1	309	15.8
Total Mollusca	**255**	**29**	**142**	**8.6**	**45**	**419**	**232**	**8.9**	**605**	**502**	**554**	**34.1**	**309**	**15.8**
Nemata	**2**	**7**	**5**	**0.3**	**0**	**0**	**0**	**0.0**	**2**	**0**	**1**	**0.1**	**2**	**0.1**
Platyhelminthes	**0**	**0**	**0**	**0.0**	**0**	**0**	**0**	**0.0**	**0**	**0**	**0**	**0.0**	**0**	**0.0**
Hydrozoa	**74**	**5**	**39**	**2.4**	**26**	**21**	**24**	**0.9**	**0**	**24**	**12**	**0.7**	**25**	**1.3**
TOTAL INVERTEBRATES	**1715**	**1570**	**1642**	**100**	**1117**	**4105**	**2611**	**100**	**2129**	**1121**	**1625**	**100**	**1960**	**100**