GULL (KEEYASK) PROJECT

Generating Station

October 2004

Report # 01-14

Lake Sturgeon Investigations in the Gull (Keeyask) Study Area, 2001

Draft

ENVIRONMENTAL STUDIES PROGRAM

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LAKE STURGEON INVESTIGATIONS IN THE GULL (KEEYASK) STUDY AREA, 2001

Draft Report Prepared for Manitoba Hydro

by
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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 (GS) 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 lake sturgeon investigations in the Gull (Keeyask) Study Area. The investigations were conducted at four locations in 2001: the Burntwood River downstream of First Rapids; the Nelson River and Grass River in the vicinity of Kelsey GS; the Nelson River between Birthday Rapids and Gull Rapids (including Gull Lake); and Stephens Lake downstream of Gull Rapids. Gill nets and larval drift nets were used to sample adult lake sturgeon and lake sturgeon eggs and larvae, respectively. To monitor movements, radio and acoustic transmitters were applied to lake sturgeon in the Nelson River between Birthday Rapids and Gull Rapids, and in Stephens Lake downstream of Gull Rapids. Lake sturgeon investigations were also conducted 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 during lake sturgeon investigations conducted in the Gull (Keeyask) Study Area in 2001. Specific objectives of the program were:

- to gain a better understanding of lake sturgeon biology;
- to identify lake sturgeon spawning areas;
- to better describe lake sturgeon abundance and habitat use;
- to identify any critical habitats;
- to better understand the timing and spatial extent of lake sturgeon movements; and
- to determine whether lake sturgeon presently ascend Birthday Rapids and/or Gull Rapids.

Lake sturgeon investigations were conducted at four locations in the Gull (Keeyask) Study Area during 2001, including: the Burntwood River downstream of First Rapids; the Nelson and Grass rivers in the vicinity of Kelsey GS; the Nelson River between Birthday Rapids and Gull Rapids; and Stephens Lake downstream of Gull Rapids. Gill nets were used to capture

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

lake sturgeon at each location. Drift nets were used to sample **larval** lake sturgeon at each location, with the exception of the Nelson and Grass rivers in the vicinity of Kelsey GS.

A total of 139 individual lake sturgeon were captured in gill nets (at all four locations combined) between 21 May and 31 July, 2001. The majority of lake sturgeon were captured in the Nelson River between Birthday Rapids and Gull Rapids (n=79), followed by Stephens Lake (n=24), the Burntwood River (n=23), and in the vicinity of Kelsey GS (n=13).

Seven of 23 lake sturgeon captured in the Burntwood River during spring 2001 were identified as males preparing to spawn. Twenty-two larval lake sturgeon were captured in three drift nets (DN) set downstream of First Rapids in the Burntwood River indicating that successful spawning had occurred in the area. Larval lake sturgeon were first captured on 19 June, with the catch peaking on 21 June when nine lake sturgeon larvae were captured.

None of the thirteen lake sturgeon captured in the Nelson and Grass rivers in the vicinity of Kelsey GS displayed any sign of reproductive activity in 2001.

The capture of 12 lake sturgeon in spawning condition over a three-day period immediately downstream of Birthday Rapids suggests that spawning occurred at this location in 2001. Peak spawning probably occurred between 6 and 8 June at water temperatures of 14.0ºC and 14.5ºC. Although lake sturgeon in spawning condition were captured at Birthday Rapids, lake sturgeon eggs and larvae were not captured in any of the four larval drift nets set at this location.

Of the 24 lake sturgeon captured in Stephens Lake immediately downstream of Gull Rapids, five were pre-spawning males and three were pre-spawning females. Gillnetting data show that pre-spawning lake sturgeon were present immediately downstream of Gull Rapids when water temperatures ranged from 7.5ºC to 11.0ºC (24 - 29 May). However, few lake sturgeon were captured at this location when water temperatures were within the preferred spawning range of 11.0ºC to 17.0ºC and no eggs or larvae were captured in drift nets set at this location. These data suggest that lake sturgeon had staged below the rapids and had later moved into the rapids to spawn.

Twenty acoustic and 12 radio transmitters were applied to lake sturgeon in the Study Area during 2001. Twenty-two of the transmitters (16 acoustic and 6 radio) were applied to lake sturgeon captured in the Nelson River between Birthday Rapids and Gull Rapids, and 10 transmitters (6 radio and 4 acoustic) were applied to lake sturgeon captured downstream of Gull Rapids in Stephens Lake. All transmitters have a life-expectancy of at least three years.

Five lake sturgeon tagged with transmitters moved upstream over Birthday Rapids in 2001. In addition, one tagged sturgeon moved downstream from Gull Lake (through Gull Rapids) into Stephens Lake. None of the lake sturgeon tagged with either acoustic or radio transmitters were found to have moved upstream over Gull Rapids.

The congregation of lake sturgeon in an area of Gull Lake (n=9) and in an area of Stephens Lake (n=5) during fall 2001 suggests that these areas are overwintering sites. Both areas have similar habitat characteristics, including depths in excess of 7.0 m, water velocities between 0.5 and 1.5 m/sec, and hard substrates.

ACKNOWLEDGEMENTS

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Chief and Council of the Tataskweyak Cree Nation (TCN) are gratefully acknowledged for their support of this program. We would also like to thank Douglas Kitchekeesik and Victor Spence of TCN for arranging logistic support and personnel needed to conduct the field work.

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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**, 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, describing results of lake sturgeon investigations conducted in the Gull (Keeyask) Study Area during 2001, 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 requests from 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 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

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

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.

The purpose of this report is to document results of lake sturgeon studies conducted in the Gull (Keeyask) Study Area during 2001. Specific objectives of the lake sturgeon investigations were:

- to gain a better understanding of lake sturgeon biology;
- to identify lake sturgeon spawning areas;
- to better describe lake sturgeon abundance and habitat use;
- to identify any critical habitats;
- to better understand the timing and spatial extent of lake sturgeon movements; and
- to determine whether lake sturgeon presently ascend Birthday Rapids and/or Gull Rapids.

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 an 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 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 structure 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

2.3.1 Split Lake to Birthday Rapids

Split Lake is located along the Nelson River approximately 7 km downstream of Kelsey GS (Figure 1). Immediately downstream of the Kelsey GS the Grass River flows into the Nelson River, and the Burntwood River flows into Split Lake in the western portion of the lake. The Aiken (Landing) River enters Split Lake in the southern-most portion of the lake adjacent to the community of York Landing. The Ripple and Mistuska rivers enter Split Lake along the southern shore west of the Aiken River.

Split Lake is situated in a landscape with poor drainage, dominated by black spruce forest in upland areas, and black spruce **bogs**, peatlands, and fens in lowland areas. The shoreline is stable and largely bedrock controlled interspersed with bog and marsh areas. **Riparian** vegetation includes willow and alder, black spruce, and trembling aspen. Riparian vegetation extends to the water line along portions of the shoreline. Mineral and **organic soils** occur adjacent to Split Lake, with **sporadically** distributed permafrost (Agriculture and Agri-Food Canada 2003). Lake **substrates** are primarily composed of fine mineral **sediments** (clay and **silt**) with small amounts of organic material. Ice typically forms on the lake during November and break-up occurs in April. Following break-up, the surface of the lake warms to 20°C by mid-July.

As discussed in Section 2.2, Split Lake hydrology has been affected by both LWR and by CRD. Split Lake receives its largest inflow from the Nelson River, with an annual average discharge at Kelsey GS of 2,150 m^3/s, about 68% of the total inflow for Split Lake. Inflow from the Burntwood River prior to CRD was estimated at 90.0 m^3/s at First Rapids, and following CRD increased nearly 10-fold to 849.0 m^3/s or about 29% of inflow to Split Lake (Manitoba Hydro 1996b). This large increase in river discharge resulted in extensive **erosion** of clay and silt sediments along the existing shoreline at First Rapids, as well as an increase in the surface area of Split Lake by approximately 100 ha (Environment Canada and Department of Fisheries and Oceans 1992; Manitoba Hydro 1996b). The Grass River watershed, not affected by hydroelectric development, has an average annual discharge of 66.5 m^3/s at Standing Stone Falls (approximately 40 km upstream of Witchai Lake Falls).

The remainder of the inflow to Split Lake is from the Aiken (Landing) River and other small tributaries such as the Ripple and Mistuska rivers.

The land adjacent to Clark Lake and the Nelson River downstream to Birthday Rapids is well-drained and dominated by black spruce forest, with stands of trembling aspen sporadically distributed. Mineral soils are predominant in the area with permafrost distributed sporadically and bedrock outcrops near Birthday Rapids (Agriculture and Agri-Food Canada 2003).

Clark Lake is located immediately downstream of Split Lake, and approximately 42 km upstream of Gull Rapids on the Nelson River (Figure 1). Current is restricted to the main section of the lake, with off-current bays outside the main channel. Lake substrates are composed of fine mineral sediments and areas of bedrock. The shoreline is stable and largely bedrock with areas of mineral and organic sediments. Riparian vegetation includes willow, alder, and black spruce. Aquatic vegetation is restricted to and abundant in shallow off-current bays. The Assean River is the only major **tributary** to Clark Lake, flowing into the north side of the lake. Two small **ephemeral** creeks also flow into the north shore of Clark Lake.

Downstream from the outlet of Clark Lake, the Nelson River narrows and water **velocity** increases significantly for a 3 km stretch, with numerous rapids that are largely confined within bedrock shorelines. The substrate and shoreline features of this section of the river are largely bedrock and boulder/cobble. For the next 7 km the river widens, velocity decreases, and fine sediments become predominant. Five small ephemeral creeks drain into the Nelson River between Clark Lake and Birthday Rapids.

2.3.2 Nelson River: Birthday Rapids to Gull Lake

The majority of the reach of the Nelson River between Birthday Rapids and Gull Lake 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 to 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.

2.3.3 Nelson River: Gull Lake

Gull Lake is situated within a landscape of well-drained mineral soils, dominated by black spruce forest. Trembling aspen occurs sporadically along the shores of Gull Lake and in areas that are well drained. Permafrost is sporadically distributed along this section of the river (Agriculture and Agri-Food Canada 2003).

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 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.

2.3.4 Nelson River: Gull Lake to Gull Rapids

The landscape between Gull Lake and Gull Rapids consists of well-drained mineral soils, with bedrock outcrops. Black spruce is the dominant forest cover, with trembling aspen occurring sporadically along the shore. Permafrost is sporadically distributed adjacent to this section of the river (Agriculture and Agri-Food Canada 2003).

This 3 km reach of the Nelson River 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.

2.3.5 Nelson River: Gull Rapids

Gull Rapids is located approximately 3 km downstream of Caribou Island on the Nelson River (Figure 1). Two large islands and several small islands are located within the rapids, prior to the river narrowing. The rapids are approximately 2 km in length, and the river elevation drops approximately 19 m from the downstream end of Gull Lake to the downstream end of Gull Rapids. The substrate and shoreline of Gull Rapids are composed of bedrock and boulders. Gull Rapids Creek is a small tributary that flows into the south side of Gull Rapids, approximately 1 km downstream from the upstream end of Gull Rapids (Figure 1). This tributary is approximately 2.5 km long, and is fed by bogs and fens.

2.3.6 Stephens Lake

The land bordering Stephens Lake includes areas of poor, moderate, and well-drained soils, dominated by black spruce forest in upland areas and black spruce bogs, peatlands, and fens in lowland areas. Trembling aspen occurs sporadically along the shoreline of Stephens Lake in areas that are well-drained. Soils are predominantly organic along the north shore, but include a section of mineral soil surrounding the north arm, and both mineral and organic soils along the south shore. Permafrost is discontinuous and sporadic, and exposed bedrock occurs at the west end of the lake (Agriculture and Agri-Food Canada 2003).

As discussed in Section 2.2, construction of the Kettle GS resulted in extensive flooding immediately upstream of the GS. Moose Nose Lake (north arm) and several other small lakes that previously drained into the Nelson River became continuous with the Nelson River to form Stephens Lake. Flooded **terrestrial** habitats compose a large portion of the existing lake substrates, and include organic sediments as well as areas of clay and silt. Woody **debris** is abundant due to the extensive flooding of the treed areas. Outside the flooded terrestrial areas, substrates are dominated by fine clay and silt. Sand, gravel, and cobble, and

areas of organic material dominate the shoreline, with much of the shoreline being prone to erosion. Riparian vegetation includes willow and alder, black spruce, tamarack, and scattered stands of trembling aspen.

Major tributaries of Stephens Lake include the North and South Moswakot rivers that enter the north arm of the lake. The only other major tributary of Stephens Lake was the Butnau River. However, during construction of the Kettle GS an earth dyke was constructed at the inlet of the Butnau River at Stephens Lake, and a channel developed to divert the Butnau River through Cache Lake into the Kettle River (Manitoba Hydro 1996a). Looking Back Creek is a second order ephemeral stream that drains into the north arm of Stephens Lake (Figure 1).

3.0 METHODS

Lake sturgeon investigations were conducted at four locations in the Gull (Keeyask) Study Area during 2001, including: the Burntwood River downstream of First Rapids (Figure 2); the Nelson and Grass rivers in the vicinity of the Kelsey GS (Figure 3); the Nelson River between Birthday Rapids and Gull Rapids (figures 4 and 5); and Stephens Lake downstream of Gull Rapids (Figure 6). Gill nets were used to capture lake sturgeon at each location. Sampling for lake sturgeon eggs and larvae was conducted with larval drift nets at each location, with the exception of the Nelson and Grass rivers in the vicinity of the Kelsey GS. A summary of the start and completion dates of sampling programs is provided in Table 1.

3.1 FIELD MEASUREMENTS

Water temperature was recorded daily at each study location with a hand-held thermometer (± 0.5°C).

3.2 SAMPLING GEAR

3.2.1 Gill Nets

3.2.1.1 Burntwood River

Twenty-six sites in the Burntwood River between First Rapids and the Odei River were fished from 30 May to 8 July, 2001 (Figure 7). Five gillnet gangs, measuring 2.5 m (2.7 yd) deep and consisting of two or three 22.9 m (25 yd) long panels of 140, 203, 229, 254, or 305 mm (5.5, 8, 9, 10, and 12 inch) twisted nylon stretched mesh, were used to capture adult lake sturgeon. Weather permitting, gill nets were checked approximately every 24 hours. Gillnetting sites were selected based on their suitability for capturing lake sturgeon that may be spawning in or near First Rapids. Therefore, most gillnetting sites fished during early spring (i.e., water temperature <16°C) were concentrated near First Rapids; however, as water temperatures increased above 16°C, gillnetting sites were selected further downstream along the Burntwood River to capture post-spawn lake sturgeon. The reach of the Burntwood River between First Rapids and its confluence with the Odei River has physical characteristics that make it difficult to gillnet for lake sturgeon, including: water depths between 5 m and 10 m; high water velocities (>1.5 m/s); highly turbulent water; and hard substrates. Therefore, to maximize gillnet efficiency, gill nets were set in eddies or along current breaks.

3.2.1.2 Nelson River and Grass River in the Vicinity of the Kelsey GS

A total of 44 sites were fished with gill nets in the Nelson and Grass rivers in the vicinity of Kelsey GS from 28 May to 8 July, 2001. Thirty-eight sites were located in the Nelson River downstream of Kelsey GS and six were in the lower reaches of the Grass River (Figure 8). Four gillnet gangs were set at each site and checked approximately every 24 hours. Gillnet gangs were 2.5 m (2.7 yd) deep and consisted of three 22.9 m (25 yd) long panels of 140, 203, or 254 mm (5.5, 8, and 10 inch) twisted nylon stretched mesh. Gillnetting sites were selected based on their proximity to potential spawning locations (e.g., sites in the tailrace area of the Kelsey GS and at the mouth of the Grass River). Due to high water velocities and turbulent water, most gill nets were set in eddies, along current breaks, or angled back slightly with the current in order to maximize their efficiency.

3.2.1.3 Nelson River between Birthday Rapids and Gull Rapids

A total of 37 gillnetting sites were fished in the Nelson River between Birthday Rapids and Gull Rapids from 21 May to 8 June and 16 June to 31 July, 2001[1] (Figure 9). Each gillnet gang consisted of two 22.9 m (25 yd) long, 2.5 m (2.7 yd) deep panels of 203, 229, 254, or 305 mm (8, 9, 10, or 12 inch) twisted nylon stretched mesh. Gangs were checked approximately every 24 hours, weather permitting. Panels consisting of 140 mm (5.5 inch) mesh were excluded from gillnet gangs in this area due to a high mortality of non-target fish **species**. Gillnetting sites were selected based on: a) proximity to potential spawning areas; b) locations known to yield high numbers of lake sturgeon; and c) previous sites fished during a 1995 lake sturgeon survey of Gull Lake (Manitoba Water Stewardship 1995, unpublished data). Gillnetting effort in this reach was greater than that expended in the two previously discussed reaches (sections 3.2.1.1 and 3.2.1.2) because of the need to capture lake sturgeon for radio and acoustic tagging.

3.2.1.4 Stephens Lake

Eighteen gillnetting sites were fished in Stephens Lake immediately downstream of Gull Rapids between 23 May and 8 July, 2001 (Figure 10). Each gillnet gang was 45.7 or 68.6 m (50 or 75 yd) long, 2.5 m (2.7 yd) deep, and consisted of two or three 22.9 m (25 yd) long panels of 140, 203, 229, 254, or 305 mm (5.5, 8, 9, 10, or 12 inch) twisted nylon stretched mesh. Each gang was checked approximately every 24 hours. The area immediately downstream of Gull Rapids can be characterized by highly turbulent water and extremely

[1] Forest fires interrupted work from 9 June to 15 June, 2001.

high water velocities. Therefore, to maximize their efficiency, gill nets were set along current breaks, in eddies, or angled back with the current adjacent to shore.

Gill nets were also set in Stephens Lake from 26 September to 29 September, 2001 to capture additional lake sturgeon for acoustic tagging. Gill nets were identical to those used during spring sampling, set in the same locations, and checked approximately every 24 hours.

3.2.2 Index Gillnetting

A lake sturgeon index gillnetting program was conducted in the Nelson River between Birthday Rapids and Gull Rapids from 16 June to 8 July, 2001. Twenty gillnetting sites were selected and fished for two 24-hour periods (Figure 11). Four gillnet gangs, consisting of one 22.9 m (25 yd) long panel of 203 mm (8 inch) twisted nylon stretched mesh and one 22.9 m (25 yd) long panel of 254 mm (10 inch) twisted nylon stretched mesh, were set daily. Gillnet gangs were pulled and moved to different sites each day so that a given site was not fished on consecutive days. Habitat information, including water depth, relative water velocity[2], water temperature, and substrate composition and compaction, was recorded at each site. Gillnetting sites were selected to provide spatial coverage of the Nelson River between Birthday Rapids and Gull Rapids, and were loosely based on locations that had captured high numbers of lake sturgeon earlier in the spring.

3.2.3 Drift Nets

Drift nets were set in the Burntwood River downstream of First Rapids; in the Nelson River between Birthday Rapids and Gull Rapids; and in Stephens Lake downstream of Gull Rapids from 17 June to 8 July, 2001. Drift nets were placed in suspected lake sturgeon spawning areas to capture lake sturgeon eggs and larvae. Each drift net consisted of a 3 m long, 954 µm Nitex screen bag, with a 43 cm x 85 cm opening that tapered into a 9 cm diameter removable ABS pipe cod-end (Figure 12). The opening of each drift net was inserted into a metal frame weighing approximately 25 kg, which kept it anchored to the river bottom and open facing the current. Drift nets were set in either shallow or deep water. For shallow water sets, each drift net frame was held in place by two t-bars pounded into the river bottom. For deep water sets, each drift net frame was attached to a large anchor that was tied to the lower edge of the frame by approximately 20 m of sideline and two large floats were tied through two loops on either side of the metal drift net frame with at least 10 m of excess line, depending on depth of the drift net (Figure 13). To retrieve the drift net, the boat was

[2] Water velocity was based on observation of surface conditions and classified as low (< 0.5 m/s), medium (0.5-1.5 m/s), or high (> 1.5 m/s).

positioned near the floats attached to either side of the drift net frame. Each float was then grabbed by a study team member and the lines were pulled into the boat at similar speeds. As the lines were retrieved, the frame raised upward and pivoted on the anchor. Once at the surface, the drift net frame was placed on the bow of the boat and contents of the Nitex screen bag were washed towards the cod-end. The ABS cod-end container was emptied into sample jars and rinsed at least once before the drift net was reset. Weather permitting, each drift net was emptied approximately every 24 hours.

Drift samples were preserved in 10% formalin. All samples were returned to the North/South Consultants Inc. laboratory in Winnipeg where all fish larvae and eggs were sorted and identified to species. Due to high densities, sucker eggs, and larvae were not enumerated. All lake sturgeon larvae were measured for total length (±0.01 mm).

3.2.3.1 Burntwood River

Three drift nets were set in the Burntwood River downstream of First Rapids on 17 June and checked daily until 8 July, 2001 (Figure 14). All three drift nets were located within 300 m of First Rapids. A summary of the physical habitat characteristics measured at each drift net site is provided in Table 2.

3.2.3.2 Nelson River (between Birthday and Gull Rapids)

Six drift nets were set in the reach of the Nelson River between Birthday Rapids and Gull Rapids from 17 June to 8 July, 2001 (Figure 15). Four of the drift nets (DN#4, DN#5, DN#6, and DN#7) were set within 1 km of Birthday Rapids. The remaining two drift nets were set 15 km downstream of Birthday Rapids (DN#8) and 2 km upstream of Gull Rapids (DN#9). Physical characteristics (water depth and velocity, and substrate composition and compaction) of each drift net site are provided in Table 2.

3.2.3.3 Stephens Lake

Five drift nets were set at the base of Gull Rapids on 17 June and monitored until 8 July, 2001 (Figure 16). Two drift nets (DN#10 and DN#11) were set in the north channel of Gull Rapids, and two nets (DN#13 and DN#14) were set in the south channel. The remaining drift net (DN#12) was set in the middle channel of the rapids. Physical habitat characteristics for all drift net sites at the base of Gull Rapids are provided in Table 2.

3.3 LAKE STURGEON SAMPLING

All lake sturgeon captured in gill nets were enumerated, measured for fork length and total length (±1 mm), weighed (±50 g), and marked with an individually numbered plastic 'Floy' FD-94 T-bar anchor tags. Floy-tags were inserted between the **basal pterygiphores** of the dorsal fin using a Dennison Mark II tagging gun. To minimize fish injury, ageing structures were not collected from lake sturgeon.

Where possible, sex and maturity were determined for individual lake sturgeon by applying pressure to the ventral surface of the fish to express **gametes**. Sex and maturity were also determined by internal examination during the application of radio and acoustic transmitters. If no gametes were expressed, or sex could not be determined during radio or acoustic transmitter application, sex and maturity codes were not assigned. The following sexual maturity codes were used:

Females (F)	Males (M)
2 – maturing to spawn	7 – maturing to spawn
3 – **ripe**	8 – ripe
4 – **spent**	9 – spent

Each lake sturgeon recaptured during the study was re-examined for sex and maturity and the Floy-tag was inspected to confirm its security and to ensure it was not causing any damage to the fish around the attachment area (e.g., lesion).

All other fish species captured during gillnetting were measured for fork length (±1 mm) and weight (± 25 g). Northern pike, walleye, and lake whitefish greater than 250 mm in fork length were marked with a Floy-tag before being released.

3.4 ACOUSTIC AND RADIO TELEMETRY

3.4.1 Acoustic Telemetry

Twenty individually coded pinger acoustic transmitters (model #V16-4H-01-SHK1-R256) manufactured by VEMCO LTD. (Shad Bay, Nova Scotia) were applied to lake sturgeon in 2001. The cylindrical acoustic transmitters were 90 mm long, 15 mm in diameter, weighed 34.9 g (in air), and had an operating expectancy of 1,095 days (3 years). The acoustic system allows several different transmitters to operate on the same frequency as each tag emits a different pulse train (code) recognizable by either a VR-60 ultrasonic receiver, or a submersible VR1 or VR2 stationary receiver. Pulse trains are emitted at 45 – 75 second intervals to avoid simultaneous transmission of codes.

3.4.1.1 Acoustic-Transmitter Application

Eighteen acoustic transmitters were implanted in lake sturgeon during spring and three were applied during fall, 2001[3].

Prior to tagging, fish were anaesthetized in a solution of clove oil and ethanol as described by Peake (1998). Once the fish was immobile, it was placed on a measuring board, ventral side up. As the anaesthetic renders fish unable to ventilate on their own, the gills were irrigated with river water supplied through a 0.5 inch diameter rubber tube attached to a submersible pump. A 3 cm long mid-ventral incision was then made through the body wall of the fish using a sterilized 30 mm scalpel. The transmitter was then sterilized in ethanol and inserted into the body cavity of the fish. Once inserted, the tag was pushed gently forward toward the head of the fish, and the incision was closed using three chromic gut sutures (#0). The fish were monitored and released once ventilation and equilibrium were re-established.

3.4.1.2 Acoustic-Transmitter Relocation

Movements of lake sturgeon tagged with acoustic transmitters were monitored via two methods: a) stationary VR1 or VR2 receivers; and b) manual tracking with a VR-60 ultrasonic receiver.

Stationary (VR1 or VR2) Receivers

Seven stationary VR1 and two stationary VR2 submersible acoustic receivers manufactured by VEMCO LTD. were used during the 2001 investigation. The VR1 and VR2 submersible receivers are similar in their mode of operation, but VR2 receivers have a greater memory capacity. The VR1 and VR2 receivers are equipped with an omni-directional hydrophone and internal data logger. The omni-directional hydrophone detects signals emitted from active transmitters within its range of detection. The transmitter code number, as well as the date and time of each detection, are stored in the data logger. Data are retrieved by downloading each receiver with an IBM/PC/AT computer, operating with a VR1PC computer interface, also manufactured by VEMCO LTD. Data were downloaded from each receiver on a weekly to bi-weekly basis.

Stationary receivers were located within 0.5 km of the upstream and downstream sides of both Birthday Rapids and Gull Rapids in the array shown in Figure 17. The purpose of

[3] One acoustic transmitter originally applied to a lake sturgeon during spring was captured by a domestic fisher. The transmitter was returned to North/South Consultants staff and re-applied during fall, 2001.

arranging the stationary receivers in this fashion was to monitor fish movements in relation to Birthday Rapids and Gull Rapids. Although the entire area upstream and downstream of Birthday and Gull rapids could not be monitored (due to turbulent water), it is thought that any fish moving upstream over the rapids would first enter the calmer water at the base of the rapids where the receivers were placed. Although the receivers detect the presence of a transmitter in the area, they do not discern direction.

Stationary receivers were deployed on 30 May, prior to the application of acoustic transmitters. Stationary receivers were completely submersed in water, anchored to the bottom, and held vertically in the water column (above the river bottom) with a float attached to the hydrophone end (Figure 18). Stationary receivers were removed from the water on 10 October to avoid being damaged by ice.

The range of each stationary receiver was tested prior to deployment at each location. It was estimated that the stationary receivers could detect transmitters up to a distance of approximately 800 m. However, this distance can be influenced by water turbulence and other environmental factors (e.g., wind).

Manual Tracking

Manual tracking was conducted from a boat using a battery powered VR-60 ultrasonic receiver and omni-directional hydrophone. The boat was stopped and its motor turned off at fixed points between Birthday Rapids and Gull Rapids and allowed to drift downstream with the current. The omni-directional hydrophone was lowered approximately 1 m into the water and held there for 1.0 to 1.5 minutes. Upon detection, the code number of the transmitter was displayed on an LCD screen on the face of the VR-60 and attempts were made to find the area with the strongest signal. The date, time, and location of each detection were recorded. During testing, the range of the VR-60 was estimated at 500 m, but could vary depending on environmental conditions. The optimal conditions for tracking occurred on days with little or no wind. Consequently, manual tracking was conducted on calm days at 9 – 12 day intervals. No tracking was conducted during winter.

3.4.2 Radio Telemetry

Individually coded radio transmitters operating on one of five frequencies were implanted in 12 lake sturgeon during spring, 2001. Six of the transmitters were applied to fish caught in the Nelson River between Birthday Rapids and Gull Rapids, and the remaining six were applied to fish captured in Stephens Lake downstream of Gull Rapids.

3.4.2.1 Radio Transmitter Application

Fish were anaesthetized and handled as previously described for acoustic transmitter application (Section 3.4.1.1). A sterile scalpel was used to make a mid-ventral incision approximately 6 cm long. The transmitter was sterilized in ethanol, inserted through the incision into the body cavity, and gently pushed toward the head of the fish. A hollow needle was inserted into the body wall posterior to the incision, and a 5 mm diameter pipette was inserted into the needle. The needle was then withdrawn and the antenna was inserted into the pipette. Once the pipette was removed, the antenna was left protruding from a small puncture on the ventral side of the fish, posterior to the incision. The antenna was then pulled taut until the transmitter contacted the inner body wall at the puncture, thereby ensuring that the antenna was not sitting on and stressing the incision. The incision was closed with four chromic gut sutures (#0) and the puncture hole was secured with one suture. The fish were then placed in a mesh recovery pen and released once it regained equilibrium and displayed normal swimming behaviour.

3.4.2.2 Radio Tracking

Radio tracking was conducted from a helicopter using a Lotek SRX-400 receiver equipped with a single 'yagi' antenna. The date and area covered during each tracking flight are provided in Barth et al. (2003). When a fish was located, tag number (tag frequency and code) and location were recorded.

3.5 DATA ANALYSIS

The maps provided in figures 2-6 were divided into separate geographical zones (red lettering) to differentiate between areas within waterbodies in the Gull (Keeyask) Study Area and to facilitate discussion of lake sturgeon movements.

Mean length, weight, and condition factor (K) were calculated for all lake sturgeon captured in gill nets. Condition factor was calculated for individual fish based on the following equation (after Fulton 1911, in Ricker 1975):

$$K = W \times 10^5 / L^3$$

where: W = round weight (g); and
L = fork length (mm).

Length-frequency distributions were plotted by 50 mm length intervals (e.g., 1000-1049) for lake sturgeon captured at each sampling location.

Weight-length relationships were calculated for the lake sturgeon catch at each location using least squares regression analysis on logarithmic transformations of fork lengths and

round weights according to the following relationship:

$$Log_{10}W = a + b\ (Log_{10}L)$$

where: W = round weight (g);
L = fork length (mm);
a = Y-intercept; and
b = slope of the regression line.

To determine approximate hatching dates for larval fish captured in drift traps, cumulative daily water temperature units (CTU) (as per Kempinger 1988) were calculated based on the following equation:

$$CTU = \sum(\text{Daily mean water temperature} - 5.8)$$

To calculate CTU values, daily maximum water temperatures recorded during the survey were decreased by 1.5ºC (a number based on daily water temperature fluctuations) to approximate daily mean temperatures. The estimated daily means were then inserted in the equation to determine CTU values.

Catch-per-unit-effort (CPUE) was expressed as the number of fish caught in a 45.8 m net set for a 24 hour period. For the index gillnetting program, CPUE values for each set replicate were first averaged before the overall site CPUE was calculated.

4.0 RESULTS AND DISCUSSION

In total, 1,733 fish, comprising 13 fish species, were captured in gill nets during lake sturgeon studies conducted at four locations in the Gull (Keeyask) Study Area between 21 May and 31 July, 2001 (tables 3 and 4). The greatest number of fish was captured in the vicinity of the Kelsey GS (n=628), followed by Stephens Lake (n=612), the Burntwood River (n=301), and the Nelson River between Birthday Rapids and Gull Rapids (n=192) (Table 4). Data collected during these studies pertaining to fish species other than lake sturgeon are discussed by location in Dunmall et al. (2004) (for fish captured in the Nelson and Grass rivers in the vicinity of Kelsey GS, and in the Burntwood River), Pisiak et al. (2004) (for fish captured in Stephens Lake), and Remnant et al. (2004) (for fish captured between Birthday Rapids and Gull Rapids).

One hundred and thirty-nine lake sturgeon were captured in gill nets set in the Gull (Keeyask) Study Area during this study. The majority of these sturgeon were captured in the Nelson River between Birthday Rapids and Gull Rapids (n=79), followed by Stephens Lake (n=24), Burntwood River (n=23), and Kelsey GS (n=13) (Table 4). The largest lake sturgeon was captured in Stephens Lake and measured 1,447 mm in fork length and weighed 40 kg. The smallest was captured in the Burntwood River and measured 600 mm in fork length and weighed 1.8 kg. Date of capture, biological information, and Floy-tag information for all lake sturgeon captured in 2001 are presented in Appendix 1.

Six lake sturgeon were captured incidentally in the Study Area following completion of the spring lake sturgeon gillnetting studies (i.e., after 31 July). Biological and Floy-tag information associated with these fish are also presented in Appendix 1. One lake sturgeon was captured on 20 August during the Split Lake index gillnetting program at the mouth of the Burntwood River (Dunmall et al. 2004). This fish was 90 mm long and represented the smallest lake sturgeon captured in the Gull (Keeyask) Study Area during 2001. The length of this sturgeon suggests that it was hatched during spring 2001 (i.e., young-of-the-year). Another small lake sturgeon was captured on 19 August, 2001, during the Gull Lake index gillnetting program (Remnant et al. 2004). It measured 212 mm (fork length) and weighed 55 g. Using a weight at age relationship derived from lake sturgeon in the Mattagami River (Beamish et al. 1996), this fish was estimated to be 15 months old. Three lake sturgeon were captured between 26 and 29 September in Stephens Lake immediately downstream of Gull Rapids; acoustic transmitters were applied to all three fish. The remaining lake sturgeon was captured on 6 October, 2001, in Gull Lake during fall gillnetting (Remnant et al. 2004).

4.1 GILLNETTING

Results of lake sturgeon gillnetting studies are discussed by location in the following sections. The 5.5 inch (140 mm) mesh panel used in the Burntwood River, in the Nelson and Grass rivers in the vicinity of Kelsey GS, and in Stephens Lake did not capture any lake sturgeon, and therefore, was excluded from CPUE calculations.

4.1.1 Burntwood River

Twenty-six gillnetting sites in the reach of the Burntwood River between First Rapids and the Odei River were fished between 30 May and 8 July, 2001, for a total 3,950.03 hours. In total, 23 lake sturgeon were captured, producing an overall CPUE of 0.14 lake sturgeon/45.8 m/24 h (Table 5). Twenty-one of the 23 lake sturgeon were captured within 5 km of First Rapids in Zone BWR-A (Figure 2). Only two of the lake sturgeon were captured more than 5 km from First Rapids in Zone BWR-B.

For lake sturgeon captured in the Burntwood River during 2001, mean fork length was 945 mm (range: 600 – 1,436 mm), mean weight was 6,620 g (range: 1,600 – 15,600 g), and mean condition factor was 0.76 (range: 0.46 – 1.04) (Table 6). The mean condition factor was the lowest of all locations sampled suggesting that, on average, lake sturgeon captured in the Burntwood River were less robust than lake sturgeon captured at the other three locations. Lake sturgeon between 900 and 999 mm in fork length were captured most frequently (Figure 19). The weight-length regression equation for lake sturgeon captured in the Burntwood River is provided in Appendix 2.

Water temperature in the Burntwood River was 13ºC when gillnetting commenced on 30 May. The daily lake sturgeon catch peaked at four fish on 2 June at a water temperature of 12.0ºC (Figure 20). Forty-percent of the lake sturgeon were captured over a six-day period between 31 May and 5 June. The first lake sturgeon classified as maturing to spawn in 2001 was a male captured on 31 May. In total, gametes were expressed from seven male lake sturgeon in the Burntwood River between 31 May and 8 June (Table 7). No female lake sturgeon were identified in the catch.

Two lake sturgeon marked with Floy-tags in the Burntwood River on 2 June were recaptured one or more times during the study. Two were recaptured 6 and 20 days later near their original tagging locations (0.1 km) (Appendix 3). The third lake sturgeon was recaptured on 12 June (10 days after tagging) by a local fisherman near the Split Lake ferry landing, a distance of 66 km from the original tagging location (Appendix 3).

4.1.2 Kelsey GS

Forty-four gillnetting sites were fished in the vicinity of the Kelsey GS between 28 May and 8 July, 2001 (Figure 8). In total, 13 lake sturgeon were captured, producing an overall CPUE of 0.06 lake sturgeon/45.8 m/24 h (Table 5). This CPUE value was the lowest among the four locations sampled for lake sturgeon in 2001. In the vicinity of the Kelsey GS, most lake sturgeon were captured in the Nelson River approximately 12 km downstream of the GS in Zone KGS-C (n=6), followed by KGS-B (n=4), KGS-A (n=2), and KGS-D (n=1) (Figure 3).

For lake sturgeon captured in the vicinity of Kelsey GS, mean fork length was 940 mm (range: 692 – 1,423 mm), mean weight was 8,334 g (range: 3,200 – 26,000 g), and mean condition factor was 0.92 (range: 0.81-1.09) (Table 6). The majority of the lake sturgeon (77.5%) measured less than 1,050 mm in fork length, and the modal length interval for the catch was 800-849 mm (Figure 21). The weight-length regression equation for lake sturgeon captured in the vicinity of Kelsey GS is provided in Appendix 2.

The water temperature at the start of the gillnetting program downstream of Kelsey GS was 13ºC. The first lake sturgeon was captured a week later (5 June) and the last on 1 July (Figure 22). Peak daily catch occurred on 20 June when four lake sturgeon were captured. None of the lake sturgeon captured at this location displayed any sign of reproducing during the current year (Table 7).

One lake sturgeon Floy-tagged in the vicinity of Kelsey GS was recaptured. This fish was tagged on 1 July and recaptured 6 days later at the same location (Appendix 3).

4.1.3 Nelson River between Birthday Rapids and Gull Rapids

Excluding index gillnetting (discussed in Section 4.2), 37 sites were fished with gill nets between Birthday and Gull rapids (including Gull Lake) for a total of 4,537.57 hours (Table 5; Figure 9). In total, 60 lake sturgeon were captured[4] (an additional 19 were captured during the sturgeon index gillnetting program), producing an overall CPUE of 0.32 lake sturgeon/45.8 m/24 h, the highest lake sturgeon CPUE by location for sturgeon studies in the Gull (Keeyask) Study Area in 2001 (Table 5). Most of the lake sturgeon were captured in Zone GL-C (n=27), followed by zones BR-D (n=21), GL-B (n=10), and GL-A (n=2) (figures 4 and 5).

[4] Of the 60 lake sturgeon captured in the Nelson River between Birthday Rapids and Gull Rapids, four were originally tagged during a gillnetting study conducted in Gull Lake in 1995 (Manitoba Water Stewardship, unpublished data).

Mean fork length for all of the lake sturgeon captured (n=79) between 21 May and 31 July, 2001, was 1,022 mm (range: 739 – 1,355 mm), mean weight was 9,984 g (range: 3,500 – 24,000 g) and mean condition factor was 0.88 (range: 0.64 – 1.26) (Table 6). Most of the lake sturgeon measured between 900 and 1,149 mm, and the modal length interval was 900-949 mm (Figure 23). A weight-length regression for lake sturgeon captured in the Nelson River between Birthday Rapids and Gull Rapids is provided in Appendix 2.

Gillnetting for lake sturgeon commenced on 21 May when water temperatures measured 6.5ºC. The first lake sturgeon was captured three days later when the water temperature reached 7.5ºC (Figure 24). Between 25 May and 5 June, the water temperature of the Nelson River increased gradually and the number of lake sturgeon captured on a daily basis ranged from zero to four. The daily catch of lake sturgeon peaked on 6 and 7 June when six and seven lake sturgeon, respectively, were captured (Figure 24). Eleven of these fish were captured in two nets set immediately downstream of Birthday Rapids, at a water temperature of 14.5ºC. Gillnetting was halted from 9 to 15 June due to the evacuation of field crews because of forest fires. After 15 June, daily catches peaked at six fish on 20 and 24 June (Figure 24).

Five male lake sturgeon captured between 26 May and 5 June were classified as maturing to spawn in 2001 (Table 7). Ten ripe male lake sturgeon, were captured on three consecutive days (6, 7, and 8 June) within 2 km of Birthday Rapids. One spent male lake sturgeon was captured on 7 June approximately 2 km downstream of Birthday Rapids.

Although eggs were not expressed from any lake sturgeon captured in the Nelson River between Birthday Rapids and Gull Rapids in 2001, three females were identified during the application of radio and acoustic transmitters. The first female (also the first lake sturgeon captured in 2001) was captured approximately 2 km downstream of Birthday Rapids on 24 May. This fish was recaptured at Birthday Rapids on 1 June, but its sex was not confirmed until it was recaptured again on 6 June and tagged with an acoustic transmitter. The other two females, originally captured on 28 May and 31 May, were recaptured at least once at Birthday Rapids between 31 May and 6 June.

In total, 12 lake sturgeon in spawning condition were captured within 2 km of Birthday Rapids between 6 and 8 June. These data suggest that lake sturgeon spawned at this location in 2001. Peak spawning probably occurred between 6 June and 8 June at water temperatures of 14.0ºC and 14.5ºC.

Auer (1982) suggested that lake sturgeon remain in the vicinity of the spawning grounds for 5 to 6 weeks and may make several movements onto the spawning grounds during this time.

The gillnetting information from the Nelson River in the vicinity of Birthday Rapids suggested that females and males were present near the spawning grounds more than a week prior to spawning, and the high number of recaptures suggested that lake sturgeon either remained on the spawning grounds or made several movements on to them.

Eleven lake sturgeon originally Floy-tagged in the Nelson River between Birthday Rapids and Gull Rapids were recaptured one or more times during 2001 (Appendix 3). The longest distance travelled between tagging and recapture site was 7.4 km. Most of the fish were recaptured near their original tagging location. Six were Floy-tagged immediately downstream of Birthday Rapids and recaptured at the same location one to five days after the original capture date.

4.1.4 Stephens Lake

Eighteen gillnetting sites were fished downstream of Gull Rapids between 23 May and 8 July, 2001, for a total of 6,253.60 hours (Table 5; Figure 10). This was the greatest amount of gillnetting effort expended at any location sampled in 2001. In total, 24 lake sturgeon were captured, producing an overall CPUE of 0.09 fish/45.8 m/24 h. All of the lake sturgeon were captured in Zone STL-A (Figure 6).

For lake sturgeon captured in Stephens Lake, mean fork length was 1,077 mm (range: 792-1,447 mm), mean weight was 13,148 g (range: 4,400 – 40,000 g) and mean condition factor was 0.94 (range 0.71-1.56) (Table 6). Size and condition of lake sturgeon captured at this location were higher than at any of the others sampled in 2001. Most lake sturgeon captured (62.5%) measured less than 1,100 mm in fork length, although the modal length interval was 1,200-1,249 mm (Figure 25). A weight-length regression equation for lake sturgeon captured in Stephens Lake is provided in Appendix 2.

Gillnetting was initiated in Stephens Lake downstream of Gull Rapids on 23 May. Fourteen of the 24 lake sturgeon were captured during the first week of gillnetting, when water temperatures ranged from 7.5ºC to 11.0ºC. Daily catches peaked at six fish on 28 May at a water temperature of 11.0ºC (Figure 26). Excluding recaptures, only one lake sturgeon was captured between 30 May and 12 June, when the water temperature was 11.5ºC - 15.0ºC (Figure 26).

Four female and five male lake sturgeon were identified from the catch in Stephens Lake downstream of Gull Rapids during 2001 (Table 7). The first lake sturgeon that was captured on 24 May was later identified as a female preparing to spawn when it was recaptured and radio tagged on 31 May. Two other female lake sturgeon, also preparing to spawn in 2001,

were captured three days later on 27 May. Although eggs were not expressed from these fish, they were identified as females based on their large size and swollen ventral opening. The five male lake sturgeon classified as preparing to spawn in 2001 were all captured over a three-day period between 27 May and 29 May, when water temperatures were between 10.0ºC and 11.0ºC (Figure 26). Another female lake sturgeon was identified during the application of an acoustic transmitter on 13 June. Based on the appearance of the eggs it was concluded that this fish would not spawn for at least one year.

Seven of the 24 lake sturgeon originally Floy-tagged in Stephens Lake were recaptured one or more times during the study (Appendix 3). Since gillnetting effort was concentrated near the base of Gull Rapids, the maximum distance travelled from original tagging location to recapture site was 0.1 km. The recapture data indicated that lake sturgeon remained in the vicinity of Gull Rapids for a lengthy period during spring 2001. For example, one lake sturgeon (Floy-tag # 46701) originally captured on 24 May was recaptured downstream of the rapids on 5, 10, and 25 June. Most of the sturgeon recaptured were believed to be spawning in 2001. As previously discussed, lake sturgeon have been found to frequently visit a spawning area, sometimes remaining near the spawning area for five to six weeks.

4.2 INDEX GILLNETTING

Forty-four fish were captured during the index gillnetting program conducted at 20 sites in the Nelson River between Birthday Rapids and Gull Rapids (including Gull Lake) in 2001 (Figure 11). Lake sturgeon (n=22) were the most frequently captured fish species, composing 50% of the total catch, followed by northern pike (n=11), walleye (n=7), and freshwater drum (n=2). One lake whitefish and one white sucker were also captured (Table 10). Three lake sturgeon were recaptures from gillnetting that was conducted earlier in the spring. The mean CPUE for lake sturgeon was 0.59 lake sturgeon/45.8 m/24 h (Table 11). Site specific and mean CPUE ranged from zero to two fish, with the highest CPUE (2.70) occurring at Site 6 (Table 11). Biological information for all sturgeon captured during index gillnetting in the Nelson River between Birthday Rapids and Gull Rapids is provided in Appendix 1. Biological information for fish species other than lake sturgeon captured during index gillnetting are provided in Remnant et al. (2004). Habitat information collected at each index gillnetting site is provided in Appendix 4.

4.3 LARVAL DRIFT

4.3.1 Burntwood River

Twenty-two larval lake sturgeon were captured in three drift nets set in the Burntwood River during 2001. Fifty percent of the lake sturgeon larvae were captured in DN#2 (n=11), 31.8%

(n=7) were captured in DN#3, and 18.2% (n=4) were captured in DN#1 (Table 8; Figure 14). The first larval lake sturgeon was captured on 19 June in DN#1. The larval lake sturgeon catch peaked on 21 June when nine larvae were captured, three in DN#2, and six in DN#3 (Table 8). The last larval lake sturgeon was captured on 30 June in DN#3.

Mean total length of the 22 larval lake sturgeon captured in 2001 was 17.27 mm (range 14.57 – 19.79 mm) (Table 9). All of the larvae captured had absorbed their yolk sacs. Lake sturgeon generally hatch five to eight days after spawning occurs and absorb their yolk sacs after an additional 9 to 18 days at temperatures between 15 and 18ºC (Scott and Crossman 1998). Assuming that the larval lake sturgeon captured in the Burntwood River on 19 June had just finished absorbing their yolk sacs, requiring approximately 14 days (the midpoint between yolk sac absorption times at similar water temperatures), and assuming another seven days were required for the larvae to hatch, spawning may have occurred as early as 29 May. However, based on the total length description of larval lake sturgeon in both Kempinger (1988) and Auer (1982), it is likely that the larval lake sturgeon captured on 19 June had absorbed their yolk sacs two to four days prior to capture. Therefore, it is possible that lake sturgeon in the Burntwood River may have started to spawn as early as 26 May. By the same logic, the age of the last larval lake sturgeon captured (30 June) is estimated at 20 days old. This suggests that spawning could have occurred as late as 10 June. Alternatively, by back calculating CTU values for the first and last lake sturgeon larvae captured (as described in Kempinger 1988; see methods Section 3.5), a more narrow, though similar, range of potential spawning dates was reached (3 June – 10 June). Folz and Meyers (1985) suggest that lake sturgeon may spawn over a 4 to 10 day period, with 2 to 3 days of peak activity. The data suggest that sturgeon likely spawned in the Burntwood River between 26 May and 10 June when water temperatures ranged between 12ºC and 17ºC.

4.3.2 Nelson River between Birthday Rapids and Gull Rapids

No larval lake sturgeon were captured between Birthday Rapids and Gull Rapids. Larval drift net data are presented in Remnant et al. (2004).

4.3.3 Stephens Lake

No larval lake sturgeon were captured in drift nets set in and below Gull Rapids in 2001. The information collected from these drift nets is presented in Pisiak et al. (2004).

4.4 RADIO AND ACOUSTIC TELEMETRY

Twenty acoustic and 12 radio transmitters were applied to lake sturgeon within the Study Area during 2001. Twenty-two of the transmitters (16 acoustic and 6 radio tags) were

originally applied to lake sturgeon in the Nelson River between Birthday Rapids and Gull Rapids, and ten (4 acoustic and 6 radio tags) were originally applied downstream of Gull Rapids in Stephens Lake. However, one acoustic transmitter, originally applied to a lake sturgeon in the Nelson River between Birthday Rapids and Gull Rapids, was recaptured by a domestic fisher and returned to North/South Consultants field staff. This transmitter was subsequently re-applied to a lake sturgeon captured downstream of Gull Rapids during fall 2001. With the exception of three acoustic transmitters that were applied downstream of Gull Rapids between 26 and 29 September, all transmitters were applied between 30 May and 24 June, 2001. Biological details for lake sturgeon implanted with radio and acoustic transmitters are provided in Appendix 5. Maps showing site-specific tagging locations and subsequent relocation dates for each individual lake sturgeon implanted with transmitters are provided in Appendix 6.

A considerably larger quantity of data was collected from lake sturgeon tagged with acoustic transmitters compared to fish fitted with radio transmitters. Perhaps the most important factor limiting the number of relocations provided by the radio transmitters was the depth to which radio signals could be received. Lake sturgeon are known to frequent deep areas of lakes and rivers (Scott and Crossman 1998) and the Gull (Keeyask) Study Area has numerous areas where water depth is greater than 8 m, which exceeds the estimated 6 to 8 m maximum depth from which radio signals can be received. In addition, radio tracking flights occurred once every two weeks, as opposed to acoustic tracking, which was conducted continuously by the stationary receivers and approximately every 10 days with the manual tracking equipment.

An extensive amount of data was collected on sturgeon movements during 2001. However, because the transmitters applied to sturgeon have a three-year life expectancy, they will provide two more years of additional data and a more comprehensive understanding of lake sturgeon movements in the Gull (Keeyask) Study Area. Consequently, an extensive analysis of sturgeon movements is not warranted at this time. The following section provides a summary of movements observed in 2001 based on results from gillnetting, Floy-tag recaptures, drift nets, and telemetry that will be useful in the analysis of the complete data set in the future.

4.5 LAKE STURGEON MOVEMENTS

4.5.1 Burntwood River

Little is known about lake sturgeon movements and habitat utilization in the Burntwood River. Lake sturgeon appear to congregate in the vicinity of First Rapids during spring and

move into the rapids to spawn once water temperatures are appropriate. Data collected from gill nets and drift nets suggested that spawning took place between 29 May and 10 June in 2001. The recapture of a lake sturgeon (Floy-tag # 46408), originally marked in the vicinity of First Rapids approximately 20 days after spawning was thought to be complete, suggests that at least some of the lake sturgeon (Floy-tag # 46409) remain near the spawning area for extended periods (Appendix 3). In addition, the recapture of one lake sturgeon that had moved from the Burntwood River into Split Lake, travelling a distance of 66 km in 10 days, suggests that some of the fish disperse over large distances after spawning (Appendix 3). No information is available concerning lake sturgeon movements in the Burntwood River during late summer, fall, or winter.

4.5.2 Kelsey GS

Very little information was collected on lake sturgeon movements in the Nelson and Grass rivers in the vicinity of Kelsey GS during 2001. Few sturgeon were captured in this area and only one was recaptured. This fish was recaptured at its original tagging location shortly after being tagged.

4.5.3 Nelson River between Birthday Rapids and Gull Rapids

4.5.3.1 Seasonal Movements

During the first five days of gillnetting (21 – 25 May) in the Nelson River between Birthday Rapids and Gull Rapids, very few lake sturgeon were captured (Figure 24). However, once water temperatures reached 8ºC, the number of lake sturgeon captured on a daily basis began to increase. These data suggest that as water temperatures rise, lake sturgeon become more active and may begin to move towards spawning areas.

Between 26 May and 5 June, when water temperatures ranged from 8ºC and 14ºC, sturgeon in pre-spawn condition were captured in gill nets at various locations between the rapids. At these water temperatures, it appears as though the sturgeon move towards spawning areas to stage prior to spawning. Peak spawning activity was not thought to have occured at Birthday Rapids until 6 to 8 June, when water temperatures had reached 14.5ºC (Figure 24). Many of the sturgeon first captured at Birthday Rapids one week prior to the estimated peak in spawning activity were later recaptured at Birthday Rapids during peak spawn. Non-spawning lake sturgeon were also captured at Birthday Rapids at this time.

Between 31 May and 9 June, 2001, approximately half of the bio-telemetry transmitters (7 of 15 acoustic transmitters and 3 of 6 radio transmitters) had been applied to lake sturgeon in the Nelson River within 5 km of Birthday Rapids. Data from these transmitters suggest that

once spawning was complete (between 8 and 10 June) some lake sturgeon remained in the vicinity of Birthday Rapids for as long as two weeks, while others dispersed downstream into Gull Lake into areas with lower water velocity. Telemetry data indicate that by 7 July, many of the lake sturgeon tagged at Birthday Rapids had moved downstream into Gull Lake (Figure 27).

During July, August, and September, most of the tagged sturgeon were located in Gull Lake, between the upstream end of Gull Rapids and the upstream end of Gull Lake (Appendix 6). Movements during these months were likely related to feeding and/or habitat preferences. During this time, some lake sturgeon moved long distances over short periods of time. For example, one lake sturgeon (AT#50) moved from the upstream end of Gull Rapids to Birthday Rapids in a period of two days (Figure 28). This fish was subsequently relocated back at the upstream end of Gull Rapids on 12 July. Therefore, during a 16-day period (26 June - 12 July), this lake sturgeon moved approximately 90 km.

During early October, 9 out of 15 lake sturgeon tagged with acoustic transmitters were relocated in a small area of Gull Lake (Figure 29). Their presence in this area suggests it may be a preferred overwintering area for lake sturgeon. In terms of physical habitat characteristics, this site can be described as deep (7 – 13 m), with medium water velocity (0.5 – 1.5 m/s) and hard substrate.

4.5.3.2 Movements Over Large Sets of Rapids

Four lake sturgeon tagged with acoustic transmitters and one tagged with a radio transmitter moved upstream over Birthday Rapids in 2001. Three of the tagged sturgeon (AT#39, AT#43, and AT#45) moved upstream over the rapids for a brief period (less than a day) before moving back downstream over Birthday Rapids. Another tagged lake sturgeon (AT#48) was located upstream of Birthday Rapids on 24 and 25 June, but was not relocated after this time, suggesting that it did not move back downstream in 2001 (Figure 30). A lake sturgeon radio-tagged (Freq-149.720, Code 4) immediately downstream of Birthday Rapids was relocated in Clark Lake on 28 August and 8 October, 2001 (Figure 30).

One lake sturgeon tagged with an acoustic transmitter (AT#36) moved downstream over Gull Rapids from Gull Lake into Stephens Lake during 2001 (Figure 31). This fish was originally tagged at Gull Lake camp on 24 June and was relocated by stationary receivers upstream of Gull Rapids on 28 June. It was located downstream of Gull Rapids on 13 July and remained in Stephens Lake for the remainder of 2001.

4.5.4 Stephens Lake

4.5.4.1 Seasonal Movements

Gillnetting data from 2001 show that pre-spawn lake sturgeon were present immediately downstream of Gull Rapids when water temperatures ranged from 7.5ºC to 11.0ºC (24 – 29 May). However, few sturgeon were captured at this location when water temperatures were within the preferred spawning range of 11.0ºC to 17.0ºC. These data suggest that lake sturgeon had staged below the rapids and had later moved into the rapids to spawn.

Data collected on lake sturgeon movements in this area is limited after 15 July. The two acoustic transmitters (AT#34 and AT#35) that were applied in this area during spring were frequently relocated immediately downstream of the rapids from 17 June to 19 July. Radio and acoustic tag information suggests that lake sturgeon frequent the base of Gull Rapids throughout the open-water season. The capture of three lake sturgeon at the base of the rapids during September indicates that sturgeon also utilize this area during fall.

Five of the six acoustic-tagged lake sturgeon known to be downstream of Gull Rapids in the fall were located around an island located approximately 3 km downstream of the rapids on 5 October, 2001 (Figure 32). The congregation of fish in this area suggests that it may be an important overwintering location for lake sturgeon in Stephens Lake. This area is characterized by depths in excess of 10 m, medium water velocity (0.5 – 1.5 m/s) and hard substrate.

4.5.4.2 Movements Over Large Sets of Rapids

No acoustic or radio-tagged lake sturgeon moved upstream over Gull Rapids in 2001.

5.0 GLOSSARY

Algae (a; al) − 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 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.

ASL − Above Sea Level.

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).

Basal pterygiophores – form the base of support for the dorsal and anal fin rays.

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 – a distinct section of a lake, separated from the remainder of the lake by a constriction.

Bog – 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 coniferous trees such as spruce, fir, and pine.

Catch-per-unit-effort (CPUE) – the number or weight of fish caught in a given time period with a specific length of net.

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.

Debris – any material, including floating or submerged items (e.g., driftwood, plants), suspended ***sediment***, or bed load, moved by flowing water.

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

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.

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

Erosion – the wearing away of the Earth's surface by the action of water, wind, current, etc.

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.

Gamete – mature male or female reproductive cell (i.e., sperm, egg).

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.

Larva (ae; al) – the early, immature form of an animal when more or less of a ***metamorphosis*** takes place, before the assumption of the mature shape.

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

Metamorphosis – a change in the form or function of a living organism, by a natural process of growth or development.

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

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 − sub***soil*** 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.

Rapids – a section of shallow, fast moving water in a stream made turbulent by totally or partially submerged rocks.

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

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

Riffle – a shallow area of a stream where water flows swiftly over partially or completely submerged materials to produce surface agitation; generally of lower slope and ***velocity*** than ***rapids***.

Riparian – along the banks of rivers and streams.

Ripe – running male (M8) or female (F3) fish ready to spawn immediately.

Run – an area of a stream 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.

Spent – male (M9) or female (F4) fish that has just finished spawning.

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

Standard deviation (Std) – the square root of the variance of a collection of numbers.

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

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

Topography − a graphic representation of the surface features of a place or region on a map, indicating their relative positions and elevations.

Tributary (ies) – a river or stream flowing into a lake or a larger river or stream.

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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TABLES AND FIGURES

Table 1. Summary of start and completion dates, by gear type, for lake sturgeon investigations conducted at four locations in the Gull (Keeyask) Study Area, 2001.

Location	Gear Type					
	Gill Nets		Drift Nets		Index Gill Nets	
	Start Date	Completion Date	Start Date	Completion Date	Start Date	Completion Date
Burntwood River	30-May	8-Jul	17-Jun	8-Jul	-	-
Kelsey GS	28-May	8-Jul	-	-	-	-
Nelson River (BR-GR)	21-May	31-Jul	17-Jun	8-Jul	16-Jun	8-Jul
Stephens Lake	23-May 26-Sep	8-Jul 29-Sep	17-Jun	8-Jul	-	-

GS = Generating Station

BR-GR = Birthday Rapids to Gull Rapids

Table 2. Summary of physical habitat characteristics for all drift nets set as part of lake sturgeon studies in the Gull (Keeyask) Study Area, 2001.

Location	Drift Net Number	Water Depth (m)	Water Velocity[1]	Substrate Compaction	Substrate Type
Burntwood River	DN 1	3.0	high	hard	bedrock
Burntwood River	DN 2	4.2	medium	hard	sand/gravel
Burntwood River	DN 3	5.0	high	hard	bedrock
Nelson River (BR-GR)	DN 4	0.5	high	hard	bedrock
Nelson River (BR-GR)	DN 5	0.6	high	hard	bedrock
Nelson River (BR-GR)	DN 6	2.5	high	hard	bedrock
Nelson River (BR-GR)	DN 7	4.0	high	hard	bedrock
Nelson River (BR-GR)	DN 8	2.5	high	hard	bedrock
Nelson River (BR-GR)	DN 9	1.5	high	hard	boulder/cobble
Stephens Lake	DN 10	0.6	medium	hard	bedrock
Stephens Lake	DN 11	0.6	medium	hard	bedrock
Stephens Lake	DN 12	1.1	medium	hard	boulder
Stephens Lake	DN 13	1.2	high	hard	sand
Stephens Lake	DN 14	1.2	high	hard	sand

[1]Water velocity was classified as either low < 0.5 m/s, medium 0.5-1.5 m/s, or high > 1.5 m/s.
BR-GR = Birthday Rapids to Gull Rapids

Table 3. List of fish species captured during lake sturgeon gillnetting studies conducted at four locations in the Gull (Keeyask) Study Area, 2001.

Common Name	**Scientific Name**	**Abbreviation**
Burbot	*Lota lota*	BURB
Carp	*Cyprinus carpio*	CARP
Freshwater drum	*Aplodinotus grunniens*	FRDR
Lake cisco	*Coregonus artedi*	LKCS
Lake sturgeon	*Acipenser fulvescens*	LKST
Lake whitefish	*Coregonus clupeaformis*	LKWH
Longnose sucker	*Catostomus catostomus*	LNSC
Mooneye	*Hiodon tergisus*	MOON
Northern pike	*Esox lucius*	NRPK
Sauger	*Sander canadensis*	SAUG
Shorthead redhorse	*Moxostoma macrolepidotum*	SHRD
Walleye	*Sander vitreus*	WALL
White sucker	*Catostomus commersoni*	WHSC

Table 4. Number of fish, by species, and sampling location, that were captured in gill nets set during lake sturgeon studies conducted in the Gull (Keeyask) Study Area between 21 May and 31 July, 2001.

Species	Location				Total Captured
	Burntwood River	Kelsey GS	Nelson River (BR-GR)[1]	Stephens Lake	
Burbot	3	3	0	2	**8**
Carp	1	19	0	0	**20**
Freshwater drum	2	38	5	14	**59**
Lake cisco	0	1	0	0	**1**
Lake sturgeon	23	13	79	24	**139**
Lake whitefish	19	91	12	12	**134**
Longnose sucker	0	0	0	20	**20**
Mooneye	19	4	2	10	**35**
Northern pike	28	206	62	179	**475**
Sauger	1	2	0	14	**17**
Shorthead redhorse	3	20	0	1	**24**
Walleye	5	129	28	149	**311**
White sucker	197	102	4	187	**490**
Total	**301**	**628**	**192**	**612**	**1733**

[1] Total does not include 3 lake sturgeon that were recaptured during the index gillnetting program
GS = Generating Station
BR-GR = Birthday Rapids to Gull Rapids

Table 5. Catch-per-unit-effort (CPUE; # lake sturgeon/45.8 m net/24 hours) at each of the four locations fished with gill nets for lake sturgeon in the Gull (Keeyask) Study Area, spring 2001.

Location	Number of Sites	Total Number Lake Sturgeon	Total Gillnet Hours	CPUE
Burntwood River	26	23	3950.03	0.14
Kelsey GS	44	13	5626.70	0.06
Nelson River (BR-GR)[1]	37	60	4537.57	0.32
Stephens Lake	18	24	6253.60	0.09

[1]Total number does not include sturgeon captured (n = 19) and recaptured (n = 3) as part of index gillnetting studies
GS = Generating Station
BR-GR = Birthday Rapids to Gull Rapids

Table 6. Mean fork length, weight, and relative condition factor (K), by location, for lake sturgeon captured in the Gull (Keeyask) Study Area, spring 2001.

Location	Fork Length (mm)				Weight (g)				K			
	n	Mean	Std	Range	n	Mean	Std	Range	n	Mean	Std	Range
Burntwood River	23	945	188.5	600-1436	22	6620	3279.1	1600-15600	22	0.76	0.14	0.46-1.04
Kelsey GS	13	940	197.5	692-1423	12	8334	6522.0	3200-26000	12	0.92	0.08	0.81-1.09
Nelson River (BR-GR)	79	1022	147.8	739-1355	78	9984	5059.1	3500-24000	78	0.88	0.12	0.64-1.26
Stephens Lake	24	1077	181.2	792-1447	24	13148	9498.5	4400-40000	24	0.94	0.17	0.71-1.56

n = number of fish
Std = standard deviation
GS = Generating Station
BR-GR = Birthday Rapids to Gull Rapids

Table 7. Number of lake sturgeon identified as sexually mature during gillnetting studies conducted at four locations in the Gull (Keeyask) Study Area, spring 2001.

Location	Sex	Total	Maturing to Spawn	Ripe	Spent
Burntwood River	Males	7	7	-	-
	Females	-	-	-	-
	Unknown	16	-	-	-
	Total	23	7	-	-
Kelsey GS	Males	-	-	-	-
	Females	-	-	-	-
	Unknown	13	-	-	-
	Total	13	-	-	-
Nelson River (BR-GR)	Males	16	5	10	1
	Females	3	3	-	-
	Unknown	41	-	-	-
	Total	60	8	10	1
Stephens Lake	Males	5	5	-	-
	Females	4	3	-	-
	Unknown	15	-	-	-
	Total	24	8	-	-

GS = Generating Station

BR-GR = Birthday Rapids to Gull Rapids

Table 8. Number of larval lake sturgeon captured in three drift nets set in the Burntwood River, spring 2001.

Date	Drift Net #1	Drift Net #2	Drift Net #3
18-Jun	-	-	-
19-Jun	4	-	-
20-Jun	-	-	-
21-Jun	-	3	6
22-Jun	-	-	-
23-Jun	-	-	-
24-Jun	-	-	-
25-Jun	-	-	-
26-Jun	-	4	-
27-Jun	-	4	-
28-Jun	-	-	-
29-Jun	-	-	-
30-Jun	-	-	1
1-Jul	-	-	-
2-Jul	-	-	-
3-Jul	-	-	-
4-Jul	-	-	-
5-Jul	-	-	-
6-Jul	-	-	-
7-Jul	-	-	-
Total	**4**	**11**	**7**

Table 9. Total length measurements for the 22 larval lake sturgeon captured in the Burntwood River, 2001.

Date	Drift Net #	Total Length (mm)
19-Jun	1	15.62
19-Jun	1	18.73
19-Jun	1	17.68
19-Jun	1	17.69
21-Jun	2	15.61
21-Jun	2	14.57
21-Jun	2	18.72
21-Jun	3	16.64
21-Jun	3	15.59
21-Jun	3	16.65
21-Jun	3	16.65
21-Jun	3	16.65
21-Jun	3	17.69
26-Jun	2	17.68
26-Jun	2	16.65
26-Jun	2	15.61
26-Jun	2	15.62
27-Jun	2	18.79
27-Jun	2	19.79
27-Jun	2	18.76
27-Jun	2	19.79
30-Jun	3	18.73
Mean		**17.27**

Table 10. Number of fish, by species and site, captured during lake sturgeon index gillnetting in the Nelson River between Birthday Rapids and Gull Rapids, 2001.

Site	Freshwater drum	Lake sturgeon[1]	Lake whitefish	Northern pike	Walleye	White sucker	Total
1	-	-	-	-	-	-	**0**
2	-	2	-	2	-	1	**5**
3	-	1	-	-	-	-	**1**
4	-	-	-	-	1	-	**1**
5	1	-	-	-	-	-	**1**
6	-	5	-	-	-	-	**5**
7	-	-	1	-	-	-	**1**
8	-	2	-	3	-	-	**5**
9	-	-	-	-	-	-	**0**
10	-	1	-	4	2	-	**7**
11	-	-	-	1	-	-	**1**
12	1	5	-	-	-	-	**6**
13	-	3	-	-	4	-	**7**
14	-	-	-	1	-	-	**1**
15	-	-	-	-	-	-	**0**
16	-	1	-	-	-	-	**1**
17	-	-	-	-	-	-	**0**
18	-	1	-	-	-	-	**1**
19	-	1	-	-	-	-	**1**
20	-	-	-	-	-	-	**0**
Total	**2**	**22**	**1**	**11**	**7**	**1**	**44**

[1] Includes recaptured lake sturgeon (n = 3)

Table 11. Summary of data, by replicate and site, for the 2001 lake sturgeon index gillnetting program conducted in the Nelson River between Birthday Rapids and Gull Rapids.

Site	Replicate	Net Pull Date	Duration (hrs)	n	CPUE	Mean CPUE/site
1	1	17-Jun	21.47	0	0.00	0.00
	2	5-Jul	22.35	0	0.00	
2	1	17-Jun	20.22	1	1.19	1.07
	2	6-Jul	25.13	1	0.96	
3	1	17-Jun	21.98	0	0.00	0.46
	2	6-Jul	26.25	1	0.91	
4	1	17-Jun	20.87	0	0.00	0.00
	2	6-Jul	25.98	0	0.00	
5	1	19-Jun	22.70	0	0.00	0.00
	2	7-Jul	21.80	0	0.00	
6	1	19-Jun	22.58	2	2.13	2.70
	2	7-Jul	21.93	3	3.28	
7	1	19-Jun	22.83	0	0.00	0.00
	2	7-Jul	22.08	0	0.00	
8	1	19-Jun	23.50	0	0.00	0.96
	2	8-Jul	25.08	2	1.91	
9	1	20-Jun	18.77	0	0.00	0.00
	2	27-Jun	23.30	0	0.00	
10	1	20-Jun	19.20	0	0.00	0.52
	2	27-Jun	23.22	1	1.03	
11	1	20-Jun	20.62	0	0.00	0.00
	2	27-Jun	23.57	0	0.00	
12	1	20-Jun	21.63	3	3.33	2.67
	2	27-Jun	23.75	2	2.02	
13	1	21-Jun	21.23	1	1.13	1.65
	2	2-Jul	22.18	2	2.16	
14	1	21-Jun	19.25	0	0.00	0.00
	2	28-Jun	22.08	0	0.00	
15	1	21-Jun	19.48	0	0.00	0.00
		28-Jun	22.17	0	0.00	
16	1	21-Jun	19.53	1	1.23	0.61
	2	28-Jun	22.00	0	0.00	
17	1	22-Jun	22.78	0	0.00	0.00
	2	3-Jul	27.58	0	0.00	
18	1	22-Jun	22.72	0	0.00	0.60
	2	4-Jul	19.88	1	1.21	
19	1	22-Jun	22.78	0	0.00	0.44
	2	3-Jul	27.18	1	0.88	
20	1	22-Jun	22.37	0	0.00	0.00
	2	3-Jul	27.20	0	0.00	
Total			**901.22**	**22**		
Mean					**0.59**	

n = number of fish captured
CPUE = Catch-per-unit-effort (# lake sturgeon/45.8 m net/24 hours)

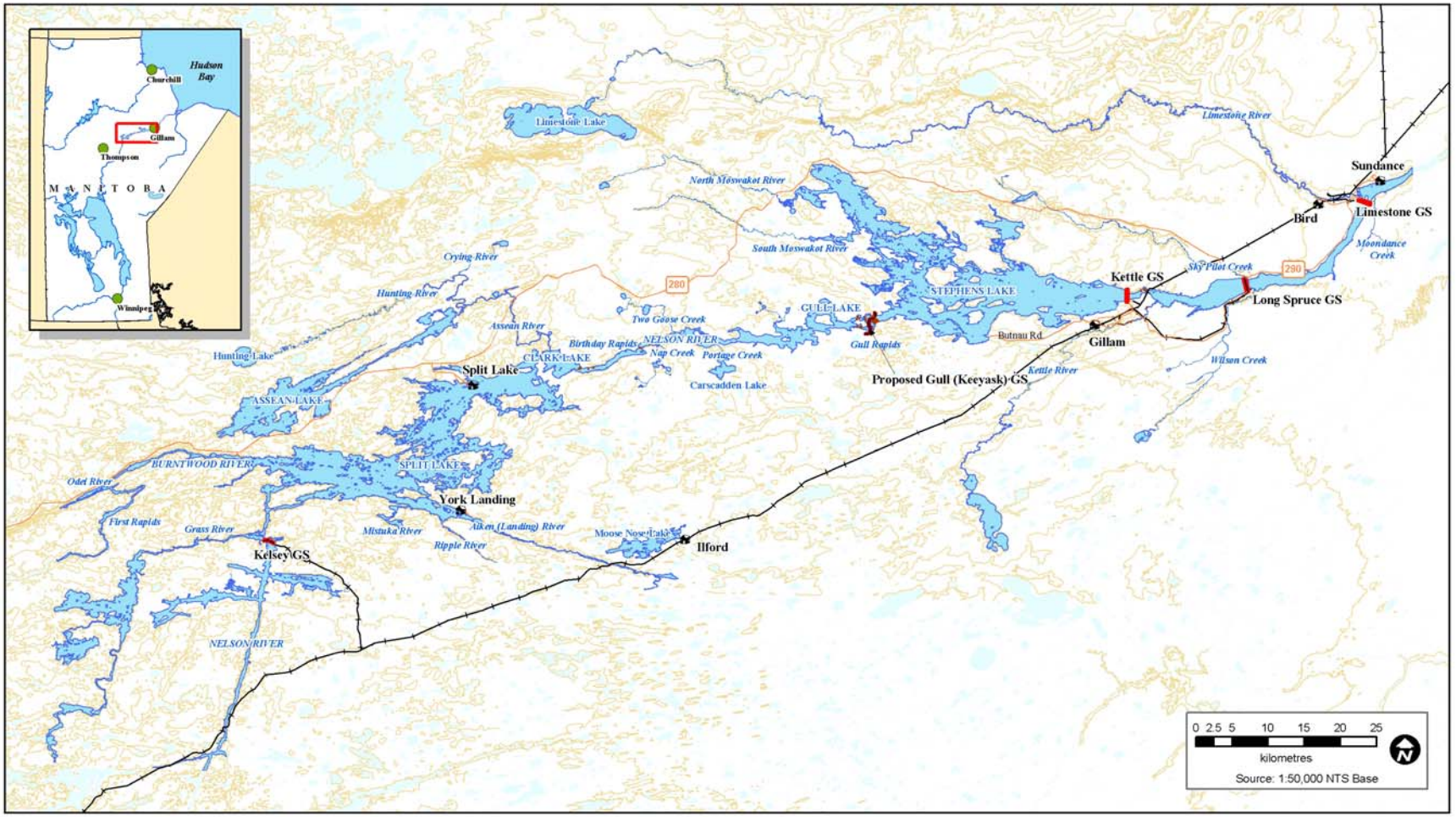

Figure 1. Map of the Gull (Keeyask) Study Area showing proposed and existing hydroelectric development.

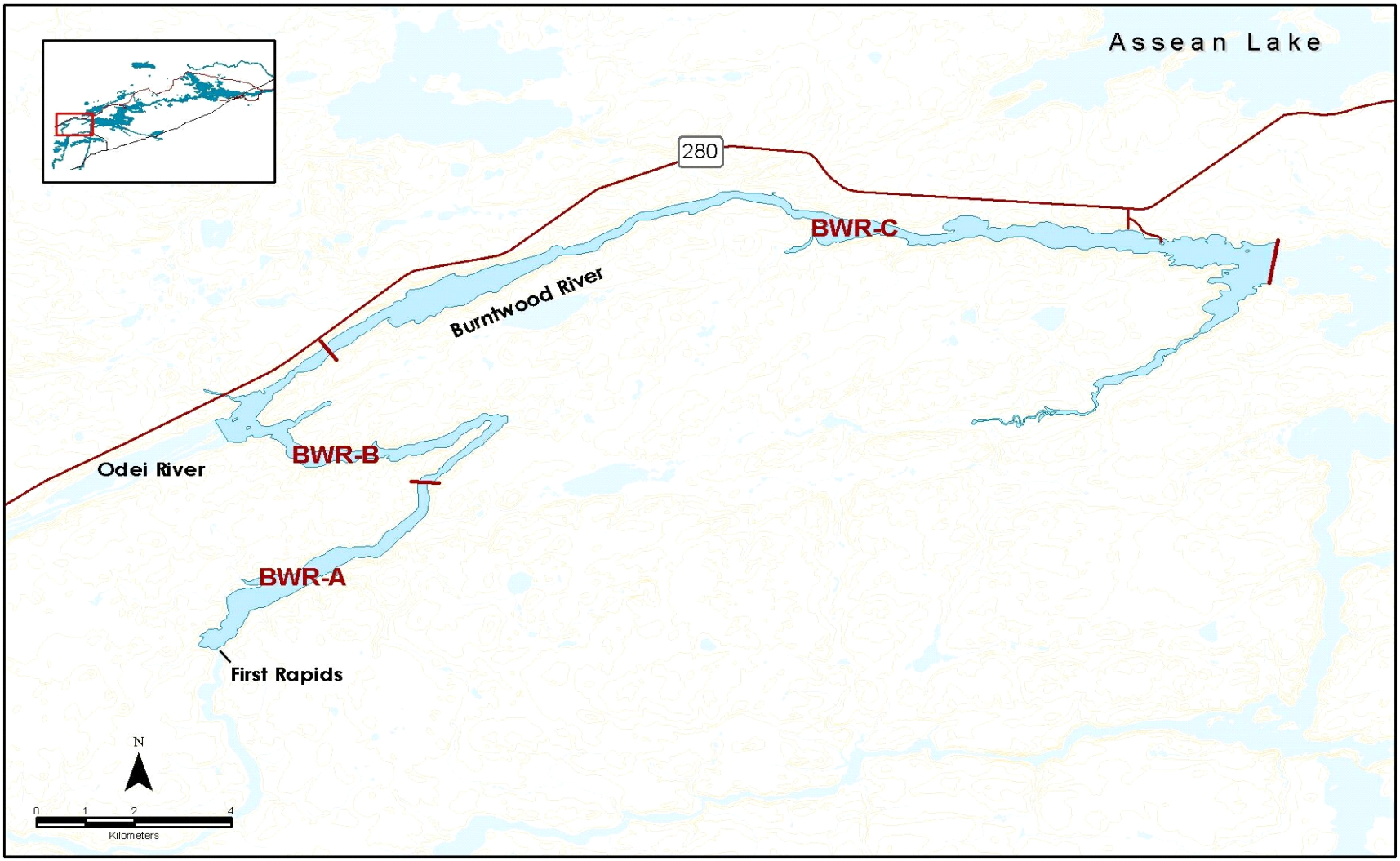

Figure 2. Map of the Burntwood River illustrating zones BWR-A, BWR-B, and BWR-C.

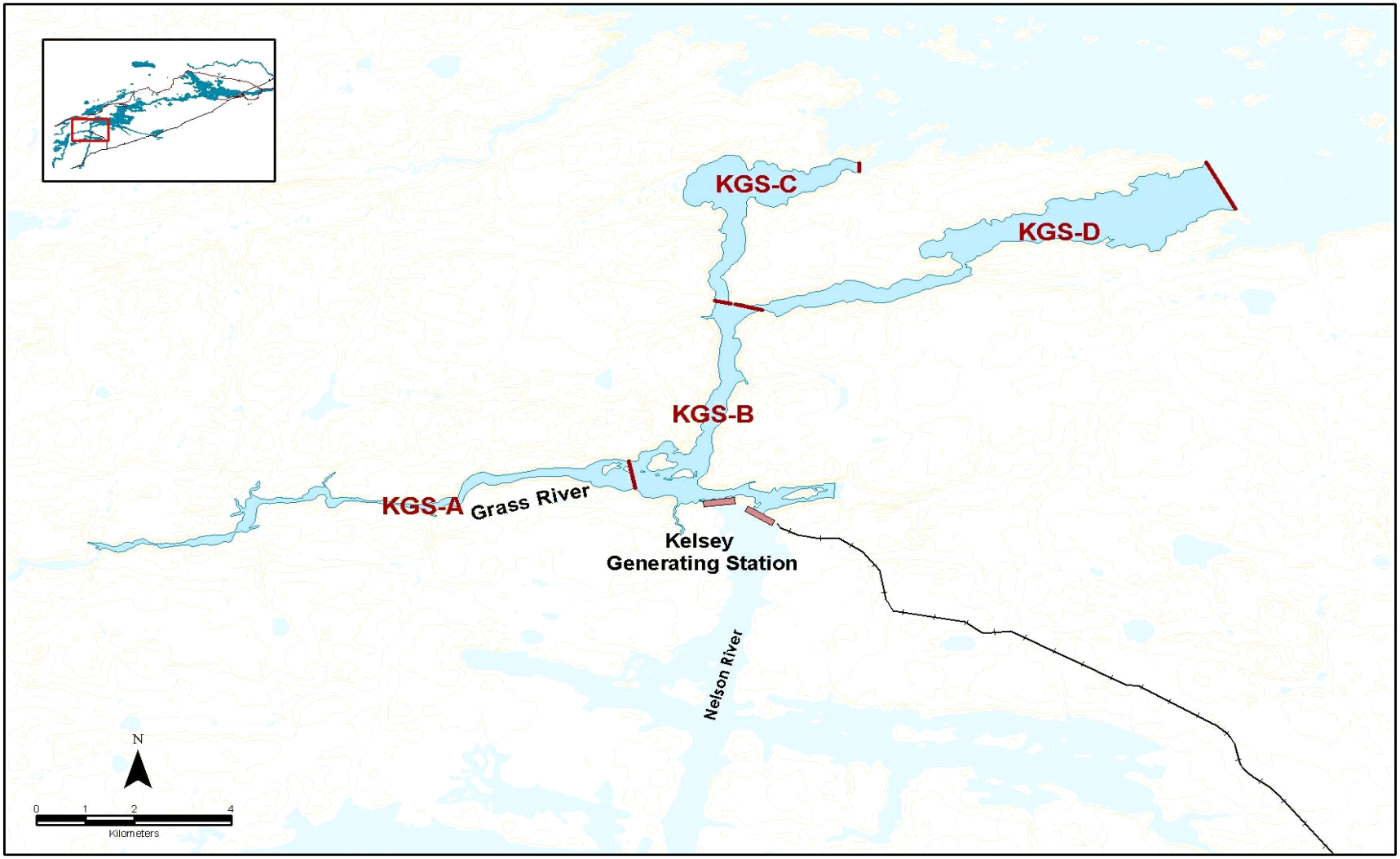

Figure 3. Map of the Nelson River and the Grass River in the vicinity of Kelsey GS illustrating zones KGS-A to KGS-D.

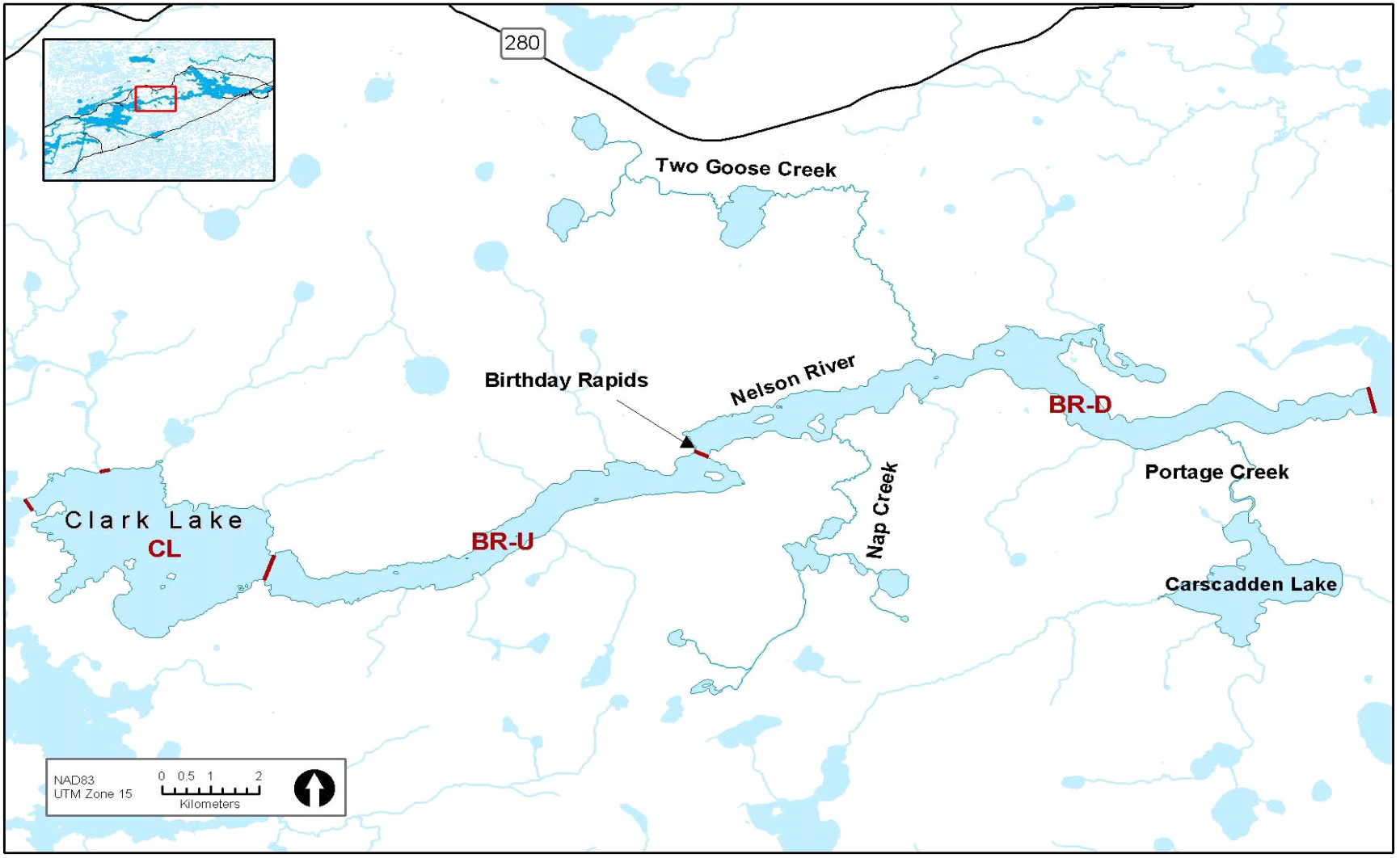

Figure 4. Map of the Nelson River and Clark Lake in the vicinity of Birthday Rapids illustrating zones CL, BR-U, and BR-D.

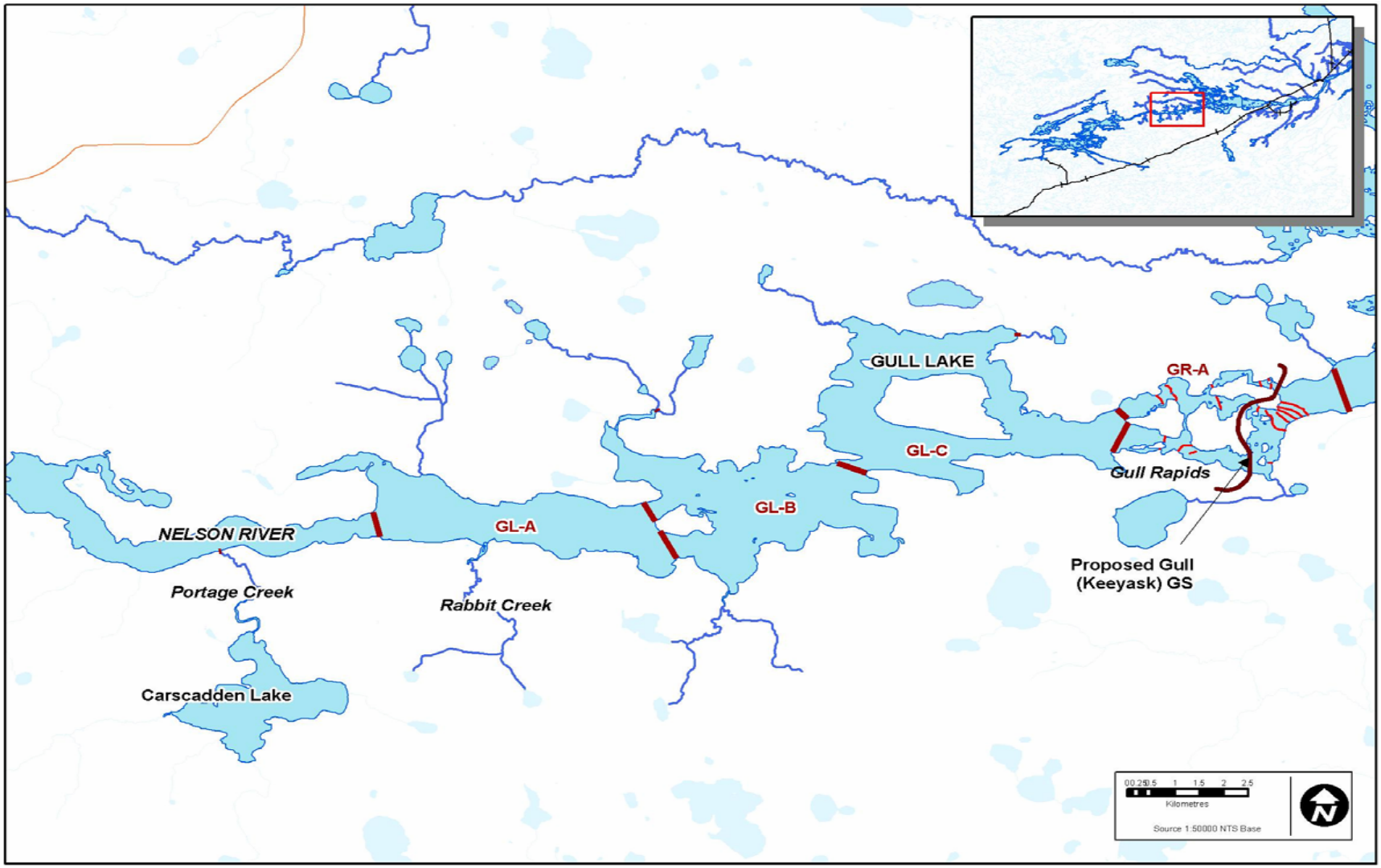

Figure 5. Map of Gull Lake illustrating zones GL-A, GL-B, and GL-C.

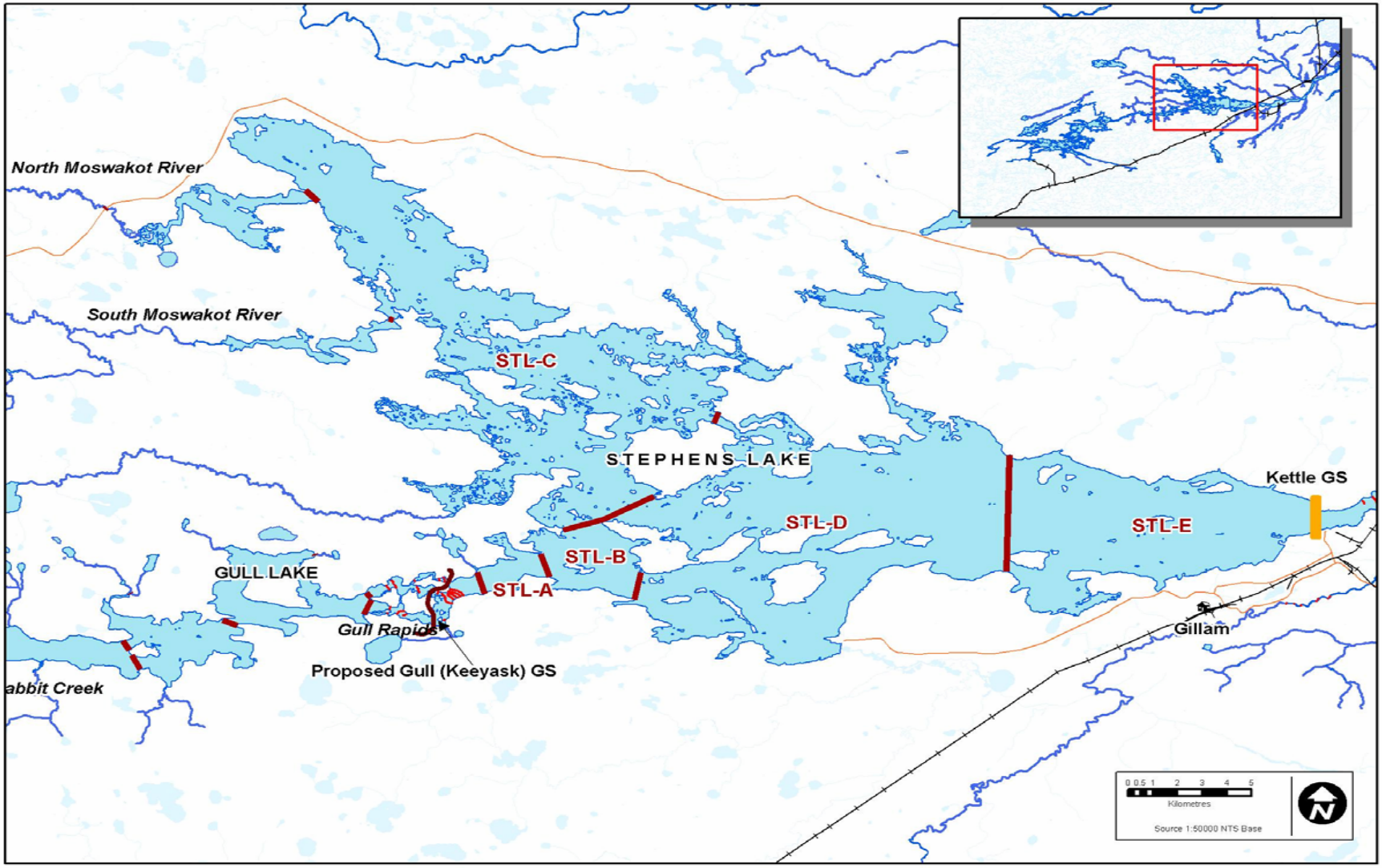

Figure 6. Map of Stephens Lake illustrating zones STL-A to STL-E.

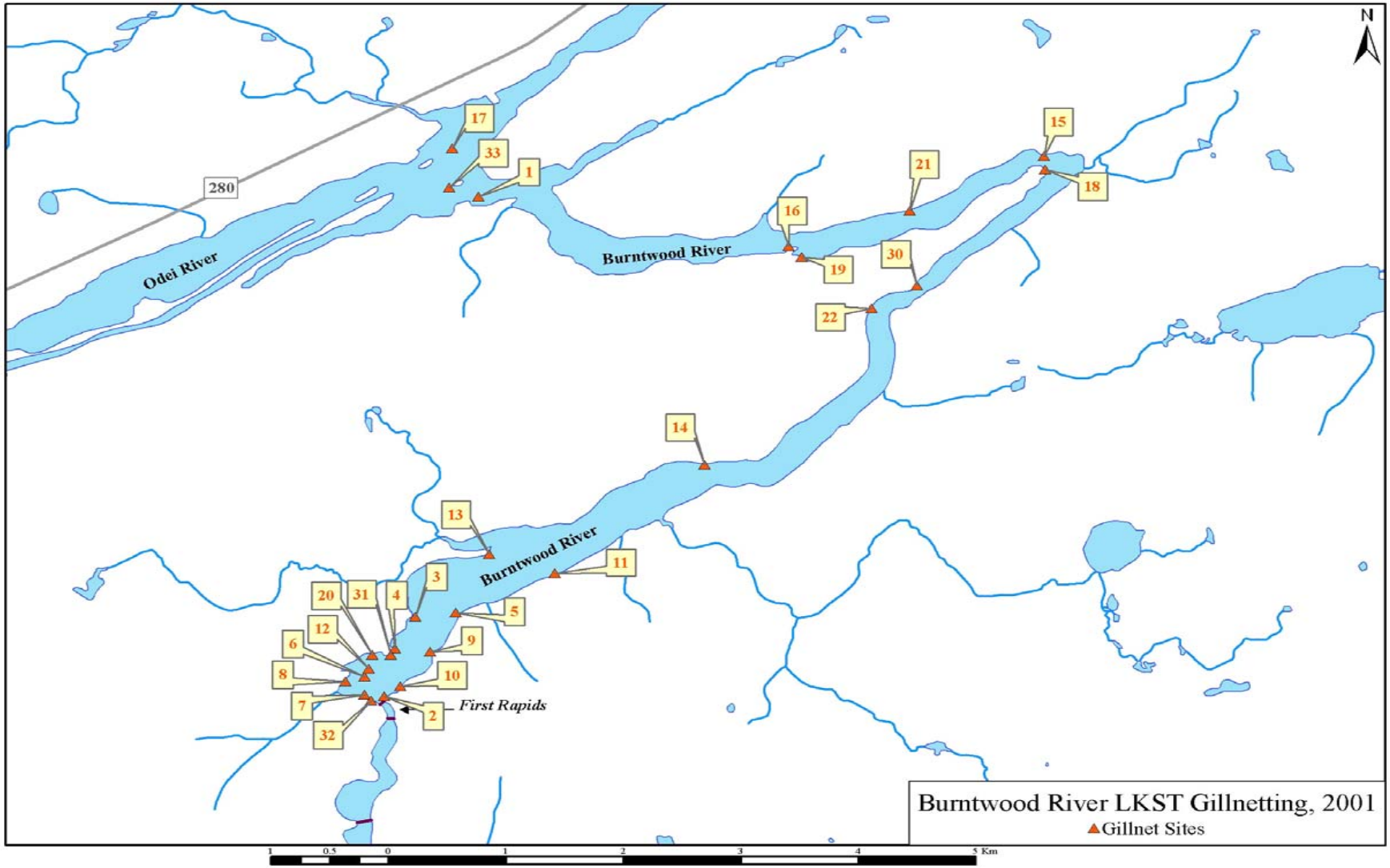

Figure 7. Map of gillnetting sites fished for lake sturgeon in the Burntwood River between 30 May and 8 July, 2001.

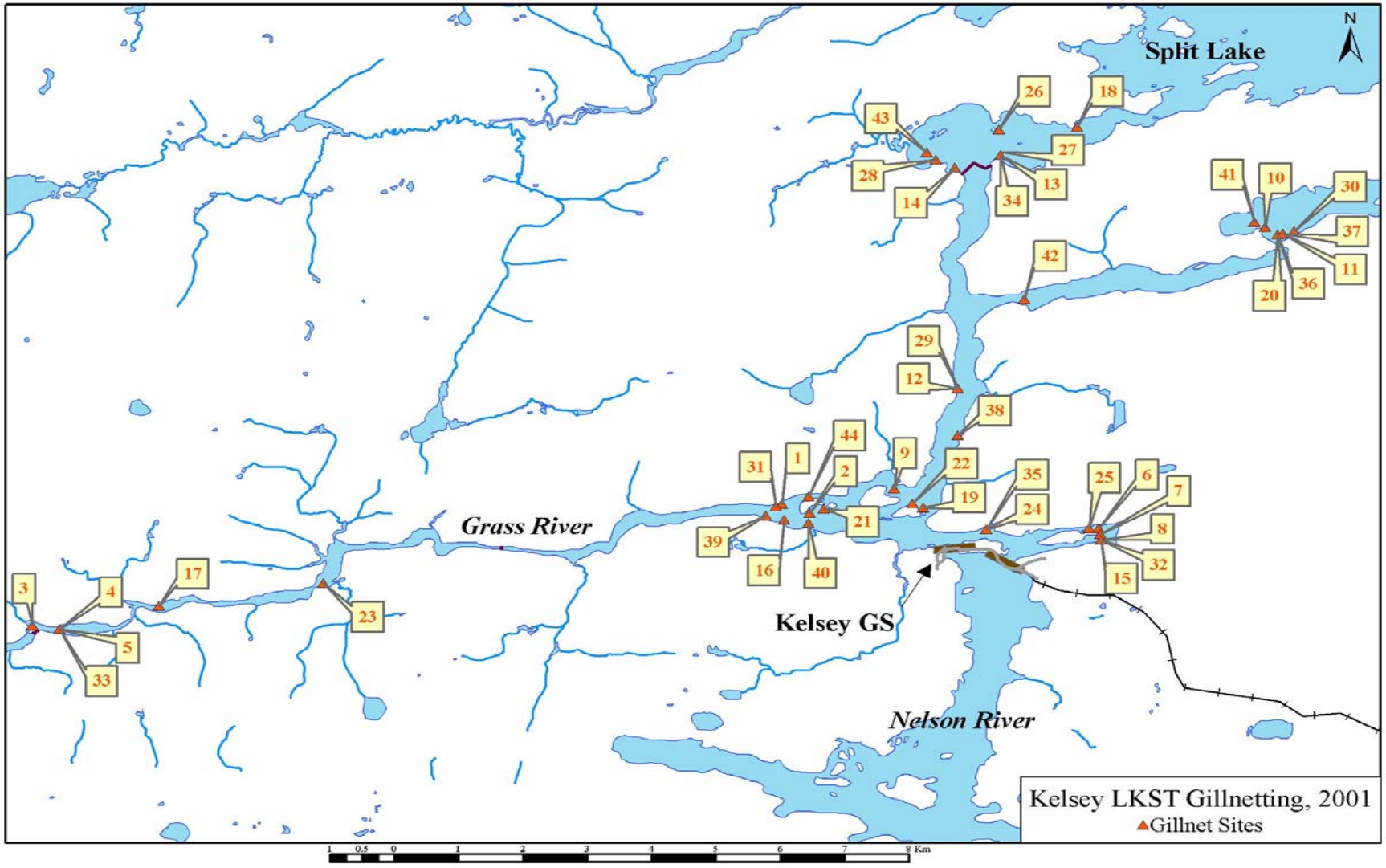

Figure 8. Map of gillnetting sites fished for lake sturgeon in the Nelson River and lower Grass River in the vicinity of the Kelsey GS between 28 May and 8 July, 2001.

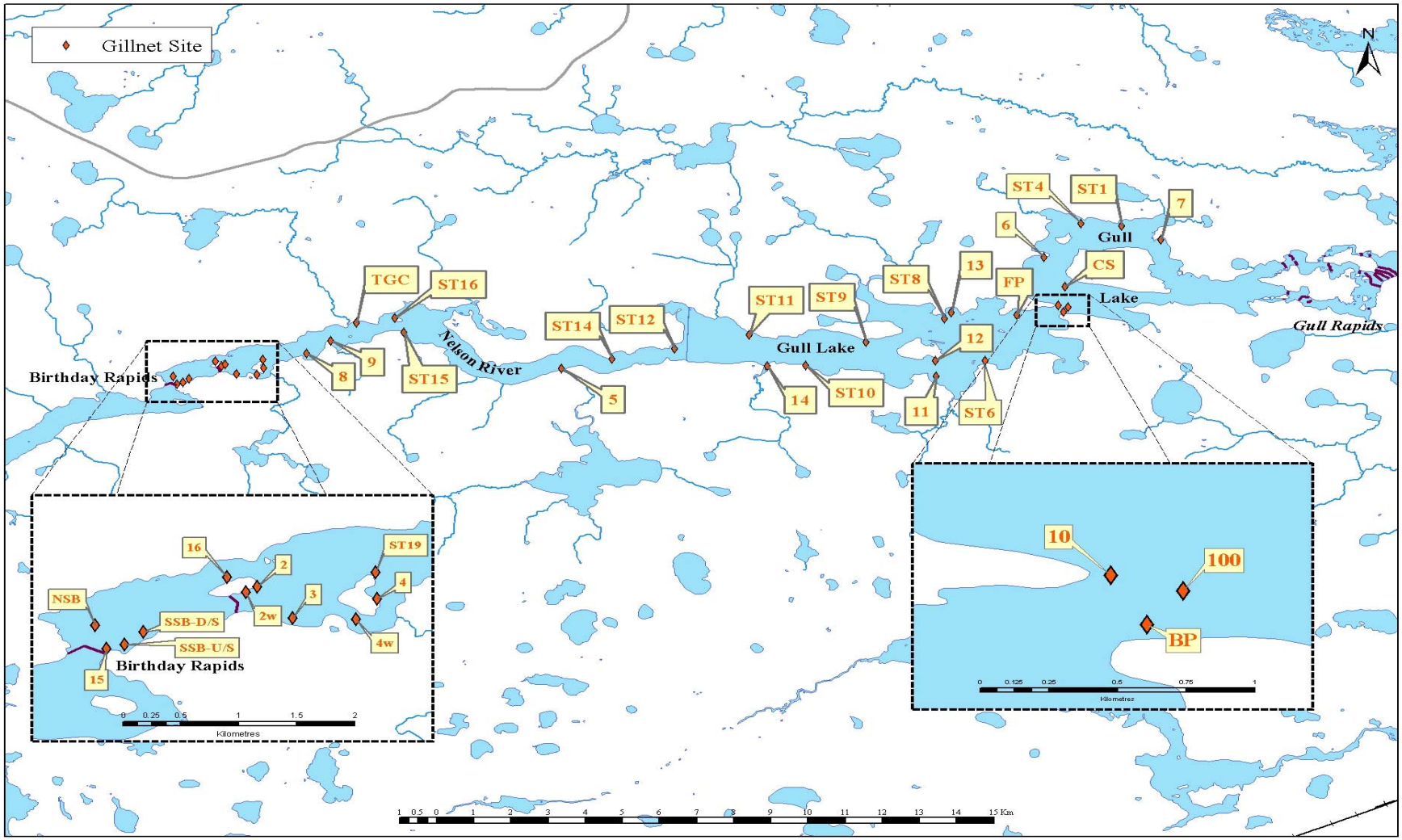

Figure 9. Map of gillnetting sites fished for lake sturgeon in the Nelson River between Birthday Rapids and Gull Rapids between 21 May and 31 July, 2001.