

Appendix G1

2006 Aquatic Assessment



**ISLAND FALLS HYDROELECTRIC
PROJECT AQUATIC ASSESSMENT**

File No. 160960168

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Executive Summary

Introduction

This document presents the results of the 2005/2006 Aquatic Sampling Program (the “study”) for Yellow Falls Power Limited Partnership (“YFP”) for the proposed Island Falls Hydroelectric Project (“the Project”). The study was specifically developed for the Project with input from the Ministry of Natural Resources (“MNR”) and the Department of Fisheries and Oceans (“DFO”). The full study workplan is described in the report *Island Falls Aquatic Field Sampling Program 2006* (the “workplan”; **Appendix VII**). Agency comments on the Draft *Island Falls Aquatic Field Sampling Program* are contained in **Appendix VIII**.

The proposed Project is located on the Mattagami River approximately 16 km south of the Town of Smooth Rock Falls, Ontario (see **Figure I1-1**). The purpose of the study was to characterize the distribution and habitat uses of aquatic biota in the vicinity of the Project, including the associated headpond. The study was also designed to acquire baseline data against which to evaluate the biophysical conditions of the area post construction and during operation. This report contains general study-design information, including field methods and data collected during the autumn 2005 (October), spring (April to June), summer (August) and autumn (September and October) 2006 field surveys. Inventories documented distributions of fish and fish habitats, benthic invertebrates and water quality, and passability of existing river features by fish. Methyl-mercury concentrations in fish tissues were determined and the potential for methyl mercury development was assessed.

Study Area Description

The Mattagami River is 443 km long, falling 329 m along its length, and is one of nine major rivers in the Moose River drainage basin in northeastern Ontario. The Mattagami River system, including tributaries, has been used to produce electricity for more than 90 years, and currently supports 10 generating stations. The Mattagami River itself supports eight generating stations. The river flows through three physiographic regions from its headwaters to its confluence with the Moose River before ultimately draining into James Bay.

The proposed Project is a 20 Megawatt (“MW”) hydroelectric generating facility with a 17 m high impoundment structure. The length of the Mattagami River influenced by the facility extends from approximately 500 m downstream of Island Falls, upstream to Loon Rapids, a distance of approximately 9 km.

The Study Area for these investigations focused on three distinct reaches of the Mattagami River, namely:

- Area A: generally defined as the stretch of river between the Town of Smooth Rock Falls and Island Falls – with specific focus on the 500 m reach immediately downstream of Island Falls
- Area B: defined as the approximate two-kilometre stretch of river between Island Falls and Yellow Falls
- Area C: defined as the approximately seven-kilometre stretch of river between Yellow Falls and the upper extent of the proposed headpond area (i.e., area of proposed inundation). The heterogeneous nature of Area C required it to be subdivided into four Sub-Areas (C1, C2, C3, C4; **Figure I1-2**) to facilitate morphological description.

Fish Community and Habitat Survey

The workplan focused on 10 fisheries-related questions identified during workplan development with the MNR and DFO. These questions and the principle findings associated with each are provided below:

1. What fish species are currently using Areas the Study Area?

More than 25 species of fish are present in the Study Area including game species (walleye, pike, whitefish), other large bodied species (white sucker), and forage species (darters, minnows, shiners). Four species of interest (“target species”) were the focus of the study: lake sturgeon (*Acipenser fulvescens*), white sucker (*Catostomus commersoni*), walleye (*Sander vitreus*) and northern pike (*Esox lucius*). These four species were considered appropriate target species because of their abundance in the system, as well as their recreational, commercial or ecological importance. All target species were present in Areas A, B and C with the exception of lake sturgeon, which were only captured in Area A immediately downstream of Island Falls. The absence of lake sturgeon in Areas B and C can be attributed to factors including commercial over-fishing, combined with anthropogenic, natural river fragmentation and larval drift. The commercial fishery operated from 1927 to about 1985, when it closed due to a significant catch decline. Yellow Falls is also impassable by sturgeon, resulting in further population declines in that part of the Study Area likely due to habitat fragmentation.

2. What are the population characteristics of targeted fish that use the Study Area (approximate sizes, age classes, etc.)?

Population characteristics vary between the four target species, due mainly to habitat availability and anthropogenic activities such as dams and historical commercial fishing activities. White sucker was the most abundant large-bodied species comprising 51% of the overall large-bodied fish catch (1486 fish in 2006), with walleye (20%) and northern pike (11%) being subdominant in 2006.

All age classes of white sucker were present in the Study Area. Young-of-year ("YOY") and juvenile white suckers were present in relatively large numbers in the tributaries entering the Mattagami within the Study Area, while older juveniles and adults (maximum age 13 yrs) were principally found in the mainstem Mattagami River.

Young walleye (below the age of 3) were also found in Rat Creek and one juvenile was discovered in the lower reach of Tributary A. Adult walleye (maximum age 19 yrs) and juveniles over the age of 3 were found in the mainstem Mattagami River.

YOY and juvenile northern pike were found along the margins of the mainstem, as were adults (maximum age 7 yrs).

Lake sturgeon were found in low numbers, all in the mainstem, and none upstream of Island Falls. No sturgeon younger than 3 years was found, with few younger than 10, and none older than 40 years. The lack of YOY sturgeon was consistent with previous inventories of sturgeon in the Moose River Basin that have failed to find YOY sturgeon.

Age data for white sucker, northern pike and walleye indicated healthy populations. Lake sturgeon age data indicated an aging population, with poor recruitment.

3. *For what life history stages are the fish using the Study Area (e.g., is the area used for spawning, or other 'critical' life functions)?*

Adult white sucker, northern pike, and walleye used the mainstem habitats of Areas A, B and C for feeding. YOY and juvenile northern pike were limited to the margins of the mainstem Mattagami River. Pike spawning habitat is limited in the Study Area (both mainstem and tributaries), suggesting that young pike found in the Study Area were spawned and reared upstream, above Loon Rapids. The presence of YOY white sucker in Tributaries A and B, and Rat Creek indicate the use of those tributaries for spawning. A single juvenile walleye was found in Tributary A, while several were found in Rat Creek which is considered the principal walleye spawning area in the Study Area. Muskego River, downstream of the Study Area, is considered a major walleye spawning location (based on anecdotal evidence) in this reach of the Mattagami River. Lake sturgeon congregated at the base of Island Falls in the spring of 2006, indicating the use of that area for spawning as well.

There is no indication that the riffle habitat between Yellow Falls and Loon Rapids is a significant spawning habitat for any of the four target species. Lake sturgeon cannot ascend Yellow Falls, and therefore, the lake sturgeon found below Island Falls cannot access that area.

4. *What is the seasonal abundance of fish in the Study Area?*

Area A provides pool and shoal habitat used by white sucker, walleye, northern pike and lake sturgeon for feeding throughout the year, and for spawning in the spring. The mainstem of Areas B and C is used as feeding areas for white sucker and walleye in the summer/fall and spring. Northern pike, walleye, and white sucker were present during fall sampling in Area B. Within the Study Area, tributaries A and B, and Rat Creek are used for spawning by white

sucker, while walleye appear to principally use Rat Creek for spawning. Lake sturgeon are limited to Area A, probably because habitats at the base of Island Falls are suitable for spawning, and because they have difficulty ascending Island Falls. There is no indication that lake sturgeon or any other species ascend Yellow Falls to access spawning habitats. There is also no indication that any fish species migrate from above the Study Area, downstream to Tributaries A and B, and Rat Creek for the purpose of spawning. None of the habitats within the Study Area, therefore, provide “critical” spawning habitats for fish that normally reside (feed) outside the Study Area during non-spawning periods.

5. *How common are the habitat types in the Study Area within the Middle Mattagami River system?*

Pool and run habitats dominate the area between the two impoundments at Smooth Rock Falls (downstream) and Lower Sturgeon Falls (upstream). Abundances of these morphological features within the Study Area are generally similar to occurrences elsewhere in the middle reaches of the Mattagami River. Five small areas of high-velocity morphology (riffles or falls) occur in this approximately 60 km reach, four of which fall within the Project Study Area. The fifth occurs at the base of Lower Sturgeon Generating Station, an Ontario Power Generation (“OPG”) hydroelectric generating facility. Within the Study Area, the four riffles and falls make up approximately 23% of the morphology by area. These high-velocity areas can be considered suitable spawning habitat for several species based on physical features (flow velocity, depth, substrate), but the catch data demonstrated that these habitats are not used for spawning by any of the four target species. Hydrologic flow and general river conditions during the sampling period were within historic normals, so it is reasonable to assume that sampling conditions and catch data were representative of average conditions. The remaining 77% of morphology is a mix of run (46%), pool (20%) and shallows (11%).

Despite their apparent suitability, and the limited presence of riffle and falls morphology features in the middle reach of the Mattagami River, the four high velocity areas are not identified as locations of limiting habitat for any of the four target species. The common representation of the other 3 morphology types (run, pool, and shallows) within the middle reach of the Mattagami River supports the assertion that these features also represent non-limiting habitat features in the Study Area.

6. *How will inundation change habitat in Areas B and C (i.e., sizes and types and for what species)?*

Inundation caused by the creation of a 17 m high dam at Island Falls will generally change the 9 km reach above Island Falls from a lotic type environment to one more lentic in nature. Inundation will increase aquatic habitat by 111 ha, almost doubling local aquatic habitat availability. The headpond, being deeper than the riffle-run habitats being inundated, will create ideal over-wintering habitat for several species. The headpond will also produce a 17% increase in littoral habitat, producing a net increase in fish productivity. Over time, the littoral area will provide additional spawning, rearing and foraging habitat for northern pike with the establishment and growth of aquatic plants. Spawning habitats for white sucker in the lower reaches of Tributaries A and B and Rat Creek and for walleye in the lower reaches of Rat Creek

will be inundated, but will also be replaced (naturally via access to suitable new areas through inundation) by new spawning habitats of similar size for these two species. The loss of riffle habitats in Areas B and C is considered to be non-critical to the spawning success of white sucker, walleye and sturgeon (and other species) because these species do not use those areas for spawning purposes.

No net changes in fish habitat are anticipated downstream of the proposed dam at Island Falls. The run-of-the-river operational approach and the proposed dam design will approximate existing flow rate downstream of Island Falls. The existing shoal will still be on the periphery of higher velocity water, thus retaining its function as a spawning shoal for lake sturgeon, walleye, and possibly white sucker. Spawning habitat for northern pike is not expected to experience a net loss, as the amount of shallow, low-velocity areas is not expected to change significantly.

7. How will the Project and resulting habitat change affect benthic organisms in the Study Area?

Several changes to the fauna can be predicted in the headpond area upstream of the proposed dam. First, the conversion of a lotic to a lentic habitat will alter the composition of the benthic community. Those forms requiring flowing water (i.e., typically the larger insects that are sensitive to changes in dissolved oxygen and nutrient levels) will be replaced by those forms requiring or tolerant of still waters (i.e., simpler and more tolerant insects and worms). Benthos will colonize newly flooded soils, initially in high numbers, with numbers stabilizing over time. High spring water levels should flush the system of fine organic materials, minimizing the possibility of seasonal depressions in dissolved oxygen in deeper water.

Since the dam is operating as a run-of-the-river system, effects to the benthic community should be minimal. Minor differences in water temperature from the upstream to downstream ends of the headpond may occur, but such differences have had minimal effects in other run-of-the-river operations in the Moose River system (e.g., Carmichael Falls).

Though headpond creation represents a substantive alteration to benthic habitats, inundation will approximately double the local area of wetted habitat. There will be an increase in the littoral zone of approximately 4.5 ha, where benthic community composition will be diverse and productive. Benthos in the littoral zone will be more productive than benthos in the sub-littoral and profundal areas of the headpond, and should include numerous mayfly taxa, as well as chironomids, worms, snails and clams, among other taxa, that would serve as food supplies for sturgeon, white sucker and other benthic feeding fishes.

Physical habitat in the area immediately downstream of Island Falls is not expected to change significantly after construction. The facility, operating as a run-of-river facility, will retain pre-construction discharge levels after headpond filling, and thus preventing a change in water levels below Island Falls.

8. What fish habitat (i.e., type and amount) creation opportunities exist in the Study Area?

Opportunities for construction of artificial habitats were also reviewed. This review included opportunities for habitat construction in the main channel of the Mattagami River within the headpond and downstream of the Project, habitat enhancement in tributaries to the Mattagami River, fish passage, stocking, and contributions to fisheries management initiatives.

The review of habitat creation opportunities revealed limitations associated with habitat construction within the Mattagami River. Highly dynamic seasonal watercourse flows create a high likelihood that the constructed habitat features would be damaged or destroyed, thus requiring constant maintenance or re-construction. The replacement of riffle habitat simply cannot be practically or effectively accomplished within the Study Area. Opportunities for habitat creation within tributaries to the Mattagami River were considered, however these opportunities possess similar limitations to construction associated with habitat damage due to water flows. Further, habitat construction within the tributaries would require construction of extensive access road systems, with the corresponding resulting environmental impacts associated with deforestation, and the requirement for access road watercourse crossings. The construction of riffle habitats in these tributaries would also necessitate the alteration or loss of existing in-stream habitats, presumably more suited to the topography and flow volumes in those catchments. Further, man-made river habitats can fail, with the probability of failure increasing with the size of the river being modified. There would be considerable risk that the created habitats would fail, due to the size and power of the reaches being modified.

However, there is potential for creating or enhancing spawning habitat at the base of Island Falls. Since fish already utilize this area for spawning, it seems logical to enhance its characteristics. In addition, it is easily accessed for construction, maintenance, and ongoing monitoring. If habitat conditions around the base of Island Falls become more conducive to spawning, some species may make greater use of this area to spawn.

Several beneficial effects on fish habitat associated with headpond creation have been identified. The headpond will cause water levels to rise above existing bedrock barriers that currently impede upstream migrations by white sucker in Tributary A and Tributary B. Headpond inundation will enable fish migrations to significant portions of the upper reaches of these two tributaries, and thus offset the alteration of existing spawning habitat in the lower reaches of these tributaries.

Further, headpond formation will nearly double the existing aquatic habitat area within that reach. The upstream (headpond) Study Area currently occupies 120 ha, while the inundated area will add 111 ha of new aquatic habitat, for a total of 231 ha in the headpond. The headpond will provide 17% (4.5 ha) more shallow littoral habitat (i.e., < 2 m deep) than currently exists, an area anticipated to be highly productive in terms of generating benthic and fish biomass (**Appendix IV**). The increase in littoral fish habitat will benefit a number of fish species including those that require slower velocities such as YOY pike and white sucker, and smaller-bodied species such as shiners (common, emerald, golden, spottail, rosyface), dace (northern redbelly, finescale), darters (Johnny, Iowa), and brook stickleback.

9. What is the extent and magnitude of the Project changes to the littoral zone and the riparian area?

The littoral zone (<2 m water depth) within the proposed headpond footprint currently approximately covers 24 ha. After inundation, the littoral zone will cover approximately 28 ha, an increase of approximately 4.5 ha (17%). The existing "littoral" environment occurs throughout the channel, and has numerous areas with high flows, with substrate that is predominantly gravel and coarse rock. The proposed future condition will have reduced flow velocities at all flow volumes. Average existing flow velocities at average flow volumes are generally > 1 m/s, and will reduce to an average of approximately 0.3 m/s. Slower velocities in the headpond will be associated with buildup of fine sediments, especially along the margins of the headpond in the littoral zone.

The littoral zone of the new headpond will contain a benthic community that is relatively productive and diverse. The mayfly *Hexagenia*, a major food item in the diet of lake sturgeon, is a common invertebrate in depositional reaches of the Abitibi River, and can be expected to increase in numbers in the depositional areas of this reach of the Mattagami River. The littoral zone can also be expected to support large numbers of chironomids, worms, snails, and bivalves, all of which will provide food for sturgeon and other benthic feeding fishes such as white and longnose sucker, as well forage fish such as darters and sculpins.

10. How will inundation affect contaminant transport, particularly methyl mercury?

Flooding of organic soils is anticipated to result in some increase of methyl mercury concentrations in the headpond. Walleye and pike are efficient bioaccumulators of methyl mercury, whereas suckers are not. Sturgeon are less efficient bioaccumulators than walleye or pike because they are benthivores, but have long lifespans and grow to a large size, potentially resulting in bioaccumulation of methyl mercury through less efficient processes.

Inundation of the Island Falls headpond will inundate 111 ha of land previously occupied by terrestrial and wetland habitats. Flooding will facilitate methylation of mercury, in the short term, and may lead to short-term and modest increases in mercury concentrations in tissues of game fish within the vicinity of the proposed headpond. Concentrations will then decline over time, commencing 10 to 20 years after inundation. The primary effective mitigation technique proposed to minimize methyl mercury inputs involves cutting and removing timber, and grubbing (stump removal) to remove large woody material.

Increases in fish tissue methyl mercury concentrations are anticipated to be spatially limited to the headpond. Concentrations of mercury in fish caught from within the Study Area are currently just above consumption guidelines for young children and women of child-bearing age. With enrichment of methyl mercury, concentrations in fish tissues could increase, but would not be expected to exceed the general or total restrictions for the general public.

In addition to mercury, nutrients will be leached from flooded soils and decaying vegetation. In the short term (2 to 5 yrs), dissolved nutrient levels can be expected to increase. In the longer

term (maximum 5 to 10 yrs) nutrient concentrations should subside to background concentrations.

Conclusions

The Study Area supports a diverse fish community. The Study Area supports more than 25 species of fish, including important game species (northern pike, walleye) and lake sturgeon.

The Study Area does not contain any limiting habitats. Limiting habitat is defined in Section 2 of the Species at Risk Act as “habitat that is necessary for the survival or recovery of the species”. All habitat types located in the project study area are abundant and also found outside but in the immediate vicinity of the project study area. Local stocks of walleye, sucker, sturgeon and pike have access to these alternate habitats for spawning, rearing and feeding. Loss or alteration of any of the habitats within the study area will not lead to the loss of any local stock.

Specifically, the area below Island Falls provides adult feeding and spawning habitats for the four target species. Spawning habitats in Rat Creek currently used by walleye and white sucker will be naturally re-created via inundation associated with the headpond. Spawning habitats that may be used by white sucker during seasons with sufficient flow in the lower reaches of Tributaries A and B will also be naturally re-created via inundation of the headpond area and the associated fish access to upstream habitats within these tributaries.

The lake sturgeon population within Area A may be unhealthy. Data indicate the lake sturgeon population downstream of Island Falls is limited and not likely to be self-sustaining. However, numbers of lake sturgeon captured in Area A during the 2006 sampling period are similar to those reported by Payne (1985), indicating the population may be in equilibrium. There is no evidence to indicate that lake sturgeon were ever present or commercially harvested between Island Falls and Loon Rapids. Numbers of sturgeon in Area A are below values that are considered necessary to support a healthy, self-sustaining population (Soule 1980). Age classes indicate generally poor recruitment, though there was apparently strong recruitment between 22 and 26 yrs ago, based on histogram calculations. The local sturgeon population is negatively affected by barriers at Smooth Rock Falls (impassable dam), Yellow Falls (natural impassable barrier), and Lower Sturgeon Falls (impassable dam). A commercial fishery that operated up to and including Area A and also above the study area between 1927 and 1980 depleted numbers of sturgeon. The currently fragmented nature of the population limits genetic mixing, and minimizes the size of the local spawning populations, especially considering that female fish do not spawn every year. Another significant issue facing lake sturgeon populations in the upper reaches of the Mattagami River is larval drift. Lake sturgeon larvae have been shown to drift up to 45 kilometers, 40 days after hatching (Auer and Baker, 2002). Populations in upper reaches of rivers lose large proportions of their potential recruitment because the young drift far downstream, past structures (dams, falls) that are barriers to upstream passage.

The proposed headpond will result in a significant increase in fish habitat and fish productivity within the Study Area. The headpond will almost double the available fish habitat, and will increase the littoral zone by 17% (4.5 ha). The headpond will increase overwintering and foraging habitats for the four target species.

Conditions in the headpond will be of high quality in the long term. Water quality may be moderately degraded due to nutrient enrichment in the short term, but is anticipated to return to background quality within 2 to 5 yrs. Mercury concentrations in the flesh of sport fish (walleye, northern pike) within the headpond can be expected to increase slightly, but not above levels that pose significant risk to most casual consumers. Like changes in water quality, changes in mercury content of fish flesh is anticipated to decrease to normal levels within a reasonable time (~ 20 yrs) after inundation. Mercury levels in fish tissue are not anticipated to increase downstream of the Project.

An increase in the size of the littoral zone will increase rearing and feeding habitats for smaller cyprinids, thus increasing productivity of all species within the fish community. There may be greater benefit to species that prefer lentic environments (e.g., lake whitefish), but abundances of target species (sucker, walleye, pike, sturgeon) will not be negatively affected by the headpond.

The proposed Island Falls Hydroelectric Project will provide for a net increase in the productive capacity of fish habitat in the Study Area. In addition, several habitat compensation measures for altered riffle habitat are being considered (**Appendix G5**). These measures include creation of off-site spawning habitat in the North Muskego River, enhancement of spawning habitat at the base of Island Falls, and stocking of lake sturgeon.

The proposed future condition of the Study Area will be of higher quality (due to increased connectivity as well as improved overwintering and foraging habitat), and provide greater support to the overall fish community than is provided under existing conditions.

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ISLAND FALLS HYDROELECTRIC PROJECT AQUATIC ASSESSMENT

1.0 Introduction

1.1 BACKGROUND

1.1.1 Project Description

Yellow Falls Power Limited Partnership ("YFP") is proposing to build, own, and operate a 20 megawatt ("MW") run-of-the-river hydroelectric generating station at Island Falls on the Mattagami River, approximately 16 km upstream from the Town of Smooth Rock Falls, Ontario (see **Appendix I, Figure I1-1**). YFP was awarded a Renewable Energy Supply ("RES") Contract under the Ontario Ministry of Energy's Renewables II Request for Proposals ("RFP") process and plans to be in operation by the end of 2008. The Island Falls Hydroelectric Project (the "Project") will include site access, generating equipment, powerhouse, sluiceway, emergency spillway, embankment dams, headpond, substation, and a transmission line.

The general partner of YFP is Carlex Corporation Inc. ("Carlex"). Limited partners of Carlex are Canadian Hydro Developers, Inc. (50%) and two individuals (25% each). YFP will draw directly upon the proven construction and operation experience of Canadian Hydro Developers, Inc. ("Canadian Hydro"). With 18 renewable energy generating stations in operation, and 7 under development throughout Canada, Canadian Hydro is recognized as one of Canada's premier developers of EcoLogo® certified low-impact renewable energy projects.

The company operates seven hydroelectric power stations in Alberta and British Columbia and five hydroelectric power stations in Ontario: Moose Rapids (Wanapitei River), Ragged Chute (Montreal River), Appleton (Mississippi River), Galetta (Mississippi River), and Misema (Misema River). In addition to the Island Falls Hydroelectric Project, Canadian Hydro is also pursuing development of its Melancthon II and Wolfe Island Wind Projects, also awarded RES Contracts under RFP II. Four hydroelectric facilities are also under development in British Columbia.

In 2005, YFP retained Stantec Consulting Ltd ("Stantec") to conduct an environmental assessment for the proposed Island Falls Hydroelectric Project. The environmental assessment undertaken by Stantec will meet the requirements of the Ontario *Environmental Assessment Act*, specifically the Ontario Ministry of the Environment's ("MOE") *Guide to Environmental Assessment Requirements for Electricity Projects* (March 2001) as mandated under Ontario Regulation 116/01, the *Electricity Projects Regulation*. Further, the environmental assessment is consistent with the provisions of the *Canadian Environmental Assessment Act* ("CEAA") and requirements identified in the 1990 Ontario Ministry of Natural Resources ("MNR") *Waterpower Program Guidelines* ("WPPG").

This Aquatic Assessment represents the culmination of a rigorous aquatic sampling program developed in consultation with the Ministry of Natural Resources ("MNR") and the Department of Fisheries and Oceans Canada ("DFO"), and carried out by Stantec in 2005 and 2006 as a component of the environmental assessment process. Agency comments on the Draft version of this report and Project team responses are provided as **Appendix VIII**.

1.1.2 The Mattagami River

The Project is located in the Mattagami River watershed, a sub-watershed of the Moose River Basin. The Moose River flows into James Bay. Major tributaries of the Moose River include the Mattagami, Abitibi, Kwataboahegan, Missinaibi, and North French Rivers. Major tributaries of the Mattagami River include the Kapuskasing and Groundhog Rivers (Buttle et al, 1998).

The headwater for the Mattagami River is Lake Mesomikenda, south of Gogama, Ontario. The Mattagami River joins with the Missinaibi River to become part of the Moose River, which eventually flows into James Bay. The Mattagami River is approximately 443 kilometres long, has a total drainage area of approximately 37,000 square kilometres and falls 329 metres over its length (Natural Resources Canada, 2004).

The Mattagami River has been used to produce electricity for more than 90 years. Today, the River supports eight generating stations, with a combined installed capacity of approximately 510 MW. Seven generating stations are operated by Ontario Power Generation ("OPG") and one is operated by Tembec Industries Inc. ("Tembec"). The existing generating stations represent barriers to upstream fish movement, and fish populations on the river are fragmented as a result.

1.1.3 Aquatic History

Commercial lake sturgeon (*Acipenser fulvescens*) fisheries were operated on the Mattagami River between 1927 and 1980. Over these years, more than 100 tonnes of sturgeon were removed from the River. The reach between Lower Sturgeon Generating Station ("GS") and Loon Rapids and the reach between Island Falls and Smooth Rock Falls GS historically contained large numbers of sturgeon and were the prime location for commercial sturgeon fishing efforts (Payne, 1987).

It is believed that commercial fisheries have significantly depleted sturgeon stocks in the Mattagami River and the effects of over-fishing have been exacerbated by habitat alteration and fragmentation resulting from hydroelectric development (Acres, 1990).

In addition to historical commercial fisheries, sport fishing has been, and continues to be prevalent on the Mattagami River. Walleye is the primary sport fish throughout the Study Area, although northern pike are also caught on a regular basis by recreational anglers. A fish sanctuary, downstream of Lower Sturgeon GS, is intended to provide protection to walleye during spawning season (MNR, 2005; 2006) but also provides protection to spawning sturgeon because of an overlap in spawning times.

Assessment of the local aquatic environment has been a prime consideration throughout the lengthy Project history. Aquatic sampling began with a limited study performed by Acres International Limited in July 1989 for inclusion in an Environmental Appraisal of the Project. The scope of work included water quality sampling for turbidity, temperature, dissolved oxygen, pH, colour, nitrate, nitrite, total kjeldahl nitrogen ("TKN"), and phosphorus. In addition, a limited gillnetting program was undertaken, resulting in a catch of 178 fish over five days of sampling.

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Common species identified in the Environmental Appraisal included walleye, northern pike, yellow perch, and shiners. Due to the limited nature of the study, several information gaps regarding the fish population characteristics remained.

A lake sturgeon radio-tagging study of was initiated in the Study Area by Ontario Hydro in 1989, which captured and tagged 10 fish that were tracked during spring 1990. The small sample size and single year of study provides incomplete and inconclusive data, but suggests that lake sturgeon do not move above Island Falls, or below Loon Rapids.

Preliminary investigations by Stantec were undertaken in the fall of 2005. A rigorous aquatic sampling program was developed in consultation with MNR and DFO and undertaken by Stantec throughout 2006, the results of which are presented in this report.

1.1.4 Guiding Questions

The comprehensive aquatic sampling program (spring-summer-fall inventories) was designed to address 10 “guiding” questions related to anticipated or potential aquatic environment effects associated with constructing a hydroelectric facility at Island Falls. The 10 guiding questions were developed through consultation with the DFO and MNR. The answers to each of these questions provide the basis for development of mitigation measures, and potential fish habitat compensation measures (**Appendix G5**), and post-construction monitoring recommendations. Each of the 10 questions is listed below, with a rationale for inclusion.

1. What fish species are currently using the Study Area?

This Study Area represents the habitats that will be influenced by the proposed dam and associated headpond. Areas A, B, and C represent three distinct areas separated in the river by morphological features including Island Falls and Yellow Falls. This question was posed because there is considerable interest in knowing where the species currently occur within the Study Area.

Lake sturgeon was considered to be of special interest in this study, since they are listed by the Committee on the Status of Endangered Wildlife in Canada (“COSEWIC”) as a species of special concern in the Southern Hudson Bay/James Bay area (COSEWIC, 2007), but have not been listed in the Species at Risk Act (“SARA”). Lake sturgeon are considered to be “not at risk” by the Committee on the Status of Species at Risk in Ontario (“COSSARO”), since a risk category has yet to be assigned by the MNR (MNR, 2006a).

Other target species, as identified during consultation with MNR and DFO, include walleye, northern pike, and white sucker. This information will contribute to understanding use of the Study Area by fish, and assists in developing mitigation and compensation plans.

Brook trout and longnose sucker were also initially considered for inclusion as target species, but preliminary sampling results showed the absence of brook trout, and very low densities of longnose sucker. Thus, these two species were excluded from further study.

2. What are the population characteristics of fish that use the Study Area (approximate sizes, age classes, etc.)?

This question was posed because there is interest in knowing whether the Study Area supports a mixture of age classes, or provides habitat only for a limited age class selection. This information assists in understanding use of the Study Area by fish, assessing the effects of the Project, and in developing mitigation and compensation plans.

3. For what life history stages are the fish using the Study Area (e.g., is the area used for spawning, or other 'critical' life functions)?

This question was asked because there is interest in knowing whether the Study Area or specific areas therein, provide habitat for spawning activities, rearing of young, and adult feeding. Understanding whether any habitats are considered critical spawning habitats is an important part of understanding Project effects, and in designing mitigation and compensation strategies.

4. What is the seasonal abundance of fish in the Study Area?

Seasonal abundance of fish species by Area relates very closely to questions 2 and 3 in that the answer provides numerical data relating size and age classes to the particular life stage(s) that use each Area.

5. How common are the habitat types in the Study Area within the Mattagami River system?

The Study Area contains a diversity of fish habitats including riffle, run and pool habitats, each providing a function (rearing, feeding, spawning, etc.) in support of the existing fish community. This question was asked because there is interest in understanding the relative importance of specific habitats, within the broader context of the local and regional reaches of the Mattagami River system, including the identification of potentially limiting habitats.

6. How will inundation change habitat in Areas B and C (i.e., sizes and types and for what species)?

The proposed dam will result in the inundation of 111 ha of land presently occupied by terrestrial habitat, and cause changes to depths and flow velocities in the headpond area. This question was asked because there is a need to understand the consequences of that inundation to fish habitats, and the potential for altering "critical" habitats. The answer to this question will provide a basis for compensation and mitigation options.

7. How will the Project and resulting habitat change affect benthic organisms in the Study Area?

Benthic macroinvertebrates are a significant trophic level in aquatic environments, and provide the linkage between primary production (algae and plants) and fish, in the aquatic food web. Inundation and spillway discharge have the potential to alter substrates and flow regimes, both of which will affect the composition and productivity of

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benthic macroinvertebrates. This question was asked in order to clarify the nature and extent of the potential changes to the benthic community.

8. What fish habitat (i.e., type and amount) creation opportunities exist in the Study Area?

In keeping with DFO's 'no net loss of productive capacity' policy, YFP will be required to provide a fish habitat compensation plan to DFO. DFO typically prefers habitat compensation activities be carried out locally. This question was asked in order to initiate consideration of the potential options for habitat compensation within the Study Area.

9. What is the extent and magnitude of the Project changes to the littoral zone and the riparian area?

Littoral zones (<2 m water depth) are the most productive and diverse habitats in river systems. The creation of the dam and associated headpond will result in raising water levels about 12 m, thus creating new littoral zones at the new water level. This question was asked in order to prompt a discussion of the anticipated effects of the headpond water level elevation on the important littoral zone.

10. How will inundation affect contaminant transport, particularly methyl mercury?

Inundation of terrestrial soils results in the leaching of soil nutrients and the production and release of methyl mercury into overlying waters. Methyl mercury production in headponds can significantly increase mercury levels in fish flesh, thus posing potential risks to fish-eating biota or humans. This question was posed in order to address those concerns.

1.2 OBJECTIVES

The main objective of this Aquatic Assessment is to address the 10 guiding questions presented in **Section 1.1.6** using data and analyses from the 2005 and 2006 aquatic sampling program, coupled with information presented in existing literature and previous fisheries studies (McKinley and Sheehan, 1990; Payne, 1987; Acres International, 1996; ESG, 2000; Acres, 1990; Stantec, 2004; Stantec, 2007a).

This report presents:

- A comprehensive baseline description of the aquatic environment.
- A summary of potential effects of the Island Falls Hydroelectric Project on the aquatic environment.
- A general discussion of potential mitigation measures that address Project-related changes to fish habitat and effects (including beneficial effects) on aquatic receptors.

1.2.1 Report Structure

This report is structured to meet the objectives described above by answering the 10 guiding questions (**Section 1.1.6**). **Section 2.0** provides an overview of the component studies and a

general description of the Study Area. **Section 3.0** characterizes common fish species in the Mattagami River through a literature review. **Section 4.0** discusses the 10 guiding questions using the results of detailed field studies conducted throughout 2006 as well as secondary and historical data sources. **Section 5.0** provides a brief overview of potential mitigation concepts arising from aquatic sampling work. **Section 6.0** discusses regulatory requirements in broad terms, and details the next steps in seeking regulatory approval, presented from the proponent's perspective.

The detailed results of the aquatic studies conducted throughout 2006 are presented as appendices to this report.

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2.0 Overview of Aquatic Sampling Program

2.1 STUDY AREA

The headpond of the proposed Island Falls Hydroelectric Project will occupy a 9 km stretch of the Mattagami River. The existing river reach represents approximately 120 ha of water surface area, while the proposed Project will inundate about an additional 111 ha. The Project headpond will have a total area (including the existing river stretch) of about 231 hectares.

As seen in **Figure I1-1**, the proposed Project will be located between Lower Sturgeon Generating Station ("GS") and Smooth Rock Falls GS. Yellow Falls, located two kilometres upstream from the proposed Project site, is an existing falls feature presenting an impassable barrier to upstream fish movement (see **Figure I2-1, Appendix II**).

The Aquatic Assessment Study Area encompasses reaches of the Mattagami River that are anticipated to be directly affected by the proposed Project. These reaches include the anticipated area of inundation extending from Island Falls to Loon Rapids, and the area of potential downstream effects from Island Falls to the Town of Smooth Rock Falls.

On the basis of the existing environmental and topographic features, coupled with the Project design, the Study Area was divided into three distinct areas for evaluation (see **Figure I2-1**)

- **Area A** is generally defined as the 18 km stretch of river between the Town of Smooth Rock Falls and the Project location at Island Falls. The 500 m reach immediately downstream of Island Falls, where sampling was focused, consisted of two main plunge pools associated with the falls, a deep pool, a shallow shoal, and a run.
- **Area B** is defined as the approximate two kilometre stretch of river between Island Falls and Yellow Falls. This area contains a riffle section approximately 100 m upstream of Island Falls, a large run section, and Yellow Falls
- **Area C** is defined as the approximate seven kilometre stretch of river from Yellow Falls upstream to Loon Rapids encompassing the upper reach of the headpond area (i.e., maximum upstream area of proposed inundation). Major features include a long run section, Davis Rapids, two large islands, and Loon Rapids.

Area C was further subdivided into four reaches to facilitate detailed description of morphological features:

- **Area C1** is a long, moderately deep run extending from Yellow Falls to Davis Rapids
- **Area C2** is a shallow riffle encompassing Davis Rapids.
- **Area C3** is the area between Davis Rapids and the plunge pool associated with Loon Rapids. Pool, run, and riffle features are located throughout this section
- **Area C4** includes Loon Rapids and its associated plunge pool

2.2 COMPONENT TECHNICAL STUDIES

This document summarizes the specific studies that have been carried out during the field seasons of 2005 and 2006. Canadian Projects Limited ("CPL") conducted a LiDAR radar survey of Yellow Falls, and modeled flow velocities over that feature at a variety of flow regimes in order to evaluate the passability of the structure by target fish species during spawning migrations. An important factor in understanding fish use of the Study Area was determining whether lake sturgeon and the other target species could ascend past Yellow Falls, and therefore access habitats within the 40 km reach of river between Yellow Falls and Lower Sturgeon GS (**Appendix II**). Field programs were carried out in 2005 and 2006 for the purpose of characterizing fish communities (**Appendix III**) and fish habitats (**Appendix IV**). Fish habitat characterizations included the development and use of habitat suitability indices in order to quantitatively characterize the suitability of the Study Area for each target species. An invertebrate community inventory was conducted in 2006 (**Appendix V**). Finally, fish tissue samples were collected and analyzed for methyl mercury content in order to characterize the existing mercury levels in fish for later comparison with post inundation mercury levels (**Appendix VI**). The Aquatic Sampling Workplan details data collection methodology and rationale (**Appendix VII**).

3.0 Literature Review

A literature review was conducted to provide relevant background for several issues considered important to understanding the potential ecological effects of the proposed Island Falls Hydroelectric Project. Lake sturgeon, walleye, northern pike, and white sucker were identified as the target fish species for this Aquatic Assessment. The first four sections of the literature review describe the general requirements of these four fish species for migration, spawning, rearing of young, and feeding by adult fish. A review of impingement and entrainment data in run-of-river facilities, along with a review of population dynamics associated with fragmented rivers, was also conducted.

3.1 LAKE STURGEON (*ACIPENSER FULVESCENS*)

Information presented below was compiled from a number of sources, though primarily from peer-reviewed journals. Several general summary and review documents (Auer, 1996; Portt et al., 1999) as well as one Moose River-specific document (Seyler, 1997b) were used as a base for this literature review and supplemented with more recent publications.

Lake sturgeon are distributed extensively throughout the Mississippi River System, Great Lakes, Hudson Bay, James Bay, and the Moose River Basin (**Figure I3-1**). Distribution in Canada spans Alberta, Saskatchewan, Manitoba, Ontario, and Quebec (Scott and Crossman, 1973). More effort has been directed toward understanding the biology of lake sturgeon (*Acipenser fulvescens*) in the Moose River Basin than any other fish species (Seyler, 1997b). Sturgeon presence in the Moose River Basin is essentially limited to rivers; however, there is anecdotal evidence of lacustrine populations near the southernmost edge of their range (**Figure I3-1**; Seyler, 1997b).

3.1.1 Habitat

Lake sturgeon have the broadest habitat requirements of the 27 sturgeon species found world-wide (Peterson et al., 2003). Knights et al. (2002) studied lake sturgeon habitat use in the upper Mississippi River system over an 18 month period and found fish utilized a wide range of depths (< 1 m – 18.4 m). However, most fish were located in areas where depths were less than 7.0 m, most commonly at depths below 3.0 m. Adults tagged above Carmichael Falls on the Groundhog River (NEA, 1992) utilized deep pools during winter months and at the height of the spring freshet. Reported substrate use by adult lake sturgeon varies widely. Knights et al. (2002) found substrates containing silt (silt or silt/sand) were used extensively by lake sturgeon throughout the study, and sand-only substrates were also used frequently, except in the spring.

Knights et al. (2002) found lake sturgeon utilized a wide range of bottom current velocities (0-0.75 m/s) over an 18-month study period, though most fish were located in areas where velocities were less than 0.4 m/s.

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Very little has been reported regarding cover use by adult lake sturgeon. La Haye et al. (1992) noted that lake sturgeon congregated behind large boulders, which acted as breaks from stronger currents.

Predation on sturgeon eggs by longnose and common white suckers has been documented by Rich (1987). Seyler (1997b) noted that no sturgeon eggs were discovered in the gut contents of any fish species on the Mattagami River, but young-of-year ("YOY") sturgeon have been discovered in the gut contents of walleye in the lower Abitibi River (EAG, 1980; Seyler, 1997b).

Life history information for juvenile lake sturgeon is limited. There is evidence that juvenile and adult sturgeon occupy different sections of rivers (McCrudden, 1982; MacRitchie, 1983; Nowak and MacRitchie, 1984). McCrudden (1982) noted that juvenile sturgeon occupied a discrete area at the convergence of a major tributary, the Bushkego River. Seyler (1997a) conducted extensive sampling along the Groundhog River near Faquier, and found that approximately 90% of all sturgeon captured there were juveniles, while reaches located further upstream were inhabited almost exclusively by adults (Seyler, 1997b). Phoenix and Rich (1988) and NEA (1988) note that sections of the Groundhog River near Carmichael Falls also contain predominately juvenile sturgeon. Threader and Brousseau (1986) concluded that 90% of all sturgeon sampled near the junction of the Moose and Abitibi Rivers were juveniles. Auer and Baker (2002) report that larval lake sturgeon drift from upstream spawning sites to areas between 16 km and 45 km downstream, where they remain for much of their juvenile life stage. This explains many of the study results cited above where lake sturgeon populations in lower river reaches are composed predominantly of juvenile fish. The process of larval drift over downstream impassable barriers effectively prevents significant recruitment to upstream lake sturgeon populations, thus the sturgeon populations in the upper portions of the species range are older, and minimal replacement occurs when these fish die.

Seyler (1997b) and NEA (1992) report that juvenile lake sturgeon abundance on the Groundhog River is highest between May and June, in from 4 to 9 m deep pools. Portt et al. (1999) report medium to high use of water depths greater than 2 m. Catch per unit effort (CPUE) data indicate that juveniles utilize a variety of habitat types throughout the summer and autumn, however, pools likely play an important role year round (Seyler, 1997b). Yearlings in Black Lake, Michigan utilized two distinct depths on an individual basis, 38% consistently selecting shallow, nearshore areas (mean depth 2 m) and 62% selected deeper, off shore areas (mean depth 9 m) (Smith and King, 2005). Juvenile fish in the same study (5 to 13 years old) selected deeper off shore areas (mean 9 m).

In the Mattagami and Groundhog Rivers the largest concentration of juvenile lake sturgeon were found adjacent to sand and clay dominated substrates (Chiasson et al., 1997). McCrudden (1982) noted that juvenile sturgeon occupied a discrete area at the convergence of a major tributary, the Bushkego River, where bottom substrates consisted predominately of gravel and rubble. Peake (1999) reported juvenile sturgeon raised in a hatchery preferred sand substrates over gravel or rock, substrate types. Portt et al., (1999) reports substrate use by juveniles to be highest for rubble, gravel, and sand. Yearling and juvenile fish were most commonly associated with sand and sand-organic, and were never found over clay substrates in Black Lake, Michigan (Smith and King, 2005).

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Habitat preference curves indicate that where velocity exceeded 0.7 m/s, sturgeon utilization was very low (Seyler, 1997a).

3.1.2 Movement

All 27 sturgeon species throughout the world use freshwater rivers to spawn, some covering thousands of kilometres to complete their spawning activities (Auer, 1996). Migrations are seasonal with the most extensive movements of lake sturgeon commonly related to spawning activities (McKinley et al., 1998) and least during the summer (McKinley et al., 1998; Borkholder et al., 2002), possibly due to high water temperatures. There is a positive correlation between fish length and migration distance. Auer (1996) concluded that a 1.5 m lake sturgeon should be able to migrate between 1,000 and 1,800 km, though confirmed migration distances of this species are generally between 100 and 200 km.

Lake sturgeon is reported to initiate upstream migrations in late winter for the purpose of spawning (Peterson et al. 2003) and frequently congregate below falls or at the tailwaters below dams to spawn (McKinley et al., 1998; D'Mours et al., 2001; Knights et al., 2002). Several radiotelemetry studies have been undertaken to examine adult lake sturgeon seasonal movement. Knights et al. (2002) found movements of 31 lake sturgeon in the Upper Mississippi River system to be complex and extensive. Movements ranged between 3 and 198 km over an 18-month period. However, because sampling was infrequent (weekly-monthly) and fish were not always located during a sampling period, movement distances may have been greater than reported. Borkholder et al. (2002) found fish remained in a 32-km reach, even though physical barriers were absent both upstream and downstream.

Sturgeon overwintering in the Little Long hydroelectric facility headpond migrate more than 42 km in order to access a suspected spawning site at Cypress Falls on the Mattagami River (Sheehan and McKinley, 1992), even though Noakes et al. (1999) was unable to document spawning success at this site. McKinley et al. (1990) recorded the movements of 19 adults in the Little Long headpond on the Mattagami River. Adults migrated upstream, 42 km to Cypress Falls, an impassible barrier and suspected spawning area, at the onset of spring freshet. After spending several weeks in the vicinity of Cypress Falls, there was a mass migration downstream into the headpond where sturgeon spent the summer months. In the autumn, at low flows, many sturgeon moved back upstream into riverine portions of the system but overwintered in the deeper water of the Little Long headpond. Adults from this population move very little over the course of the winter (Seyler, 1997b).

Phoenix (1991) and NEA (1992) implanted adults with radio transmitters, below Carmichael Falls on the Groundhog River. They were initially captured in a series of pools below the falls in May. By June, many of these sturgeon moved 20 to 30 km downstream and spent the summer months in channel flats and runs. Several individuals moved approximately 3 km up a small tributary, the Wakusimi River, prior to the spring freshet, and moved back into the Groundhog River in July. Very little movement occurred between July and September. The majority of radiotagged sturgeon returned to the initial capture location and remained there over the winter. Following the freshet, sturgeon moved extensively both up and downstream, returning in the autumn.

The results of these studies suggest that adult lake sturgeon move extensively prior to maximum flow periods in order to access spawning sites. However, deep pools may play an important role as refugia following spawning and during winter months. Pools may be of critical importance downstream of peaking operations such as Kipling Generating Station year round. During low-flow periods in late summer and autumn, adults utilize a variety of habitats, likely to forage for food.

Movements of yearling lake sturgeon in Black Lake, Michigan, between late May and mid July are reported to range from 4 to 16 km (Smith and King, 2005). Movements of juvenile lake sturgeon (5 to 13 years) in the same study recorded from July through October ranged from 9 to 23 km. Gillnet catches of lake sturgeon in the Mattagami and Groundhog Rivers indicate juvenile lake sturgeon are more active at night (Chiasson et al., 1997).

Sturgeon are poor swimmers compared to most other large-bodied species (suckers, walleye, northern pike, etc.), and upstream migrations can be inhibited. Burst speeds that can be maintained for a 10 second period are upwards of 1.9 m/s, while prolonged speeds that can be maintained for a period of 60 minutes are upwards of 0.85 m/s (Peak et al., 1996). Maximum flow velocity for a 1.2 m lake sturgeon to pass a 10 m fishway is 1.4 m/s (at 14°C, Peake et al., 1997).

3.1.3 Reproduction

Kempinger (1988) reported that water temperature strongly influences spawning activity of lake sturgeon in the Lake Winnebago system, Wisconsin. Radio telemetry data has shown that large numbers of adults begin moving towards spawning areas several weeks prior to spawning, when water temperatures reach 6 to 9°C (NEA, 1992; McKinley et al., 1990). Researchers have documented peak spawning activity at water temperatures that range between 8.5 and 16°C (Kempinger, 1988; La Haye et al., 1992; Peake et al., 1997; Peterson et al., 2003). Ripe female sturgeon were captured at a spawning site on the Groundhog River at water temperatures of 10 to 11°C, in the third week of May, 1995 (Seyler, 1997b).

Lake sturgeon spawning generally occurs in the upper reaches of larger rivers in fast flowing water (Auer, 1996; Ferguson and Duckworth, 1997). Spawning activity has been reported below rapids on the Mattagami, the Ivanhoe and the Groundhog Rivers (Rich, 1987; Seyler, 1997b), however, Noakes et al., (1999) report finding no evidence of recruitment or spawning of lake sturgeon in the Mattagami and Groundhog Rivers.

La Haye et al. (1992) found spawning fish in current velocities that ranged from 0.61 to 0.84 m/s. Lake sturgeon typically spawn in water depths greater than 0.6 m (Portt et al., 1999). McKinley et al. (1998) found spawning lake sturgeon located close to shore in less than 2.5 m of water at Cypress Falls, Mattagami River (77 km downstream of the proposed Project). Kempinger (1988) found spawning fish under similar conditions on the Wolf River, Wisconsin. La Haye et al. (1992) reported that lake sturgeon eggs were deposited in less than 1 m of water over coarse gravel and cobble substrates.

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Lake sturgeon require large rough substrate for spawning (Portt et al., 1999; Peterson et al., 2003) and embryo incubation (Ferguson and Duckworth, 1997). Lake sturgeon eggs are adhesive, attaching to bottom substrate to incubate (Kempinger, 1988). Seyler (1997b) found large numbers of spawning sturgeon congregated in quiet areas, behind protruding boulders over rubble and bedrock substrate, at the base of an extensive set of rapids. It was unclear whether eggs were deposited and fertilized in these areas. Houston (1987) reports spawning sturgeons' relative utilization of substrate for spawning to be high for boulder, cobble, rubble, gravel, and sand substrates. There is historic and incomplete documentation of lake sturgeon spawning on wave-washed shorelines of lakes (Scott and Crossman, 1973; Carlson, 1995).

Spawning frequency differs between male and female lake sturgeon. Males are reported to spawn every 1 to 4 years, while females spawn every 3 to 7 years (Harkness and Dymond, 1961; Lyons and Kempinger, 1992; Auer, 1996; Smith and Baker, 2005). McKinley et al. (1998) suggest that lake sturgeon in the Mattagami River spawn in alternate years once they reach maturity.

Age at maturity is variable, ranging between 14 to 25 years for females and 16 to 25 years for males with approximate length at maturity for both sexes reported to be between 1 and 1.5 m (Threader and Brousseau, 1986; Peake et al., 1997; Peterson et al., 2003). Gonadal development towards sexual maturity in the Groundhog and Mattagami Rivers (below the present study site) begins at 14 years for females and 18 years for males (Threader and Brousseau, 1986). Additionally, they report the approximate age at first spawning in females to be 20 years and 25 years for males.

Egg incubation periods, hatching times, and YOY lake sturgeon have never been documented in the Moose River Basin. According to Kempinger (1988), lake sturgeon eggs hatch eight to 14 days following fertilization. Upon hatching they burrow into gravel until the yolk is nearly absorbed (Kempinger, 1988). After yolk absorption, young sturgeon begin to drift downstream, predominately at night when water temperatures are between 19 and 20 °C (D'Amours et al., 2001). Kempinger (1988) documented maximum larval drift approximately nine days following the peak hatch and reported the capture of YOY lake sturgeon over smooth sand and gravel substrates in less than one meter of water. Sturgeon fry have been tracked up to 40 km downstream of hatching sites in Quebec rivers (Seyler, 1997b, D'Amours et al., 2001), however, knowledge of YOY habitat utilization remains incomplete. Reports of YOY sturgeon presence in small tributary creeks of the Groundhog and Frederick House Rivers (within the Moose River Drainage Basin) are anecdotal (Seyler, 1997b).

3.1.4 Feeding and Growth

Sturgeon are generalist feeders, foraging almost exclusively on macroinvertebrates. Preferred food items include the mayfly *Hexagenia*, Diptera and Odonata (dragonfly) larvae. Densities of preferred prey items in the Mattagami and Groundhog Rivers are very low (Chiasson et al., 1997), with reported gut contents of sturgeon collected above the Mattagami generating station complex containing primarily *Hexagenia*, Diptera and Tricoptera (greater than 96% of prey items). However, sturgeon captured downstream fed primarily on crayfish and cyprinids.

Chiasson et al. (1997) found macroinvertebrate densities in the Mattagami River to be extremely low when compared to other rivers and suggested that may be the cause of the lower growth rates experienced in the Mattagami River. Seyler (1997b) and Rossiter et al. (1995) suggested that intraspecific competition for limited food resources upstream of the Little Long Generating Station headpond is severe. Preferred food items are absent in leeward areas where extensive bark and wood fiber deposition covers natural substrates. B.A.R. Environmental (1995) noted a decrease in the condition factor for sturgeon immediately downstream of Carmichael Falls Generating station despite a relatively healthy benthic community.

There is a latitudinal growth rate gradient for lake sturgeon. Growth rates are lower for lake sturgeon populations at higher latitudes and increase for more southerly populations (Beamish et al., 1996; Fortin et al., 1996; Noakes et al., 1999). Consequently, lake sturgeon growth rates are directly related to length of growing season and temperature (Beamish et al., 1996; Fortin et al., 1996; Noakes et al., 1998). Growth rates within a population have been shown to vary among years, possibly in response to fluctuating food availability as a result of altered flow regimes (Chiasson et al., 1997; Noakes et al., 1999)

3.1.5 Population Issues in the Moose River Basin

Ferguson and Duckworth (1997) considered the lake sturgeon population in the Moose River Basin to be in generally good condition, despite numbers in the Mattagami River being reduced to a few adults (Payne, 1987). Gibson et al., (1984) and Nowak (1984) found that sturgeon densities in isolated headponds on the Abitibi and Mattagami Rivers were less than one fish per hectare. Density estimates for sturgeon in sections of the lower Groundhog and Mattagami Rivers and the Little Long Headpond range from 3.5 (Nowak and Hortiguella, 1986) to 7.2 fish per hectare (Sheehan and McKinley, 1992). Lake sturgeon captured in these areas were predominately adults. Nowak and MacRitchie (1984) estimated that adult and juvenile sturgeon represented approximately 27 percent of fish biomass in the Frederick House River. The results of NEA (1992, 1993), from a nursery area on the Groundhog River, suggest that sturgeon abundance is very high in such areas.

Munkittrick *et al.* (2000) reported on fish community composition in the Moose River Basin as part of studies of cumulative effects on fish resulting from multiple stressors including dams, pulp mills and mines. Lake sturgeon were found in each of the major Moose River tributaries during surveys through the mid to late 1990s including the Missinabi, Kapuskasing, Groundhog, Mattagami, and Abitibi Rivers. At that time, sturgeon, were considered most abundant in the Groundhog River, and less abundant in the other rivers.

A variety of river uses present challenges to the continued health of sturgeon in the Moose River Basin, notably barriers created by hydroelectric facilities, and commercial and recreational fishing. Dam-related issues are discussed below, with much of the discussion being derived from Seyler (1997b). Impacts caused by fishing are also described below. Despite the presence of numerous metal mines and pulp mills in the Moose River system, there have been no documented impacts on sturgeon resulting from these facilities (SMA et al., 1997; Munkittrick et al., 2000)

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The impacts of habitat fragmentation caused by dam construction are unclear. There is evidence to suggest that restricted spatial habitat is not adversely affecting sturgeon populations, and existing habitat ranges may be sufficient to support adult populations of lake sturgeon (Auer, 1996; Smith and Baker, 2005). Movements by individual sturgeon greater than 50 km have not been reported in the Moose River Basin. Sheehan and McKinley (1992) and Gibson et al. (1984) reported that sturgeon utilize the entire length of river available to them between dams and natural barriers on the Mattagami and Abitibi Rivers, respectively. Many dammed sites (**Figure I3-3**) may have represented natural barriers to migration prior to construction.

However, population collapses have been documented in headponds along the Mattagami River (Nowak and Hortiguera, 1986; Payne 1987) where sturgeon have historically been restricted to specific areas between barriers. The collapses are likely related to other factors (such as habitat alteration) associated with impoundment, as opposed to the area imposed by the barriers. Gibson et al. (1984) and CIMA (1991) hypothesized that the sturgeon populations inhabiting the upper Abitibi are in danger of collapse because of recruitment failures associated with habitat fragmentation and flow manipulations.

NEA (1992,1993) and BAR Environmental (1995) documented anoxic conditions in the headpond of the Carmichael Falls Generating Station on the Groundhog River. Following construction, juvenile sturgeon congregated in the Carmichael Falls Generating Station headpond year round. Sturgeon abandoned the headpond when it became anoxic in the summer of 1992, dispersing upstream and downstream through the dam. Very few sturgeon returned to the headpond four years after the incident. Sturgeon abundance immediately downstream of the facility had reportedly increased, with many downstream fish having been previously captured and tagged in the headpond (BAR Environmental, 1995).

In 1960, the Adam Creek diversion was constructed on the Mattagami River in order to spill excess water around the Mattagami Generating Station complex. Spillway operation in the spring periodically coincides with the return of adult lake sturgeon to the Little Long Headpond following the spawning period. Sturgeon passing near open spillway gates are flushed downstream and become stranded in pools after flows subside (Seyler et al., 1996). Seyler (1997b) suggested that a continual loss of adults predisposes sturgeon populations to collapse, leading to low recruitment. The authors hypothesize that lake sturgeon longevity and repeat spawning are evolutionary adaptations that compensate for high natural juvenile mortality.

Impacts to sturgeon populations by recreational and commercial fishing are difficult to quantify, though trends in commercial catch records have provided good evidence of declining numbers. Lawson (1983) and Nowak (1984) presented recreational catch records for the Lower Groundhog and Mattagami Rivers. Catches are generally low, with about 1 fish for every 20 hours of angling effort (**Table 3-1**). Lawson (1983) noted that the sturgeon biomass removed through angling exceeded commercial harvest, but this was during the 1970's period when commercial harvests were very low. Kristmanson (1989) estimated that less than 1% of angling effort was directed at sturgeon in the Little Long Headpond, below the Groundhog and Mattagami Rivers and that 90% of all sturgeon caught by anglers were released alive. Most sturgeon angled near Carmichael Falls on the Groundhog River, an area inhabited primarily by

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juveniles, are released alive (NEA, 1993). Subsistence fishing for sturgeon is known to occur in the Abitibi, Mattagami and Moose Rivers, however harvests have never been quantified.

Historically, sturgeon were commercially harvested using baited hooks and large mesh gill nets. Commercial licenses were cancelled in the 1970s and mid 1980s primarily due to infractions of license conditions and reduced abundance of 'legal sized' sturgeon within the licensed areas. Nowak and Hortiguella (1986) and Payne (1987) hypothesized that gross overfishing contributed to the collapse of the lake sturgeon population in the upper Mattagami River. Commercial catches in the reach between Yellow Falls and Loon Rapids produced over 400 kg of fish per year between 1927 and 1963 (**Table 3-2**). Catches declined in the 1970s and 1980s to an average of 35 kg of fish per year (**Figure I3-2**).

Table 3-1 Recreational Angling Data for the Moose River Basin (Lawson, 1983; Nowak, 1984; both cited in Seyler, 1997)

Location	Yield (kg/ha)	Yield (kg/km)	Catch per unit effort (number per hour)	Proportion of Harvest (% of total numbers)
Lower Groundhog/Mattagami River (Site 1) (Lawson)	2.52	66.9	0.05	-
Lower Groundhog/Mattagami River (Site 2) (Nowak)	4.5	119.6	0.05	17.6
Lower Groundhog/Mattagami River (Site 3) (Nowak)	3.6	104.8	0.045	17.9

Table 3-2 Commercial Harvest Data for Lake Sturgeon in the Moose River Basin (Seyler, 1997b)

Location	Years	Mean Annual Harvest (kg)	Estimated Yield (kg/km)
Mattagami/Groundhog River	1961 - 1971	2352	2.05
Upper Mattagami River	1927 - 1963	432	0.74
	1970 - 1980	35	0.06
Abitibi River	1935 - 1982	527	0.21

3.2 NORTHERN PIKE (*ESOX LUCIUS*)

3.2.1 Habitat

Northern pike are usually found in clear, cool rivers and are not adapted to life in strong currents (Scott and Crossman, 1973). They tend to prefer low velocity habitats, such as back waters and shallow pools in reaches with low gradients to permit movement between preferred habitats (Inskip, 1982).

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Adult northern pike are most often captured in shallow back eddies, wide areas of rivers, and near the mouths of small, inflowing creeks where flows are low. More frequent substrates consist of sand, silt, clay, or organic material and depth ranges 1-5 m, but sometimes as deep as 12 m (Casselman and Lewis, 1996; Seyler 1997b). As flows decrease after the spring freshet, pike are found more frequently in main channel areas and creek mouths (Seyler, 1997b). Limiting habitat variables in northern rivers may include the availability and accessibility of suitable spawning and nursery habitat, water level fluctuations during embryo and fry stages, availability of slow or backwater water areas, and stream gradient as it relates to flow (Inskip, 1982).

3.2.2 Movement

Generally, pike will migrate very long distances to reach suitable spawning habitat. Authors cited by Inskip (1982) report migration distances between 14 km and 322 km. Northern pike have been shown to have prolonged swimming speeds of up to 0.42 m/s, and burst speeds of up to 4.7 m/s. Currents greater than 1.5 m/s can block upstream movement. Northern pike move upstream into tributaries to flooded wetlands or shallow shorelines to spawn in a variety of habitats; however, it is generally accepted that they spawn in sheltered areas over vegetation in slow, shallow water (Casselman and Lewis, 1996; Seyler, 1997b). Preferred vegetation for spawning are grasses and sedges, but other types may be used (Casselman and Lewis, 1996). Spawning activity in the Moose River System occurs at water temperatures between 3 to 10 °C, and has been noted as early as 30 April and as late as 24 May (Seyler, 1997b).

An important component for management of northern pike spawning and nursery habitat is maintaining beds of emergent and submergent vegetation (Holland and Huston, 1984). Nowak and MacRitchie (1984) and MacRitchie (1983) reported that pike congregate in localized areas to spawn and widely disperse immediately following spawning in the Frederickhouse and Mattagami Rivers.

Northern pike have been shown to have prolonged swimming speeds of up to 0.42 m/s, and burst speeds of up to 4.7 m/s. Current velocities greater than 1.5 m/s can block upstream movement. It is understood that northern pike do not jump during migrations, as data concerning fishway channel construction and lamprey exclusion barriers show maximum heights allowing passage to be very small (McLaughlin et. al., 2004), near 0.2 m (Katopodis, 1992). A structure with a vertical height of 1 m is generally accepted to be impassable by pike (Newbury and Gaboury, 1993).

3.2.3 Reproduction

Pike eggs are often attached to vegetation and submerged debris and generally hatch within 14 days (Scott and Crossman, 1973). During this period they are extremely susceptible to desiccation due to water fluctuations and water level drawdowns associated with dam operations.

Larval pike remain in shallow spawning areas for several weeks after hatching (Scott and Crossman, 1973). These consist of shallow areas (1 m) with detritus covered bottom and sparse vegetation in early summer, to deeper (3 m) clay, boulder, or muck substrates with sparse or moderately dense vegetation later in the summer (Casselman and Lewis, 1996; Seyler, 1997b). Macrophytes provide important cover for young fish and refuge from prey species (Casselman and Lewis, 1996).

3.2.4 Feeding Habits

Young-of-year northern pike are planktivorous for a short period following hatching, after which they become opportunistic feeders, switching to a diet of invertebrates (Scott and Crossman, 1973). As YOY northern pike grow, fish become a major component of their diet (Holland and Huston, 1984), with the most common objects found in pike stomachs being crayfish and dragonfly nymphs (ESP, 1993; EAG 1980). Another food item found less frequently was burbot (EAG, 1980). Northern pike are day active, hunting by sight. It is unknown if high turbidity within Clay Belt rivers has a direct impact upon the foraging efficiency of northern pike in these areas. Shallow areas with instream cover, such as submerged vegetation or debris, are thought to be important in providing hunting cover and, for small pike, refuge from predation (Inskip, 1982).

3.2.5 Population Issues in the Moose River Basin

There are no significant issues of concern for northern pike in the Moose River Basin. This species is abundant in all major tributaries with the exception of the Abitibi River (Munkittrick et al., 2000).

3.3 WHITE SUCKERS (*CATOSTOMUS COMMERSONI*)

3.3.1 Habitat

White suckers are ubiquitous in Canada, being found in every province, and large parts of the US (Scott and Crossman, 1973). Adults are found in slow to moderate flows and in depths ranging from 2-6 m, and over a variety of substrate types. They are typically associated with main channels or near the mouths of creeks (Seyler, 1997b). White sucker fry have been captured in large schools on slow, shallow sand and gravel bars (Sheehan, 1989) and in shallow back eddies or near the mouths of creeks (MNR, 1983). Yearling white suckers have been captured along the edge of mainstem flats and in small inflowing creeks, usually over organic, sand, or gravel substrates. Capture sites were characterized by an absence of vegetation, sparse instream cover and low currents (Seyler, 1997b).

3.3.2 Movement

Adult white suckers will “home” to their natal stream in order to spawn, and will congregate in very large numbers. As discussed in Appendix IV, white suckers will migrate dozens of kilometers (Becker, 1983) from moderately deep pools and other refuge areas to reach their natal stream. Twomey et al., 1984 cite numerous authors indicating that spawning movement usually begins when water temperatures reach approximately 10°C.

The maximum prolonged swimming speeds for white sucker are approximately 0.86 m/s (Jones et al., 1974). Haro et al. (2004) found that white suckers can travel up to 20 m through water flowing at 1 m/s, but can travel at upwards of 4.5 m/s for short (< 5 m) distances.

3.3.3 Reproduction

White suckers spawn in the spring, typically from early May to early June when temperatures reach 10 °C (Seyler, 1997b). They spawn in lake margins or move upstream into tributaries, typically spawning in the daytime over gravel and boulder substrates, in shallow, fast flowing areas. The incubation period for white suckers is approximately two weeks, dependent upon water temperatures. Two weeks after hatching white sucker fry begin to move into lakes (Scott and Crossman, 1973).

3.3.4 Feeding habits

Fry initially feed near the surface on plankton and other small invertebrates. Early in the first year of life there is a shift to benthivorous feeding habits, which persists for the remainder of their life histories (Seyler, 1997b).

3.3.5 Population Issues in the Moose River Basin

White sucker is a dominant species in the Moose River Basin, being prevalent and abundant in each of the major tributaries, including the Missinaibi, Kapuskasing, Groundhog, Mattagami and Abitibi Rivers (Munkittrick et al., 2000). Munkittrick et al. (2000) used this species as an ecological sentinel (indicator) of cumulative effects in the Moose River Basin. Studies by Munkittrick and others (see Munkittrick et al., 2000, page 125) conducted on white sucker in 1991 prior to secondary treatment at the mill in Smooth Rock Falls demonstrated higher growth and larger livers compared to fish from reference locations. During the same set of studies, white suckers collected from within the headpond of the Carmichael Falls Generating Station were larger, and in better condition, with larger livers and gonads than fish from a nearby reference location. Suckers have been found throughout the Mattagami hydroelectric development complex, but with reduced condition and gonad size downstream of pulp mills (ESG, 2004). This effect is thought to be caused by pulp mill effluent, and not inundation.

3.4 WALLEYE (*SANDER VITREUS*)

3.4.1 Habitat

Walleye are native to freshwater rivers and lakes of Canada (Scott and Crossman, 1973). Juvenile and adult walleye habitat requirements are thought to be similar and are frequently caught in the same nets in the Moose River Basin (Colby et al., 1979; McMahon et al., 1984). They are commonly found in pools, wide areas, near the foot of rapids, or adjacent back eddies in depths from 1 to 9 m, over a variety of substrate types including gravel, sand, bedrock or soft substrate (CIMA, 1991; NEA, 1989; NEA, 1992; NEA, 1993; Port et al., 1999). Instream cover is considered important to both life stages and can be described both in terms of water transparency and physical shelter (McMahon et al. 1984). Turbid water conditions in many

rivers in the Moose River Basin likely provide refuge from high light intensities. Instream cover provided by boulders and submerged debris is important in providing velocity breaks in addition to refuge from the sun (Scott and Crossman, 1973). Physical shelter within river channels of the Moose River Basin is provided by islands, pools and back eddies, all of which provide low discharge habitat.

3.4.2 Movement

Movements by adult walleye have been reported to exceed 50 km (Scott and Crossman, 1973; Hagen, 1983; Nowak and MacRitchie, 1984). McKinley et al. (1990) noted that radio tagged walleye commenced upstream movement to spawning sites immediately prior to the spring freshet in the lower Mattagami River. Upon hatching, walleye fry are carried downstream by river currents. High current velocities, particularly near reservoir outlets, can result in high fry mortality (Groen and Schroeder, 1978).

Prolonged swimming speeds of walleye vary between 0.43 and 1.14 m/s, while burst speeds vary up to 2.5 m/s with larger fish attaining faster speeds (**Appendix II**). Walleye can attain speeds of up to 3.5 m/s, but only for short distances (5 m; Haro et al., 2004).

3.4.3 Reproduction

Spawning activity has been observed at the base of many rapids and dams across the Canadian Shield. Spawning typically occurs at night from late April to mid-May after fish reach maturity (males age 2-4, females age 3-8, Scott and Crossman, 1973) and water temperatures range from 3-15°C (Hagen, 1983; Booth et al., 1988; Sheehan, 1989). Becker (1983) indicates that walleye may migrate as much as 160 km between spawning and non-spawning habitat. Spawning success is highly dependant on suitable water temperature and quality, as well as quality and quantity of preferred substrate. Walleye are most often observed spawning over gravel and rubble substrates, in 0.5 to 1.0 m of water (Scott and Crossman, 1973; Booth, 1986, McMahon et al., 1984) with water velocities of 0.5 -1.0 m/s. Spawning of walleye in lakes has been reported to occur on coarse gravel shoals (Scott and Crossman, 1973).

Walleye eggs hatch in 12-18 days, the yolk sac is quickly absorbed, and the larval fish disperse into the upper water column, usually within 10 to 15 days of hatching. By the end of their first summer, YOY walleye move to deeper areas near the bottom of the water column (Scott and Crossman, 1973). During June and July YOY walleye, captured primarily in seine nets, are usually found along stream banks over a variety of substrate types (rubble, gravel, sand, clay, muck, and detritus), in slow to moderate currents (0.8 m/s), at depths between 0.6-2.0 m, with little instream cover (MNR, 1983b). Inflowing creeks and tributaries may represent important sources of food.

Hydroelectric facilities located throughout the Moose River Basin impact walleye spawning success and behavior. Spawning activity has been documented in tailraces and may occur immediately downstream of peaking facilities (Sheehan, 1989). As long as discharges are maintained below hydroelectric facilities throughout the spring freshet, walleye eggs should not be in danger of desiccation (Carson et al., 1991). Peaking operations may expose walleye

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spawning shoals below facilities and managers should be aware of this potential danger where peaking flows commence prior to mid-June.

3.4.4 Feeding habits

Walleye fry are primarily insectivorous but feeding patterns quickly change to piscivorous as their size increases (Scott and Crossman, 1973). Walleye fry feed predominately upon microcrustaceans and likely compete with other fishes for suitable prey (Colby *et al.*, 1979). Several observations of walleye diet in the Moose River Basin have been reported, with the following items listed in order of frequency: crayfish, mayfly larvae, stonefly larvae, dragonfly larvae, walleye, YOY sturgeon, northern pike, longnose dace, and Johnny darters (ESP, 1993; NEA, 1993; Sheehan, 1989; EAG, 1980).

Walleye feed by sight usually near or at the bottom in shallow water (Colby *et al.*, 1979), because of their extreme sensitivity to light (Scott and Crossman 1973). Feeding activity is believed to be greatest during the night and early morning hours. McKinley *et al.* (1990) found that walleye in the lower Mattagami were most active between 1:00 a.m. and 8:00 a.m. In more turbid waters such as the Frederickhouse and Abitibi Rivers, it is possible that feeding occurs throughout the day.

3.5 POPULATION DYNAMICS IN FRAGMENTED RIVERS

The Moose River Basin is a highly fragmented watershed. **Figure I3-3** shows the locations of hydroelectric generating stations and rapids that are known to prevent fish passage (Stokes *et al.*, 1999). Habitat loss and population fragmentation are major threats to the viability of any wildlife population (Ferrerias, 2001; Gibbs, 2001; Nunney and Campbell, 1993; Morita and Yamamoto, 2002; Santos *et al.*, 2006).

Several factors influence the population dynamics of fish species on fragmented river systems. Environmental stochasticity (variation in birth and death rates resulting from environmental influences), resulting from both natural conditions and anthropogenic changes, can result in loss of suitable habitat and population fragmentation. Demographic stochasticity (variability in population growth rates resulting from population structure) and genetic stochasticity (i.e. genetic drift) influence population viability over the long term and can reflect a lack of genetic adaptability in local populations (Nunney and Campbell, 1993).

Natural and anthropogenic catastrophes, including rapid changes in environmental conditions, influx of toxic contaminants, and disease, can stress individuals and potentially result in the mortality of less suitable individuals or even entire communities, especially if individuals adaptable to the new conditions do not exist in the genetic pool.

Past dam construction has had an effect on riverine fish populations. Fragmented populations are confined to relatively small reaches of a river, where habitat may or may not be suitable. In addition to isolating populations, dams may also alter habitat characteristics, especially in inundated areas. The combination of population isolation and habitat alteration can result in reduced species richness, can lower genetic diversity within an isolated population, and can lower effective population size (Santos et al., 2006).

Fragmentation isolates metapopulations of fish (a number of populations using different reaches of a river) into populations that diverge genetically over a long period of time. Depending on size, small isolated populations are exposed to an increased risk of chance extinction resulting from natural or anthropogenic catastrophes. If the population is large enough to survive chance extinction via natural or anthropogenic catastrophes, genetic drift will eventually result in the depression of a number of population fitness components, such as heterozygosity. In metapopulations, connectivity between populations is usually vital to retaining genetic diversity and in preventing genetic or demographic stochasticity. (Gibbs, 2001; Morita and Yokata, 2002; Ferreras, 2001; Wiens, 1997).

To illustrate the effects of river fragmentation on a metapopulation, Jager et al., (2001) created a sophisticated computer model of a river and fragmented it into between one and 20 stretches. The computer model demonstrated that fragmentation alters migration patterns among fish populations and converts free-flowing rivers to more reservoir-like habitat. Increased fragmentation produced an exponential decline in the likelihood of species persistence within isolated stretches. Genetic diversity decreased within populations, but increased between populations. Despite these conditions, the presence of a small amount of limiting habitat prevented habitat loss from amplifying the effects of fragmentation alone. Conversely, lack of any limiting habitat amplified fragmentation effects.

The status of sturgeon populations, regardless of species, demonstrates that the model results described above are at least somewhat accurate in the real world. Sturgeon are depleted, threatened, or extinct almost everywhere they exist (or used to exist). Sturgeon are perhaps uniquely adapted to large rivers featuring seasonally dynamic habitat conditions, such as those found in the Moose River Basin. Individuals often range widely to take advantage of seasonally abundant resources. In addition, seasonal variations in flow, temperature, velocity, and turbidity might summon life-cycle actions such as spawning. Altered morphological conditions and population isolation caused by dams may reduce or eliminate dynamic river conditions necessary for sturgeon survival (Beamesderfer and Farr, 1997).

3.6 IMPINGEMENT AND ENTRAINMENT

3.6.1 Introduction

Entrainment is the intake of organisms through a turbine with the intake water. Impingement is the trapping of fish against a physical barrier, typically a trash rack or screen (U.S. EPA, 2005), due to high flow velocities. Entrainment and impingement is a concern with any water intake or turbine. Impingement and entrainment are of most concern during periods of high fish movements (migration), and both can have significant effects on local fish populations.

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Impingement and entrainment, though not responsible for losses of large numbers of fish, are considered potential threats to fish in the Moose River Basin, particularly for sturgeon because of their low numbers (Seyler et al., 1996; Commerce Management Group, 1997). The objective of this section is to provide an overview of:

- The proposed design of the turbines that will be used at the Project,
- Factors that influence fish movements
- Factors that influence mortality as fish pass through turbines, with specific reference to turbines similar to those proposed for the Project.
- A summary of the anticipated outcome of the proposed turbine design, as it relates to fisheries in the vicinity of Project area.

3.6.2 Proposed Turbine Design

YFP is currently planning to use two Kaplan-type Saxo turbines. These turbines have a variable pitch propeller type, with a 90 degree elbow on both intake and outlet, and with variable vanes to control flow through the intake elbow. The turbine itself is vertically oriented. Trash rack spacing will be 23 mm. Flow velocities through the intake screen will be 0.6 m/s.

3.6.3 Fish Movement

Movement behaviors of stream fishes have been studied extensively throughout North America and the construction of dams has long been recognized to limit migrations of fish and affect fish populations. Movements are often required by fish to complete their life cycles and result from the separation in space and time of optimal habitats needed to maximize production. Furthermore, use of habitats and movements between those habitats are dependent on the life stage and habitat required. In north-temperate areas, including the Mattagami River, fish movements are seasonally cyclic, alternating between spawning, rearing-feeding, and wintering habitats. Juvenile fish typically emerge from spawning habitat and either passively or actively move to their first feeding habitat. This movement may be only a few metres or may be several kilometres. Downstream movement of all of the target species is typically limited during adulthood, but larval drift of lake sturgeon and walleye has been documented in a number of studies (Auer and Baker, 2002; LaHaye et al., 1992; Corbett and Powels, 1986)

3.6.4 Factors Influencing Entrainment and Impingement Mortalities

Generally, depending on intake flow velocity and the spacing and size of trash racks, entrainment typically involves smaller organisms, such as small fish and ichthyoplankton (i.e., fish eggs and larvae), and other aquatic organisms (Cada, 1990). Once entrained in the intake water, organisms will pass through the turbine. Fish injury or mortality is a concern when fish pass through the turbines of hydroelectric facility, as injuries and mortalities can result in negative effects on fish populations. In general, smaller fish suffer lower injury rates passing through turbines, likely due to the ability of smaller fish to pass between gaps in the turbine

blades without making physical contact. Injuries and mortalities can be minimized by reducing the number of entrained fish (i.e., diverting fish from the water intake via physical transportation or bypass) and improving passage conditions within the turbine (Cada, 2001).

The likelihood of an entrained fish sustaining an injury or mortality is affected by several direct and indirect conditions encountered during turbine passage, including: turbine design and associated conditions (rapid pressure change, cavitation, shear stress, turbulence, mechanical damage, grinding), fish size, species, and post emergence predation (Navarro et al., 1996; Cada 2001).

Skanski et al., (2001) re-examined past studies involving Kaplan turbines to determine what design factors affected fish survival. They summarize the results of 25 turbine passage studies, including several dams with similar characteristics as the proposed Project. They reported survival probability of fish from these studies to be greater than 90%, in 90% of the studies, and greater than 95%, in 60% of the studies. It is also thought that the number of turbine blades, speed of the turbines, and dam head contribute to mortality.

Studies of turbine passage survival are commonly focused on economically important anadromous species of salmonids and clupeids. Results of studies of fish passage survivability have varied widely and range from 54 to 100% (Stokesbury and Dadswell 1991, Mathur et al., 1994, Cada 2001, Skalski et al., 2002). Stokesbury and Dadswell (1991) examined Kaplan turbine mortality in juvenile clupeids (YOY American shad, alewives, blueback herring, and Atlantic menhaden) over two years and reported mean mortality to be 46%. Mathur et al., (1994) studied Kaplan type turbine related mortality of American shad at Hadley Falls, Connecticut, and estimated mortality to be 0% ($\pm 14.5\%$, $\alpha=0.05$) with wicket gates 35% open, and 2.7% ($\pm 16.2\%$, $\alpha=0.05$) with wicket gates 100% open. A study of ichthyoplankton mortality in propeller type turbines suggests mortality would be relatively low at a low-head, propeller-type turbine installation, similar to the proposed Project (Cada, 1990). Pressure fluctuations related to sudden changes in depth likely did not have a significant effect on mortality of ichthyoplankton (Cada, 1990).

Another turbine design factor thought to influence fish survival during turbine passage is the operating efficiency of the turbine. Major hydroelectric projects on the Snake and Columbia rivers are required by the National Marine Fisheries Service to operate within 1% of peak turbine operating efficiency under the belief that survival of salmonid smolts is directly related to turbine efficiency with the highest survival occurring at peak efficiency (Cada, 2001; Skanski et al., 2001). Skanski et al. (2001) re-examined past studies involving Kaplan turbines to evaluate this policy and found that efficiency curves for Kaplan turbines have shallow slopes and therefore cover a wide range of values, likely corresponding with maximum turbine survival of fish in many cases; however, there can be an appreciable difference between peak observed survival and peak operating efficiency, depending on other site specific conditions.

Fish size is known to influence survival during passage through turbines. Heisey et al., (1996), studying the effects of small fish (i.e., fish <200 mm in length) passage through Kaplan turbines (similar to those proposed for the proposed Project), suggest a mean survival rate of 96-97% during normal plant operations and a mean survival rate of 95% during inefficient plant

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operations, independent of species type. Therefore, regardless of the operating efficiency, the mean fish survival rate was at least 95% for Kaplan turbines. Consequently, we expect most of the entrained fish passing through the Island Falls power facility will enter downstream areas alive.

Additional factors that can contribute to mortality of entrained fish are fish species and post passage predation. Mortality of entrained fish can be significantly affected by fish species. A comparison of similar sized minnows to bullheads indicated the more delicate minnows had a higher mortality rate (Navarro et al., 1996). Fish passing through a turbine are subjected to a variety of stresses, including shear, change in water pressure, and turbulence. These stresses can cause a loss of equilibrium and disorientation, which can lead to increased susceptibility to predation. These additional factors have not been rigorously studied, therefore the significance is currently unknown (Cada, 2001).

Impingement can be regulated with a number of mitigation options, limiting water velocities, optimizing screen\mesh size, and installing screen cleaners. Impingement may occur to larger aquatic organisms that become entrained in the intake water and trapped against the trash rack. Therefore, in order to reduce the possibility of impinging smaller organisms, trash rack spacing of 23 mm has been proposed for the Project. Such spacing should allow most entrained aquatic organisms to pass through the trash racks without experiencing the effects of impingement.

3.6.5 Anticipated Effects

Entrainment and impingement are anticipated to cause minimal losses to fish in the Project headpond. Trash rack spacing of 23 mm has been proposed, which is expected to exclude all adult large-body fish found in the Study Area from becoming entrained. Velocities at the intake screens will be 0.6 m/s, which is slower than the burst speeds of small sturgeon (0.7 m/s), the poorest swimming species in the river. Note that swimming speeds for all target species in the Project area are reported in **Appendix II** – swim speeds are also discussed in Section 3.0 of this report.

Entrainment in the Project headpond will be minimal because none of the species makes significant downstream migrations. Passive drift may occur in the fry stage for some species; however, during that life stage, fish are of a size that would pass through the turbines with survival rates greater than 95% (Heisey et al., 1996).

Larger fish will be rheotactic (generally swim upstream) when encountering the initial downstream flows associated with the intake (turbines), and will utilize burst speeds to escape intake velocities.

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A great variety of exclusion measures have been developed to reduce turbine entrainment, including spill flows, various screens, barrier nets, and sound- or light-based guidance measures. No single measure or device has been found to be biologically effective, practical, and widely acceptable to regulatory agencies

Appendix 3 in Seyler et al., (1996) describes common techniques for mitigating entrainment including the use of mechanical devices (screens, by-pass systems, traveling screens, wedge-wire screens, etc.). They concluded that physical techniques were generally less effective than behavioral measures, such as air-bubble curtains, strobe lights and acoustic devices. However, responses to stimuli vary greatly by species and size of fish, these methods are generally regarded as ineffective (U.S. Department of the Interior, Bureau of Reclamation, 2006)

A study at the Grand Coulee Dam third power plant provides the following conclusions, strobe lights had little effect on fish during daylight hours and attracted fish at night, however, fish avoided lights at < 10 m distance (Johnson et al. 2005). A study of acoustic deterrents produced mixed results, concluding that acoustic deterrents had little effect on species without swimbladders and species with swimbladders were significantly reduced during test periods (Maes et al. 2004).

Field studies conducted on fish mortality related to impingement suggest that for small hydro projects impingement is negligible. For example, results of various monitoring programs at three hydro sites indicate no evidence of fish mortality caused by impingement (Heisey et al., 1996). Typical sampling methodology involved daily cleaning and monitoring of trash racks for impinged fish (dead or alive).

More recent research conducted by CHD (with significant input from Chris Katopodis of DFO) for the Dunvegan Project in the Peace River, Alberta provided the following estimates of fish fork lengths that are excluded at various bar spacings. Only species coincident at both project locations are included.

Table 3-3 (adapted from P&E, 2003) Estimated fork length ($\pm$ 95% CI) of fish that will be physically excluded by a certain bar spacing based on body width-fork length relationships of fish sampled from the Peace River, 2002.

Species	Estimated Fork Length ($\pm$ 95% CI) versus Bar Spacing (mm)			
	30	40	50	60
Northern pike	379 $\pm$ 88	459 $\pm$ 85	539 $\pm$ 85	619 $\pm$ 85
Walleye	276 $\pm$ 31	353 $\pm$ 31	431 $\pm$ 31	508 $\pm$ 33

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In order to exclude fish of 300 mm or greater, it was determined that the following trash rack spacing was needed:

Northern pike -	20.2 mm ($\pm$ 11.5)
Walleye -	33.2 mm ($\pm$ 4.0)

Trash rack spacing was then calculated using the formula in Katopodis (1992), from which a result of 23 mm was obtained. Since average fork length of adult fish in the target species group within the Island Falls Project Study Area is greater than that found for the same species in the Dunvegan project it is assumed that the trash rack spacing requirement of 23 mm calculated for the Dunvegan Project will more than adequately address exclusion requirements at the Island Falls Project site.

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As discussed in **Appendix III**, the main objective of the aquatic sampling program was to gain an understanding of the aquatic community structure and dynamics within the Study Area. The Island Falls Aquatic Field Sampling Program (Stantec, 2006) was developed in consultation with DFO and MNR, to investigate a series of 10 research questions related to the overall effects of the Project on fish and fish habitat. Quantitative and qualitative data were collected related to fish population characteristics, fish habitat presence and usage, water quality and chemistry conditions, benthic community characteristics and methyl mercury concentrations in fish flesh.

Data were then used to characterize habitat usage by species and life stage, to gain an understanding of the potential effects of inundation and operation on the existing habitat and to provide a basis for calculating a quantitative estimate of losses and gains in future discussions related to DFO's policy of no net loss of fish habitat.

It is important to note that habitat suitability is primarily based upon data gathered in the field concerning actual habitat use by each species, but will be supplemented by HSI modeling where appropriate. As stated in the HSI model created by the United States Fish and Wildlife Service (1982), "the HSI models presented...are complex hypotheses of species-habitat relationships, not statements of proven cause and effect relationships." For this reason, actual field data were used to validate calculated HSI values.

4.1 Q1. WHAT FISH SPECIES ARE CURRENTLY USING THE STUDY AREA?

A diverse fish community exists within the Moose River basin, consisting of 34 species of fish (16 large bodied and 18 small bodied) commonly found in cool and cold-water habitats. Species such as lake sturgeon, northern pike, walleye and white sucker are common in all but one sub-basin (Seyler, 1997). Within the Moose River system, the Mattagami River supports the highest diversity of fish species, with upwards of 30 fish species residing in its waters (Seyler, 1997). The Abitibi River is the next most diverse sub-basin, with 25 different fish species present. A total of 29 species were captured during sampling efforts conducted by Stantec (25 of which were reported by Seyler).

Sampling program design and target species selection was based on this historic research on fish populations, along with other work previously conducted on the Mattagami River by Stantec Consulting Ltd. ("Stantec") (Stantec, 2004; ESG, 2000). Sampling efforts targeted four species (lake sturgeon, northern pike, walleye, and white sucker) due to their ecological, recreational and commercial importance in the Mattagami River system. The target species were finalized through consideration of numerical dominance, ecological and recreational importance, and agency consultation. White sucker are the most common large-bodied fish in the Study Area, followed by walleye, northern pike, and lake sturgeon.

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Lake sturgeon abundance within the Moose River basin as a whole is very low, and the most recent assessment by the Committee On the Status of Endangered Wildlife In Canada ("COSEWIC") has recommended that the James Bay populations, of which the Moose River is a part, be designated a species of "special concern" under the federal *Species At Risk Act* ("SARA"). However, the process of listing this species is incomplete (COSEWIC, 2007). At the time this report was written, no status ranking for lake sturgeon is available under the SARA. Lake sturgeon are considered to be "not at risk" by the Committee on the Status of Species at Risk in Ontario ("COSSARO"), since a risk category has yet to be assigned by the MNR (MNR, 2006a).

Northern pike and walleye are considered top level predators, while white sucker and lake sturgeon are considered benthivores. Environmental effects of any alteration manifest differently, depending on trophic level, with top-level predators frequently expressing the most obvious signs.

The recreational and commercial importance of the various fish species has been taken into account when assessing effects. Historically, lake sturgeon have been a significant part of commercial fishing operations on the Mattagami River. Commercial fishing of lake sturgeon occurred on the Mattagami from 1927 to 1963, and from 1970 to 1980, after which commercial licenses were revoked "primarily due to infractions of license conditions and reduced abundance of 'legal sized' sturgeon within the licensed areas" (Seyler, 1997). Based on the assumption that the average sturgeon weighs 15 kg, harvest rates in Seyler (1997) indicate approximately 700 lake sturgeon could have been removed from the Study Area (Area A) between 1927 and 1980. The removal of such a large number of fish, coupled with the infrequent nature of the species' spawning activity, is likely a major reason for the current low abundance of lake sturgeon in the Study Area, and within the Mattagami River itself. The other major contributor to the decreasing abundance of sturgeon is the presence of numerous dams on the river that do not have fish passage structures capable of passing all migratory species that exist in the river. Lake sturgeon, and to a lesser extent walleye, northern pike and white sucker, are known to migrate long distances to reach spawning grounds (see **Section 3.0**). With the historic construction of impassable dams on the river, many species migration routes to spawning grounds are cut short.

In October 2005, field crews initiated preliminary surveys of portions of the Study Area. Four short-set (4 hours) gillnets were set immediately downstream of Island Falls, each composed of 3 panels of differing mesh size (3", 4", 6"). Netting efforts resulted in the capture of two adult lake sturgeon, one burbot, two white suckers and one longnose sucker. This catch was consistent with species capture lists associated with historical studies (McKinley and Sheehan, 1990; Payne, 1987; Acres International, 1996; ESG, 2000; Acres, 1990; Stantec, 2004; Stantec, 2007).

Intensive fisheries sampling efforts commenced in April 2006 and were timed to coincide with the start of the spawning season for the earliest spawning fish, northern pike. Fisheries sampling continued throughout the spring, and was ongoing through summer and fall. Sampling efforts in 2006 showed that all species except lake sturgeon are present in all Areas (A, B and C) at some time during the sampling period. Lake sturgeon were only caught downstream of

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Island Falls (Area A). Historical information (Payne, 1987) and more recent environmental effects monitoring work ("EEM"; ESG, 2000; Stantec, 2004) support these findings, showing that lake sturgeon have been captured downstream of Island Falls, and upstream of Loon Rapids, but not in the reach between the two.

4.2 Q2. WHAT ARE THE POPULATION CHARACTERISTICS OF FISH THAT USE THE STUDY AREA?

Population characteristics vary between the four target species, due mainly to habitat availability, and sensitivity to anthropogenic activities such as dams and historical commercial fishing activities.

White sucker populations dominate in the Study Area, comprising 51% of the 1486 large-bodied fish captured during 2006 sampling efforts and 59% of the target species captured. Walleye, northern pike and lake sturgeon comprise 20%, 11% and 6%, respectively, of all large-bodied fish species captured. These catch percentages indicate that three of four target species (white sucker, walleye and northern pike) are the most abundant fish species in the Project area. Age data (discussed in Q3) shows that each age class is well represented for white sucker, walleye and northern pike, and therefore these populations are not in decline. Lake sturgeon catch results (**Appendix III**) show a small population that is primarily composed of larger, older individuals (ages and sizes are addressed in detail in Q3). Age-class data (**Appendix III**) show the presence of all life stages of target fish species within the Study Area, except YOY lake sturgeon. Young of year lake sturgeon were not specifically targeted in sampling efforts and their absence from the sampling data does not conclusively determine their absence from the study site.

Age-class distributions for northern pike, walleye, and white sucker indicate healthy populations having a peak number of individuals with mean ages of 4 years, 7 years and 7 years, respectively, after which the number of individuals gradually drops until maximum ages of 8 years, 15 years, and 19 years, respectively are reached. Mean age of lake sturgeon in Area A (the only location in the Study Area where lake sturgeon were found) is 17 years, which is roughly the age of maturity (Seyler, 1997). The lake sturgeon age-class histogram (**Appendix III**) shows results that are significantly different than those found for the other target species. Two peaks occurred in the lake sturgeon histogram, with neither peak corresponding to mean age of lake sturgeon. One peak occurs at approximately 10 years and another broad peak occurred approximately between 22 years and 26 years, suggesting high recruitment in the mid 1990's and early 1980's.

Habitat availability is the main ecological factor limiting species presence in any given reach of the Study Area. The main river channel generally has suitable foraging habitat for white sucker and walleye, but lacks similar habitat for pike and lake sturgeon. This habitat assessment is supported by the low overall catch rate of northern pike, and the complete lack of catch for lake sturgeon in Areas B and C. Because northern pike habitat is generally limited, catch rates for young fish are similar to the low catch results for adults. Large numbers of YOY and juvenile white sucker were restricted to the lower reaches of tributaries as expected, given that typical spawning locations for the species are small tributary streams. Much like white sucker, juvenile

walleye were well represented in catch results generally throughout the Study Area, with the exception of tributaries A and B (**Appendix III**), supporting the statement that populations are sustainable, and not in decline.

The leading anthropogenic activities affecting fish populations are the operation of dams without fish passage facilities and historic commercial fishing. The fragmented nature of the Mattagami River isolates populations of migratory fish such as lake sturgeon and effectively decreases gene-pool size by limiting possible spawning interactions between fish populations. Lake sturgeon do not spawn every year and limited potential for recruitment exists due to larval drift of young to areas downstream of the Study Area. These two factors severely limit population growth and recruitment in a population that is as small as that found at Island Falls, which can result in population collapse. As discussed in Q1, historical data shows that large numbers of lake sturgeon were removed from the Mattagami River between 1927 and 1980. Based on harvest rates cited in Payne (1987) over-harvesting of lake sturgeon has been a major contributor to the small, likely unsustainable population.

4.3 Q3. FOR WHAT LIFE HISTORY STAGES ARE TARGET FISH SPECIES USING THE STUDY AREA?

As briefly discussed in Q2 above, all life stages for white sucker, northern pike and walleye are present in the Study Area. Few (3) sturgeon below the age of 10 years were captured, and only one sturgeon below the age of 8 years was captured (3 years). As indicated in **Appendix III**, lake sturgeon were only captured in Area A despite the apparent suitability of habitat for sturgeon in other parts of the Study Area.

Generally, slower moving run and pool channel morphology within the Study Area supported adult and juvenile fish of all species, (except lake sturgeon in Areas B and C), as it provides ideal resting and foraging habitat. The capture of juvenile and YOY white suckers was restricted to the three tributaries (**Appendix III**), whereas young of all other species (except sturgeon) were captured in the main channel at various points in the Study Area. A single juvenile walleye was also captured in the lower reaches of Tributary A. These results were expected given the typical habitat used by each species for spawning and rearing (**Section 3.0**). Catch data in **Appendix III** also shows that the age classes for all species except lake sturgeon represent stable populations that are not in decline. Lake sturgeon age data indicate that the majority of the population is made up of aging adults and juveniles nearing maturity. Habitat suitability calculations were supported by field observations and historical studies in demonstrating that, although habitat in the Study Area is at least moderately suitable for all life stages of lake sturgeon, no sturgeon exist within the area proposed for inundation.

Yellow Falls is located approximately 2 km upstream of the proposed Project site at Island Falls. Yellow Falls consists of a steep 4-m rise in elevation, and effectively precludes upstream passage, thereby segregating upstream and downstream populations of all target fish species, including lake sturgeon. Lake sturgeon are the least powerful swimmers of all target species, and the ability of these fish to pass upstream through Yellow Falls is highly unlikely in all but very infrequent high flow events (i.e., approximately 1 in 100 years, see **Appendix II**). Population segregation caused by impassable barriers, both natural and manmade, is a

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demonstrated ecological problem on many rivers, and for many fish species. Lake sturgeon and other fish species with very long life spans can be affected by segregation as well as overfishing, more so than other fish species due to their infrequent spawning activity. Most fish species spawn every year after they reach maturity, and will therefore be more likely to find a mate, even if population sizes are reduced. In species such as lake sturgeon that spawn every one to seven years (depending on sex; **Section 3.0**), a small population size, coupled with infrequent spawning, loss of young through larval drift, and limited recruitment from downstream, can mean the inability to find a mate. The consequences of this are low recruitment and eventually population collapse.

The main channel is primarily used by juvenile and adult fish as foraging habitat. Catch results indicated that lake sturgeon spawn at the base of Island Falls, in the fast moving water over large substrate. Walleye also likely spawn at Island Falls on the cobble shoal present at the base of the falls. Some evidence (low catch numbers) of ripe northern pike indicates that limited northern pike spawning habitat may be present below Island Falls. Large numbers of white sucker captured during spring at the base of Island Falls are likely not using the area for spawning (based on the limited amount of suitable spawning habitat present) but are using the area for staging, to ascend Island Falls and spawn in Tributaries A and B. It appears from catch results that none of the other target species are ascending Island Falls in significant numbers during spring. Very low spring catch results for all species in Area B indicate that Area B is likely not used by any species as spawning habitat. In Area C, sampling showed habitat use is primarily limited to foraging and staging for adult and juvenile northern pike, walleye and white sucker, in spite of high suitability values for spawning generated by habitat suitability models for this reach. Several walleye, and a large number of white sucker were captured approximately 100 m to 200 m upstream of the mouth of Rat Creek during the spring, presumably moving to spawning habitats that exist further upstream. Additionally, juvenile white suckers were captured in the lower reaches of Tributaries A and B. Seasonal catch results (**Appendix III**) in Davis Rapids indicate white sucker and walleye are using this area as foraging habitat and not as spawning habitat. All spawning by Area C walleye and white sucker appears to be taking place in Rat Creek. Limited evidence (very low catch results of spawning-condition adults and YOY) (**Appendix III**) of northern pike spawning exists in Rat Creek, so it is presumed that a small amount of spawning occurs in Rat Creek, but most northern pike captured above Yellow Falls have likely migrated there from areas above Loon Rapids.

Table 4-1 Spring: Fish Species Usage by Area

SPECIES	Area A			Area B			Area C		
	YOY	Juvenile	Adult	YOY	Juvenile	Adult	YOY	Juvenile	Adult
Lake Sturgeon		X	X						
Northern Pike		X	X						X
Walleye		X	X		X	X		X	X
White Sucker		X	X			X		X	X

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Table 4-2 Summer/Fall: Fish Species Usage by Area

SPECIES	Area A			Area B			Area C		
	YOY	Juvenile	Adult	YOY	Juvenile	Adult	YOY	Juvenile	Adult
Lake Sturgeon		X	X						
Northern Pike		X	X	X	X	X	X	X	X
Walleye	X	X	X	X	X	X	X	X	X
White Sucker		X	X		X	X	X	X	X

4.4 Q4. WHAT IS THE SEASONAL ABUNDANCE OF TARGET FISH SPECIES IN THE STUDY AREA?

In general, all fish species except northern pike use faster moving areas of rivers and streams during the spring to perform spawning activities. Catch data from the 2006 field program supports this generalization. Lake sturgeon were found congregating in mid to late May in areas of higher velocity, immediately downstream of Island Falls. As outlined in **Appendix III** and in the responses to the previous questions, lake sturgeon catch numbers were very low relative to other target species. A total of 54 adult sturgeon were captured in the spring, all in Area A. Area A was also found to support relatively large numbers of adult walleye and white sucker in the spring. A small number of white suckers and walleye were caught in Area B during spring sampling, and no northern pike and lake sturgeon were caught. Overall Area B appeared very underutilized in the spring based on catch data. Spring sampling in Area C found the highest catch rates were for white sucker (**Appendix III**) captured approximately 100 to 200 m up Rat Creek from Area C presumably to utilize spawning habitat further upstream. As expected, northern pike were found in low numbers in Area C during the spring, due to the unsuitable nature of most habitat in this area for northern pike spawning activities.

Summer and fall catch results generally show a shift in habitat use relative to spring sampling for adults of all species, although in Area A the deep pool – shoal interface continued to provide suitable foraging habitat for all four target species, and catch numbers remained relatively constant compared to spring. However, Area B, which had very low catch results relative to other Areas in the spring, showed increased use by all species except lake sturgeon (which were never found in Area B). Despite the increase in habitat use relative to spring data, catch numbers for all species in Area B were still low relative to Areas A and C during the summer/fall. Supporting evidence for white sucker spawning in Area B tributaries was found during the detailed surveys of both those tributaries in the summer/fall through high catch numbers of very young white suckers. Catch data showed Area C is used by adult northern pike, walleye and white sucker, juvenile northern pike, walleye, and white sucker, and YOY northern pike and walleye. White sucker YOY reside in tributaries and are not likely to be found in the main channel.

In general, slower moving pool and run areas are used by all species as staging areas in spring, and as foraging habitat in the summer/fall. Riffle areas are generally underutilized despite appearing to be suitable spawning habitat for white sucker, walleye and lake sturgeon. It should be noted that riffle habitats with extremely fast flows were not accessible to field crews due to safety concerns. It is possible that walleye and white sucker utilize microhabitats of slower

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water within riffles. However, those areas of very high flow would not be used as principle areas by these species

Catch data also suggests that resident fish populations are the only fish utilizing habitat within the Study Area. Similar catch per unit efforts ("CPUE") are reported for both spring and fall sampling, indicating that there is likely no mass immigration of fish from outside the Study Area to use seasonally important habitats. .

4.5 Q5. HOW COMMON ARE THE HABITAT TYPES IN THE STUDY AREA?

In the area between the two impoundments at Smooth Rock Falls and Lower Sturgeon Falls, pool and run habitats predominate. Abundances of these morphological features within the Study Area generally coincide with abundances found elsewhere in the middle reaches of the Mattagami River outside the Study Area. Five small areas of high-velocity morphology (riffles or falls) occur in this approximately 60 km reach, four of which fall within the Project Study Area. The fifth high-velocity area occurs at the base of Lower Sturgeon Generating Station, an Ontario Power Generation ("OPG") hydroelectric generating facility.

Within the Study Area, the four riffles and falls make up approximately 23% of the river morphology. Based on habitat suitability calculations and relevant literature, these high-velocity areas are optimal spawning habitat for a number of species. Catch data, however, indicate that those areas are not utilized for spawning.

The plunge pool and high-velocity water below Island Falls is the only area of this type where spawning appears to be taking place, based on spring catch data. Catch data also show that white sucker are using tributaries in Areas B and C to spawn rather than the mainstem riffle habitats. Catch data also show that the primary spawning area of walleye and northern pike above Island Falls is Rat Creek. Therefore, despite their apparent suitability, and the limited presence of plunge pool, high-velocity areas and riffle features in the middle reach of the mainstem Mattagami River, the three areas are not identified as locations of limiting habitat for any of the four target species.

4.6 Q6. HOW WILL INUNDATION CHANGE HABITAT IN THE STUDY AREA?

Inundation will generally change the 9 km reach above Island Falls from a lotic type environment to one more lentic in nature. Area B, which is currently a shallow riffle and run type habitat dominated by boulder substrate will become an approximately 15-m deep pool at the dam, with depth decreasing to 9 m at Yellow Falls. The relative abundance of silt as a substrate component will increase over time.

The lower reaches of the two tributaries within 400 m upstream of Island Falls will become lentic habitat with features very similar to the headpond at this point. The upper reaches of these tributaries, which are currently inaccessible because of impassable bedrock shelves, will become accessible due to inundation of the bedrock shelves, providing access to upstream habitat for fish species where access did not exist before.

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At Yellow Falls, although the channel bed elevation rises by approximately 4 m, the depth of the headpond and morphology of the river will continue to create a deep pool, albeit at a relatively shallower depth of approximately 9 m compared to the 15 m depth immediately behind the headworks. In a post-inundation scenario, Yellow Falls may become a deep run, but under most flow conditions will likely change to pool habitat.

River gradient is relatively flat to a point approximately mid-way between Yellow Falls and Davis Rapids, where the depth of post-construction pool habitat created by the headpond will be approximately 6 m. The natural rise in stream gradient and elevation at this location will result in Davis Rapids becoming a 3 to 5 metre deep run after inundation. The gradient remains steep to the top of Loon Rapids, approximately 2 km further upstream. Minimal effects of inundation will be visible at Loon Rapids, where there will be an increase in water depth of approximately 1 m. The approximate upstream limit of the headpond is the top end of Loon Rapids, beyond which no increase in water depth will occur.

The changes outlined above will affect fish and fish habitat, but the majority of these effects are positive or neutral. The process of inundation will have no effect on Area A, but construction and operation of the dam at Island Falls will change flow patterns and morphology in the area immediately downstream of the falls. Post-construction, high-velocity flows will originate from the powerhouse on the southwest side of the river, whereas present conditions have three main chutes of approximately equal discharge spaced across the face of the falls. The post-construction flow conditions will mimic a falls, creating a plunge-pool and run morphology immediately downstream of the powerhouse. Pool morphology will also be created on the northeast side of the river by the back-eddy formed by the dissipating flows. The negligible change in river discharge, combined with standard mitigation measures relating to replacement of original substrate after construction is complete, will ensure that existing habitat, in particular the shoal area downstream of Island Falls will not dramatically change. As a result, current usage by all target species in Area A is expected to be unchanged.

Although inundation will significantly alter Area B habitat, changing it from a shallow riffle/run to a deep slow moving pool, none of the target species utilize this area to any significant extent at any time of the year. The pool habitat created by the construction of a dam at the downstream extent of Area B will provide almost ideal overwintering and staging habitat for all four target species. Nearly ideal foraging habitat for lake sturgeon, northern pike and white sucker is also created by inundation. Over time, it will also create additional spawning and rearing habitat in the littoral area for northern pike with the growth of aquatic plants encouraged by minimal water level fluctuations in the headpond. The plunge pool and high velocity run associated with Yellow Falls at the upstream end of Area B will also become inundated as described above, but again, due to very limited usage by any of the target fish species, no significant negative effects are expected. In fact, the inundation of Yellow Falls will result in the removal of an existing barrier to fish passage, and will therefore connect two previously disconnected areas of the river. As a result, fish will gain access to areas of the river that were previously inaccessible.

Inundation of the lower reaches of two tributaries in Area B will alter two small (between 100 m and 200 m) reaches of white sucker and potentially some limited walleye spawning habitat. However, inundation also creates passage past the previously impassable bedrock shelves in

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both tributaries, creating access for fish to many kilometres of spawning and rearing habitat upstream within these tributaries. HSI calculations, in addition to current knowledge of fish life history requirements, provide evidence that the habitat in upstream reaches of both Tributaries A and B, which is dominated by cobble and sand substrates, is near optimal for white sucker and walleye.

The lower reaches of Area C (Area C1) will become more lentic in nature, much like Area B though not quite as deep. Benefits of inundation will be similar to those found in Area B. All four target species will have access to greater areas of foraging, staging and overwintering habitat, and the littoral area will provide greater opportunities for northern pike spawning and rearing after aquatic vegetation is established. The inundation of Davis Rapids (Area C2) will change the area into a 4 m to 6 m deep run and alter an area of habitat that currently appears to be suitable spawning habitat for lake sturgeon despite the absence of spawning sturgeon. Depths and water velocities in a post-construction scenario will continue to fall within the “highly suitable” range of values for spawning habitat when site conditions are input to the lake sturgeon HSI model. Consequently, inundation will not cause significant adverse effects to this potential lake sturgeon habitat.

Northern pike, walleye and white sucker usage of Davis Rapids is low, and inundation of this area will likely provide increased suitability for foraging and staging for these three species based on HSI values generated in **Appendix III**. The area upstream of Davis Rapids (Area C3) is a diverse mixture of riffle, pool and run habitat that will become predominantly run morphology with a pool and a relatively large shallow area near the upstream end of what is currently Davis Rapids. There will not be a net change in suitability for most target species, with the exception of northern pike which will see an increase in habitat suitability due to the large shallow area created on the western downstream bank of this reach. Loon Rapids (Area C4), along with the large pool and shoal at its downstream end, will be minimally affected by inundation. Based on habitat suitability values, a 1 to 2 m rise in water levels does not significantly alter the habitat suitability of this reach of Area C for any of the three target species (white sucker, walleye and northern pike) that currently use it. Foraging habitat will remain in the pool at the base of Loon Rapids and suitable walleye and sturgeon spawning habitat (despite the current absence of lake sturgeon in this reach) will remain in the rapids themselves.

Inundation will affect Rat Creek, an Area C tributary, by changing the diversity of existing habitat from an almost equal riffle, pool and run composition to morphology dominated by runs. An increase in shallows will also occur as the Rat Creek floodplain is inundated, which will provide an increase in northern pike spawning, rearing and foraging habitat. Overall, net effects will be positive, as the white sucker and walleye that were migrating upstream in spring 2006 will still have access to areas upstream of the inundated area where highly suitable spawning habitat exists.

Net effects on target species will be positive in a post-construction scenario, but it is also important to consider non-game forage fish. Based on current projections, the littoral zone will increase in size by approximately 17% (4.5 ha). Littoral zones are important areas of benthic production (see **Section 4.9**) and diversity and will increase feeding opportunities for several

species, particularly the non-game forage species (e.g., darters, cyprinids). Walleye and pike will benefit as a result of increased forage species productivity.

In summary, changes to habitat as a result of inundation will not result in significant adverse effects in fish habitat. In spite of the theoretically high suitability of some habitat features in the future headpond area, data collected during 2006 sampling show that most habitats typically modeled as highly suitable for critical life functions are not being used by target species within the Project Study Area. Where potential negative effects are anticipated for a particular habitat, inundation provides access to areas with similar or higher suitability and provides habitat for foraging, rearing and overwintering, creating a net positive effect.

Lake sturgeon population declines have likely been caused by habitat fragmentation (through construction of dams and natural barriers), overfishing, and naturally poor recruitment (a result of the the study area being near the upper limits of the sturgeon population in the Mattagami River). Despite the suitable nature of many reaches within the Study Area as lake sturgeon spawning or foraging habitat, literature and current sampling data indicates that no lake sturgeon are present in the area proposed for inundation. The absence of lake sturgeon in the proposed inundation area, combined with the continued suitability of the identified sturgeon spawning area downstream of Island Falls, and the improved suitability of the headpond for sturgeon overwintering and foraging, will result in no net negative effects for lake sturgeon populations or habitat as a result of inundation associated with the proposed Project.

4.7 Q7. HOW WILL THE PROJECT AND RESULTING HABITAT CHANGE AFFECT BENTHIC ORGANISMS IN THE STUDY AREA?

A literature review related to the effects of headponds on benthic invertebrates is provided in **Appendix V**. Within the headpond, several changes to the fauna can be predicted. First, the conversion of a lotic to a lentic habitat will alter the composition of the benthic community. Those forms requiring flowing water (i.e., typically the larger “sensitive” insects) will be replaced by those forms requiring (or tolerant of) still waters (i.e., simpler insects and worms). Benthos will colonize newly flooded soils, initially in high numbers, with numbers declining over time. Deep benthic habitats in the headpond may contain nutrient enriched soil particles, potentially leading to anoxia and further reduction of the benthic community. In the absence of anoxia, enriched sediments may actually fertilize the benthos leading to increased numbers. Anoxia is not likely to occur in the headpond of the Island Falls Project due to its relatively small relative size, and low likelihood of stratification and a water velocity of 0.3 m/s.

Downstream of hydroelectric dams, alterations to thermal and flow regimes, sedimentation, water chemistry and biotic interactions have the potential to alter the benthic community. Discharges of warmer than average surface water may occur. Such thermal enrichment can alter natural reproductive cycles of insects, with subsequent effects on the downstream benthic community. Impoundments typically entrap suspended sediments, removing natural sediment load from the river. There is usually an increase in river-bed degradation downstream of dams leading to armouring of the substrate. Although reservoirs trap some suspended solids, they can export large quantities of limnoplankton that become food for filtering invertebrates (e.g., some caddisflies and blackfly larvae).

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The effects of impoundments on benthos have been demonstrated numerous times. Run-of-the-river hydroelectric developments do not have the same effects on benthos as other more typical peaking dams or dams built for flood protection. At Carmichael Falls Generating Station on the Groundhog River (with a 9 km headpond), even though mid-summer temperatures were as much as 5°C higher downstream (generally within 1°C), there were no apparent effects on the benthos (ESG, 1999). Sensitive benthic taxa such as mayflies, stoneflies and caddisflies were present downstream.

Though headpond creation represents a substantive alteration to benthic habitats, the inundation will approximately double the local area of wetted habitat. Additionally, there will be a 4.5 ha increase in littoral zone (see **Section 4.9**), where benthic community composition will be diverse and productive. Benthos in the littoral zone will be more productive than benthos in the sub-littoral and profundal areas of the headpond, and should include numerous mayfly taxa, as well as chironomids, worms, snails and clams, among other taxa, that would serve as food supplies for lake sturgeon, white sucker and other benthic feeding fishes.

In summary, the conversion of riverine habitats from running water (lotic) to more of a standing-water (lentic) environment is anticipated to change the benthic community from one dominated by large insects (mayflies, stoneflies, caddisflies) to one dominated by smaller insects, Crustacea, amphipods, Mollusca (clams, snails) and worms. Benthic communities will continue to provide food for the variety of fish species that use the inundated reach. Further, the amount of littoral area created by the inundation will increase, thus increasing the productive potential of that habitat type.

4.8 Q8. WHAT FISH HABITAT CREATION OPPORTUNITIES EXIST IN THE STUDY AREA?

The proposed impoundment structure (powerhouse and embankment dam) will cover an area of approximately 1000 m², with alteration of riffle habitat associated with headpond formation, as well as some riffle spawning habitats in the tributaries to the mainstem of the Mattagami River. None of the affected riffle habitats are considered critical to fish populations and losses will be offset through headpond inundation. Inundation associated with the creation of the headpond will nearly double the existing aquatic habitat area within that reach. The river reach between Island Falls and Loon Rapids currently occupies 120 ha, while the inundated area will add 111 ha of additional aquatic habitat for a total river area of 231 ha post-construction. The headpond will provide 17% more shallow littoral habitat (i.e., < 2 m deep) than currently exists (i.e. 4.5 ha). This new littoral habitat is anticipated to be highly productive in terms of generating benthic and fish biomass (**Appendix IV**). The increase in littoral fish habitat will benefit a number of species, including those that require slower velocities such as YOY pike and white sucker, and smaller-bodied species such as shiners (common, emerald, golden, spottail, rosyface), dace (northern redbelly, finescale), darters (Johnny, Iowa), and brook stickleback. The deep pool habitat within the headpond will provide adult foraging and overwintering habitat for each of the four target species and deep habitats will also benefit additional species such as lake whitefish, which are relatively rare in this stretch of the Mattagami River.

Section 5.0 provides a review of potential constructed fish habitat creation options. As described in Section 5.0, the size and flows associated with the Mattagami River and its tributaries, as well as the limited access to these areas, creates limitations to construction of artificial habitats. Section 5.0 also provides a review of opportunities to minimize the effects on the sturgeon populations of natural downstream larval drift and the minimal recruitment into upstream populations.

4.9 Q9. WHAT IS THE EXTENT AND MAGNITUDE OF THE ANTICIPATED PROJECT-RELATED CHANGES TO THE LITTORAL ZONE AND THE RIPARIAN AREA?

The Project will increase water levels at the proposed generating station by approximately 13.5 m. The increase in water levels will alter light regimes in the river and inundate ~ 111 ha of land that is presently occupied by terrestrial and wetland habitats. The objective of this section is to review the potential changes to the limnology of the river within the headpond, with emphasis on understanding potential changes in the littoral zone of the river.

Definitions

The **littoral zone** of a waterbody is the area from the water's edge down to the depth at which sufficient light is available for the growth of aquatic macrophytes (Cole, 1994). The bottom substrate in this zone can consist of soft mud, sand or rocks. Typically, there is also a large amount of plant debris, including leaves, stems, twigs or whole trees that may fall into the water from the riparian zone. The littoral zone is used by numerous species of fish, benthic invertebrates, and zooplankton for feeding, resting, reproduction and nursery habitat (USEPA, 2004). Water temperatures and dissolved oxygen concentrations can be higher in the littoral zone than in deeper areas, so invertebrates and their food grow more quickly. The littoral zone is important to the aquatic ecosystem due to the diversity of plants and animals that inhabit the area. The benthic invertebrate community in the littoral zone has greater diversity and annual production relative to communities in deeper areas (Cole, 1994). This is due to the abundance and variety of habitats available in the near-shore area. Small fish and invertebrates use the plants for shelter and feed on the algae and insects growing on the plants. The presence of small fish attracts larger fish that prey upon them. Large woody debris (i.e., fallen trees) provide excellent cover for small fish, and can play a large role in increasing the diversity and productivity of the aquatic food web (Northcote and Atagi, 1997).

The offshore **limnetic zone** is the surface layer of a waterbody where most of the light is absorbed. Because it is offshore, it supports fewer species of fish and invertebrates relative to the littoral zone. At certain times of the year, some fish and invertebrate species that spend daylight hours hiding on the bottom rise to the water surface at night to feed. Some aquatic insects that develop in lake or river sediments attract foraging fish as they move through the limnetic zone to reach the water surface and fly away.

The **profundal zone** is made up of deeper, colder water where light penetration is poor, and aquatic macrophytes are absent. Primary productivity by phytoplankton is also low due to the absence of sunlight. In the presence of sufficient dissolved oxygen levels, the profundal zone

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will support a variety of benthic invertebrate and fish species. Many fish species that use this type of habitat migrate to shallower littoral areas to spawn.

Effects of Inundation on the Littoral Environment

Northcote and Atagi (1997) present a model showing the changes in nutrients in reservoirs after flooding. Initial leaching of nutrients from the soil causes an initial sediment oxygen demand (SOD). Dissolved oxygen concentrations, therefore, decline shortly after flooding. Dissolved nutrient concentrations spike initially (2 to 5 years), and gradually decline over time (maximum 5-10 years) as nutrients are released from rotting vegetation and from soils. On rare occasions compounds toxic to fish (e.g., terpenes, topolones, lignans, etc.) have been shown to leach from decaying vegetation causing effects on fish and invertebrates (Pease, 1974). Water quality effects associated with inundation are not always long lived (Ball et al., 1975).

Aquatic primary producers typically benefit from the flooding of the terrestrial environment, because of the release of dissolved nutrients. Substantive growths of periphyton (attached algae) can be expected to grow on hard surfaces (fallen trees, logs, stumps) in response to the spike in nutrients. Rooted macrophytes, protected by in-water structures (fallen trees, etc.) can also increase in density within reservoirs and headponds in response to the new nutrient supply (Thomas and Bromley, 1968). The removal of the topsoil layer prior to flooding has been shown to reduce nutrient supplies and limit growths of algae and plants (Campbell et al., 1975). This mitigation measure is not practical due to the areal extent of headpond.

Invertebrates can also benefit from the flooding of terrestrial vegetation. Chironomids (midge larvae), and other algal grazers (snails, some mayflies, etc.) can benefit from surges in the biomass of periphytic algae (Aggus, 1971; Wiens and Rosenberg, 1984). Zooplankton can also increase in numbers, especially if there are areas of still water in the newly flooded environment (Northcote and Atagi, 1997). Benthic invertebrate communities were more diverse in the littoral zone of the Campbell Reservoir (Campbell River, BC) than in the littoral zone of a control lake (Northcote, 1996). Aggus (1971) showed high numbers of the chironomids *Glyptotendipes*, *Polypedilum* and various Tanytarsini during the first three years of impoundment.

As with invertebrates and plants, the presence of downed trees within headponds and reservoirs can provide nursery habitat for young fish, and thus feeding habitat for adults (Northcote and Atagi, 1997). Abundances of fish can increase even with clearcutting and burning much of the remaining woody debris (e.g., Stables et al., 1990).

Expected Changes to the Littoral Zone and Anticipated Effects

The littoral zone (<2 m water depth) within the proposed headpond footprint currently covers 23.6 ha. After inundation, the littoral zone will cover approximately 28.12 ha, an increase of approximately 4.5 ha (17%). The existing "littoral" environment occurs throughout the channel, and has significant areas with high flows, with substrate that is predominantly gravel and coarse rock. The proposed future condition will have reduced velocities at all flow volumes. Currently, average flow velocities at average flow volumes are generally greater than 1 m/s. After inundation, velocities will generally be reduced to an average of 0.3 m/s. Slower velocities in

the headpond will be associated with buildup of fine sediments, especially along the margins of the headpond in the littoral zone, and in deeper sections of the headpond.

The littoral zone of the new headpond will contain a benthic community that is relatively productive and diverse. The mayfly *Hexagenia*, a major food item in the diet of lake sturgeon and white sucker, is a common invertebrate in depositional reaches of the Abitibi River (C. Portt and Associates and Jacques Whitford, 2004), and can be expected to increase in numbers in the depositional areas of this reach of the Mattagami River. The littoral zone can also be expected to support large numbers of chironomids, worms, snails, and bivalves, all of which will provide food for sturgeon, white sucker, and other benthic feeding fishes.

4.10 Q10. HOW WILL INUNDATION AFFECT CONTAMINANT TRANSPORT, PARTICULARLY METHYL MERCURY?

Inundation of the proposed headpond will flood 111 ha of previously terrestrial and wetland habitat. Flooding will facilitate methylation of mercury in the short term, and will likely lead to short-term and modest increases in mercury concentrations in tissues of game fish within the vicinity of the proposed headpond. Concentrations of mercury increased moderately in walleye within the headpond of the Carmichael Falls Generating Station. The headpond associated with that facility is about 9 km long, and resulted in minimal flooding of the surrounding terrestrial environment (ESG, 1999). Being similar in size and conformity, similar increases in fish body burdens of mercury can be anticipated in the headpond of the proposed Project.

Concentrations will likely increase early in the life of the headpond, and decline over time, with declines commencing 10 to 20 years after inundation. The primary feasible mitigation technique involves cutting and removing timber, and grubbing (stump and large root removal) to remove large woody material (**Appendix VI**).

Increases of mercury concentrations in fish tissue can be anticipated to be limited spatially. Seyler and Kristmanson (1999) demonstrated that though walleye in headponds tend to have elevated mercury concentrations, concentrations in fish downstream of headponds tend to be at background or pre-impoundment levels. That phenomenon was observed at Carmichael Falls post inundation (ESG, 1999).

Concentrations of mercury in fish caught from within the Study Area are below consumption guidelines for the general population except young children and women of child-bearing age (**Appendix VI**). With enrichment of methyl mercury, concentrations could increase, but would not require further restrictions in consumption.

4.11 SUMMARY

The Study Area supports over 25 species of fish, including important game species (northern pike, walleye) and lake sturgeon, a species of significant interest and recent focus by COSEWIC.

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Although upstream fish passage over Island Falls was found to be generally limited to white sucker, the proposed dam will create a barrier to upstream fish migration, while the headpond will increase the surface area of fish habitat. Changes to the characteristics of the river within the headpond area will occur, but those changes are anticipated to result in a net benefit to most species.

The Study Area does not contain any habitat vital to the survival or recovery of fish species present in the Study Area. The area below Island Falls provides adult feeding and spawning habitats for all four target species in varying amounts. Spawning habitats within the tributaries that are currently used by the white sucker will be inundated. Inundation of the headpond, however, will result in removal of instream barriers in tributaries A and B, and allow fish access to extensive spawning habitat in upstream reaches.

Numbers of lake sturgeon in the study area are below values that are considered necessary to support a healthy, self-sustaining population. Age classes indicate generally poor recruitment, though there was apparently strong recruitment 10 yrs ago. The local sturgeon population is negatively affected by barriers at Smooth Rock Falls (impassable dam), Yellow Falls (impassable falls), and Lower Sturgeon Falls (impassable dam). A commercial fishery that operated between 1927 and 1980 depleted numbers of sturgeon within the Study Area. The currently fragmented nature of the population limits genetic mixing, and minimizes the size of the local spawning populations, especially considering that female fish do not spawn every year. Data suggest that sturgeon currently do not ascend Yellow Falls, and only white sucker were found to ascend Island Falls. The construction of the dam will, therefore, have no net negative effect on the local sturgeon population.

The proposed headpond will result in a significant increase in fish habitat and fish productivity within the Study Area. The headpond will almost double the available fish habitat and create valuable overwintering habitats for the four target species. Furthermore, headpond creation will increase the littoral zone by 17% (4.5 ha)

Overall, water quality may be moderately degraded due to reasons such as nutrient enrichment and an increase in TSS in the short term, but is anticipated to return to background quality within 2 to 5 yrs. Mercury concentrations in the flesh of sport fish (walleye, northern pike) can be expected to increase in the headpond, but not above levels that pose significant risk to most casual consumers. Like changes in water quality, changes in mercury content of fish flesh within the headpond is anticipated to decrease to normal levels within a reasonable time (~ 20 yrs) after inundation. An increase in the size of the littoral zone will increase rearing and feeding habitats for smaller cyprinids etc., thus increasing productivity of all species within the fish community. There may be greater benefit to species that prefer lentic environments (e.g., lake whitefish), but abundances of target species (sucker, walleye, pike, sturgeon) will not be negatively affected by the headpond.

The proposed Island Falls Hydroelectric Project will provide for a net increase in the area and productive capacity of fish habitat in the Study Area. The proposed future condition of the Study Area should produce higher quality foraging, overwintering and staging habitats, and also provide greater support to the overall fish community than is provided under existing conditions.

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5.0 Mitigation/Compensation Concepts

Alterations to fish habitat in the Mattagami River, resulting from the construction of the proposed dam, will require YFP to obtain an authorization from the Department of Fisheries and Oceans. As discussed previously inundation of the headpond is partially self-compensating in that there is a net gain in aquatic habitat. However, the lentic nature of the headpond and alteration of riffle habitat need to be considered. Thus, options addressing alterations to riffle habitats were reviewed. The principal options under consideration for mitigating and compensating habitat alteration are provided in **Appendix G5**.

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6.0 Permits and Approvals Process

The Island Falls Hydroelectric Project must secure approval from a number of provincial and federal agencies prior to construction. With specific regard to potential aquatic effects, Authorization must be received federally from the DFO pursuant to Sections 32(1) and 35(2) of the *Fisheries Act*.

Although not currently listed under SARA, the James Bay lake sturgeon population (of which the Mattagami River population is part of) have been designated by COSEWIC as “special concern”. As such, consultation is ongoing regarding its listing under SARA, and any works having potential effects to lake sturgeon populations may be assessed informally with SARA conditions. Provincially, approval for the Project is required from MNR in accordance with the *Lakes and Rivers Improvement Act*.

6.1 NEXT STEPS

The next steps in the permitting and approval process, as perceived by Stantec and YFP, are outlined below:

- Consultation with agencies regarding the results of this report
- Consultation with agencies regarding mitigation options
- Development and submission of a detailed mitigation plan with the feedback of relevant agencies and stakeholders
- presentation of the aquatic assessment and accompanying mitigation options to the public as part of the environmental assessment processes (MNR/provincial/federal)

Stantec and YFP believe that discussion with relevant agencies and stakeholders will be vital in maximizing the potential positive benefits resulting from identified mitigation opportunities for the Island Falls Hydroelectric Project,.

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8.0 Glossary of Terms

Definitions related to morphology and substrates are adapted from MNR *Manual of Instructions – Aquatic Habitat Inventory*, 1984.

Term	Definition
Allochthonous	Referring to nutrients and organic debris within an aquatic system that originated outside of that system.
Anoxia	The condition of a mass of water that has had most or all of its dissolved oxygen removed.
Bedrock	All exposed rock with no overburden
Benthic	Pertaining to or associated with the substrate below a body of water.
Benthic macroinvertebrate/ invertebrate	Organisms without backbones living in and around the substrate below a body of water. Macroinvertebrate refers to organisms visible to the naked eye.
Benthos	Organisms living in and around the substrate below a body of water.
Biomass	The total mass of organisms within a given area. Typically this is limited to fauna.
Boulder	Rock over approximately 25 cm (10 inches) in diameter.
Clay	A material of inorganic origin with a greasy feel between the fingers and no apparent structure.
Cobble/Rubble	Rock material between 8 cm (3 inches) and 25 (10 inches) cm in diameter
Collector	A trophic strategy whereby the organism concentrates food particles before consumption. Collectors include gatherers and filter feeders.
CPUE	Catch Per Unit Effort. The number or weight of fish caught using a particular method or gear over a particular time period.
Density	The total number of organisms within a specified area.
Depositional	Describing a habitat or environment where entrained sediment particles fall and collect on the bottom as water velocities become too slow to keep them entrained.
Detritus	Dead, decaying woody and herbaceous plant material
Diversity	The number of distinct taxa in a given area or environment.
Emergence	A stage in the life cycle of many aquatic insects which takes place after transformation into the adult form, characterized by the adult extracting itself from the pupal case (a cocoon-like form) and leaving the aquatic environment, usually by flying away.
Epilimnial	Referring to the layer of water above the thermocline in a body of freshwater.
Erosional	Describing a habitat or environment where the substrate is being

ISLAND FALLS HYDROELECTRIC PROJECT AQUATIC ASSESSMENT

Glossary of Terms

February 2009

Term	Definition
	entrained and removed, usually by increased water velocity.
Falls	An abrupt vertical or near vertical drop of river water over a precipice. The tailwater is usually turbulent and deep.
Fauna	Members of the Animal Kingdom.
Fecundity	A measure of an organism's ability to reproduce and produce offspring.
Filter Feeder	A trophic strategy whereby the organism uses various anatomical or constructed structures to trap suspended particles from the water column to attain nutrients.
Gatherer	A trophic strategy whereby the organism acquires nutrients from organic deposits or films on the surface of the substrate.
Gravel	Rock material between 0.2 cm (1/8 inch) and 8 cm (3 inches)
Hyporheic	Referring to a zone or area in a body of water where groundwater and surface water mix.
Impoundment	The mass of relatively still water that collects behind a structure that restricts the flow of water in a river, stream or creek. The water behind a dam is an example of an impoundment. Also called headpond or area of inundation.
Lacustrine	Pertaining to, produced by or inhabiting a lake or lakes.
Lentic	Referring to still water, such as lakes, ponds and impoundments.
Lotic	Referring to flowing water, such as rivers streams and creeks.
Morphology	The structure and form of a stream channel e.g.: Riffles, pools, runs and shallows.
Nymph	A stage or stages in the life cycle of many aquatic insects after the egg stage and before the adult stage.
Pelagic	Referring to open water, far removed from the substrate or structure.
Plankton/Limnoplankton	Microscopic organisms living within the water column. Limnoplankton refers to plankton living in standing water such as a lake or impoundment.
Pools	Deep, slow moving bodies of water. Because of the appreciable decrease in current speed through the pool, the bottom is often composed of silt, debris and sand.
Production/Productivity	The increase in biomass for a particular area within a particular period of time.
Riffles	Shallow, swift flowing sections of streams where the water surface is broken and in many cases gravel, rubble, or boulders break the surface.
Riverine	Pertaining to, produced by or inhabiting a river or rivers.
Runs/Flats	Shallow (relative to pools), slow (relative to riffles) moving sections of water. The bottom is usually relatively featureless (bathymetrically) and composed of rock, silt or fine sand.
Sand	Material of crystalline rock origin less than 0.2 cm (1/8 inch) but

ISLAND FALLS HYDROELECTRIC PROJECT AQUATIC ASSESSMENT

Glossary of Terms

February 2009

Term	Definition
	large enough to be palpable as grit.
Scraper	A trophic strategy whereby the organism uses various anatomical structures to remove attached periphyton or algae from surfaces to be used as a food source.
Sedimentation/Siltation	A process by which entrained particles in the water column fall to the substrate and collect. It is usually associated with a reduction in water velocity.
Shallows	For the purpose of this study, Stantec Consulting Ltd. defined Shallows as areas having a depth less than approximately 2 metres. They are areas with little flow, frequently within 3 metres of shore, or surrounding an island. Substrate is predominantly fine grained particles such as sand, silt, clay mixed with sparse gravel or cobble.
Shredder	A trophic strategy whereby the organism breaks or chews larger organic debris into smaller organic debris to attain nutrients.
Silt	An inorganic material of various origins finer than sand (i.e. not large enough to be palpable as grit)
Substrate	The inorganic and/or organic material that forms the bed of the watercourse e.g.: Boulder, bedrock, etc.
Succession	The predictable ordered progression of the life cycles of all taxa in a benthic community relative to one another.
Taxa Richness	The number of distinct taxa in a given area or environment.
Taxon/Taxa	A distinct named group of organisms at any particular level. For example, all organisms of a particular species, group of species, genus or group of genera can be considered a taxon. Taxa is the plural form of taxon.
TDS	Total Dissolved Solids. The dissolved matter found in water comprised of mineral salts and small amounts of other inorganic and organic substances.
Thermocline	The boundary layer between the warmer well-mixed surface water and colder deeper water in lacustrine environments.
TKN	Total Kjeldahl Nitrogen
LT50	median lethal time Statistically derived average time interval during which 50% of a given population may be expected to die following acute administration of a chemical or physical agent (radiation) at a given concentration under a defined set of conditions.
YOY	Young-of-Year

Appendix G2

2007-2008 Aquatic Studies

EMAIL TRANSMISSION

**Golder Associates Ltd.**

1010 Lorne Street
Sudbury, ON, Canada P3C 4R9

Telephone: 705-524-6861
Fax Access: 705-524-1984

DATE: June 12, 2007 **JOB NO:** 07-1195-0014

TO: Scott Hossie
Ontario Regulatory Affairs
Yellow Falls Power LP

FROM: Rob Mellow **EMAIL:** rmellow@golder.com
John Seyler jseyler@golder.com

**RE: SUMMARY OF SPRING 2007 FISH CAPTURE SUMMARIES –
MATTAGAMI RIVER**

Dear Scott:

This memorandum contains a summary of field activities and preliminary findings completed by Golder Associates Ltd. (Golder) in May 2007, as part of the Spring Fish Habitat Utilization Study on the Mattagami River. The 2007 study was conducted by Golder to provide supporting fish community and habitat information to Yellow Falls Power Limited Partnership's (YFP) proposed Island Falls Hydroelectric Project (the Project). It is our understanding that this memorandum will be used to provide further interim information to the Department of Fisheries and Oceans (DFO) and the Ministry of Natural Resources (MNR) to facilitate their review of the Project and inform discussions relating to mitigation and compensation requirements for the Project.

This study follows similar works conducted by Stantec Consulting Ltd. (Stantec) in 2006, as documented in Stantec's 2007 report titled *Draft Aquatic Assessment – Island Falls Hydroelectric Project* (the Stantec study). Both the Stantec study and the works described herein are founded on the methodology developed in the *Island Falls Aquatic Field Sampling Program* prepared by Stantec in consultation with YFP, the MNR and the DFO.

As in the Stantec study, four species of interest were targeted during the spawning period: northern pike – *Esox lucius*, common white sucker – *Catostomus commersoni*, walleye – *Sander vitreus* and lake sturgeon – *Acipenser fulvescens*. The objectives of the spring 2007 study were to document the presence of spawning fish, representing the target species at selected locations on the Mattagami River and in inflowing tributaries, confirm spawning locations using substrate mats to capture eggs and measure habitat parameters (i.e. water temperatures, depths, velocities,



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substrates) at both fish and egg sampling locations. A final report detailing netting and egg mat effort and locations and habitat assessment data will be submitted following the completion of the summer component of the fisheries investigation.

Field crews were mobilized to the Mattagami River during the week of April 30, 2007 and field work was conducted from May 4 to May 23, 2007, within three study areas defined as follows:

Area A – Area immediately downstream of Island Falls and including three tributaries to the Mattagami River located approximately 10 to 14 km downstream of Island Falls (Bradburn Creek, Pullen Creek and the North Muskego River). These tributaries were added to the area of study for the spring 2007 field investigations.;

Area B – Yellow Falls (reach immediately below Yellow Falls) and Tributaries ‘A’ and ‘B’, directly upstream of Island Falls; and

Area C – Loon Rapids and Davis Rapids within the Mattagami River near the southern end of the proposed headpond, and Rat Creek, a tributary to the Mattagami River located below (north of) Davis Rapids.

Within each study area, select reaches were characterized at the mesohabitat level to assess their potential in terms of spawning use by each of the four target species. Combined with the habitat characterization work, various sampling techniques were employed to capture spawning fish. They included the use of hoop nets, single panel (50’x 6-7’ - 4.5”, 10” and 12” mesh size) gill nets and angling. Where ripe or gravid target species were captured, egg mats were deployed in suitable habitat types (based on target species capture locations and known spawning habitat preferences of target species) in an effort to verify spawning events.

Data loggers were installed throughout the three study areas to provide a continuous record of water temperatures through the duration of the field program. Supporting surface water chemistry data was also collected by field crews on a daily basis.

A summary of the preliminary results for each study area follows:

AREA A

Island Falls

All four target species were captured in the area immediately downstream of Island Falls during the spring survey. Ripe walleye (males and females) were first captured on May 4, 2007, with subsequent capture of one ripe male on May 5, 2007. Ripe northern pike (one male and one female) were captured on May 5, 2007. Ripe common white sucker (males and females) were

captured on May 6 and 10, 2007. Ripe male lake sturgeon were first captured on May 12, 2007, with subsequent capture of ripe males on May 16 and 18, 2007. Lake sturgeon were concentrated in the out wash area of two of four 'chutes' that comprise Island Falls. These two chutes are located on the right downstream bank of the river. Gravid lake sturgeon with external sexual characteristics consistent with spawning females (i.e. swollen and evolved cloacae), were captured on May 12 and 17, 2007. A summary of capture records related to date and corresponding water temperature is included in Table 1.

**TABLE 1- ISLAND FALLS – AREA A
MATTAGAMI RIVER FISH CAPTURE SUMMARIES
SPRING 2007**

Date	Water Temperature (°C)	Catch by Species				Comments
		Lake Sturgeon	Northern Pike	White Sucker	Walleye	
04-May	8.6	-	-	-	17	2 ripe female; 15 ripe male
		-	-	4	-	2 ripe male; 2 unknown
05-May	9.2	-	3	-	-	1 ripe male; 1 ripe female; 1 unknown
		-	-	-	1	1 ripe male
06-May	9.9	-	-	9	-	5 ripe male; 4 unknown
10-May	12.9	-	-	1	-	1 ripe female
12-May	12.1	6	-	-	-	5 ripe male; 1 unknown
		-	1	-	3	all unknown
13-May	11.8	1	-	-	-	Recap from May 12
15-May	12.3	1	-	-	-	Recap from May 12
16-May	11.7	4	-	-	-	1 ripe male; 2 unknown; 1 recap from May 12
17-May	12.1	1	-	-	-	Recap from May 16
18-May	13.0	1	-	-	-	1 ripe male
		1	-	-	-	Recap from May 12
19-May	12.1	-	-	-	12	12 unknown
20-May	11.1	-	1	-	-	1 unknown

Notes: By-catch included 1 longnose sucker (*Catostomus catostomus*) May 10 and 1 smallmouth bass on May 10

A cold front that began moving over the region on May 18, 2007, caused river water temperatures, which had risen to 13°C, to fall back approximately 3°C over the next two days before recovering. Coincident with this temperature decline, lake sturgeon that had been present at the base of Island falls dispersed, with no subsequent catch of lake sturgeon being recorded for the duration of the field program (including the period where water temperatures recovered). Similar observations have been recorded by Kempinger (1988)¹ where a sudden change in weather patterns dropped water temperatures and caused spawning lake sturgeon in the Lake Winnebago system to cease spawning until water temperatures rose again.

Egg mats were deployed at Island Falls starting on May 5, 2007 and were checked and/or redeployed throughout the spring survey. Egg mat locations were chosen based on the observed capture locations of ripe fish, and on locations suspected as being suitable for spawning.

Eggs were collected from mats on May 12, 14, 15, 18 and May 21, 2007. These mats were typically deployed in the outwash of each of four “chutes” that comprise the Island Falls location. Pending independent verification, all eggs captured appear to have been from white sucker spawning events, with the exception of eggs taken off one mat on May 14, 2007, that contained a second species. No lake sturgeon eggs were captured.

¹ Kempinger, J.J. 1988. Spawning and early life history of the lake sturgeon in the Lake Winnebago system, Wisconsin. Am. Fish. Soc. Symp. No. 5. pp. 110-112.

Photographs of the Island Falls study area are presented as follows:



PHOTO 1
ISLAND FALLS, LOOKING TOWARDS LEFT DOWNSTREAM BANK. ACTIVE
ANGLING FOR WALLEYE (MAY 20, 2007)



PHOTO 2
ISLAND FALLS AT RIGHT DOWNSTREAM BANK CIRCLED AREA INDICATES
LOCATION OF LAKE STURGEON CAPTURE (MAY 21, 2007)

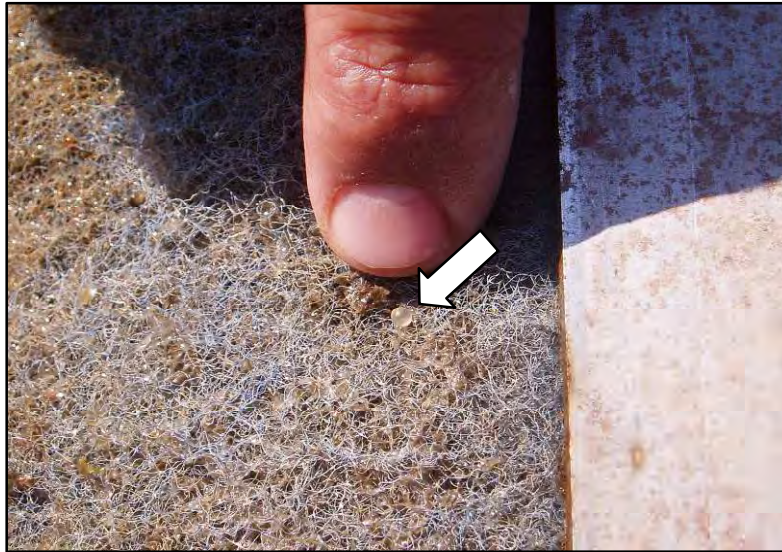


PHOTO 3
EGG CAPTURED ON EGG MAT AT ISLAND FALLS (MAY 12, 2007)

Bradburn Creek

Bradburn Creek is located approximately 9 km downstream of Island Falls on the east side of the Mattagami River. Bradburn Creek is influenced by the dam at Smooth Rock Falls Generating Station (GS) and has resulted in the lower reach being inundated for a distance of approximately 1 km, beyond which the creek became impassable, due to beaver activity. The creek was assessed for the presence of spawning target species using hoop and gill net sets from May 6 to May 11, 2007. Northern pike and common white sucker were captured during the spring survey. Both of these species when captured on May 8 and May 10, 2007 were determined to be in spawning or pre-spawning condition (Table 2).

TABLE 2- BRADBURN CREEK
MATTAGAMI RIVER FISH CAPTURE SUMMARIES
SPRING 2007

Date	Water Temperature (°C)	Catch by Species				Comments
		Lake Sturgeon	Northern Pike	White Sucker	Walleye	
08-May	11.3	-	-	1	-	1 pre-spawning male
10-May	13.9	-	6	-	-	1 ripe male; 2 ripe female; 3 female, spent
		-	-	12	-	3 pre-spawn male, 9 pre-spawn female

Notes: By-catch included 2 yellow perch (*Perca flavescens*) on May 10

Most fish captured were found at the mouth of Bradburn Creek. This reach consists of flat, slow moving water that is dominated by a clay/silt/sand substrate. Depths range from less than 1 m to 4 m.

Suitable northern pike spawning habitat (i.e. large contiguous areas of submerged shoreline vegetation) was observed throughout the lower reach of Bradburn Creek. Despite the presence of pre-spawning common white sucker, no suitable spawning habitat or substrates (i.e. riffles/rapids) were observed. Based upon catches and habitat observations no egg mats were deployed. Photographs 4 and 5 were taken along lower Bradburn Creek.



PHOTO 4
LOWER REACH OF BRADBURN CREEK (MAY 16, 2007)



PHOTO 5
NORTHERN PIKE POTENTIAL SPAWNING HABITAT IN BRADBURN CREEK
(MAY 16, 2007)

Pullen Creek

The confluence of Pullen Creek with the Mattagami River is approximately 10 km downstream of Island Falls on the east side of the Mattagami River. Pullen Creek is also influenced by the dam at Smooth Rock Falls and this has resulted in the lower reach being inundated for a distance of approximately 1 km. Pullen Creek was assessed for the presence of spawning target species between May 6 and May 11, 2007 using a combination of gill and hoop nets. Walleye and common white sucker were captured in the lower reach of Pullen Creek, between May 9 and May 10, 2007. All common white suckers captured were determined to be in a ripe spawning condition. The walleye captured on May 9, 2007, was a ripe male. Additional walleye captured on May 10, 2007, were assessed as spent or sex unknown (Table 2).

**TABLE 3- PULLEN CREEK
MATTAGAMI RIVER FISH CAPTURE SUMMARIES
SPRING 2007**

Date	Water Temperature (°C)	Catch by Species				Comments
		Lake Sturgeon	Northern Pike	White Sucker	Walleye	
09-May	12.4	-	-	-	1	1 ripe female
		-	-	17	-	4 ripe male; 13 ripe female
10-May	13.9	-	-	-	2	1 spent male; 1 unknown, immature

Notes: By-catch consisting of 1 burbot (*Lota lota*) on May 9 and May 10

The lower reach of Pullen Creek is characterized by flat, slow moving water with a depth ranging from 1.7-3.6 m. Similar to Bradburn Creek, substrates are dominated by clay/silt/sand. Backwater embayments and pockets of open water marsh within the lower reach likely provide suitable spawning locations for northern pike and may provide seasonal habitat (nursery/rearing) for northern pike and other target species such as walleye and common white sucker. No suitable spawning habitat for common white sucker, walleye and lake sturgeon was observed; therefore egg mats were not deployed within the lower reach of Pullen Creek.

Upstream of the influence of the Smooth Rock Falls GS headpond, Pullen Creek consists of a meandering channel, approximately 3-5 m wide, obstructed frequently by woody debris piles and root wads. Substrates consist predominately of clay/silt with minor amounts of gravel and small cobble interspersed. Depths were typically <0.5 m. Numerous log jams and debris piles suggest that fish passage upstream of the reservoir influence by such species as white sucker and walleye for the purpose of spawning is unlikely, based on the qualitative assessment performed. Based on this assessment, no egg mats were deployed in the reach directly above the influence of the Mattagami River. Photographs 6 and 7 illustrate conditions observed in Pullen Creek.



PHOTO 6
LOWER REACH OF PULLEN CREEK (MAY 11, 2007)



PHOTO 7
UPPER REACH OF PULLEN CREEK SHOWING TYPICAL IN-STREAM DEBRIS
PILES/OBSTRUCTIONS (MAY 10, 2007)

North Muskego River

The North Muskego River is the largest tributary to the Smooth Rock Falls GS headpond. Spring spawning assessments and habitat characterization was conducted between May 4 and May 16, 2007 within selected areas between the mouth of the North Muskego River and the first upstream barrier, a bedrock controlled falls/chute located approximately 5 km upriver. Northern pike, common white sucker and walleye were captured between May 5 and May 16, 2007 (Table 4).

**TABLE 4- NORTH MUSKEGO RIVER
MATTAGAMI RIVER FISH CAPTURE SUMMARIES
SPRING 2007**

Date	Water Temperature (C)	Catch by Species				Comments
		Lake Sturgeon	Northern Pike	White Sucker	Walleye	
05-May	-	-	10	-	-	6 unknown male; 2 spent female; 2 unknown
		-	-	-	5	3 ripe male; 1 ripe female; 1 spent female
		-	-	13	-	3 ripe male; 6 ripe female; 2 spent female; 2 unknown
13-May	10.9	-	4	-	-	2 spent male; 1 spent female; 1 pre-spawn male
		-	-	-	1	1 spent male
		-	-	5	-	1 pre-spawn male, 4 pre-spawn female
16-May	9.8	-	-	-	2	2 spent male

Notes: By-catch consisting of 2 longnose sucker on May 5 and 1 yellow perch on May 5

Ripe male and female common white sucker and walleye were captured on May 5, 2007. Post-spawn or spent fish (northern pike, common white sucker and walleye) only were captured on subsequent days. No lake sturgeon were captured or observed in the North Muskego River throughout the spring field program.

The lower portion of the North Muskego River has been inundated as a result of the dam at the Smooth Rock Falls GS. The reach is characterized by flat, slow moving water with an average depth of 4 to 6 m and a substrate that is dominated by clay/silt/sand. Preliminary assessments of shoreline features and of several small tributaries that drain into this portion of the North Muskego River suggest that the area likely provides suitable spawning habitat for northern pike. At the upper limit of the headpond's influence the North Muskego River narrows and substrates become coarser (cobble/boulder), ending with the bedrock controlled falls/chute approximately 2 to 3 m high.

The outwash of this chute appears to be suitable for spawning by white sucker, walleye and lake sturgeon and egg mats were deployed within this location to assess spawning activity. Eggs were captured on mats below the chute on May 12, 2007. Preliminary evaluation suggests that these

were common white sucker eggs. No assessment was carried out upstream of the chute as it appeared to represent an impassable barrier to fish under the flow conditions experienced in May 2007. Photographs 8 and 9 illustrate features common to the lower reach of the North Muskego River.



PHOTO 8
TYPICAL FEATURES ON LOWER REACH OF NORTH MUSKEGO RIVER
(MAY 16, 2007)



PHOTO 9
BEDROCK CONTROLLED FALLS/CHUTE ON UPPER REACH OF NORTH
MUSKEGO RIVER (MAY 4, 2007)

AREA B

Yellow Falls

Fishing effort at Yellow Falls expended between May 5 and May 19, 2007 resulted in the capture of common white sucker only from locations immediately downstream of the falls. Fish captured were caught between May 5 to May 11, 2007, with the majority being in spawning condition (Table 5). Qualitative observations of water levels and flow rates suggest that a vertical elevation in the range of 9 to 12 m was maintained at Yellow Falls during the spring survey. Under these observed conditions, fish passage upstream appeared unlikely.

**TABLE 5- YELLOW FALLS
MATTAGAMI RIVER FISH CAPTURE SUMMARIES
SPRING 2007**

Date	Water Temperature (°C)	Catch by Species				Comments
		Lake Sturgeon	Northern Pike	White Sucker	Walleye	
05-May	-	-	-	1	-	1 ripe female
07-May	9.4	-	-	2	-	2 ripe female
08-May	10.3	-	-	1	-	1 unknown
		-	-	4	-	1 ripe female; 1 unknown gravid; 2 unknown
		-	-	1	-	1 unknown
09-May	11.3	-	-	2	-	1 ripe male; 1 ripe female
		-	-	2	-	2 unknown
10-May	12.6	-	-	3	-	1 ripe female; 2 unknown
		-	-	3	-	2 ripe male; 2 unknown
11-May	12.4	-	-	5	-	4 ripe male; 1 ripe female

Notes: By-catch included 1 longnose sucker on May 9

A variety of habitat types were fished at Yellow Falls during the survey including riffles, eddie lines adjacent to rapids, pools, and flats with the majority of fish captured found to be staging in pool type habitats on the left downstream bank of the river. Fish captured were taken from depths ranging from approximately <1 to 4 m. Efforts to capture lake sturgeon at Yellow Falls included gill net sets downstream of Yellow Falls in slower moving waters at depths ranging from 4 to 6 m. Despite these efforts, no lake sturgeon were found in Area B during the spring 2007 fisheries work.

Egg mats set in a variety of habitat types (pools, pocket eddies, rapids, riffles) proved successful in capturing eggs (assumed to be white sucker pending independent verification) from spawning events that occurred on or about May 15 and May 21, 2007. Eggs were generally taken from mats deployed on the left and right downstream banks of the river, in rapid/riffle mesohabitat types located approximately 50-100 m below Yellow Falls.

Despite the lack of success in capturing other target species (northern pike, walleye and lake sturgeon) the immediate reach below Yellow Falls (within 500 m) appears to contain suitable spawning habitat for each of these species. This includes observed areas that cannot be readily or safely accessed due to river morphology (i.e. areas of high flow combined with shallow or exposed substrate). Effective deployment of sampling gear to capture target species that may utilize these areas was not always possible. However, sufficient effort was expended by Golder field crews to include similar accessible habitat types that were representative of these inaccessible locations.

Photographs 10 to 13 illustrate conditions below Yellow Falls.



PHOTO 10
YELLOW FALLS (MAY 21, 2007)



PHOTO 11
SHORE LINE HABITAT FEATURES AT YELLOW FALLS (MAY 13, 2007)

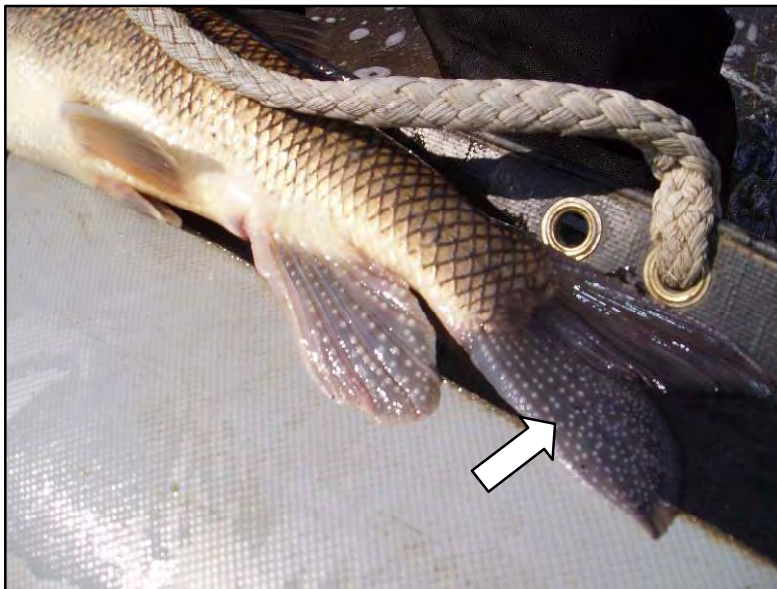


PHOTO 12
SPAWNING TUBERCLES ON RIPE MALE WHITE SUCKER AT YELLOW FALLS
(MAY 10, 2007)

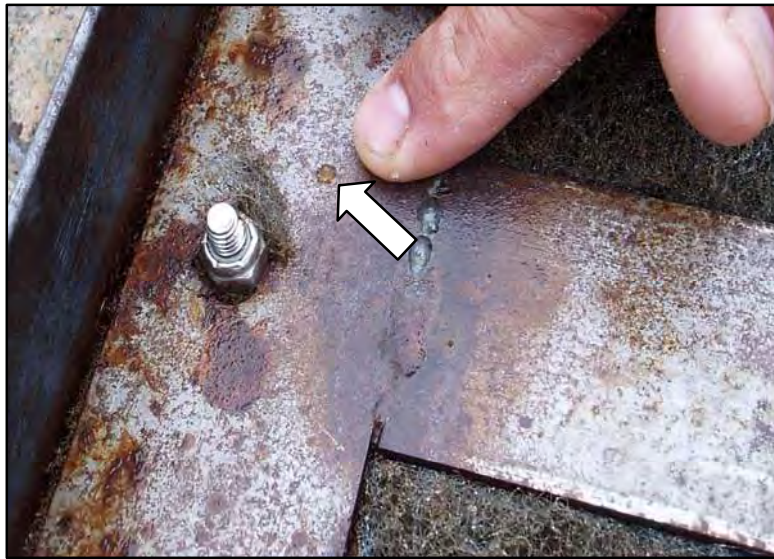


PHOTO 13
EGG DEPOSITED ON EGG MAT AT YELLOW FALLS (MAY 15, 2007)

Tributary 'A'

Tributary 'A' is located on the left downstream bank of the Mattagami River, approximately 500 m upstream of Island Falls. An assessment of Tributary 'A', completed at the start of the 2007 study determined that, based upon flow conditions and river elevation in 2007, fish passage above the lower 10 m of the stream by any of the target species would be unlikely. As a result, no sampling effort was expended in the upstream reaches of Tributary 'A'. To account for the possibility of spawning activity at the mouth of the tributary, egg mats were deployed and monitored throughout the field program. No eggs were captured during this period and no observations of target species fish at the mouth of this tributary were made. It was also observed that sediment loads coming from the tributary resulted in significant amounts of siltation of rocky substrates that exist at the mouth of the tributary, a condition that would render these locations unsuitable for egg deposition by the target species. Photograph 14 illustrates site conditions at the mouth of Tributary 'A'.



PHOTO 14
INSTALLATION OF EGG MAT AT BASE OF TRIBUTARY 'A'
ARROWS INDICATE LIMIT OF UPSTREAM PASSAGE (MAY 5, 2007)

Tributary 'B'

Tributary 'B' is located on the right downstream bank of the Mattagami River, approximately 500 m upstream of Island Falls. An assessment of Tributary 'B', made at the start of the 2007 study determined that flow conditions and river elevation for 2007, made it unlikely for there to be fish passage by any of the target species above the lower 20 m of the stream. As a result, no sampling effort was expended in upstream reaches of Tributary 'B'. To account for the possibility of spawning activity occurring at the mouth of the tributary, egg mats were deployed and monitored throughout the field program. No eggs were captured during this period. Heavy amounts of sediment were observed coming from Tributary 'B' and resulted in significant accumulation of silt on substrates at the mouth of the tributary; a condition that would be unsuitable for egg deposition by the target species. Photograph 15 illustrates site conditions at the mouth of Tributary 'B'.



PHOTO 15
BASE OF TRIBUTARY 'B' AND LIMIT OF UPSTREAM PASSAGE (MAY 14, 2007)

AREA C

Loon Rapids

The reach directly below Loon Rapids consists of a bedrock chute and two side channels that consist of a terraced series of bedrock/boulder/cobble rapids. Water depths below the chute/rapids vary from less than 1 m to over 8 m. Fishing effort was expended at Loon Rapids between May 14 and May 20, 2007.

Northern pike and walleye were captured at Loon Rapids between May 15 and May 17, 2007 (Table 6). The state of maturity for these fish could not be readily determined based on external examination. Significant effort was expended on netting for lake sturgeon to determine whether spawning adults were moving to the base of Loon Rapids. No lake sturgeon were found in Area C during the spring 2007 fisheries investigation. No common white suckers were captured at Loon Rapids, however, egg mats deployed throughout the area at the base of the rapids captured eggs (suspected white sucker) deposited on them during at least one spawning event that occurred on or around May 18, 2007. Several potential spawning areas were identified at the base of Loon Rapids, but no evidence to suggest active spawning could be determined in spring 2007. Photograph 16 illustrates site conditions below Loon Rapids.

**TABLE 6- LOON RAPIDS
MATTAGAMI RIVER FISH CAPTURE SUMMARIES
SPRING 2007**

Date	Water Temperature (°C)	Catch by Species				Comments
		Lake Sturgeon	Northern Pike	White Sucker	Walleye	
15-May	12.2	-	2	-	-	2 female
		-	-	-	3	3 unknown
16-May	11.5	-	3	-	-	1 male; 1 female
		-	-	-	3	3 unknown
17-May	12.1	-	2	-	-	1 male; 1 female
		-	-	-	1	1 unknown

Notes: By-catch consisting of 1 smallmouth bass (*Micropterus dolomieu*) on May 15



**PHOTO 16
BASE OF LOON RAPIDS FROM LEFT DOWNSTREAM BANK (MAY 16, 2007)**

Davis Rapids

Davis Rapids consists of a series of connected rapids/boulder gardens with substrates that generally consist of coarse materials such as cobble and boulder. Netting effort at Davis Rapids was expended between May 5 and May 14, 2007. Three of the four target species were captured in the vicinity of Davis rapids between May 5 and May 13, 2007 (Table 7).

**TABLE 7- DAVIS RAPIDS
MATTAGAMI RIVER FISH CAPTURE SUMMARIES
SPRING 2007**

Date	Water Temperature (°C)	Catch by Species				Comments
		Lake Sturgeon	Northern Pike	White Sucker	Walleye	
05-May	9.2	-	-	-	2	2 unknown
07-May	9.6	-	-	-	5	5 unknown
		-	-	4	-	2 ripe male; 2 ripe female
09-May	11.7	-	1	-	-	1 female
		-	-	-	2	2 unknown
		-	-	2	-	2 ripe female
10-May	12.8	-	-	-	4	1 ripe male; 3 unknown
		-	-	1	-	1 unknown
11-May	12.4	-	1	-	-	1 female; unknown
		-	-	-	6	1 male; 5 unknown
12-May	11.7	-	-	-	5	2 ripe male; 3 unknown
		-	-	1	-	1 unknown
13-May	11.9	-	1	-	-	1 female, unknown
		-	-	1	-	1 ripe female

Notes: By-catch consisting of 6 smallmouth bass on May 11

Ripe common white sucker and walleye were captured at Davis Rapids. Mature northern pike that were captured did not express gametes and were assumed to be in a post-spawn condition at the time of the survey. No eggs were collected to provide confirmation of spawning activity at Davis Rapids. However, the large amount of potential spawning habitat within Davis Rapids and the presence of target species in spawning condition suggest that spawning activity likely takes place in this reach. Similarly to field conditions at Yellow Falls, the field crew experienced difficulty in accessing some of the many suitable spawning habitats available at Davis Rapids.

Photographs 17 to 19 illustrate habitat characteristics that exist at Davis Rapids.



PHOTO 17
LOWER END DAVIS RAPIDS FROM RIGHT DOWNSTREAM BANK
(MAY 10, 2007)



PHOTO 18
LOWER END OF DAVIS RAPIDS FROM LEFT DOWNSTREAM BANK
(MAY 20, 2007)



PHOTO 19
TYPICAL SUBSTRATE TYPE AT DAVIS RAPIDS (MAY 20, 2007)

Rat Creek

Rat Creek is a tributary to the Mattagami River that drains into the river on the east side, below Davis Rapids. Northern pike, common white sucker and walleye were all captured in Rat Creek with individuals of each species in spawning or post-spawning condition. No lake sturgeon were caught within this tributary (Table 8).

Common white sucker was the predominant species captured and based on the numbers observed (>100), appear to select this tributary within the reach below Davis Rapids for spawning purposes. Preliminary habitat evaluation data from the mouth to a point approximately 400 m upstream (limit of boat accessible travel) suggests that selected portions of the creek that have been scoured to reveal coarser substrates of cobble and mixed size boulder. These substrates likely provide optimal spawning habitat conditions for a species such as common white sucker and walleye. Northern pike would also have access to potential spawning habitat based on the quality and quantity of bank cover and overhanging vegetation present.

**TABLE 8- RAT CREEK
MATTAGAMI RIVER FISH CAPTURE SUMMARIES
SPRING 2000**

Date	Water Temperature (°C)	Catch by Species				Comments
		Lake Sturgeon	Northern Pike	White Sucker	Walleye	
05-May	9.2	-	-	1	-	1 unknown
07-May	9	-	-	61	-	42 ripe male; 15 ripe female; 4 unknown
08-May	11.6	-	1	-	-	1 ripe female
		-	-	-	4	1 spent female; 1 gravid; 2 unknown
		-	-	18	-	9 male, ripe; 3 female, ripe; 2 male, unknown, 4 unknown
09-May	11.3	-	-	108	-	64 ripe male; 42 ripe female; 2 unknown

Egg mats deployed within Rat Creek did not collect any eggs. Observations of relatively high sediment loads that at times plugged the egg mat media likely affected the capture efficiency of the mats and account for the lack of collection success in this location. Photographs 20 to 21 illustrate habitat features in Rat Creek.



**PHOTO 20
UPPER REACH OF RAT CREEK (MAY 7, 2007)**



PHOTO 21
RIPE FEMALE NORTHERN PIKE AT RAT CREEK (MAY 8, 2007)

SUMMARY

AREA A

- **Island Falls** - ripe, female walleye, northern pike and common white suckers were captured below the Falls. No walleye eggs were captured using egg mats. Eggs presumed to be common white sucker eggs, were captured immediately below all of the major chutes at the Falls. Only ripe male lake sturgeon were captured although several 'unknowns' may have been green females. Most lake sturgeon were captured below the easternmost chutes of the Falls. Island Falls was the only location where lake sturgeon were captured;
- **Bradburn/Pullen Creeks** - both creeks are shallow and, in the spring of 2007, slow flowing. Bottom substrates consist of clay, sand and silt. The lower reach of both creeks is influenced by the backwater effect of the dam at Smooth Rock Falls. Common white suckers were the most common species captured in both creeks. No fast water habitat exists in the lower reaches and access to reaches above is impeded by organic debris and beaver dams. Northern pike and possibly common white suckers spawn in these tributaries; and
- **North Muskego River** - the backwater effect caused by the dam at Smooth Rock Falls extends approximately 5 km upstream to a bedrock outcrop which forms an approximately 3 m high barrier. Bottom substrates along the lower reach of the River is dominated clay, sand and silt. Northern pike likely spawn along the channel edge of the lower reach. Walleye and common white suckers spawn at the base of the bedrock chute.

AREA B

Yellow Falls - common white suckers were the only target species captured although habitat existing below the Falls would appear to be suitable for walleye and lake sturgeon. Common white sucker eggs were captured approximately 50–100 m below the Falls along the east and western edges of the channel. Given the flows and elevation difference between the head and base of the Falls (9-12 m), it would appear that Yellow Falls represented an impassable barrier to upstream fish migration throughout the spring of 2007; and

Tributaries 'A' and 'B' - only the lower portions of these tributaries (i.e. in the immediate vicinity of the mouth of each tributary) were deemed to be accessible to target fish species in the spring of 2007 due to the steep channel slopes. No fish were captured or observed in these areas. No eggs were captured in egg mats deployed in the tributaries. Extensive silt deposition took place in these areas.

AREA C

Loon Rapids - extensive areas of potential spawning habitat for walleye, common white suckers and lake sturgeon exist below Loon Rapids. Only northern pike and walleye were captured. Eggs believed to be common white sucker eggs were captured on egg mats;

Davis Rapids - ripe walleye and common white suckers were captured at Davis Rapids although exact spawning locations could not be confirmed using egg mats. Extensive, potential spawning habitat exists at the rapids. However, due to high flows and shallow water, conditions in many of these areas were not conducive to setting fixed gear or were inaccessible to the field crew; and

Rat Creek - ripe northern pike, walleye and common white suckers were captured in Rat Creek. High sediment loads may have affected the egg mat efficiency and no eggs were captured.

We trust that the information presented meets your current requirement. Should you have any questions or concerns, please do not hesitate to contact the undersigned.

Yours very truly,

GOLDER ASSOCIATES LTD.



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RM/JS/lr

7

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REPORT ON

**SPRING 2007
FISH HABITAT UTILIZATION SURVEY
MATTAGAMI RIVER**

Submitted to:

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October 3, 2007



07-1195-0014

EXECUTIVE SUMMARY

Golder Associates Ltd. (Golder) was retained by the Yellow Falls Power Limited Partnership (YFP) to complete a spring fish habitat utilization survey on the Mattagami River. This study complements the aquatic assessment conducted by Stantec Consulting Ltd. (Stantec) in 2006. The study was focused on Island Falls and adjacent tributaries, Bradburn Creek, Pullen Creek, the North Muskego River, Yellow Falls, Loon Rapids Davis Rapids and Rat Creek. As in the earlier study, four species of interest were targeted: northern pike (*Esox lucius*), white sucker (*Catostomus commersoni*), walleye (*Sander vitreus*) and lake sturgeon (*Acipenser fulvescens*). Specifically, the objectives of this study were as follows:

- Document utilization of potential spawning habitat by target species through the capture of fish and recovery of eggs during the spawning period of each species; and
- Assess physical habitat conditions at fish and egg sampling locations.

During the period May 4 to May 21, 2007, three field crews monitored spawning activity and sampled fish and eggs at ten locations. Gillnets (large and small mesh), hoop nets, angling, visual observations and egg mats were utilized. Egg mats were deployed at fish capture locations and at locations deemed to be suitable as spawning habitat for target species. Habitat characteristics (depth, substrate, velocity) were recorded at fish capture and egg recovery locations.

All four target species were captured near the base of Island Falls. In general, walleye, white sucker and northern pike were captured along the margins of all of the outwash areas below the four chutes which make up Island Falls. Lake sturgeon were only captured in the outwash area of Chutes 1 and 2, located on the right downstream bank of the river. Eighty-five percent of all eggs (walleye, northern pike, white sucker and yellow perch) were collected along the margin of Chute 1. These eggs consisted of walleye, northern pike, white sucker and yellow perch (*Perca flavescens*). The outwash area below Chutes 1 and 2 may be the most significant spawning area below the Falls. Lake sturgeon eggs were not captured below Island Falls and it is possible that no spawning event occurred in 2007.

The submerged shoal area, located below Chutes 3 and 4, appeared to provide suitable spawning conditions. However, none of the target species appear to be utilizing it to spawn. This may be due to the combination of low water velocities around the shoal and the layer of fine clay and silt material that appears to have accumulated on the coarse substrates at this location.

Northern pike and white sucker were captured in Bradburn Creek. Habitat within the creek channel and along the channel margins appears to provide optimal northern pike spawning habitat and marginal white sucker spawning habitat. No fast water/coarse substrate areas typical of walleye and lake sturgeon spawning habitat were identified and it is highly unlikely that walleye or lake sturgeon utilize Bradburn Creek to spawn.

Ripe white sucker were captured in Pullen Creek. No fast water/coarse substrate habitat was identified in the creek. Despite the fact that no northern pike were captured, potential spawning habitat exists throughout the creek. Several walleye were captured; however, given the nature of available habitat in the creek (i.e. slow flowing, fine substrates) it is highly unlikely that walleye or lake sturgeon spawn in Pullen Creek.

An assessment of shoreline features along the banks and small embayments, and in several small tributaries that drain into the North Muskego River, suggests that much of the river provides suitable spawning habitat for northern pike. The outwash of the falls/chute that is located 4 km upstream of the river mouth provides suitable habitat for spawning by white sucker, walleye and lake sturgeon. Ripe white sucker were captured below the falls/chute. Although no ripe adult walleye were captured, walleye eggs were captured below the chute.

Ripe male and female white sucker and white sucker eggs were captured along the edges of the channel downstream of Yellow Falls. No other target species or target species eggs were captured. Although small numbers of walleye were captured in the spring of 2006, only one was in spawning condition. There is no firm evidence that target species other than white suckers utilize the base of Yellow Falls to spawn.

The physical conditions assessed in both Tributaries A and B suggests that in 2007, only the lower 10 m of Tributary A and the lower 20 m of Tributary B would have been accessible to fish. Habitat characteristics within the lower reaches of both tributaries suggest that low flow rates, shallow water, steep gradients and extensive channel obstructions act as barriers to fish movement. No fish were observed in either tributary and no eggs were captured in either 2006 or 2007. It is highly unlikely that any of the target species utilize these tributaries to spawn.

No lake sturgeon or lake sturgeon eggs were found at Loon Rapids during the spring 2007 fisheries investigation. No white suckers were captured at Loon Rapids; however, egg mats deployed throughout the area at the base of the rapids captured white sucker eggs. Walleye and northern pike were captured but maturity (ripe/spent) could not be determined. Several potential spawning areas were identified at the base of Loon Rapids, but no evidence of active spawning could be determined in spring 2007. While it is possible that walleye and northern pike, in addition to white sucker, spawn at Loon Rapids, this has not been confirmed in either of the field studies completed to date.

The large amount of potential spawning habitat within Davis Rapids and the presence of walleye, northern pike and white suckers in spawning condition suggest that spawning activity likely takes place in this reach. No lake sturgeon were captured. Egg mats were deployed in the lower third of the rapids but failed to capture eggs. The field crew experienced difficulty in accessing the upper two thirds of the Davis Rapids due to shallow water and high velocities. Suitable spawning habitat appears to exist in this section. It is possible that walleye, white sucker and northern pike spawn in the upper portions of the Davis Rapids.

A large number of white sucker and low numbers of walleye and northern pike were captured in Rat Creek in 2007. Although no eggs were captured, it appears that three of the four target species spawn in Rat Creek.

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1.0 INTRODUCTION AND BACKGROUND

Yellow Falls Power Limited Partnership (YFP) is proposing to build and operate the Island Falls Hydroelectric Project (the Project). The Project will be located on the Mattagami River at Island Falls, approximately 16 km south of the Town of Smooth Rock Falls (Figure 1-1). When completed, the facility will have the capacity to generate 20 MW of run-of-river hydroelectric power.

In 2006, Stantec Consulting Ltd. (Stantec) completed an aquatic assessment for the Project. This assessment was based on a work plan developed in consultation with the Ontario Ministry of Natural Resources (MNR) and the Department of Fisheries and Oceans (DFO). The work plan is described in the *Island Falls Aquatic Field Sampling Program* (Stantec 2007). The results of the 2006 aquatic assessment are described in the *Island Falls Hydroelectric Project Aquatic Assessment* (Stantec 2007).

Golder Associates Ltd. (Golder) was subsequently retained by YFP to conduct the 2007 spring fish habitat utilization survey for the Project. Whereas the 2006 study characterized fish habitat and assessed the effects of the Project on habitat resources, the spring 2007 study focused on confirming habitat utilization by the target species and defining specific spawning locations. To ensure that data generated during the 2006 and 2007 field seasons were suitable for comparison, the 2006 Stantec study plan was consulted during the design of the 2007 study.

As in the previous study, four species of interest were targeted during the 2007 spring spawning investigation: northern pike (*Esox lucius*), white sucker (*Catostomus commersoni*), walleye (*Sander vitreus*) and lake sturgeon (*Acipenser fulvescens*). Specifically, this study was intended to:

- Document utilization of potential spawning habitat by target species through the collection of fish and eggs during the spring spawning period; and
- Assess the physical habitat conditions at fish and egg sampling locations.

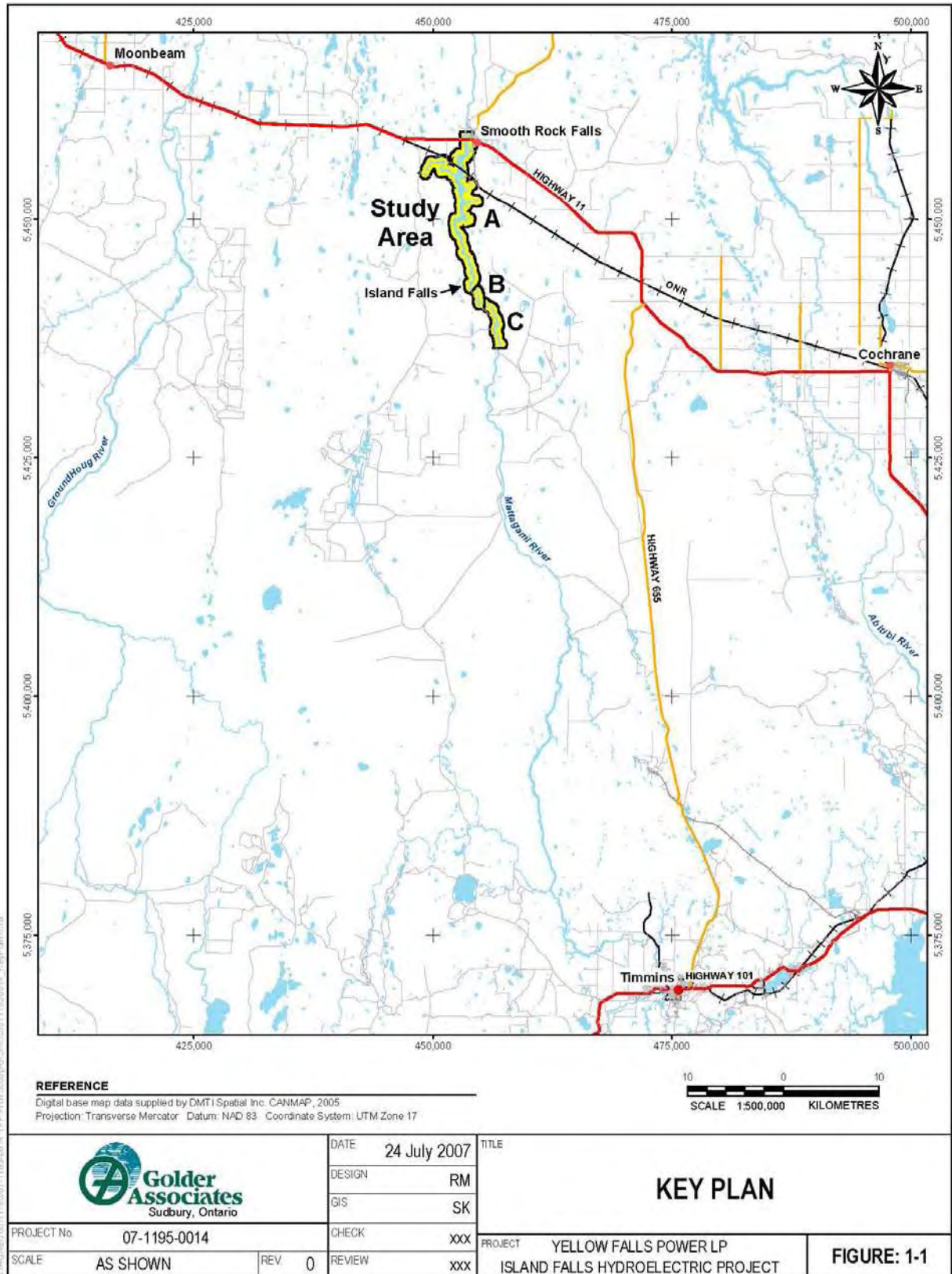
1.1 Study Area Descriptions

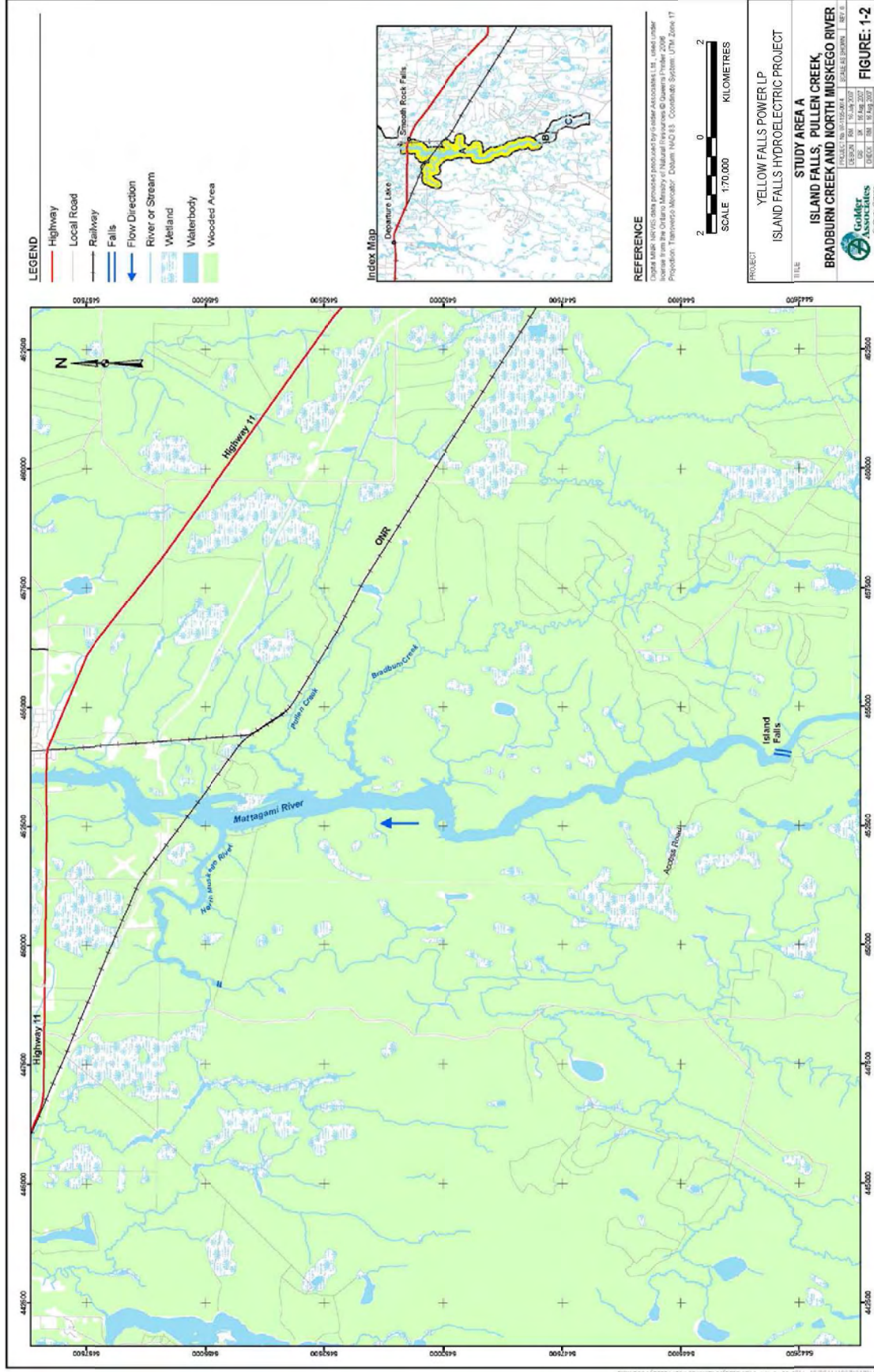
As in the previous study, three distinct reaches on the Mattagami River were defined:

Area A – This area included the reach of the Mattagami River situated between Smooth Rock Falls and Island Falls and three tributaries (Bradburn Creek, Pullen Creek, and the North Muskego River) located between 10 and 14 km downstream of Island Falls (Figure 1-2). The tributaries were not included in the 2006 Stantec study.

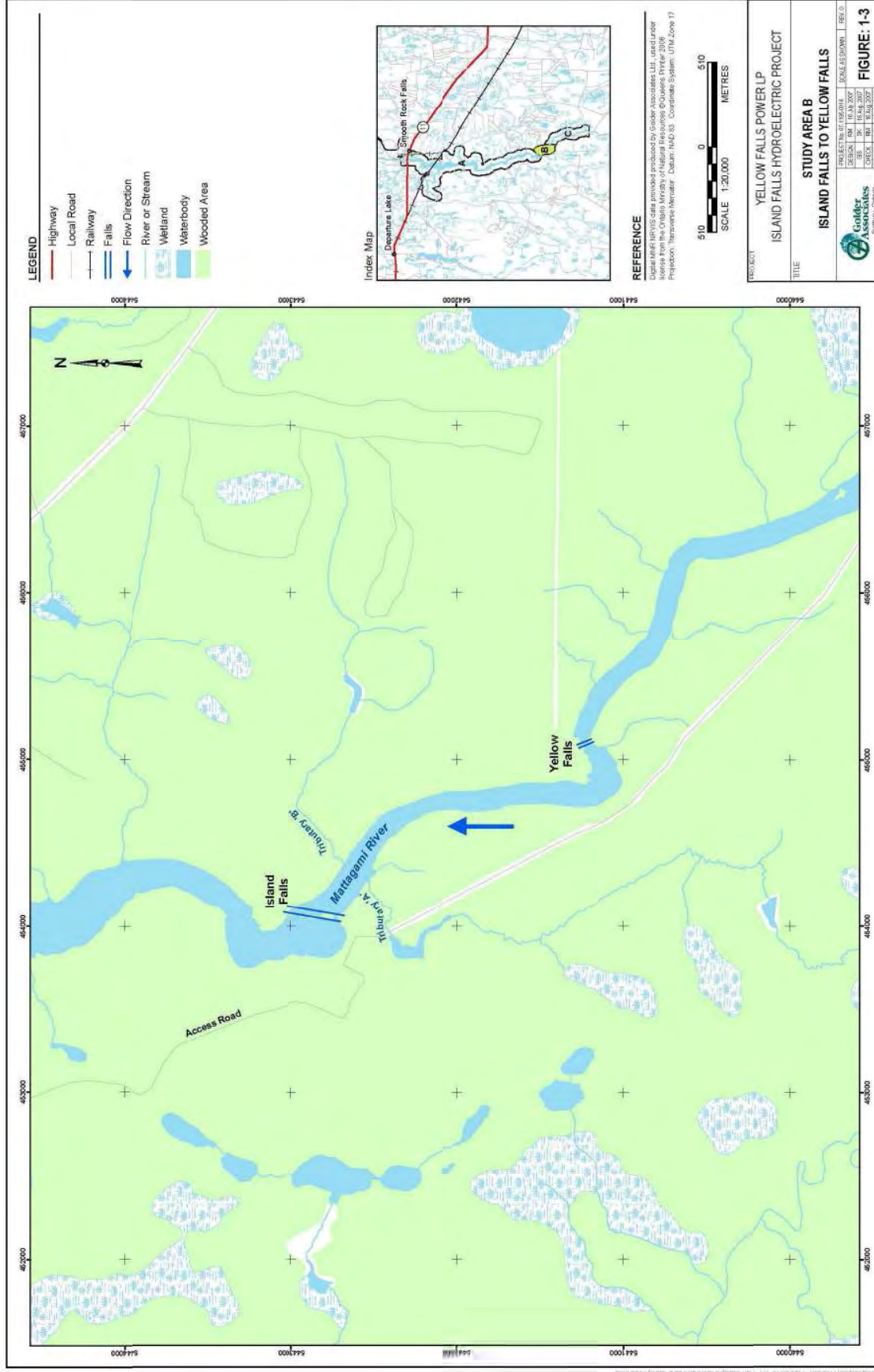
Area B – This area included the reach of the Mattagami River situated between Island Falls and Yellow Falls and included Tributaries A and B, located immediately upstream of Island Falls (Figure 1-3).

Area C – This area included the reach of the Mattagami River situated between Yellow Falls and Loon Rapids and included Davis Rapids and Rat Creek, a tributary to the Mattagami River located downstream (north of) Davis Rapids (Figure 1-4).

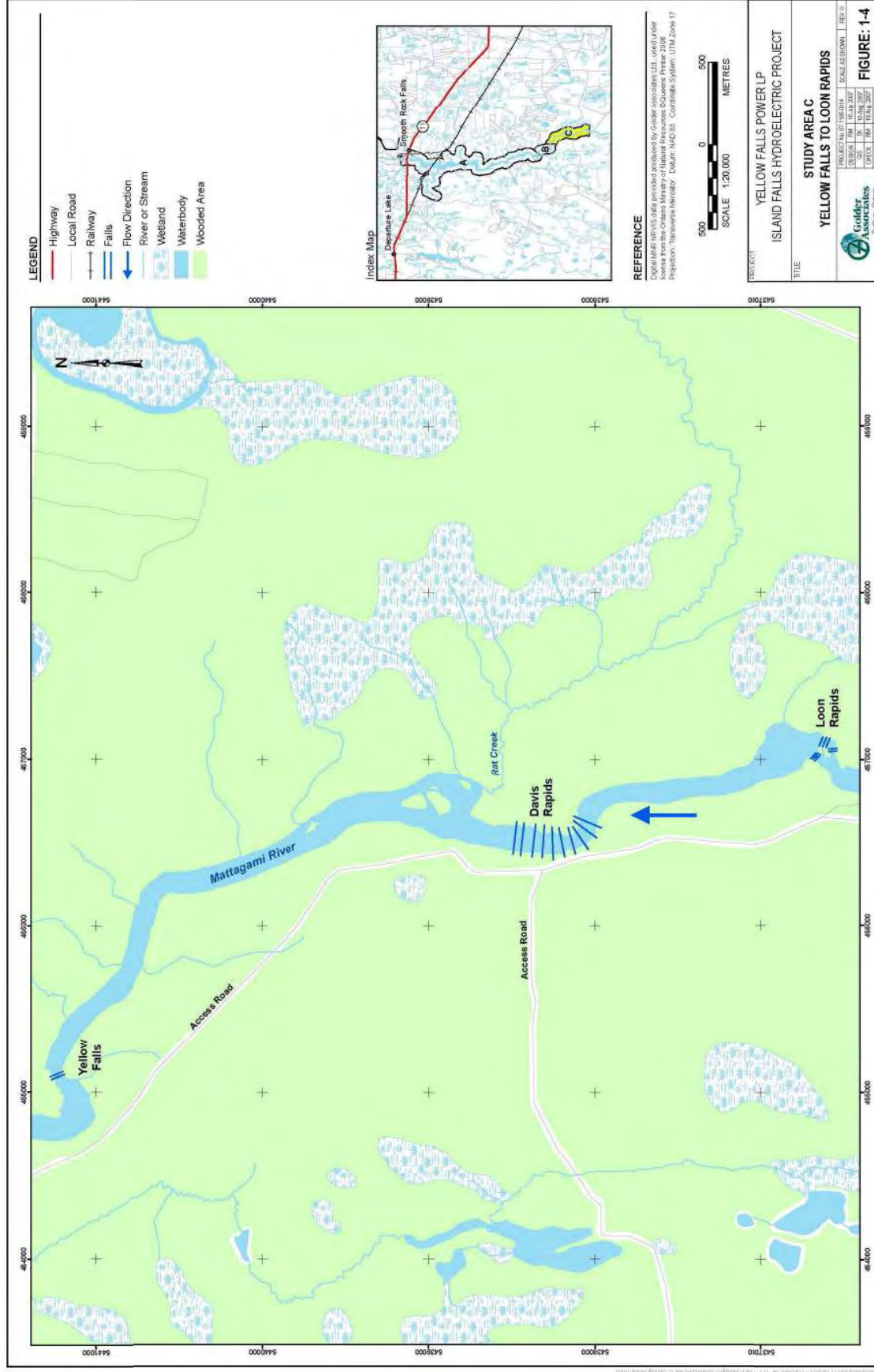




Golder Associates



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Golder Associates

2.0 METHODS

2.1 Field Crew Mobilization

A preliminary site reconnaissance was undertaken by Golder on April 19 and 20, 2007, to assess river conditions and assist in determining the timing for field crew mobilization. Most of the river, with the exception of rapids areas, was ice covered; the water temperature was -1°C. River conditions continued to be monitored until ice-out. Golder field crews were mobilized to the Mattagami River during the week of April 30, 2007.

Fieldwork within the three study areas was conducted from May 4 to May 21, 2007. Three field crews operated simultaneously. A field crew based out of Smooth Rock Falls focused on the tributaries flowing into the lower reach of Area A (Bradburn Creek, Pullen Creek and the North Muskego River). A second field crew, based at a cabin below Island Falls, conducted work in the upper reach of Area A, at the base of Island Falls, and in Area B, upstream of Island Falls to Yellow Falls. A third field crew, staged at the cabin below Island Falls, worked in Area C. They commuted daily by boat and ATV to access reaches at Loon Rapids, Davis Rapids and Rat Creek.

2.2 Fish Habitat Data Collection

Mesohabitat features for areas potentially utilized for spawning by target species were visually assessed from shore, by wading and from a boat. In some locations, features such as substrate were further assessed using an underwater video monitor. Golder Technical Procedures for Water Course Habitat Mapping (Golder 1997) were incorporated into the field program.

Mesohabitat is defined as a discrete area of a stream or river exhibiting relatively similar characteristics of depth, velocity, slope, substrate and cover (Bovee et al, 1998). In the context of this study, the mesohabitat assessment delineated habitat units that target species could potentially occupy during spawning within each study area. Fish habitat data collection was focused on locations that had previously been investigated by Stantec, and that were qualitatively judged by Golder field crews to be suitable areas for target species to utilize as spawning habitat. Habitat observations were also recorded at all fish sampling and egg mat locations.

In 2007, the study was expanded from the 2006 Stantec study to include the tributary reaches Bradburn Creek, Pullen Creek and the North Muskego River, located within the reservoir portion of Area A. The field crew completed a preliminary cruise of these tributaries in order to identify potential spawning locations and coordinate sampling effort.

Field data and notes were transcribed to produce mesohabitat maps utilizing a large river habitat classification system (Table 2-1) and substrate criteria (Table 2-2) to describe potential spawning

habitat utilization areas within each study area. Additional habitat classification features are referenced where applicable.

TABLE 2-1
LARGE RIVER HABITAT CLASSIFICATION SYSTEM

Habitat Type	Water Depth (m)	Surface	Turbulence
Falls (FA)	-	Broken	High
Chute	variable	Broken	High
Riffle (Rf)	<0.5	Broken	High
Riffle/Boulder Garden (Rf/Bg)	<0.5	Broken	High
Rapid (Ra)	>0.5	Broken	High
Run 1 (R1)	>1.0	Irregular	Moderate
Run 2 (R2)	0.5 to 1.0	Irregular	Moderate
Run 2/Boulder Garden (R2/Bg)	0.5 to 10	Irregular	Moderate
Run 3 (R3)	<0.5	Rarely broken	Moderate
Run 3/Boulder Garden (R3/Bg)	<0.5	Rarely broken	Moderate
Pool 1 (P1)	>1.0	Smooth	Variable
Pool 2 (P2)	0.5 to 1.0	Smooth	Variable
Pool 3 (P3)	<0.5	Smooth	Variable
Flat 1 (F1)	>1.0	Smooth	Laminar
Flat 2 (F2)	0.5 to 1.0	Smooth	Laminar
Flat 3 (F3)	<0.5	Smooth	Laminar

**TABLE 2-2
SUBSTRATE CRITERIA**

Class Name	Size Range (mm)
Clay/Silt (Cl/Si)	<0.06
Sand (Sa)	0.06-2.0
Small Gravel (SmGr)	2-8
Medium Gravel (MdGr)	8-32
Large Gravel (LgGr)	32-64
Small Cobble (SmCo)	64-128
Large Cobble (LgCo)	128-256
Small Boulder (SmBo)	256-762
Large Boulder (LgBo)	>762
Bedrock (Br)	-

Supporting habitat information included the use of temperature data loggers, installed throughout the three study areas, to provide a continuous record of water temperatures through the duration of the field program. Surface water chemistry data was also collected by field crews within each of the areas on a daily basis.

2.3 Fish Capture Methods and Data Collection

Various sampling gears were employed to capture spawning fish, including hoop nets, single panel gill nets measuring 15 m by 1.8 m - 2.1 m (50 ft x 6-7 ft), with a mesh size of either 114 mm (4.5 in), 254 mm (10 in) or 305 mm (12 in) and angling equipment.

Hoop nets were typically set overnight. Gill net sets were typically set for periods of two to six hours, with some overnight sets being employed in Areas B and C. Angling was conducted at various times during daylight hours using one or more rod and reel set-ups and a variety of tackles (i.e. tube jigs, spinners, spoons, etc.).

When target species were encountered, the captured fish was measured (fork length, weight), and the sex was determined, if possible (i.e. eggs or milt readily expressed, presence of tubercles, etc.). Also, a species appropriate aging structure (scales, dorsal spine or fin ray) was collected prior to the fish being live released. For lake sturgeon, a number-coded Floy tag was inserted on the left dorsal side of each fish, just posterior of the dorsal fin. Fish from the non-target fish species captured during the study were enumerated and live released.

All information related to capture methods used and fish species physical characteristics were recorded on standardized field data sheets. All net and angling locations were recorded as waypoints using a handheld Global Positioning System (GPS).

Catch and fish meristic information was organized into an electronic database. Catch summary and species composition tables summarizing capture dates, mean water temperature, sample effort (hours) and species composition by study location were compiled. Individual fish were classified by sex and maturity (ripe, spent, unknown) based on field observations and results (mean, minimum and maximum, standard deviation) for all length and weight determinations were calculated.

2.4 Egg Capture Methods and Data Collection

Egg mats were deployed at target species capture locations to verify spawning activity, and in potentially suitable spawning habitats (i.e. based on habitat preferences contained in published literature). Each mat was constructed of welded angle iron and measured 0.76 m by 0.52 m. Substrate material (an industrial furnace filter fabric) was secured within the angle iron frame with strips (flat steel bars) and fastened with stainless steel bolts to allow for replacement of the filter material. A labelled buoy line was attached to each egg mat to mark its location in the river. All mats were set by boat or by wading. Set duration and locations varied but, in general, sampling effort was concentrated in areas where the probability of collecting eggs was highest. Individual set times of mats ranged from less than twenty-four hours to as long as six days. Mats set longer than twenty-four hours were typically checked daily and re-deployed in the same location.

Catch Per Unit Effort (CPUE) of eggs for each study location was calculated based on the total number of eggs collected in relation to total sampling effort (i.e. defined as cumulative unit area of egg mats deployed in m² per total number of hours all mats were set in each location):

$$\begin{aligned}\text{CPUE} &= \# \text{ total eggs} / (\text{total area of mats set}) / \# \text{ total hours mats deployed per study location} \\ &= \# \text{egg} / \text{m}^2 / \text{hour for each study location}\end{aligned}$$

Egg mat positions were referenced with a handheld GPS. Information related to the duration of the set, water depth, flow and substrate composition was recorded for each mat location. When an egg mat was checked, or retrieved, eggs deposited were enumerated and removed from the mat. Reference samples of eggs were selectively preserved in a 10% buffered Formalin solution for verification of species which was completed by Ms. Francine Audy (Golder, Saskatoon, SK).

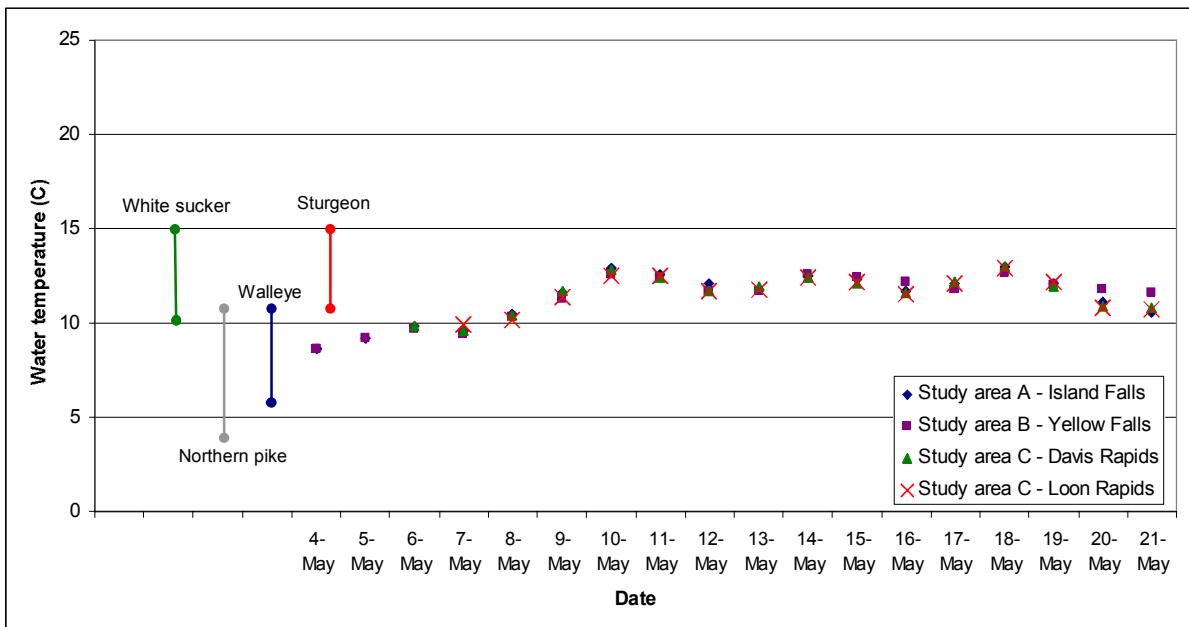
Egg mat information was organized into electronic spreadsheets to facilitate analysis. Summary tables were organized by study area to present mat location, substrate composition, set duration, species type and observed number of eggs collected.

3.0 RESULTS

3.1 Area Water Temperatures and Surface Water Quality

Continuous water temperature data was logged for each sample location within each study area during the Spring 2007 Fish Habitat Utilization Survey. This data, in relation to known spawning temperature preferences of target species, are presented on Figures 3-1 to 3-5¹.

FIGURE 3-1
MATTAGAMI RIVER
WATER TEMPERATURES RECORDED DURING SPRING 2007 IN RELATION TO
PREFERRED SPAWNING TEMPERATURES



¹ Spawning temperature ranges derived from published primary literature including habitat suitability models and non-published sources, including spawning temperature data collected in riverine systems in northeastern Ontario.

FIGURE 3-2
AREA A - BRADBURN CREEK,
WATER TEMPERATURES RECORDED DURING SPRING 2007 IN RELATION TO
PREFERRED SPAWNING TEMPERATURES

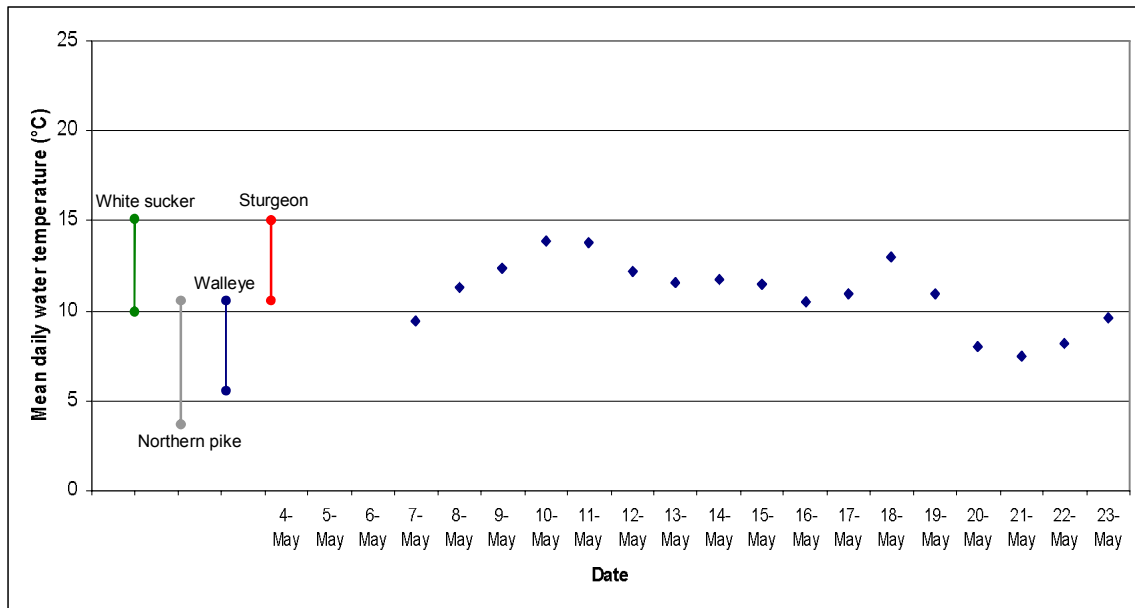


FIGURE 3-3
AREA A - PULLEN CREEK,
WATER TEMPERATURES RECORDED DURING SPRING 2007 HABITAT IN
RELATION TO PREFERRED SPAWNING TEMPERATURES

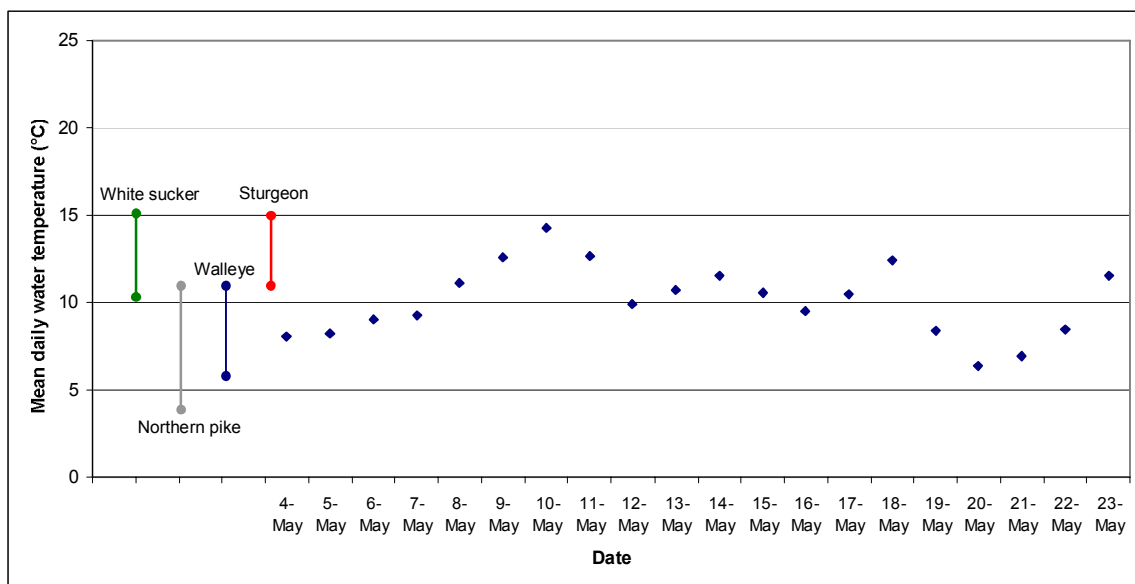


FIGURE 3-4
AREA A - NORTH MUSKEGO RIVER,
WATER TEMPERATURES RECORDED DURING SPRING 2007 IN RELATION TO
PREFERRED SPAWNING TEMPERATURES

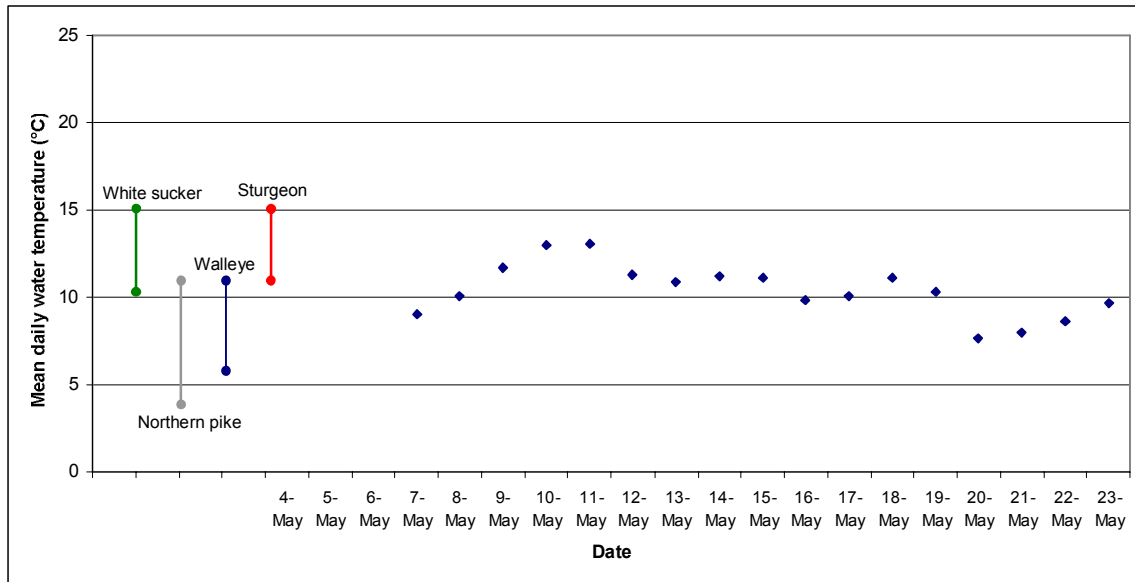
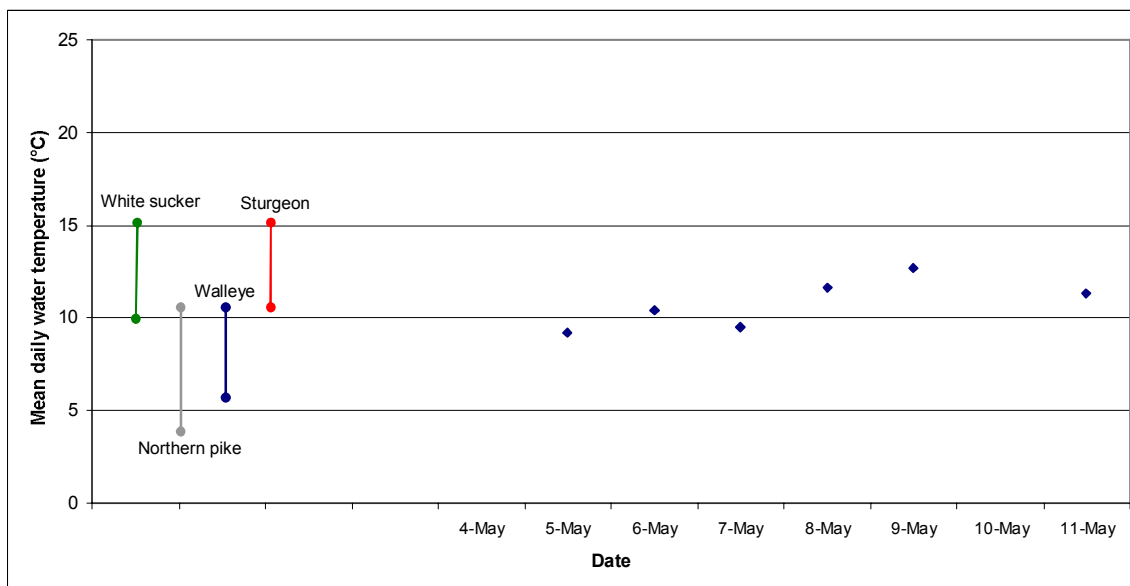


FIGURE 3-5
AREA C - RAT CREEK, STUDY
WATER TEMPERATURES RECORDED DURING SPRING 2007 IN RELATION TO
PREFERRED SPAWNING TEMPERATURES



Additional water quality information (including water temperatures) was also recorded by field crews on a daily basis (Table 3-1).

**TABLE 3-1 SURFACE WATER QUALITY SUMMARY
MATTAGAMI RIVER, SPRING 2007**

Area	Reach	Date	Air ¹ Temp. (°C)	Water ² Temp. (°C)	Dissolved Oxygen (mg/L)	pH (units)	Conductivity (µS)
A	Island Falls	May 4 - 21	0.5 - 19.8	8.6* - 13.0	10.4 - 11.3	6.7 - 7.2	68.0 - 87.0
	Bradburn Creek	May 7-11	5.2 - 19.8	9.4 - 13.9	8.3 - 8.8	7.1 - 7.3	71.0 - 88.0
	Pullen Creek	May 7 - 10	15.0 - 19.8	9.3 - 14.3	8.2 - 9.3	7.0 - 7.4	74.0 - 80.0
	N. Muskego River	May 5 - 15	5.2 - 19.8	9 - 13.1	8.2 - 10.5	7.1 - 7.5	81.0 - 90.0
B	Yellow Falls	May 4 - 21	0.5 - 19.8	8.6* - 12.7	10.4 - 14.1	6.7 - 7.3	68.0 - 85.0
C	Loon Rapids	May 14 - 21	0.5 - 12.5	10.7 - 12.9	11.0 - 11.6	6.9 - 8.4	92.0 - 101.0
	Davis Rapids	May 6 - 14	5.2 - 19.8	9.6 - 12.8	11.3 - 13.1	7.6 - 8.5	81.0 - 92.0
	Rat Creek	May 5 - 11	5.2 - 19.8	9.2* - 12.7*	7.8 - 15.5	7.4 - 8.7	66.0 - 81.0

Notes: 1. Environment Canada Timmins Daily Data (http://www.climate.weatheroffice.ec.gc.ca/climateData/dailydata_e.html)
2. Based on mean daily data logger records, except where noted as a field crew observation (*)

Surface water (and air) temperatures rose gradually during the spring survey and were within the preferred spawning ranges of all target species. A significant decline in water and air temperature was observed beginning on May 18, 2007, due a low pressure weather system moving into the region. Snow and near-freezing temperatures depressed water temperatures by 1 to 3°C between May 19 and 20, 2007. Water temperatures increased to previously observed levels by the end of the field program (May 21, 2007).

Throughout the spring survey, dissolved oxygen, pH and conductivity values were relatively consistent both within and between the study areas.

3.2 Area A

3.2.1 Island Falls

Island Falls represents the upstream limit of influence by the Smooth Rock Falls Generating Station (GS) headpond. Island Falls is characterized by a series of four bedrock-controlled falls/chutes of varying widths located on a broad river bend (Figure 3-6). The combination of the four chutes and exposed channel bedrock creates an area of high velocity outwash water characterized by turbulent flow and strong eddy currents that gradually transitions to slower, and more uniform, flow (flat). River depths in the immediate vicinity downstream of Island Falls ranged from approximately 2 to 6 m, with a shallow exposed shoal located towards the left downstream bank between Chutes 3 and 4. Approximately 100 to 200 m downstream of Island Falls, water depths increased to approximately 10 to 17 m. The delineation of habitat features was focussed on the area immediately downstream of Island Falls and is illustrated in Figure 3-6 and Figure 3-7.

Substrates assessed at Island Falls were typically dominated by coarse boulder and cobble material within the outwash areas of each chute. Bedrock was the predominant substrate type on the immediate downstream side of each chute.

Fishing effort and catch locations in relation to habitat features observed at Island Falls are presented on Figure 3-6. Catch and species composition data are summarized in Table 3-2. Length, weight and maturity characteristics are summarized in Table 3-3. All of the target species were captured in the area immediately downstream of Island Falls.

Ripe lake sturgeon (males) were first captured on May 12, 2007, with subsequent capture of other ripe males on May 16 and 18, 2007. Gravid lake sturgeon with external sexual characteristics consistent with spawning females (i.e. swollen and evolved cloacae), were captured on May 12 and 17, 2007. All lake sturgeon captures occurred in the vicinity of Chute 1 and Chute 2.

Ripe northern pike (male and female) were captured on May 5, 2007. Ripe white sucker (males and females) were captured on May 6 and 10, 2007, while ripe walleye were captured on May 4 and May 5, 2007. Non-target species at Island Falls included longnose sucker (*Catostomus catostomus*) and smallmouth bass (*Micropterus dolomieu*).

Most fish were captured in 2 to 3 m of water, in areas with coarse substrate (primarily large cobble and small boulder). Spawning fish were generally captured in gill nets set along the eddy lines of outwash areas at Island Falls (Figure 3-6).

TABLE 3-2
AREA A – ISLAND FALLS
CATCH SUMMARY AND SPECIES COMPOSITION
MATTAGAMI RIVER, SPRING 2007

Date Lifted	Mean Water Temp. (°C)	Sample ID	Sample Effort (hrs)	Lake sturgeon ¹	Northern pike	White sucker	Walleye	Other	Total (n)
May 4	8.6	IFGN01	1.6	-	-	3	1	-	4
May 4		IFGN02	2.1	-	-	-	11	-	11
May 4		IFGN03	2.0	-	-	1	3	-	4
May 5	9.2	IFGN05	1.3	-	-	1	-	-	1
May 5		IFGN06	1.3	-	-	4	-	-	4
May 5		IFGN07	1.3	-	-	4	-	1 ³	5
May 5		IFAN03	0.5	-	3	-	3	-	6
May 10	12.9	IFGN34	1.8	-	-	1	-	1 ⁴	2
May 11	12.6	IFAN11	1.9	-	-	-	6	5 ³	11
May 12	12.1	IFGN38	3.8	6	-	-	-	-	6
May 12		IFAN01	0.8	-	1	-	3	-	4
May 13	11.8	IFGN44	4.0	1 ²	-	-	-	-	1
May 15	12.3	IFGN49	2.3	1	-	-	-	-	1
May 16	11.7	IFGN52	4.0	1 ²	-	-	-	-	1
May 16		IFGN53	4.1	3	-	-	-	-	3
May 17	12.1	IFGN57	4.4	1 ²	-	-	-	-	1
May 18	13.0	IFGN58	5.8	1	-	-	-	-	1
May 18		IFGN59	5.3	1 ²	-	-	-	-	1
May 19	12.1	IFAN02	3.0	-	-	-	12	-	12
May 20	11.1	IFGN66	5.6	-	1	-	-	-	1
Total				15	5	14	39	7	80

Notes

1. May 12 - lake sturgeon tag nos. 0801, 0802, 0803, 0804, 0805 and 0806
May 16 - lake sturgeon tag nos. 0807, 0808 and 0809
May 18 - lake sturgeon tag no. 0810
2. recaptured lake sturgeon
3. smallmouth bass
4. longnose sucker

TABLE 3-3
AREA A – ISLAND FALLS
FISH LENGTH, WEIGHT AND MATURITY CHARACTERISTICS
MATTAGAMI RIVER, SPRING 2007

Physical Characteristics Target Species	Sex	Maturity			Total (n)		Min.	Max.	Mean		S.D.
		Ripe	Spent	Unknown							
Lake sturgeon	Male	7	-	-	10	Fork Length (mm)	878	1190	1067.7	±	97.7
	Female	-	-	-		Weight (gms)	5500	13200	9966.7	±	2330.7
	Unknown	-	-	3							
Northern pike	Male	1	-	-	5	Fork Length (mm)	437	860	537.2	±	180.8
	Female	1	-	-		Weight (gms)	400	3100	1220.0	±	1073.3
	Unknown	-	-	3							
White sucker	Male	6	-	-	14	Fork Length (mm)	400	510	445.5	±	33.2
	Female	1	-	-		Weight (gms)	1000	2300	1375.0	±	380.7
	Unknown	-	-	7							
Walleye	Male	16	-	1	39	Fork Length (mm)	263	526	378.1	±	66.4
	Female	2	-	-		Weight (gms)	150	3200	807.0	±	667.0
	Unknown	-	1	19							

Egg mats were deployed at Island Falls starting on May 5, 2007, and were checked and redeployed until May 21, 2007. Table 3-4 provides a summary of sampling effort and catch success, while Figure 3-7 identifies egg mat sampling and capture locations relative to habitat features.

TABLE 3-4
AREA A – ISLAND FALLS
EGG MAT RECORDS
MATTAGAMI RIVER, SPRING 2007

Mat No.	UTM (NAD 83)		Substrate Composition (%)												Observed Depth (m)	Observed Flow (m/s)	Sample Effort				No. Eggs Captured
	E	N	Cl/Si	Sa	Sm Gr	Md Gr	Lg Gr	Sm Co	Lg Co	Sm Bo	Lg Bo	Br	Other	2007			Date	Time	Hours Set		
IF-01	454028	5443004	-	-	-	-	15	15	70	-	-	-	-	0.05	Set	May-5	19:00	-	-		
															Lifted	May-9	14:30	86.5	0		
															Total	-	-	86.5	0		
IF-02	453989	5442815	-	10	-	-	10	80	-	-	-	-	1.5	0.07	Set	May-5	19:00	-	-		
															Lifted	May-8	16:00	64	0		
															Total	-	-	64	0		
IF-03	453988	5442835	50	50	-	-	-	-	-	-	-	-	0.5	0.01	Set	May-5	19:00	-	-		
															Lifted	May-8	16:00	64	0		
															Total	-	-	64	0		
IF-04	453998	5442839	30	30	-	-	-	-	-	-	-	40(a)	1.5	0.01	Set	May-5	19:00	-	-		
															Lifted	May-8	16:00	64	0		
															Total	-	-	64	0		
IF-05	454005	5442830	30	30	-	-	10	20	-	-	-	10(a)	1.0	0.03	Set	May-5	19:00	-	-		
															Lifted	May-8	16:00	64	0		
															Total	-	-	64	0		
IF-06	454047	5443011	-	-	-	-	15	15	70	-	-	-	3.5	0.03	Set	May-5	19:00	-	-		
															Lifted	May-9	14:30	91.5	0		
															Total	-	-	91.5	0		
IF-07	454048	5443011	-	-	-	-	10	10	20	-	-	60	3.5	0.03	Set	May-5	19:00	-	-		
															Lifted	May-9	14:30	91.5	0		
															Total	-	-	91.5	0		
IF-08	454026	5442900	35	35	-	-	10	10	-	-	-	10(a)	3.5	0.01	Set	May-5	19:00	-	-		
															Lifted	May-9	11:45	88.8	0		
															Total	-	-	88.8	0		
IF-09	454026	5442898	35	35	-	-	10	10	-	-	-	10(a)	3.4	0.01	Set	May-5	19:00	-	-		
															Lifted	May-8	16:30	69.5	0		
															Total	-	-	69.5	0		
IF-10	454026	5442900	35	35	-	-	10	10	-	-	-	10(a)	3.0	0.01	Set	May-5	19:00	-	-		
															Lifted	May-9	11:30	88.5	0		
															Total	-	-	88.5	0		

Mat No.	UTM (NAD 83)		Substrate Composition (%)											Observed Depth (m)	Observed Flow (m/s)	Sample Effort				No. Eggs Captured
	E	N	Cl/Si	Sa	Sm Gr	Md Gr	Lg Gr	Sm Co	Lg Co	Sm Bo	Lg Bo	Br	Other			2007	Date	Time	Hours Set	
IF-11	453969	5442763	-	-	-	-	-	20	-	30	50	-	-	0.08	3.8	Set	May-9	14:30	-	-
													Lifted			May-12	16:30	74	5	
													Total			-	-	74	5	
IF-12	453978	5442786	-	-	-	10	-	20	20	40	-	-	10(a)	0.04	3.8	Set	May-9	14:30	-	-
													Lifted			May-12	15:55	73.4	39	
													Total			-	-	73.4	39	
IF-13	454018	5442755	-	-	-	-	-	-	-	-	-	100	-	0.05	4.0	Set	May-9	14:30	-	-
													Lifted			May-12	15:20	72.8	11	
													Total			-	-	72.8	11	
IF-14	453982	5442839	45	45	-	-	-	10	-	-	-	-	-	0.06	1.3	Set	May-8	16:30	-	-
													Lifted			May-12	16:55	96.4	0	
													Total			-	-	96.4	0	
IF - 15	453994	5442853	50	50	-	-	-	-	-	-	-	-	-	0.03	1.2	Set	May-8	16:30	-	-
													Lifted			May-12	17:15	96.8	0	
													Total			-	-	96.8	0	
IF-16	454022	5442816	-	-	-	-	-	-	100	-	-	-	-	0.09	1.0	Set	May-8	16:30	-	-
													Lifted			May-12	17:30	96.5	0	
													Total			-	-	96.5	0	
IF-17	454050	5442981	-	-	-	-	-	-	50	40	10	-	-	-0.10	3.3	Set	May-12	20:25	-	-
													Lifted			May-14	16:00	43.6	25	
													Total			-	-	43.6	25	
IF-18	454043	5442985	-	-	20	-	20	20	-	-	20	-	-	-0.13	5.2	Set	May-12	20:40	-	-
													Lifted			May-14	16:15	43.5	2/4	
													Total			-	-	43.5	2/4	
IF-19	454018	5442755	-	-	-	-	-	-	-	-	-	100	-	0.05	4.0	Set	May-12	15:45	-	-
													Lifted			May-15	13:40	69.9	0	
													Total			-	-	69.9	0	
IF-20	454021	5442814	10	40	10	10	-	10	-	-	-	-	10(a)	-0.01	1.8	Set	May-12	20:00	-	-
													Lifted			May-15	14:00	66	0	
													Total			-	-	66	0	

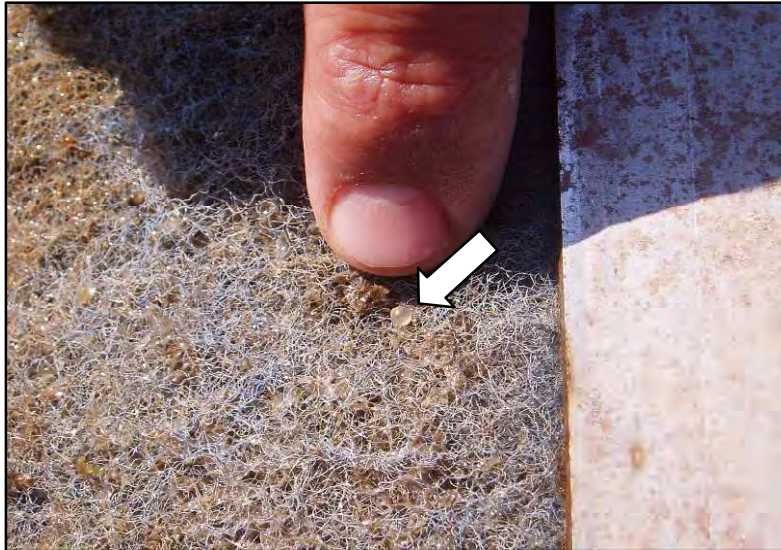
Mat No.	UTM (NAD 83)		Substrate Composition (%)											Observed Depth (m)	Observed Flow (m/s)	Sample Effort				No. Eggs Captured
	E	N	Cl/Si	Sa	Sm Gr	Md Gr	Lg Gr	Sm Co	Lg Co	Sm Bo	Lg Bo	Br	Other			2007	Date	Time	Hours Set	
IF-21	454055	5443000	-	-	-	-	-	-	-	-	-	100	-	-0.10	1.8	Set	May-15	13:15	-	-
														Lifted	May-18	11:40	70.4	0	0	
														Total	-	-	70.4	0	0	
IF-22	453970	5442820	-	-	-	-	-	-	100	-	-	-	-	0.09	3.9	Set	May-12	17:35	-	-
														Lifted	May-17	14:15	116.4	0	0	
														Total	-	-	116.4	0	0	
IF-23	453978	5442786	-	-	-	10	-	20	20	40	-	-	10(a)	0.04	3.9	Set	May-12	16:20	-	-
														Lifted	May-17	14:25	118	0	0	
														Total	-	-	118	0	0	
IF-24	454026	5442976	-	-	-	-	-	10	30	60	-	-	-	0.06	3.9	Set	May-14	16:15	-	-
														Lifted	May-17	19:00	74.8	0	0	
														Total	-	-	74.8	0	0	
IF-25	453998	5442973	-	-	-	-	-	40	40	20	-	-	-	0.40	4.7	Set	May-16	17:00	-	-
														Lifted	May-18	13:10	44.2	8	8	
														Total	-	-	44.2	8	8	
IF-26	454026	5442976	-	-	-	-	-	10	30	30	10	20	-	-0.02	3.8	Set	May-17	19:30	-	-
														Lifted	May-18	11:55	16.4	54	54	
														Total	-	-	16.4	54	54	
IF-27	454050	5442981	-	-	-	-	-	-	50	40	10	-	-	-0.10	3.3	Set	May-17	19:30	-	-
														Lifted	May-18	12:30	17.0	1	1	
														Total	-	-	17.0	1	1	
IF-28	454015	5442900	-	-	-	-	-	30	30	40	-	-	-	0.17	3.9	Set	May-14	19:30	-	-
														Lifted	May-17	15:00	67.5	0	0	
														Total	-	-	67.5	0	0	
IF-29	454031	5442964	-	-	-	-	-	25	25	30	-	20	-	0.12	4.8	Set	May-16	17:00	-	-
														Lifted	May-18	15:30	46.5	44	44	
														Total	-	-	46.5	44	44	
IF-30	453950	5442925	5	5	-	-	-	30	50	10	-	-	-	0.10	4.1	Set	May-16	17:00	-	-
														Lifted	May-18	16:20	47.3	0	0	
														Total	-	-	47.3	0	0	

Mat No.	UTM (NAD 83)		Substrate Composition (%)											Observed Depth (m)	Observed Flow (m/s)	Sample Effort			No. Eggs Captured	
	E	N	Cl/Si	Sa	Sm Gr	Md Gr	Lg Gr	Sm Co	Lg Co	Sm Bo	Lg Bo	Br	Other			2007	Date	Time		Hours Set
IF-31	454050	5442925	-	-	-	-	-	-	-	-	-	100	-	6.9	~0.06	Set	May-14	16:30	-	-
																Lifted	May-18	16:30	96.0	0
																Total	-	-	96.0	0
IF-32	454005	5442913	-	-	-	-	10	40	50	-	-	-	-	5.3	0.17	Set	May-13	18:50	-	-
																Lifted	May-18	17:00	118.2	0
																Total	-	-	118.2	0
IF-33	453995	5442917	-	-	-	-	10	30	60	-	-	-	-	~6.0	-0.15	Set	May-16	17:00	-	-
																Lifted	May-18	17:30	48.5	0
																Total	-	-	48.5	0
IF-34	454018	5442755	-	-	-	-	10	70	20	-	-	-	-	4.0	0.05	Set	May-12	15:45	-	-
																Lifted	May-18	17:40	145.9	0
																Total	-	-	145.9	0
IF-35	454036	5442758	-	-	-	-	-	-	-	-	100	-	1.8	-0.07	Set	May-16	11:00	-	-	
															Lifted	May-18	18:00	55.0	0	
															Total	-	-	55.0	0	
IF-36	454047	5442898	20	-	-	-	-	-	-	-	80	-	-	-	-	Set	May-18	19:10	-	-
																Checked	May-20	13:08	41.3	0
																Lifted	May-21	13:18	24.2	0
IF-37	454047	5442898	20	-	-	-	-	-	-	-	80	-	-	-	-	Set	May-18	19:10	-	-
																Checked	May-20	13:13	52	1
																Lifted	May-21	13:18	24.3	0
IF-38	454031	5442964	-	-	-	-	25	25	30	-	-	20	-	4.8	0.12	Total	-	-	76.3	1
																Set	May-18	19:10	-	-
																Checked	May-20	13:31	52.3	9
IF-39	454031	5442964	-	-	-	-	25	25	30	-	-	20	-	4.8	0.12	Lifted	May-21	13:05	23.5	4
																Total	-	-	75.8	13
																Set	May-18	19:10	-	-
IF-40	453929	5442978	-	-	-	-	10	10	80	-	-	-	-	4.2	0.27	Checked	May-20	13:53	52.7	0
																Lifted	May-21	12:50	22.9	1
																Total	-	-	75.6	1
IF-40	453929	5442978	-	-	-	-	10	10	80	-	-	-	-	4.2	0.27	Set	May-18	19:10	-	-
																Checked	May-20	14:07	52.9	10
																Lifted	May-21	10:30	20.4	1
IF-40	453929	5442978	-	-	-	-	10	10	80	-	-	-	-	4.2	0.27	Total	-	-	71.3	11
																Set	May-18	19:10	-	-
																Checked	May-20	14:07	52.9	10

Mat No.	UTM (NAD 83)		Substrate Composition (%)											Observed Depth (m)	Observed Flow (m/s)	Sample Effort				No. Eggs Captured
	E	N	Cl/Si	Sa	Sm Gr	Md Gr	Lg Gr	Sm Co	Lg Co	Sm Bo	Lg Bo	Br	Other			2007	Date	Time	Hours Set	
IF-41	453953	5442978	-	-	-	-	-	25	-	75	-	-	-	-	Set	May-18	19:10	-	-	
													Checked	May-20	14:19	53.1	3			
													Lifted	May-21	11:00	20.6	0			
													Total	-	-	73.7	3			
IF-42	454026	5442982	-	-	-	-	-	-	40	60	-	-	-	Set	May-18	19:10	-	-		
													Checked	May-20	14:35	53.4	0			
													Lifted	May-21	11:30	21.0	2			
													Total	-	-	74.4	2			
IF-43	454018	5442982	-	-	-	-	-	25	75	-	-	-	Set	May-18	19:10	-	-			
													Checked	May-20	14:45	53.6	0			
													Lifted	May-21	11:22	20.6	0			
													Total	-	-	74.2	0			
IF-44	454050	5442981	-	-	-	-	-	-	50	40	10	-	Set	May-18	19:10	-	-			
													Checked	May-20	15:39	50.6	0			
													Lifted	May-21	11:45	20.1	4			
													Total	-	-	70.7	4			
IF-45	454046	5443088	-	-	-	-	-	10	-	-	-	90	Set	May-18	19:10	-	-			
													Checked	May-20	15:40	54.4	0			
													Lifted	May-21	10:00	18.3	5			
													Total	-	-	72.7	5			
IF-46	454050	5442981	-	-	-	-	-	-	50	40	10	-	Set	May-18	19:10	-	-			
													Checked	May-20	15:42	54.4	43			
													Lifted	May-21	12:05	20.4	8			
													Total	-	-	74.8	51			
IF-47	454050	5442981	5	5	-	-	-	30	50	10	-	-	Set	May-18	19:10	-	-			
													Checked	May-20	15:43	54.4	0			
													Lifted	May-21	12:30	20.8	5			
													Total	-	-	75.2	5			
Notes:		a - woody debris											3467.5	351						

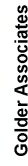
Egg mats were typically deployed in the outwash of the four Chutes that comprise the Island Falls, and around the exposed shoal located approximately 50 to 100 m downstream and between Chutes 3 and 4. Eggs collected on mats were assumed to be associated with spawning events that took place between May 12 and May 21, 2007. A typical example of an egg attached to an egg mat is shown in Plate 3-1 below. Forty-seven egg mat sets, totalling 3,468 hours of effort, were carried out. A total of 351 eggs were captured at eighteen mat locations. Set times for mats that successfully collected eggs varied from 16 to 76 hours. Based on these numbers, CPUE for Island Falls was 5.3×10^{-4} eggs/m²/hr.

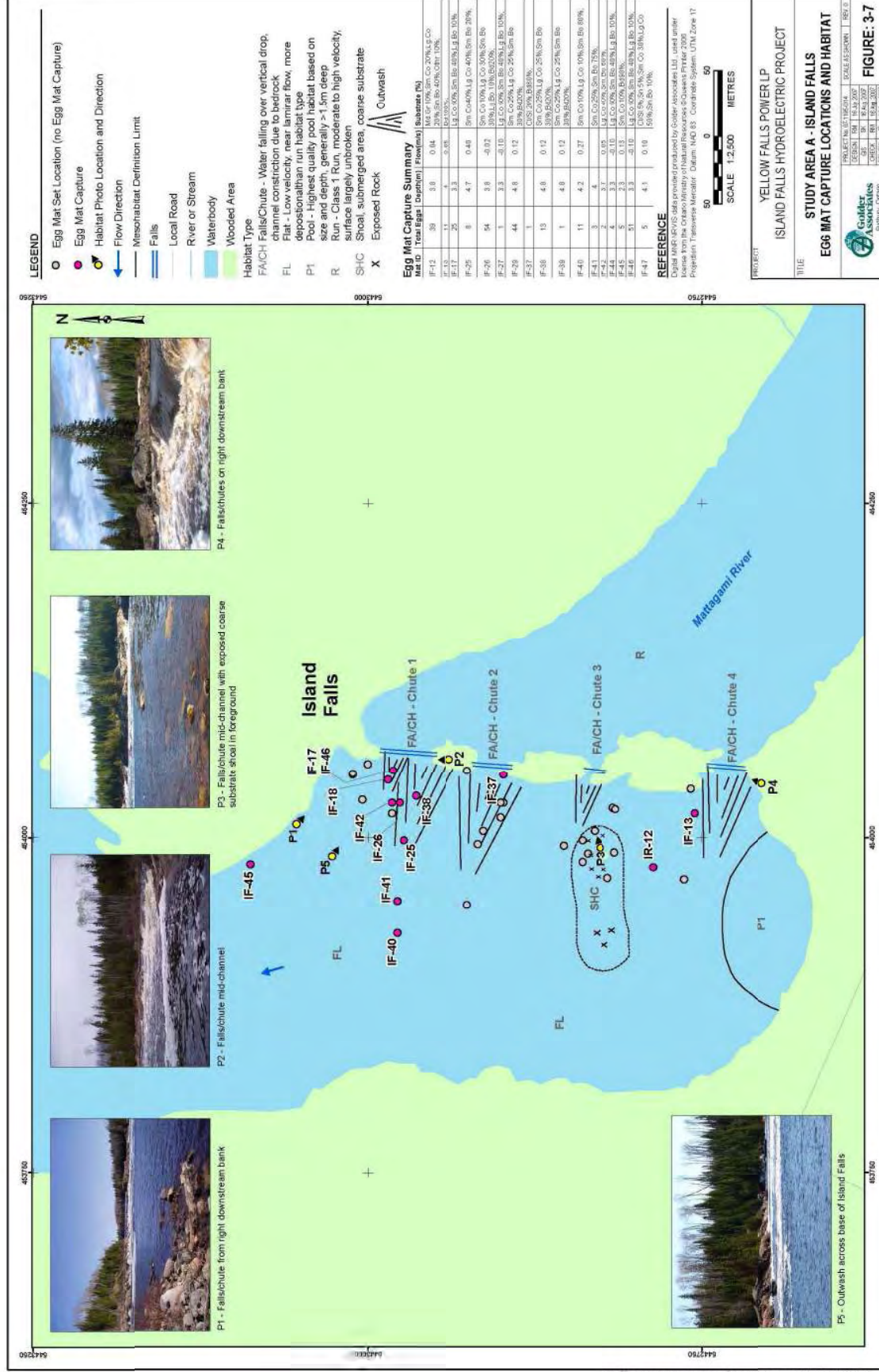
PLATE 3-1
AREA A – ISLAND FALLS
WALLEYE EGG ATTACHED TO AN EGG MAT (MAY 12, 2007)



Egg deposition was observed at depths of 2 to 5 m in, with flow velocities ranging from 0.04 to 0.4 m/s. Egg deposition was recorded primarily at the periphery of the outwash areas situated below Island Falls. The substrate in these locations was composed of coarse material (cobble, boulder). Eggs were not collected on the submerged shoal located downstream of the Island Falls.

Species identification of eggs removed from individual mats indicated the presence of eggs deposited by northern pike (IF-12, May 12; IF-26, May 18; and IF-38, May 20/21), white sucker (IF-18, May 14), walleye (IF-13, May 12; IF-17, May 14; IF-25, May 18; and IF-38, May 20/21), and yellow perch (*Perca flavescens*) eggs (IF-38, May 20/21). Lake sturgeon eggs were not collected.





3.2.2 Bradburn Creek

Bradburn Creek is located between Smooth Rock Falls and Island Falls (Figure 1-2). The lower reach of Bradburn Creek is inundated by the headpond created by the Smooth Rock Falls GS. This reach consists of flat, slow moving water that is dominated by a clay/silt/sand substrate. Depths in this reach typically ranged from less than 1 to 4 m. Inundation results in large contiguous areas of submerged shoreline vegetation that provide a range of instream and overhead cover habitat types. Submergent vegetation was abundant along channel margins and in small shallow bays. Habitat features commonly associated with walleye, white sucker and lake sturgeon spawning activity (i.e. coarse substrates, moderate/fast velocity water) were not observed in Bradburn Creek. Due to the absence of this type of habitat egg mats were not deployed.

A spawning assessment using hoop and gill net sets was conducted in Bradburn Creek from May 6 to May 13, 2007. Figure 3-8 illustrates fish capture locations and habitat features that were observed during the survey. Northern pike and white sucker were the only two target species captured. Spent male and female northern pike were captured between May 10 and May 13, 2007. Gravid and ripe white suckers (both sexes) were captured on May 8, May 10 and May 13, 2007. The only non-target species captured in Bradburn Creek was yellow perch. Catch and species composition data is summarized in Table 3-5; size and maturity data is provided in Table 3-6.

Typically, fish were captured in shallow water (1.6 to 3.8 m), with the exception of fish captured in hoop net BCHN13 which was set near the mouth of Bradburn Creek at a depth of 6.5 m. The substrate at most capture locations was dominated by fine-grained materials (clay/silt, sand). Exceptional in this regard was site BCHN13, where substrates were comprised of a mixture of fine-grained material, and coarse-grained material (small and large cobble, small boulder).

TABLE 3-5
AREA A – BRADBURN CREEK
CATCH SUMMARY AND SPECIES COMPOSITION
SPRING 2007

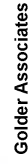
Date Lifted	Mean Water Temp. (°C)	Sample ID	Sample Effort (hrs)	Lake sturgeon	Northern pike	White sucker	Walleye	Other	Total (n)
May 8	11.3	BCHN08	3.5	-	-	1	-	-	1
May 10	13.9	BCGN06	3.2	-	1	-	-	-	1
May 10		BCGN07	3.4	-	-	2	-	-	2
May 10		BCGN08	3.5	-	1	1	-	-	2
May 13	11.6	BCHN13	4.6	-	4	9	-	2 ¹	15
Total				0	6	13	0	2	21

Notes

1. yellow perch (*Perca flavescens*)

TABLE 3-6
AREA A – BRADBURN CREEK
FISH LENGTH, WEIGHT AND MATURITY CHARACTERISTICS
SPRING 2007

Physical Characteristics Target Species	Sex	Maturity			Total (n)		Min.	Max.	Mean		S.D.
		Ripe	Spent	Unknown							
Lake sturgeon	Male	-	-	-	0	Fork Length (mm)	-	-	-	±	-
	Female	-	-	-		Weight (gms)	-	-	-	±	-
	Unknown	-	-	-							
Northern pike	Male	-	1	-	6	Fork Length (mm)	318	795	564.2	±	170.2
	Female	-	5	-		Weight (gms)	600	3700	1540.0	±	1281.8
	Unknown	-	-	-							
White sucker	Male	4	-	-	13	Fork Length (mm)	410	561	463.9	±	43.4
	Female	9	-	-		Weight (gms)	700	2000	1246.2	±	382.7
	Unknown	-	-	-							
Walleye	Male	-	-	-	0	Fork Length (mm)	-	-	-	±	-
	Female	-	-	-		Weight (gms)	-	-	-	±	-
	Unknown	-	-	-							



3.2.3 Pullen Creek

Pullen Creek enters the Mattagami River, from the east, approximately 10 km downstream of Island Falls. Pullen Creek is influenced by the dam at Smooth Rock Falls (i.e. lower reach inundated for a distance of approximately 1 km).

The inundated portion of Pullen Creek is characterized by flat, slow moving water with a depth ranging from 1.7 to 3.6 m. Similar to Bradburn Creek, substrates are dominated by clay/silt/sand. Side channels and pockets of open water marsh were also observed within the lower reach.

Upstream of the headpond influence, the creek features a meandering channel, approximately 3 to 5 m wide, that is frequently obstructed by woody debris piles and root wads. Substrates in this reach consist primarily of clay/silt with minor, interspersed gravel and small cobble deposits. Depths were typically <0.5 m. The presence of numerous log jams and debris piles suggest that fish access to the reach upstream of the reservoir influence by target species for the purpose of spawning is unlikely.

Figure 3-9 presents an overview of fish capture locations and habitat features that were observed in Pullen Creek during the spring 2007 survey. A spawning assessment directed toward the target species was conducted between May 6 and May 11, 2007, using a combination of gill and hoop nets. Mean netting effort was estimated at 4.4 hours per set for gill nets and 24.7 hours for hoop nets. Catch and species composition data is summarized in Table 3-7; size distribution and maturity data are summarized in Table 3-8.

TABLE 3-7
AREA A – PULLEN CREEK
CATCH SUMMARY AND SPECIES COMPOSITION
SPRING 2007

Date Lifted	Mean Water Temp. (°C)	Sample ID	Sample Effort (hrs)	Lake sturgeon	Northern pike	White sucker	Walleye	Other	Total (n)
May 9	12.6	PCGN03	3.9	-	-	12	-	-	12
May 9		PCGN04	4.5	-	-	2	-	-	2
May 9		PCGN05	4.7	-	-	1	1	-	2
May 9		PCHN10	26.5	-	-	1	-	1 ¹	2
May 10	14.3	PCHN12	23.0	-	-	-	2	1 ¹	3
Total				0	0	16	3	2	21

Notes

1. burbot (*Iota Iota*)

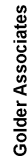
TABLE 3-8
AREA A – PULLEN CREEK
FISH LENGTH, WEIGHT AND MATURITY CHARACTERISTICS
SPRING 2007

Physical Characteristics Target Species	Sex	Maturity			Total (n)		Min.	Max.	Mean		S.D.
		Ripe	Spent	Unknown							
Lake sturgeon	Male	-	-	-	0	Fork Length (mm)	-	-	-	±	-
	Female	-	-	-		Weight (gms)	-	-	-	±	-
	Unknown	-	-	-			-	-	-		
Northern pike	Male	-	-	-	0	Fork Length (mm)	-	-	-	±	-
	Female	-	-	-		Weight (gms)	-	-	-	±	-
	Unknown	-	-	-			-	-	-		
White sucker	Male	3	-	-	16	Fork Length (mm)	436	524	471	±	27.1
	Female	13	-	-		Weight (gms)	1000	1800	1415.6	±	226.4
	Unknown	-	-	-							
Walleye	Male	-	1	-	3	Fork Length (mm)	218	578	379	±	183
	Female	1	-	-		Weight (gms)	300	2300	1300	±	1414.2
	Unknown	-	-	1							

White sucker and walleye were captured in the lower reach of Pullen Creek, between May 9 and May 10, 2007. Ripe white suckers (males and females) were captured on May 9, 2007, at various locations within Pullen Creek. One ripe female walleye was captured on May 9, 2007, at PCGN05. Two additional walleye captured on May 10, 2007 (PCHN12), were assessed as spent or sex and maturity unknown. Of the non-target species, burbot (*Lota lota*) were captured in hoop nets PCHN10 and PCHN12.

Substrate composition at fish capture locations was dominated by fine material (clay/silt and sand), although organic debris (stumps and logs) was also noted. Fish were captured at depths ranging from 0.8 to 3.5 m.

The lower reach of Pullen Creek is characterized by flat, slow moving water. Despite the presence of ripe individuals, habitat conditions typically associated with white sucker or walleye spawning were not identified anywhere in the stream. As a result, egg mats were not deployed within the lower reach of Pullen Creek.



3.2.4 North Muskego River

The North Muskego River, which enters the Mattagami River approximately 10 km downstream of Island Falls, is the largest tributary to the Smooth Rock Falls GS headpond. Mesohabitat was characterized (May 4 to May 16, 2007) within selected areas between the mouth and the first upstream barrier (i.e. an approximate 2 to 3 m high bedrock controlled falls/chute located approximately 4 km upstream from the confluence with the Mattagami River). Because this falls/chute was considered to be an impassable barrier to fish under the flow conditions observed in May 2007 assessment work was not carried out farther upstream. Habitat features at fish capture and egg collection sites are presented in Figures 3-10 and 3-11.

Below the falls/chute, the river was characterized by flat, slow moving water with an average depth of 4 to 6 m. The substrate consisted primarily of clay, silt and sand. At the upper limit of the headpond's influence the channel narrows, depth decreases and the substrate becomes coarser (cobble/boulder).

Catch and species composition data are summarized in Table 3-9. Length, weight and maturity data are presented in Table 3-10. Northern pike, white sucker and walleye were captured during the May 5 to May 16, 2007, survey. Mean fishing effort was 21.7 hours for hoop nets and gill net set duration averaged 4.5 hours.

TABLE 3-9
AREA A – NORTH MUSKEGO RIVER
CATCH SUMMARY AND SPECIES COMPOSITION
SPRING 2007

Date Lifted	Mean Water Temp. (°C)	Sample ID	Sample Effort (hrs)	Lake sturgeon	Northern pike	White sucker	Walleye	Other	Total (n)
May 5	-	NMHN03	21.1	-	1	2	1	-	4
May 5	-	NMGN02	4.5	-	2	7	-	-	9
May 6	-	NMHN04	18.2	-	7	4	4	3 ¹	18
May 12	13.1	NMHN16	22.7	-	1	4	-	-	5
May 13	11.3	NMHN18	24.4	-	3	2	-	-	5
May 13		NMHN19	24.1	-	-	-	1	-	1
May 16	11.1	NMHN24	20.1	-	-	-	2	-	2
Total				0	14	19	8	3	44

Notes

1. 2 longnose sucker (*Catostomus catostomus*) and 1 yellow perch (*Perca flavescens*)

TABLE 3-10
AREA A – NORTH MUSKEGO RIVER
FISH LENGTH, WEIGHT AND MATURITY CHARACTERISTICS
SPRING 2007

Physical Characteristics Target Species	Sex	Maturity			Total (n)		Min.	Max.	Mean		S.D.
		Ripe	Spent	Unknown							
Lake sturgeon	Male	-	-	-	0	Fork Length (mm)	-	-	-	±	-
	Female	-	-	-		Weight (gms)	-	-	-	±	-
	Unknown	-	-	-							
Northern pike	Male	1	8	-	14	Fork Length (mm)	372	750	508.6	±	93.0
	Female	-	3	-		Weight (gms)	350	3200	938.5	±	805.0
	Unknown	-	-	2							
White sucker	Male	5	-	-	19	Fork Length (mm)	242	485	443.3	±	51.6
	Female	10	2	-		Weight (gms)	800	1700	1261.8	±	285.9
	Unknown	-	-	2							
Walleye	Male	3	3	-	8	Fork Length (mm)	346	630	441.8	±	108.5
	Female	1	1	-		Weight (gms)	500	1800	835.7	±	480.2
	Unknown	-	-	-							

One ripe male northern pike (site NMHN18) was captured on May 13, 2007. Spent males and females were captured at this location on subsequent sampling days. The site was located at the mouth of a shallow bay. The shoreline was dominated by submerged terrestrial vegetation and the substrate consisted of silt and organic debris.

Ripe white suckers (males and females) were captured below the falls/chute and further downstream on May 5, May 6 and May 12, 2007. Ripe walleye (three males and one female) were captured on May 6, 2007, near the mouth of the River. These individuals were likely migrating upstream towards the falls/chute. Subsequent walleye captures were spent males or females. Substrates, at fish capture locations NMRGN02 and NMRHN03 situated downstream of the falls/chute, were a mixture of fines (clay/silt/sand) and coarse materials (cobble and boulder).

Non-target species recorded in the North Muskego River (NMRHN04 on May 6, 2007) included longnose sucker and yellow perch.

Table 3-11 provides a summary of egg mat effort and catch success. Figure 3-11 illustrates egg mat sampling and capture locations and associated habitat features at the sites.

TABLE 3-11
AREA A – NORTH MUSKEGO RIVER
EGG MAT RECORDS
SPRING 2007

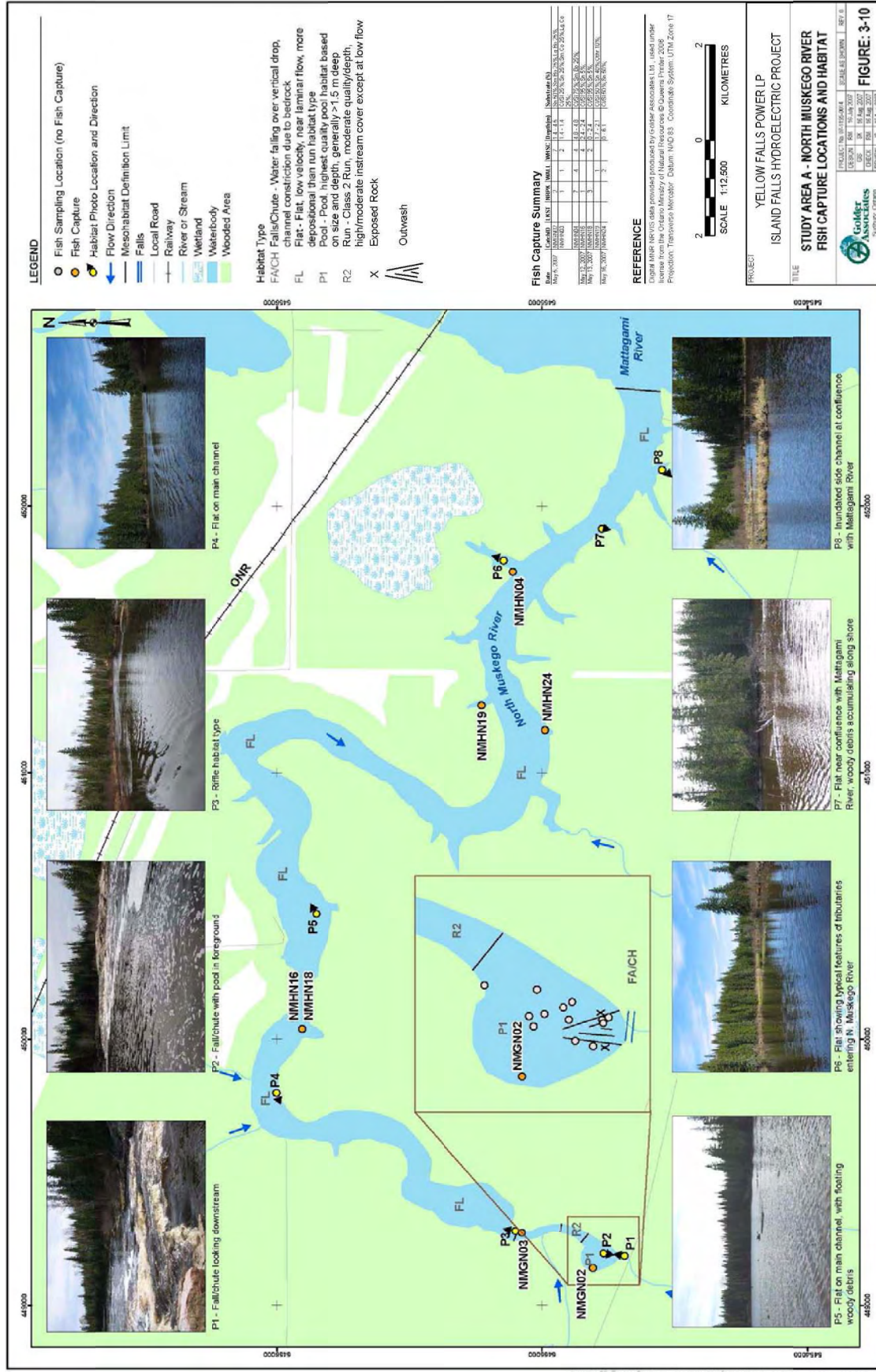
Mat No.	UTM (NAD 83)		Substrate Composition (%)										Observed Depth (m)	Observed Flow (m/s)	Sample Effort				No. Eggs Captured	
	E	N	Cl/Si	Sa	Sm Gr	Md Gr	Lg Gr	Sm Co	Lg Co	Sm Bo	Lg Bo	Br			Other	2007	Date	Time		Hours Set
NMR-01	449294	5454973	-	-	-	-	-	15	15	70	-	-	-	0.57	1.8	Set	May-5	10:28	-	-
																Checked	May-6	11:24	25	
																Lifted	May-7	11:52	24.5	
																Total	-	-	49.5	
NMR-02	449283	5454469	-	-	-	-	-	35	-	50	-	15	0.57	0.9	Set	May-5	10:31	-	-	
															Checked	May-6	11:27	25		
															Lifted	May-7	11:54	24.5		
															Total	-	-	49.5		
NMR-03	449269	5455055	-	5	15	-	-	-	15	-	50	15	0.57	1.5	Set	May-5	10:36	-	-	
															Checked	May-6	11:29	25		
															Lifted	May-7	11:57	24.5		
															Total	-	-	49.5		
NMR-04	449264	5455010	-	5	15	-	-	-	15	-	50	15	0.57	1.1	Set	May-5	10:38	-	-	
															Checked	May-6	11:31	25		
															Lifted	May-7	12:00	24.5		
															Total	-	-	49.5		
NMR-05	449189	5454720	-	-	-	5	-	-	20	-	25	50	0.76	0.9	Set	May-11	12:51	-	-	
															Checked	May-12	13:12	24.5		
															Checked	May-13	16:51	27.5		
															Checked	May-14	10:02	18		
NMR-06	449205	5454738	-	-	5	-	-	-	20	-	25	50	0.76	2.2	Set	May-11	12:53	-	-	
															Checked	May-12	13:06	24		
															Checked	May-13	16:50	28.5		
															Lifted	May-14	10:10	18		
NMR-07	449168	5454742	-	-	5	-	-	-	20	-	25	50	0.76	0.9	Total	-	-	70.5	0	
															Set	May-11	12:56	-		-
															Checked	May-12	13:19	24		
															Checked	May-13	16:44	27.5		
															Lifted	May-14	10:12	17	0	
															Total	-	-	68.5	3	

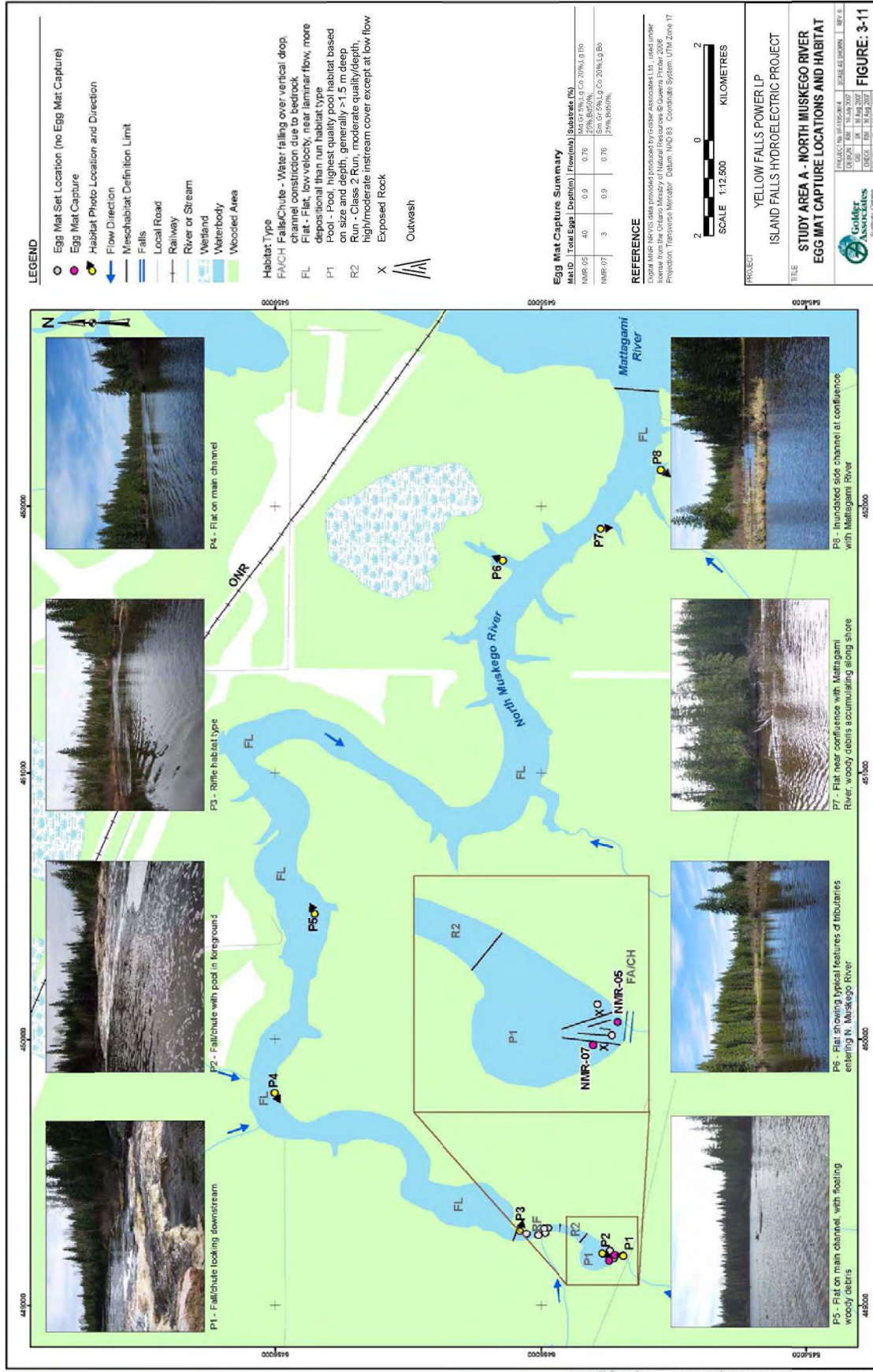
Mat No.	UTM (NAD 83)		Substrate Composition (%)										Observed Depth (m)	Observed Flow (m/s)	Sample Effort				No. Eggs Captured	
	E	N	Cl/Si	Sa	Sm Gr	Md Gr	Ig Gr	Sm Co	Lg Co	Sm Bo	Lg Bo	Br			Other	2007	Date	Time		Hours Set
NMR-08	449177	5454725	-	-	5	-	-	-	20	-	25	50	-	1.0	0.76	Set	May-11	12:59	-	-
																Checked	May-12	13:08	24	0
																Checked	May-13	16:39	27.5	0
																Checked	May-14	10:04	17.5	0
																Checked	May-15	10:08	24	0
																Checked	May-16	10:09	24	0
																Lifted	May-17	10:17	24	0
NMR-09	449273	5454984	-	-	5	-	-	20	-	25	50	-	0.6	0.76	Total	-	-	141	0	
															Set	May-12	11:08	-	-	
															Checked	May-13	17:00	30	0	
															Checked	May-14	10:06	24	0	
															Checked	May-15	10:01	24	0	
															Checked	May-16	10:02	24	0	
															Lifted	May-17	10:18	24.3	0	
NMR-10	449292	5454988	-	-	5	-	-	20	-	25	50	-	-	-	Total	-	-	126.3	0	
															Set	May-12	11:12	-	-	
															Checked	May-13	16:58	29.5	0	
															Checked	May-14	10:08	17	0	
															Checked	May-15	10:10	24	0	
															Checked	May-16	10:12	24	0	
															Lifted	May-17	10:20	24	0	
Total																118.5	0			
666.8																43				

Egg mats (deployed between May 5 and May 17, 2007) were placed across the base of the bedrock falls/chute at the upper limit of the headpond influence. Eggs captured at this site on May 12, 2007, confirmed the occurrence of a spawning event (Figure 3-11). A total of 43 eggs were collected on two of the ten mats deployed (i.e. NMR-05 and NMR-07). The total deployment time for egg mats placed below the falls/chute was approximately 669 hours. Individual set times ranged from 50 to 142 hours. Based on these numbers, CPUE for North Muskego River was calculated as 1.6×10^{-2} eggs/m²/h.

Egg deposition occurred in relatively shallow (0.9 m) and fast flowing (0.76 m/s) waters. Substrate composition in these locations was dominated by bedrock and coarse cobble/boulder material; gravel made a minor contribution. Post survey identification indicates that eggs collected from North Muskego River (NMR-05 and NMR-07, May 12) were walleye.

Although the falls/chute provided habitat conditions suitable for lake sturgeon spawning, lake sturgeon or released eggs were not encountered at this location.





3.3 Area B

3.3.1 Yellow Falls

Yellow Falls is formed by a bedrock outcrop on the Mattagami River. At high flows, the falls are characterized by a series of individual chutes. Field observations in May 2007 suggested that under the existing flow conditions the falls was an impassable barrier to fish. The estimated elevation difference between upstream and downstream was approximately 6 to 8 m. The main habitat features below the falls were an outwash area (characterized by turbulent flow and depths in the range of 2 to 3 m) and downstream rapids section. The rapids feature mainly coarse substrates (small to large boulders) and typically exceed 1 m in depth. They are bordered on both sides by rapid/riffle complexes with substrates consisting of a mixture of small and large cobble and boulders and depths ranging from 0.4 to 0.7 m (Figure 3-12). Downstream, flow velocities slowed and channel depth increased to produce a flat mesohabitat type. A large backwater pool (PI) is situated on the left downstream bank (i.e. at the point where the channel bends sharply to the right). The pool was 3 to 4 m deep with primarily large and small cobble substrate. Habitat features at fish capture egg collection sites are shown in Figure 3-12 and Figure 3-13.

Catch and species composition data for Yellow Falls are summarized in Table 3-12; fish length, weight and maturity data are presented in Table 3-13.

TABLE 3-12
AREA B – YELLOW FALLS
CATCH SUMMARY AND SPECIES COMPOSITION
MATTAGAMI RIVER, SPRING 2007

Date Lifted	Mean Water Temp. (°C)	Sample ID	Sample Effort (hrs)	Lake sturgeon	Northern pike	White sucker	Walleye	Other	Total (n)
May 6	9.7	YFGN09	1.9	-	-	1	-	-	1
May 8	9.4	YFGN19	17.7	-	-	2	-	-	2
May 8	10.3	YFGN20	5.6	-	-	1	-	-	1
May 8		YFGN21	4.8	-	-	4	-	-	4
May 8		YFGN22	4.8	-	-	1	-	-	1
May 9	11.3	YFGN27	7.7	-	-	2	-	1 ¹	3
May 9		YFGN28	6.8	-	-	2	-	-	2
May 10	12.6	YFGN30	5.5	-	-	3	-	-	3
May 10		YFGN31	5.3	-	-	3	-	-	3
May 11	12.4	YFGN36	16.8	-	-	5	-	-	5
Total				0	0	24		1	25

Notes

1. longnose sucker (*Catostomus catostomus*)

TABLE 3-13
AREA B – YELLOW FALLS
FISH LENGTH, WEIGHT AND MATURITY CHARACTERISTICS
SPRING 2007

Physical Characteristics Target Species	Sex	Maturity			Total (n)		Min.	Max.	Mean		S.D.
		Ripe	Spent	Unknown							
Lake sturgeon	Male	-	-	-	0	Fork Length (mm)	-	-	-	±	-
	Female	-	-	-		Weight (gms)	-	-	-	±	-
	Unknown	-	-	-							
Northern pike	Male	-	-	-	0	Fork Length (mm)	-	-	-	±	-
	Female	-	-	-		Weight (gms)	-	-	-	±	-
	Unknown	-	-	-							
White sucker	Male	7	-	-	24	Fork Length (mm)	399	495	449.3	±	25.0
	Female	8	-	-		Weight (gms)	750	1900	1358.3	±	276.5
	Unknown	-	-	9							
Walleye	Male	-	-	-	0	Fork Length (mm)	-	-	-	±	-
	Female	-	-	-		Weight (gms)	-	-	-	±	-
	Unknown	-	-	-							

Gill netting effort at Yellow Falls occurred between May 5 and May 19, 2007, but all fish were caught between May 6 and May 11, 2007. White sucker was the only target species caught the area immediately downstream of Yellow Falls. Mean sampling effort, for gill nets that captured fish, was 7.7 hours per set. Ripe individuals (males and/or females) were captured on May 6, May 8 to May 11, 2007. A single longnose sucker was captured on May 9, 2007.

Most white suckers were captured in shallow (1 to 2 m) water, in areas with coarse substrate (predominantly small and large cobble with some small boulder). Fish considered to be in spawning condition were typically captured along the edge of the main rapid complex, and within pool and flat areas downstream of Yellow Falls (Figure 3-12).

Eggs from a white sucker netting mortality on May 8, 2007, were found to be well-formed yet tightly bound (Plate 3-2). Ripe males in the Yellow Falls area had prominent spawning tubercles (Plate 3-3).

PLATE 3-2
AREA B – YELLOW FALLS
EGGS FROM RIPE FEMALE WHITE SUCKER (MAY 8, 2007)



PLATE 3-3
AREA B – YELLOW FALLS
SPAWNING TUBERCLES ON RIPE MALE WHITE SUCKER (MAY 10, 2007)

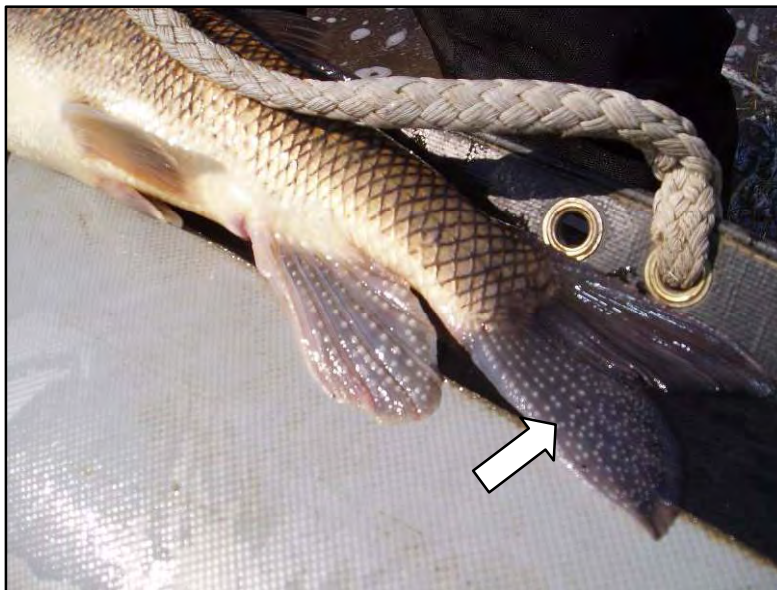


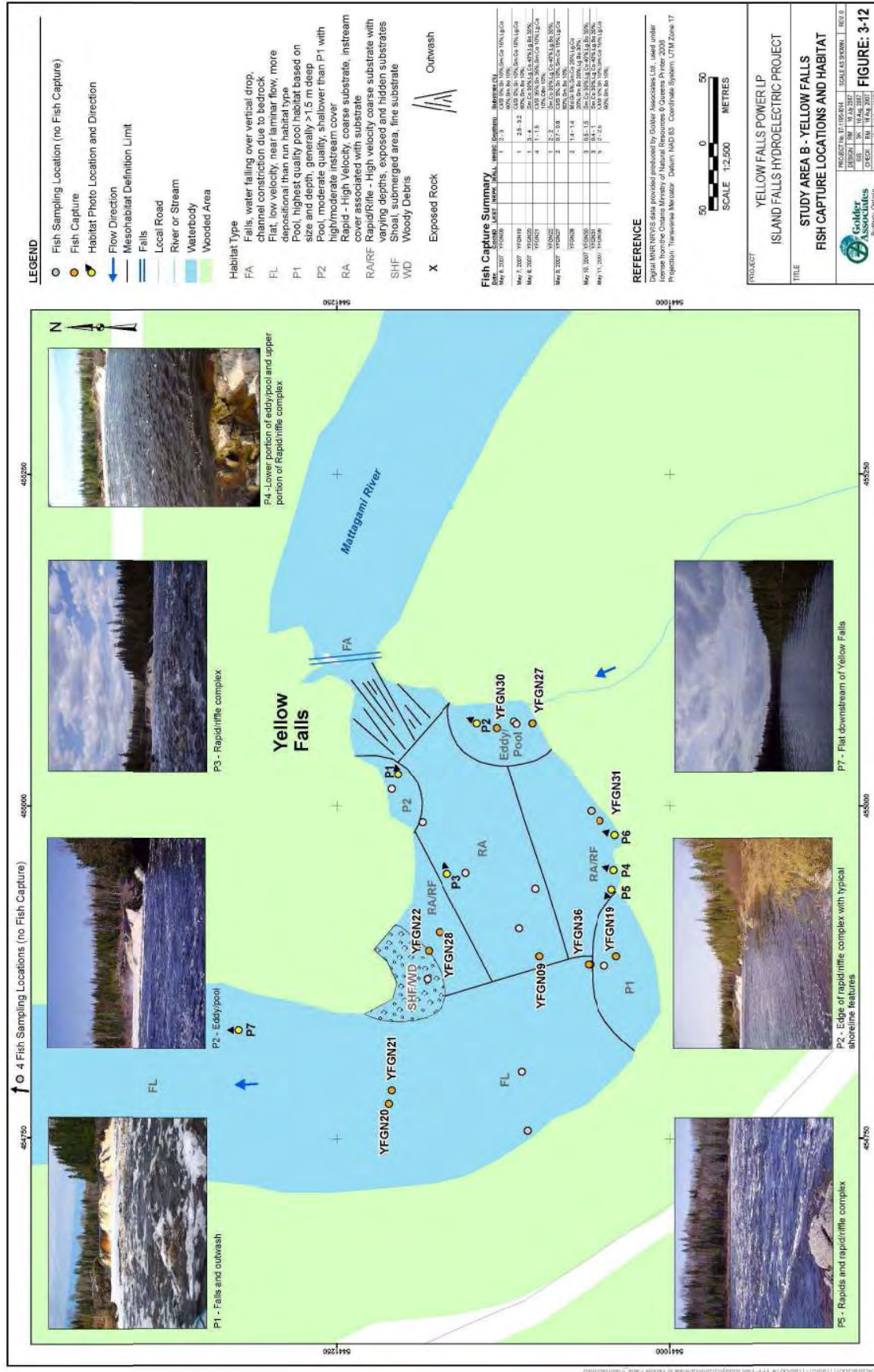
Table 3-14 and Figure 3-13 provide a summary of effort and sampling locations for egg mats at Yellow Falls.

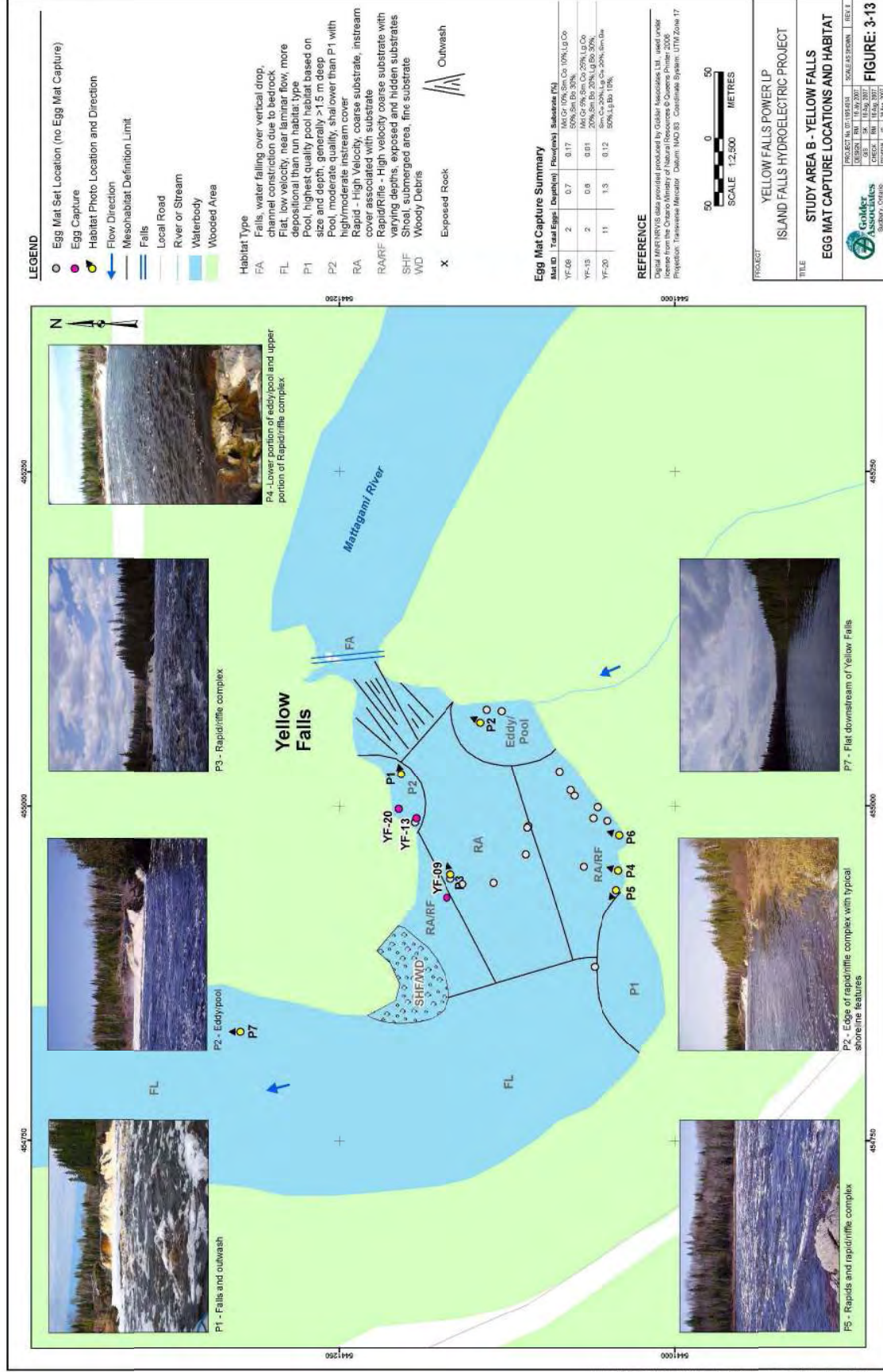
TABLE 3-14
AREA B – YELLOW FALLS
EGG MAT RECORDS
MATTAGAMI RIVER, SPRING 2007

Mat No.	UTM (NAD 83)		Substrate Composition (%)										Observed Depth (m)	Observed Flow (m/s)	Sample Effort				No. Eggs Captured
	E	N	Cl/Si	Sa	Sm Gr	Md Gr	Lg Gr	Sm Co	Lg Co	Sm Bo	Lg Bo	Br	Other		2007	Date	Time	Hours Set	
YF-01	454946	5441167	-	-	-	-	-	60	20	20	-	-	-	0.30	Set	May-9	17:00	-	-
															Lifted	May-10	18:00	25	0
															Total	-	-	25	0
YF-02	454964	5441111	-	-	-	-	-	-	70	30	-	-	-	-	Set	May-9	17:00	-	-
															Lifted	May-10	10:00	17	0
															Total	-	-	17	0
YF-03	455071	5441129	30	30	-	-	-	-	40	-	-	-	-	-	Set	May-8	18:50	-	-
															Lifted	May-10	10:30	39.7	0
															Total	-	-	39.7	0
YF-04	455072	5441140	7	8	-	-	-	15	70	-	-	-	-	0.15	Set	May-10	11:15	-	-
															Lifted	May-10	16:45	7.5	0
															Total	-	-	7.5	0
YF-05	455072	5441140	30	30	-	-	-	20	10	-	10	-	-	0.15	Set	May-10	11:15	-	-
															Lifted	May-12	12:10	48.9	0
															Total	-	-	48.9	0
YF-06	454991	5441061	-	-	-	-	-	60	30	10	-	-	-	0.18	Set	May-10	17:30	-	-
															Lifted	May-12	11:20	41.8	0
															Total	-	-	41.8	0
YF-07	454880	5441060	3	2	5	15	5	50	10	10	-	-	-	0.20	Set	May-10	18:10	-	-
															Lifted	May-12	11:20	41.1	0
															Total	-	-	41.1	0
YF-08	455002	5441055	-	-	10	20	10	30	20	10	-	-	-	0.10	Set	May-8	18:50	-	-
															Lifted	May-12	10:10	87.4	0
															Total	-	-	87.4	0
YF-09	454932	5441170	-	-	-	10	-	10	50	30	-	-	-	0.17	Set	May-12	19:00	-	-
															Lifted	May-15	16:00	93	2
															Total	-	-	93	2
YF-10	454997	5441038	-	-	5	10	5	40	40	-	-	-	-	0.07	Set	May-12	11:35	-	-
															Lifted	May-15	10:50	72.2	0
															Total	-	-	72.2	0

Mat No.	UTM (NAD 83)		Substrate Composition (%)										Observed Depth (m)	Observed Flow (m/s)	Sample Effort				No. Eggs Captured
	E	N	Cl/Si	Sa	Sm Gr	Md Gr	Lg Gr	Sm Co	Lg Co	Sm Bo	Lg Bo	Br			Other	2007	Date	Time	
YF-11	454985	5441109	-	-	-	-	-	20	70	-	10	-	-	Set	May-12	11:45	-	-	-
														Lifted	May-15	10:40	71.0	0	0
														Total	-	-	71.0	0	0
YF-12	454988	5441194	-	-	-	-	-	20	-	-	-	80	-	Set	May-12	12:35	-	-	-
														Lifted	May-13	11:30	22.9	0	0
														Total	-	-	22.9	0	0
YF-13	454991	5441193	-	-	-	5	-	25	20	20	30	-	-	Set	May-13	17:15	-	-	-
														Lifted	May-15	10:10	41.0	2	2
														Total	-	-	41.0	2	2
YF-14	454985	5441109	-	-	-	-	-	-	20	70	10	-	-	Set	May-12	11:45	-	-	-
														Lifted	May-15	10:40	71.0	0	0
														Total	-	-	71.0	0	0
YF-15	454984	5441110	-	-	5	10	5	40	40	-	-	-	-	Set	May-12	11:35	-	-	-
														Lifted	May-15	10:50	71.4	0	0
														Total	-	-	71.4	0	0
YF-16	455026	5441086	-	-	-	-	5	15	25	40	10	-	-	Set	May-15	11:00	-	-	-
														Lifted	May-21	17:00	150.0	0	0
														Total	-	-	150.0	0	0
YF-17	454955	5441068	-	-	-	-	-	40	40	10	10	-	-	Set	May-15	11:25	-	-	-
														Lifted	May-21	17:00	149.5	0	0
														Total	-	-	149.5	0	0
YF-18	454942	5441158	-	-	-	10	-	40	40	10	-	-	-	Set	May-15	11:55	-	-	-
														Lifted	May-21	16:40	148.7	0	0
														Total	-	-	148.7	0	0
YF-19	454943	5441135	-	-	-	10	-	40	40	10	-	-	-	Set	May-15	12:18	-	-	-
														Lifted	May-21	17:00	148.7	0	0
														Total	-	-	148.7	0	0
YF-20	454998	5441206	-	-	-	-	-	20	20	50	10	-	-	Set	May-17	12:00	-	-	-
														Lifted	May-21	16:40	100.6	11	11
														Total	-	-	100.6	11	11
YF-21	454055	5443000	-	-	5	15	5	25	30	20	-	-	-	Set	May-15	11:00	-	-	-
														Lifted	May-21	17:00	150.0	0	0
														Total	-	-	150.0	0	0
YF-22	455012	5441078	-	-	10	25	15	25	15	5	-	-	-	Set	May-17	12:35	-	-	-
														Lifted	May-21	17:00	100.5	0	0
														Total	-	-	100.5	0	0
YF-23	455008	5441075	-	-	5	5	5	25	25	35	-	-	-	Set	May-17	12:45	-	-	-
														Lifted	May-21	17:00	102.25	0	0
														Total	-	-	102.25	0	0

Egg captures suggest that spawning occurred between May 12 and May 21, 2007. A total of 1,801 hours of effort were applied at the twenty-three mat locations. Eggs were collected at only three of the mat locations (total of 15 eggs). Set times for individual mats varied from 7.5 to 150 hours. The overall CPUE for the area was 9.9×10^{-3} eggs/m²/h. Eggs were generally collected on mats deployed on the left and right downstream banks of the river, in rapid/riffle mesohabitat. The successful sites were located approximately 50 to 100 m below Yellow Falls. Egg deposition depths ranged from 0.6 to 1.3 m at recorded velocities ranging from 0.01 to 0.17 m/s. The presence of coarse substrate (large cobble and small boulder dominant) provided large interstitial spaces and protection from high flowing velocities. All of the eggs collected at Yellow Falls were identified as white sucker eggs.





3.3.2 Tributary A

Tributary A is located on the left downstream bank of the Mattagami River, approximately 500 m upstream of Island Falls. Habitat assessment was completed in the section extending from the confluence with the Mattagami River to approximately 200 m upstream, on May 9, 2007. This reach consists of a series of stepped boulder gardens and riffle/pool complexes terminating in a series of three bedrock ledges. The ledges, which are situated approximately 200 m upstream of the mouth, were considered to be impassable to upstream fish migration. Figure 3-14 provides an overview of habitat features in the surveyed section of Tributary A. In general, water depth ranged from 0.1 to 0.3 m and channel width varied between 2 and 3 m. In the fast flowing section located near the mouth, the substrate consisted of large cobble.

Based upon flow conditions in the tributary and river elevation at the time of the survey, fish passage beyond the lower 10 m of the stream by any of the target species was considered to be unlikely. As a result, no netting effort was expended in the upstream reaches of Tributary A.

To detect possible spawning activity in the lower section of Tributary A, one egg mat was deployed and monitored during the field program. Table 3-15 and Figure 3-14 provide a summary of effort and identifies the sampling locations in Tributary A. Eggs were not collected during the May 5 and May 13, 2007, survey and target species fish were not observed near the tributary mouth.

TABLE 3-15
AREA B – TRIBUTARY A
EGG MAT RECORDS
SPRING 2007

Mat No.	UTM (NAD 83)		Substrate Composition (%)										Observed Depth (m)	Observed Flow (m/s)	Sample Effort			No. Eggs Captured																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
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3.3.3 Tributary B

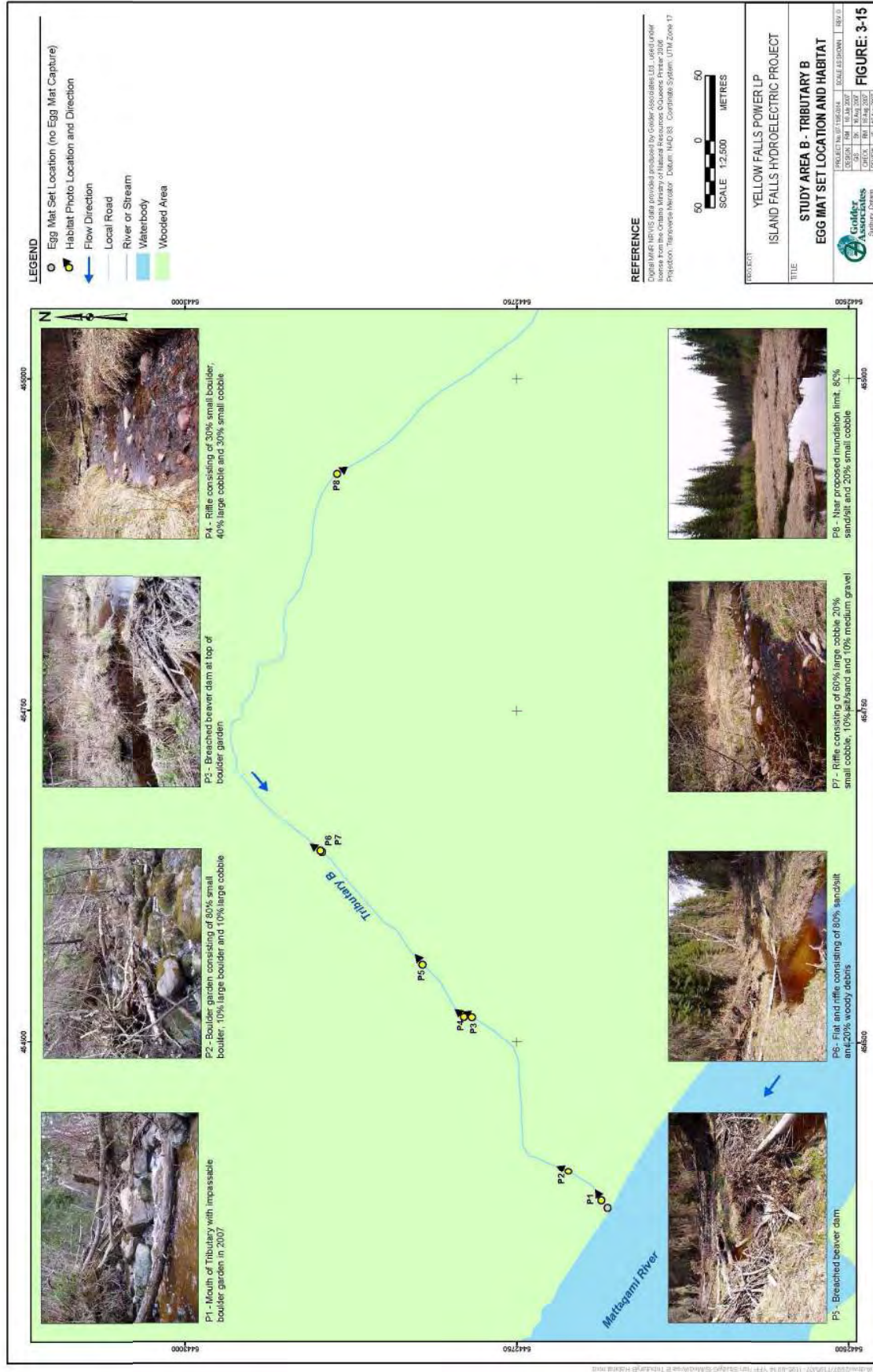
Tributary B enters the right downstream bank of the Mattagami River, approximately 500 m upstream of Island Falls. Habitat assessment, which occurred on May 14, 2007, concentrated on the lower 500 m of the stream. The surveyed reach extended from the mouth to the proposed limit of inundation by the Project. The lower portion of the reach featured a confined channel that was dominated by a terraced boulder garden. Beyond this section the channel widened into a broader floodplain with a well defined channel and it was characterized by a series of breached beaver dams. Channel width varied from 2 to 3 m on average and depths were relatively shallow (0.1 to 0.3 m). Figure 3-15 provides an overview of habitat features in the surveyed section of Tributary B.

A shallow boulder garden and an organic debris jam at the mouth of the tributary appeared to create impassable conditions for fish at the observed flows. The substrate immediately below this barrier consisted of a thick layer of extremely soft silt. Based on the presence of instream obstructions successful fish passage by target species beyond the lower 20 m of the stream at the time of the survey was unlikely. As a result, no netting effort was expended in upstream reaches of Tributary B.

To account for the possibility of spawning activity occurring at the mouth of the tributary, egg mats were deployed and monitored throughout the field program but no eggs were captured. Table 3-16 and Figure 3-15 provide a summary of effort and identifies the sampling location for Tributary B. No fish were observed in the tributary during the field program.

TABLE 3-16
AREA B – TRIBUTARY B
EGG MAT RECORDS
MATTAGAMI RIVER, SPRING 2007

Mat No.	UTM (NAD 83)		Substrate Composition (%)											Observed Depth (m)	Observed Flow (m/s)	Sample Effort				No. Eggs Captured
	E	N	Cl/Si	Sa	Sm Gr	Md Gr	Lg Gr	Sm Co	Lg Co	Sm Bo	Lg Bo	Br	Other			2007	Date	Time	Hours Set	
Trib B	454387	5442700	80	-	-	-	-	-	10	10	-	-	-		Set	May-5	10:30	-	-	
														Checked	May-9	16:30	102.0	0		
														Lifted	May-13	13:00	91.5	0		
														Total	-	-	193.5	0		
																			193.5	0



3.4 Area C

3.4.1 Loon Rapids

Loon Rapids consists of a bedrock chute (left downstream bank) and two side channels (mid-channel and right downstream bank). The side channels were comprised of a terraced series of rapid/riffles over bedrock and coarse substrate. Water depths below the chute/rapids varied from less than 1 m to over 8 m. Habitat features and fish sampling locations are illustrated on Figure 3-16; egg collection sites are shown on Figure 3-17.

Catch and species composition data are summarized in Table 3-17; length, weight and maturity data are presented in Table 3-18. Fishing effort (gill nets, hoop nets and angling) was applied at Loon Rapids between May 10 and May 20, 2007. Northern pike and walleye were the only species captured in the surveyed area.

Captured northern pike and walleye were assessed, but maturity (ripe/spent) could not be readily determined on the basis of an external examination.

Capture locations were limited to the rapid/riffle and riffle complexes along the right downstream bank of Loon Rapids, as well as below the outwash area of the main rapid/chute. Substrates in these locations primarily composed of large cobble and small boulder, although locations LRAN16 and LRAN17 featured a more varied mix of fine and coarse substrates (Figure 3-16).

TABLE 3-17
AREA C – LOON RAPIDS
CATCH SUMMARY AND SPECIES COMPOSITION
MATTAGAMI RIVER, SPRING 2007

Date Lifted	Mean Water Temp. (°C)	Sample ID	Sample Effort (hrs)	Lake sturgeon	Northern pike	White sucker	Walleye	Other	Total (n)
May 15	12.2	LRAN14	1.1	-	2	-	2	-	4
May 15		LRAN15	1.3	-	-	-	1	-	1
May 15		LRAN16	1.3	-	2	-	2	-	4
May 16	11.5	LRHN02	23.8	-	1	-	1	-	2
May 17	12.1	LRAN17	1.5	-	2	-	1	-	3
Total					7		7		14

TABLE 3-18

AREA C – LOON RAPIDS
FISH LENGTH, WEIGHT AND MATURITY CHARACTERISTICS
SPRING 2007

Physical Characteristics Target Species	Sex	Maturity			Total (n)		Min.	Max.	Mean		S.D.
		Ripe	Spent	Unknown							
Lake sturgeon	Male	-	-	-	0	Fork Length (mm)	-	-	-	±	-
	Female	-	-	-		Weight (gms)	-	-	-	±	-
	Unknown	-	-	-							
Northern pike	Male	-	-	2	7	Fork Length (mm)	495	682	567.1	±	70.6
	Female	-	-	4		Weight (gms)	750	2050	1114.3	±	454.3
	Unknown	-	-	1							
White sucker	Male	-	-	-	0	Fork Length (mm)	-	-	-	±	-
	Female	-	-	-		Weight (gms)	-	-	-	±	-
	Unknown	-	-	-							
Walleye	Male	-	-	-	7	Fork Length (mm)	346	415	384.0	±	25.0
	Female	-	-	-		Weight (gms)	400	1550	848.3	±	416.9
	Unknown	-	-	7							

Egg mats were deployed between May 14 and May 21, 2007. Sampling effort and locations are summarized in Table 3-19 and Figure 3-17.

Eggs were captured during spawning events that occurred between May 16 and May 21, 2007, (Figure 3-7). Sixteen egg mats were installed for a total effort of 2,058 hours; 54 eggs were collected. Individual set times for mats that successfully collected eggs varied between 117 and 187 hours. Estimated CPUE for the collection of eggs was 8.6×10^{-3} eggs/m²/h.

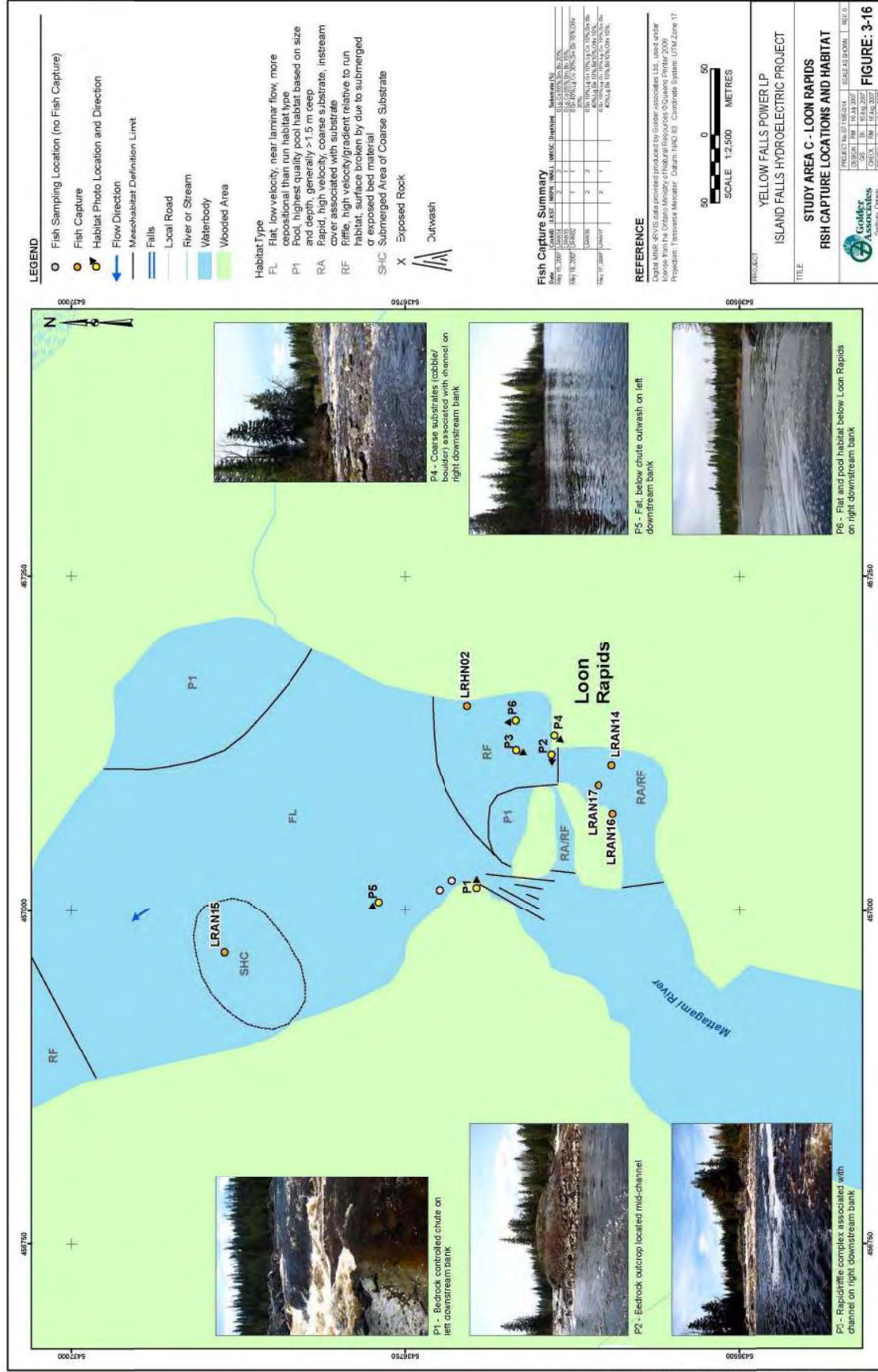
Typical egg deposition depths ranged from 0.2 (LR-16) to 2 m (LR-12). Flow velocities at the egg deposition sites ranged from 0.02 (LR-08) to 1.06 m/s (LR-12). Substrate composition at egg recovery locations was comprised of either cobble and boulder, or bedrock. One mat set location (LR-16) featured a gravel and small cobble substrate.

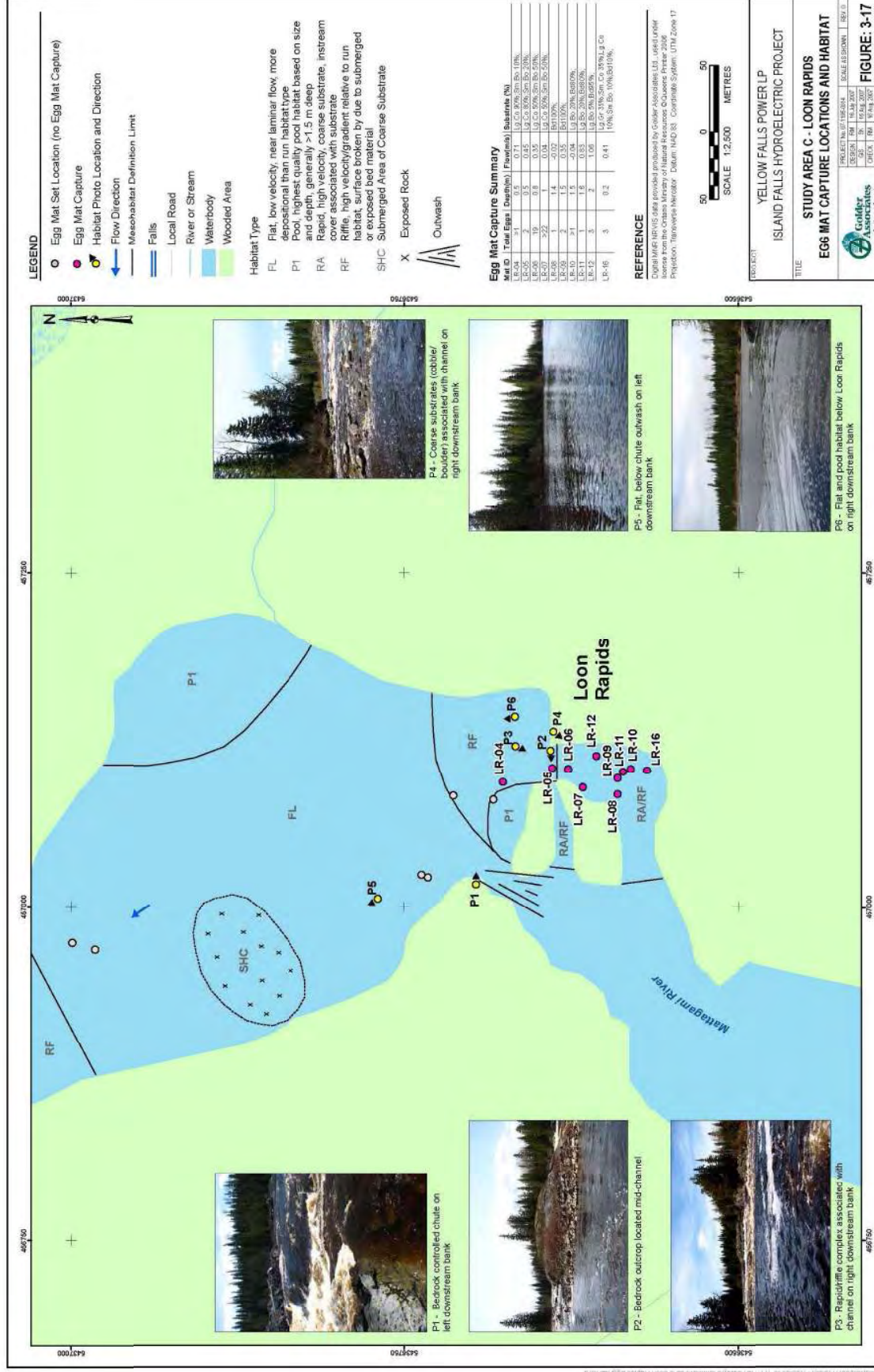
All of the eggs sent for identification were white sucker eggs. Although adult walleye and northern pike were captured near Loon Rapids, none of the eggs sent for identification were associated with these species. Lake sturgeon, or lake sturgeon eggs, were not recorded at Loon Rapids.

TABLE 3-19
AREA C – LOON RAPIDS
EGG MAT RECORDS
MATTAGAMI RIVER, SPRING 2007

Mat No.	UTM (NAD 83)		Substrate Composition (%)										Observed Depth (m)	Observed Flow (m/s)	Sample Effort				No. Eggs Captured
	E	N	Cl/Si	Sa	Sm Gr	Md Gr	Lg Gr	Sm Co	Lg Co	Sm Bo	Lg Bo	Br	Other		2007	Date	Time	Hours Set	
LR-01	457024	5436737	-	-	-	-	-	-	-	-	-	-	-	0.30	Set	May-14	14:20	-	-
															Lifted	May-16	11:24	45.0	0
															Total	-	-	45.0	0
LR-02	457022	5436732	-	-	-	-	-	-	-	-	-	-	-	0.30	Set	May-14	14:23	-	-
															Lifted	May-16	11:24	45.0	0
															Total	-	-	45.0	0
LR-03	457080	5436683	-	-	-	-	-	-	-	15	85	-	-	0.29	Set	May-14	14:25	-	-
															Checked	May-16	12:20	45.7	0
															Lifted	May-18	12:09	47.8	0
LR-04	457093	5436676	-	-	-	-	-	-	90	10	-	-	-	0.71	Total	-	-	93.5	-
															Set	May-14	14:27	-	-
															Checked	May-16	12:22	45.8	>1
LR-05	457104	5436639	-	-	-	-	-	-	80	20	-	-	-	0.45	Checked	May-18	12:20	47.9	0
															Lifted	May-21	10:41	70.2	0
															Total	-	-	163.9	>1
LR-06	457103	5436627	-	-	-	-	-	-	50	50	-	-	-	0.35	Set	May-14	14:28	-	-
															Checked	May-16	12:37	46.1	1
															Checked	May-18	12:30	47.8	0
LR-07	457089	5436616	-	-	-	-	-	-	50	50	-	-	-	0.04	Lifted	May-21	10:46	70.3	1
															Total	-	-	164.2	2
															Set	May-14	14:30	-	-
LR-07	457089	5436616	-	-	-	-	-	-	50	50	-	-	-	0.04	Checked	May-16	12:53	46.4	10
															Checked	May-18	12:33	69.9	0
															Lifted	May-21	10:49	70.3	9
LR-07	457089	5436616	-	-	-	-	-	-	50	50	-	-	-	0.04	Total	-	-	186.6	19
															Set	May-14	14:32	-	-
															Checked	May-16	13:08	46.6	>1
LR-07	457089	5436616	-	-	-	-	-	-	50	50	-	-	-	0.04	Checked	May-18	12:42	47.6	16
															Lifted	May-21	10:53	70.2	6
															Total	-	-	164.4	>22

Mat No.	UTM (NAD 83)		Substrate Composition (%)										Observed Depth (m)	Observed Flow (m/s)	Sample Effort				No. Eggs Captured	
	E	N	Cl/Si	Sa	Sm Gr	Md Gr	Lg Gr	Sm Co	Lg Co	Sm Bo	Lg Bo	Br			Other	2007	Date	Time		Hours Set
LR-08	457084	5436590	-	-	-	-	-	-	-	-	-	100	-	1.4	-0.02	Set	May-14	14:34	-	-
															Checked	May-16	13:22	46.7	0	
																Checked	May-18	12:51	47.5	1
																Lifted	May-21	10:58	70.1	0
																Total	-	-	164.3	1
LR-09	457096	5436590	-	-	-	-	-	-	-	-	-	100	-	1.5	0.35	Set	May-14	14:36	-	-
															Checked	May-16	13:28	46.7	0	
																Checked	May-18	12:56	47.5	1
																Lifted	May-21	11:01	70.1	1
																Total	-	-	164.3	2
LR-10	457103	5436580	-	-	-	-	-	-	-	-	20	80	-	1.5	-0.04	Set	May-14	14:39	-	-
															Checked	May-16	13:52	47.1	0	
																Checked	May-18	13:10	47.3	0
																Lifted	May-21	11:07	70.1	1
																Total	-	-	164.5	
LR-11	457101	5436586	-	-	-	-	-	-	-	-	20	80	-	1.6	0.83	Set	May-14	14:41	-	-
															Checked	May-16	13:35	46.8	*	
																Lifted	May-21	11:10	71.0	1
																Total	-	-	117.8	>1
																Set	May-14	14:44	-	-
LR-12	457113	5436606	-	-	-	-	-	-	-	-	5	95	-	2.0	1.06	Set	May-14	14:44	-	-
															Checked	May-16	14:04	47.4	0	
																Checked	May-18	12:14	46.2	2
																Lifted	May-21	11:15	71.0	1
																Total	-	-	164.6	3
LR-13	456973	5436999	-	-	-	-	-	50	50	-	-	-	-	0.8	0.54	Set	May-16	14:38	-	-
															Checked	May-18	12:14	45.6	0	
																Lifted	May-21	10:31	70.3	0
																Total	-	-	115.9	0
																Set	May-16	14:39	-	-
LR-14	456968	5436982	-	-	-	-	-	50	50	-	-	-	-	0.9	0.74	Set	May-16	14:39	-	-
															Checked	May-18	12:09	45.4	0	
																Lifted	May-21	10:28	70.4	0
																Total	-	-	115.8	0
																Set	May-18	12:20	-	-
LR-15	457083	5436713	-	-	-	-	-	40	40	10	10	-	-	3.6	-	Lifted	May-21	10:36	70.2	0
																Total	-	-	70.2	0
																Set	May-16	13:58	-	-
																Checked	May-18	15:11	49.2	2
																Lifted	May-21	11:10	68.0	1
LR-16	457102	5436568	-	-	-	-	35	35	10	10	-	10	-	0.2	0.41	Set	May-16	13:58	-	-
															Checked	May-18	15:11	49.2	2	
																Lifted	May-21	11:10	68.0	1
																Total	-	-	117.2	3
																Total	-	-	2057.2	>54





3.4.2 Davis Rapids

Davis Rapids are situated immediately downstream from a sharp, right downstream oriented river bend. The section consists of a linked series of riffle/run, flat, riffle and riffle/boulder gardens. Cobble and boulder substrates are predominant in this location. Habitat features of the section (mesohabitat distribution, depth, substrate, photographs) are presented on Figure 3-18 and Figure 3-19.

Catch and species composition data is summarized in Table 3-20, while length, weight and maturity data are summarized in Table 3-21. Netting effort at Davis Rapids was applied between May 5 and May 13, 2007. All of the target species, with the exception of lake sturgeon, were captured in the surveyed section. Mature northern pike were captured on May 9, May 11 and May 13, 2007; these individuals were determined to be in a post-spawn (spent) condition. Ripe white sucker (both sexes) and walleye (males) were caught between May 7 and May 13, 2007. Fish (all species) were typically captured in shallow waters ranging from 1 to 2 m deep. The substrate at the capture locations consisted primarily of large cobble and small boulder.

TABLE 3-20
AREA C – DAVIS RAPIDS
CATCH SUMMARY AND SPECIES COMPOSITION
MATTAGAMI RIVER, SPRING 2007

Date Lifted	Mean Water Temp. (°C)	Sample ID	Sample Effort	Lake sturgeon	Northern pike	White sucker	Walleye	Other	Total (n)
May 5	-	DRAN04	0.7	-	-	-	1	-	1
May 5	-	DRGNB01	4.1	-	-	-	1	-	1
May 7	9.6	DRGNA04	1.4	-	-	4	-	-	4
May 7		DRAN07	0.9	-	-	-	5	-	5
May 9	11.7	DRGNA06	6.9	-	1	1	-	-	2
May 9		DRGNB07	2.3	-	-	1	-	-	1
May 9		DRAN08	1.4	-	-	-	2	-	2
May 10	12.8	DRHN01	20.1	-	-	1	4	-	5
May 11	12.4	DRHN02	3.7	-	1	-	-	1 ¹	2
May 12	11.7	DRGNB10	5.5	-	-	1	-	-	1
May 12		DRAN12	1.2	-	-	-	3	-	3
May 12		DRAN13	0.7	-	-	-	2	-	2
May 13	11.9	DRHN04	25.5	-	1	1	-	-	2
Total									

Notes

1. smallmouth bass (*Micropterus dolomieu*)

TABLE 3-21
AREA C – DAVIS RAPIDS
FISH LENGTH, WEIGHT AND MATURITY CHARACTERISTICS
SPRING 2007

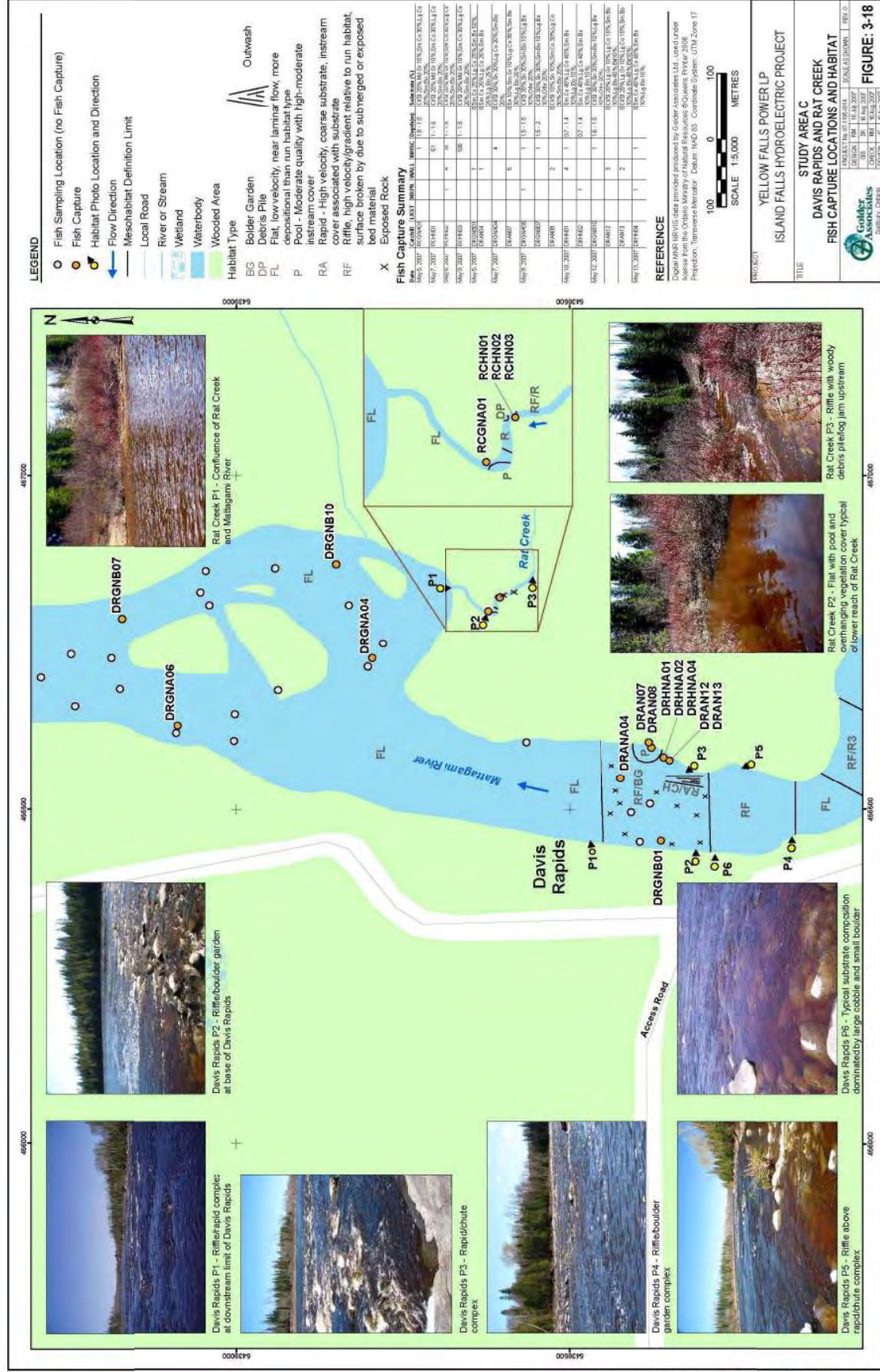
Physical Characteristics Target Species	Sex	Maturity			Total (n)		Min.	Max.	Mean		S.D.
		Ripe	Spent	Unknown							
Lake sturgeon	Male	-	-	-	0	Fork Length (mm)	-	-	-	±	-
	Female	-	-	-		Weight (gms)	-	-	-	±	-
	Unknown	-	-	-							
Northern pike	Male	-	-	-	3	Fork Length (mm)	515	655	573.0	±	73.0
	Female	-	-	3		Weight (gms)	1000	2000	1333.3	±	577.4
	Unknown	-	-	-							
White sucker	Male	2	-	-	9	Fork Length (mm)	398	449	420.7	±	20.3
	Female	5	-	-		Weight (gms)	850	1800	1327.8	±	344.7
	Unknown	-	-	2							
Walleye	Male	3	-	-	15	Fork Length (mm)	316	494	375.7	±	39.0
	Female	-	-	-		Weight (gms)	250	1100	615.6	±	203.9
	Unknown	-	-	15							

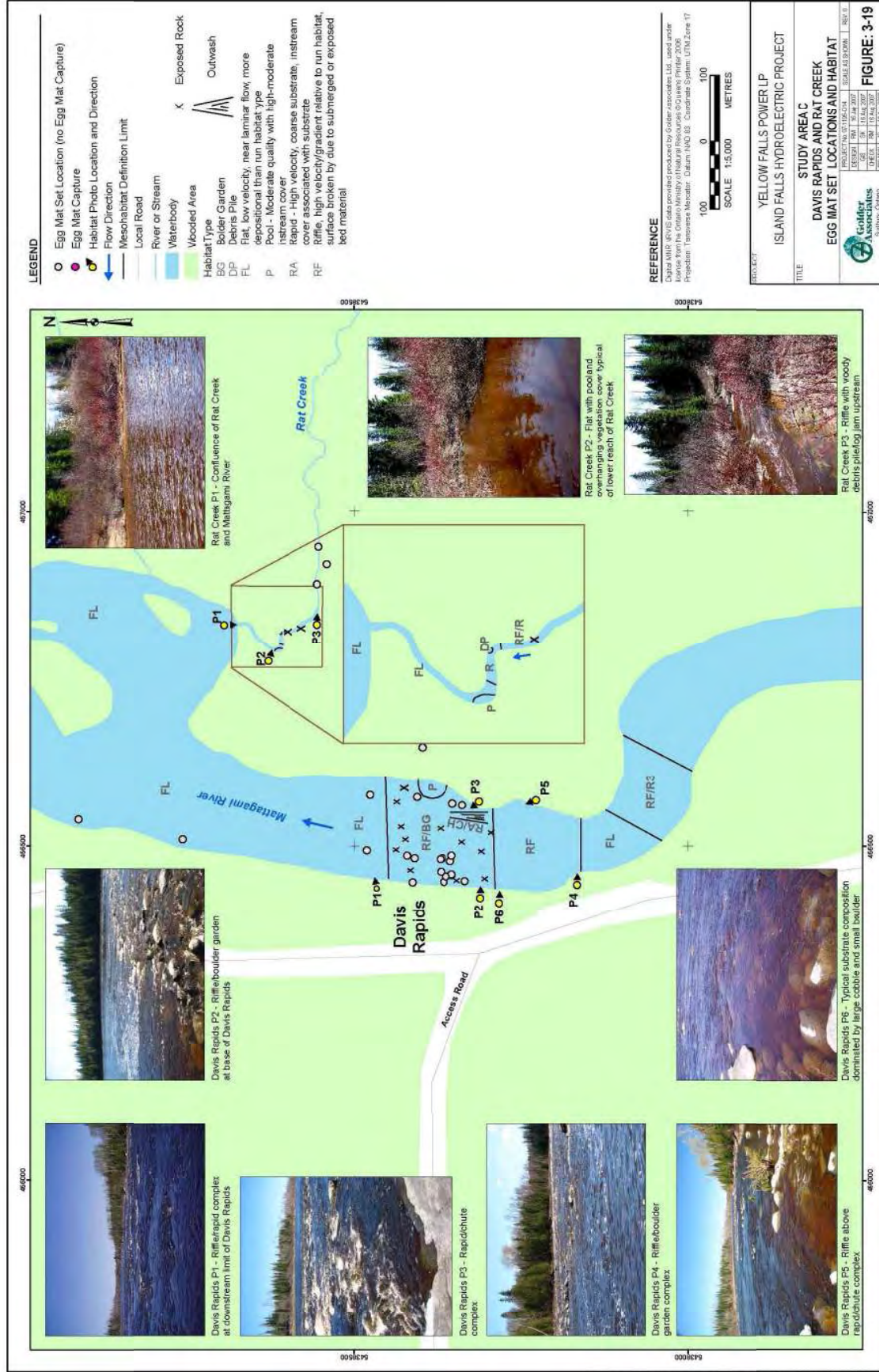
The location of egg mats set in the surveyed section between May 6 and May 13, 2007, are shown on Figure 3-19. Eggs were not collected in the area; therefore, it was not possible to confirm spawning activity at Davis Rapids by target species. Table 3-22 provides a summary of effort and sampling locations for Davis Rapids. Because of sampling limitations (i.e. shallow water and high velocities), use of netting gear and egg mat deployment was limited to the lower third (approximately 100 m) of Davis Rapids. It is possible that target species were able to ascend into and spawn in the upper 200 m of the rapids. However, no fish were observed in this section (i.e. observations made from vantage points along the shoreline).

TABLE 3-22
AREA C – DAVIS RAPIDS
EGG MAT RECORDS
MATTAGAMI RIVER, SPRING 2007

Mat No.	UTM (NAD 83)		Substrate Composition (%)										Observed Depth (m)	Observed Flow (m/s)	Sample Effort				No. Eggs Captured	
	E	N	Cl/Si	Sa	Sm Gr	Md Gr	Lg Gr	Sm Co	Lg Co	Sm Bo	Lg Bo	Br			Other	2007	Date	Time		Hours Set
DR-01	456457	5438354	-	-	-	-	-	-	80	-	20	-	-	0.4	0.41	Set	May-6	17:13	-	-
																Lifted	May-8	16:37	47.4	0
																Total	-	-	47.4	0
DR-02	456458	5438354	-	-	-	-	-	-	60	-	40	-	-	0.9	0.11	Set	May-6	17:17	-	-
																Lifted	May-8	16:33	47.4	0
																Total	-	-	47.4	0
DR-03	456448	5438334	-	-	-	-	-	-	60	-	40	-	-	0.4	0.12	Set	May-6	17:22	-	-
																Lifted	May-8	16:28	47.1	0
																Total	-	-	47.1	0
DR-04	456648	5438398	-	-	-	-	20	-	80	-	-	-	-	0.6	0.14	Set	May-6	17:26	-	-
																Lifted	May-8	16:38	47.0	0
																Total	-	-	47.0	0
DR-05	456478	5438356	-	-	-	-	-	-	50	-	50	-	-	0.5	0.03	Set	May-6	17:30	-	-
																Lifted	May-8	16:47	47.3	0
																Total	-	-	47.3	0
DR-06	456486	5438354	-	-	-	-	-	-	50	-	50	-	-	0.7	0.35	Set	May-6	17:33	-	-
																Lifted	May-8	16:50	47.3	0
																Total	-	-	47.3	0
DR-07	456561	5438338	-	-	-	-	-	-	25	-	75	-	-	1.0	0.28	Set	May-6	17:41	-	-
																Checked	May-8	17:01	47.3	0
																Checked	May-10	11:00	79.3	0
																Lifted	May-13	12:27	152.8	0
																Total	-	-	279.4	0
DR-08	456563	5438353	-	-	-	-	-	-	20	-	80	-	-	1.5	0.11	Set	May-6	17:45	-	-
																Checked	May-8	17:11	47.5	0
																Checked	May-10	11:03	89.6	0
																Lifted	May-13	12:23	163.9	0
																Total	-	-	301.0	0
DR-09	456573	5438406	-	-	-	-	-	-	100	-	-	-	-	0.9	0.37	Set	May-6	17:49	-	-
																Checked	May-8	17:18	47.5	0
																Checked	May-10	11:09	89.3	0
																Lifted	May-13	12:32	162.8	0
																Total	-	-	299.6	0
DR-10	456576	5438476	-	-	-	-	-	-	100	-	-	-	-	1.4	0.36	Set	May-6	17:52	-	-
																Checked	May-8	17:29	47.6	0
																Checked	May-10	11:17	41.8	0
																Lifted	May-13	12:37	73.3	0
																Total	-	-	162.7	0

Mat No.	UTM (NAD 83)		Substrate Composition (%)										Observed Depth (m)	Observed Flow (m/s)	Sample Effort				No. Eggs Captured		
	E	N	Cl/Si	Sa	Sm Gr	Md Gr	Lg Gr	Sm Co	Lg Co	Sm Bo	Lg Bo	Br			Other	2007	Date	Time		Hours Set	
DR-11	456447	5438366		10	10			40	50					0.50	Set	May-8	16:31	-	-		
															Checked	May-10	12:00	43.5	0		
															Lifted	May-13	12:19	48.3	0		
															Total	-	-	91.8	0		
DR-12	456455	5438363		10	10			40	50					N/A	Set	May-8	16:33	-	-		
															Lifted	May-10	11:50	43.3	0		
															Total	-	-	43.3	0		
DR-13	456446	5438413		10	10			40	50					N/A	Set	May-8	16:40	-	-		
															Lifted	May-10	12:04	43.4	0		
															Total	-	-	43.4	0		
DR-14	456482	5438369	-	-	-	-	-	-	50	-	50	-	-	0.03	Set	May-8	16:55	-	-		
															Checked	May-10	11:35	42.7	0		
															Lifted	May-13	12:44	73.2	0		
															Total	-	-	115.9	0		
DR-15	456462	5438370	-	-	-	-	-	-	80	-	20	-	-	0.4	Set	May-6	16:41	-	-		
															Checked	May-10	11:39	90.9	0		
															Lifted	May-13	12:14	72.6	0		
															Total	-	-	163.5	0		
DR-16	456481	5438371		10	10			40	50					N/A	Set	May-8	16:56	-	-		
															Lifted	May-10	11:36	42.7	0		
															Total	-	-	42.7	0		
DR-17	456494	5438481			70			30						N/A	Set	May-10	12:16	-	-		
															Lifted	May-13	12:03	71.9	0		
															Total	-	-	71.9	0		
DR-18	456482	5438410							50	50				0.06	Set	May-10	12:14	-	-		
															Lifted	May-13	12:06	71.9	0		
															Total	-	-	71.9	0		
DR-19	456540	5438913	-	-	-	-	-	-	25	50	-	-	-	no result	Set	May-11	13:03	-	-		
															Lifted	May-13	11:52	46.9	0		
															Total	-	-	46.9	0		
DR-20	456510	5438757	-	-	-	-	-	-	-	-	-	-	-	no result	Set	May-11	13:09	-	-		
															Lifted	May-13	12:59	47.9	0		
															Total	-	-	47.9	0		
DR-21	456486	5438421	-	-	-	-	-	-	35	65	-	-	-	0.43	Set	May-10	12:13	-	-		
															Lifted	May-13	12:10	71.2	0		
															Total	-	-	71.2	0		
																				2136.6	0





3.4.3 Rat Creek

Rat Creek drains into the Mattagami River on the east side (right downstream bank) immediately downstream of Davis Rapids. Habitat evaluation was carried out from the mouth to a point approximately 400 m upstream (limit of boat accessible travel). It was observed that selected portions of the creek have been scoured to reveal coarse substrates (i.e. cobble and mixed size boulder). Delineation of habitat features associated with the capture of target species and of egg mat locations is illustrated on Figure 3-18 and Figure 3-19.

Catch and species composition data is summarized in Table 3-23; length, weight and maturity are presented in Table 3-24. Northern pike, white sucker and walleye were captured in Rat Creek, a short distance from the confluence with the Mattagami River. A single ripe male northern pike was recorded in the catch. White suckers were well-represented in the catch between May 7 and May 9, 2007, particularly on May 9, 2007, when a large number of spawning individuals (64 males and 42 females) were captured. Lake sturgeon were not captured in Rat Creek.

Fish were captured in relatively shallow, ranging from 1 to 1.5 m. Substrates at the capture locations consisted primarily of cobble and small boulder, but also contained a minor clay/silt and gravel component.

TABLE 3-23
AREA C – RAT CREEK
CATCH SUMMARY AND SPECIES COMPOSITION
SPRING 2007

Date Lifted	Mean Water Temp. (°C)	Sample ID	Sample Effort (hrs)	Lake sturgeon	Northern pike	White sucker	Walleye	Other	Total (n)
May 5	9.2	RCGNA01	3.2	-	-	1	-	-	1
May 7	9.5	RCHN01	18.7	-	-	61	-	-	61
May 8	11.6	RCHN02	24.8	-	1	18	4	-	23
May 9	12.7	RCHN03	17.5	-	-	108	-	-	108
Total					1	188	4		193

TABLE 3-24
AREA C – RAT CREEK
FISH LENGTH, WEIGHT AND MATURITY CHARACTERISTICS
SPRING 2007

Physical Characteristics Target Species	Sex	Maturity			Total (n)		Min.	Max.	Mean		S.D.
		Ripe	Spent	Unknown							
Lake sturgeon	Male	-	-	-	0	Fork Length (mm)	-	-	-	±	-
	Female	-	-	-		Weight (gms)	-	-	-	±	-
	Unknown	-	-	-							
Northern pike	Male	-	-	-	1	Fork Length (mm)	461	461	461	±	-
	Female	1	-	-		Weight (gms)	-	-	-	±	-
	Unknown	-	-	-							
White sucker	Male	114	-	3	188	Fork Length (mm)	168	462	373.8	±	50
	Female	48	-	-		Weight (gms)	200	2000	944.1	±	297.3
	Unknown	-	-	23							
Walleye	Male	-	-	-	4	Fork Length (mm)	304	440	377.5	±	55.9
	Female	-	1	-		Weight (gms)	-	-	-	±	-
	Unknown	-	-	3							

Egg mats were deployed in Rat Creek between May 6 and May 11, 2007, at locations deemed suitable for walleye and white sucker spawning, but no eggs were collected. Table 3-25 and Figure 3-19 provide a summary of capture effort and sampling locations in Rat Creek.

TABLE 3-25
AREA C – RAT CREEK
EGG MAT RECORDS
SPRING 2007

Mat No.	UTM (NAD 83)		Substrate Composition (%)										Observed Depth (m)	Observed Flow (m/s)	Sample Effort				No. Eggs Captured
	E	N	Cl/Si	Sa	Sm Gr	Md Gr	Lg Gr	Sm Co	Lg Co	Sm Bo	Lg Bo	Br			Other	2007	Date	Time	
RC-01	456922	5438541	20	20	30	-	-	-	-	-	-	-	-	Set	May-6	13:56	-	-	
														Lifted	May-8	12:06	46.2	0	
														Total	-	-	46.2	0	
RC-02	456892	5438555	20	20	30	-	-	-	-	-	-	-	Set	May-6	13:59	-	-		
													Lifted	May-8	12:10	46.2	0		
													Total	-	-	46.2	0		
RC-03	456948	5438553	20	20	30	-	-	-	-	-	-	-	Set	May-8	12:14	-	-		
													Lifted	May-11	12:35	72.3	0		
													Total	-	-	72.3	0		
RC-04	456948	5438553	20	20	30	-	-	-	-	-	-	-	Set	May-8	12:14	-	-		
													Lifted	May-11	12:35	72.3	0		
													Total	-	-	72.3	0		
Total																		237.0	0

4.0 DISCUSSION

The objectives of the spring 2007 assessment were somewhat different than the 2006 Stantec study objectives. The 2006 study focused on describing fish community composition, habitat attributes in broad terms and predicting habitat changes associated with the Project. The present study focused on confirming habitat utilization by the target species and defining spawning locations on a site-specific scale. Fishing effort was carried out to document the presence of spawning adults. This was followed up by an egg collection program at fish capture locations, and at locations where habitat conditions seemed conducive to spawning activity (i.e. based upon professional experience and scientific literature).

The 2007 assessment was not designed to quantify the amount of suitable spawning habitat available at each location. Rather, the approach was to sample areas which appeared to provide optimal conditions, in order to confirm their utilization by spawning fish.

It is anticipated that the information generated in 2007 will clarify the potential effects of the Project on fish habitat and assist in the development of compensation strategies (if required).

4.1 Area A

4.1.1 Island Falls

The spring 2007 investigation focussed on the area immediately downstream of Island Falls. Substrates and flow velocity conditions in the area are consistent with the spawning habitat preferences of lake sturgeon, white sucker and walleye. In both the 2006 and 2007 assessments, ripe individuals of the four target species were captured at the base of Island Falls. In both studies, this was the only location at which all target species were recorded.

In general, walleye, white suckers and northern pike were captured along the margins of the outwash areas below each of the four chutes which make up Island Falls. However, eighty-five percent of all eggs were captured along the margin of Chute 1 which is situated adjacent to the right downstream bank. The sample was comprised of walleye, northern pike, white sucker and yellow perch eggs. This area may be the most significant spawning area at the base of Island Falls.

Lake sturgeon were only captured in the outwash area of Chutes 1 and 2, which are located along the right downstream bank of the river. Netting results and fish maturity data collected at the onset of the field program suggest that lake sturgeon were staging for spawning activity. Ripe male individuals and several 'unknowns' that may have been pre-spawn females (fish that were heavier and more robust) were captured. The cold front that began moving over the region on

May 18, 2007, caused water temperatures, which had risen to 13°C, to decline approximately 2 to 3°C. Coincident with this temperature decline, lake sturgeon that had been present at the base of Island Falls dispersed. Subsequent to this event, lake sturgeon were not recorded for the duration of the field program. Similar observations have been recorded by Kempinger (1988). This author reported that a sudden change in weather patterns dropped water temperatures and caused lake sturgeon in the Lake Winnebago system to cease spawning until water temperatures rose again. Lake sturgeon eggs were not collected below Island Falls and it is possible that no spawning event occurred in 2007. Alternatively, it is possible that spawning activity may have occurred after the survey was completed (i.e. after May 21, 2007). However, given that lake sturgeon appeared to abandon the area around Island Falls, this seems unlikely.

Based on our initial assessment, the submerged shoal area located below Chutes 3 (mid-channel) and 4 (along left downstream bank) appeared to provide suitable spawning conditions. However, none of the target species appeared to be utilizing it for spawning. This may be due to the combination of low water velocities on the shoal and the layer of fine clay and silt material that has accumulated on the coarse substrate at this location.

Captured northern pike varied widely with respect to lengths and weights, suggesting that a mix of juveniles and adults was present. Although it was not readily apparent that the base of Island Falls provided suitable northern pike spawning habitat (i.e. submerged vegetation), ripe male and female northern pike were captured and several egg mats collected northern pike eggs.

Ripe white suckers also were captured along the base of Island Falls. White sucker eggs were collected primarily along the periphery of Chute 1.

Walleye was the most abundant of the four target species encountered. Spawning adults and eggs were caught along the base of the Island Falls site.

4.1.2 Bradburn Creek

Large, contiguous areas of suitable northern pike spawning habitat (i.e. submerged shoreline vegetation) were observed in the lower reach of Bradburn Creek. Not surprisingly, spent male and female northern pike were captured in the surveyed section. Despite the presence of ripe white sucker in the area, no suitable spawning habitat (i.e. riffles/rapids with coarse substrate) was observed.

Northern pike and white suckers were typically captured at depths of 1.6 to 3.8 m, with the exception of fish caught in hoop net BCHN13, which was placed near the mouth of Bradburn Creek at a depth of 6.5 m. The substrate at all capture locations was dominated by fine-grained materials (clay/silt, sand). An exception was site BCHN13, where the substrate was comprised of

a mixture of fine and coarse material (i.e. clay/silt, small and large cobble). Based fish capture results and habitat observations, no egg mats were deployed.

Walleye and lake sturgeon were not captured in Bradburn Creek and based on the absence of coarse substrate it is highly unlikely that these species utilize the creek for spawning.

4.1.3 Pullen Creek

The lower reach of Pullen Creek is characterized by flat, slow moving water, similar to Bradburn Creek. Backwater bays and pockets of open water marsh within the lower reach likely provide suitable spawning, and possibly seasonal nursery/rearing habitat for northern pike. These areas may also provide seasonal (rearing/feeding) for other target species such as walleye and white sucker. No suitable spawning habitat for white sucker, walleye and lake sturgeon was observed; therefore, egg mats were not deployed within the lower reach of Pullen Creek.

Upstream of the influence of the Smooth Rock Falls GS headpond, Pullen Creek consists of a meandering channel, varying from 5 m to less than 3 m in width. The channel is frequently obstructed by woody debris piles and root wads. Fine-grained substrates of clay/silt may produce elevated levels of silt in the water column when disturbed. The presence of numerous log jams and debris piles, restricted flows, and absence of coarse substrates indicate that spawning use of the reach upstream of the reservoir by white suckers and walleye is unlikely. For this reason, egg mats were not deployed in this section.

The substrate at fish capture locations was dominated by fines (clay/silt and sand). Organic debris (stumps, logs etc.) was also noted. One ripe and two spent walleye were captured in the surveyed section near the end of the field study. However, based on habitat conditions (absence of riffle/rapid areas with coarse substrate) it is highly unlikely that walleye or lake sturgeon spawn in Pullen Creek.

4.1.4 North Muskego River

The survey data suggests that much of the North Muskego River is suitable for northern pike spawning. This assessment is based on the wide availability of preferred habitat types along the river banks, in small bays, and in several small tributaries.

The outwash of the falls/chute that is located 4 km upstream of the river mouth provides suitable spawning habitat spawning for white sucker, walleye and lake sturgeon. Ripe white suckers were captured below the falls/chutes. Although no ripe adult walleye were captured, walleye eggs were collected below the chute. No lake sturgeon adults or lake sturgeon eggs were encountered in North Muskego River.

4.2 Area B

4.2.1 Yellow Falls

Based on visual observations, it appeared that a vertical drop in water surface elevation in the range of 6 to 8 m existed at Yellow Falls during the spring 2007 survey. In view of the vertical drop and high flow velocities generated upstream fish passage upstream would appear to be unlikely.

In the spring of 2006, Stantec captured small numbers of walleye and white suckers in the reach below Yellow Falls (Stantec 2007). Only one of the captured walleye was in spawning condition. They concluded that it was unlikely that either species spawned below Yellow Falls.

In 2007, ripe male and female white suckers and white sucker eggs were collected along the channel margins downstream of the falls. No other target species or target species eggs were collected. The reach immediately below Yellow Falls (within 500 m) appears to contain suitable spawning habitat for all of the target species. This includes observed areas that cannot be readily or safely accessed due to river hydraulics (i.e. areas of high flow and velocity immediately below the falls).

It remains unclear whether white suckers spawning below the falls are permanent residents of the reach, migrate from downstream sections below Island Falls to access Yellow Falls to spawn. Based upon the 2007 assessment, no target species other than white sucker appear to spawn below Yellow Falls.

4.2.2 Tributary A

Tributary A, which enters the left downstream bank of the Mattagami River approximately 500 m upstream of Island Falls, was investigated to determine the type and extent of spawning activity occurring within the system. Based on the restricted stream flows, shallow depths and instream obstructions observed, fish passage beyond the lower 10 m of the stream by any of the target species seems unlikely. As a result, no sampling effort was expended in the upstream reaches of Tributary A. To account for the possibility that spawning occurs at the mouth of the tributary, egg mats were deployed and monitored throughout the field program. No eggs were collected, and no target species fish were observed in the vicinity of the mouth during the survey. It was also observed that suspended sediment loads coming from the tributary produced significant amounts of siltation of rocky substrates at the mouth of the tributary, a situation that would render these locations unsuitable for spawning by the target species. Based on the conditions observed it is highly unlikely that any of the target species spawn in Tributary A.

Stantec (2007) also failed to capture adult fish or eggs in Tributary A in the spring of 2006. A juvenile walleye, several juvenile white suckers and numerous cyprinids were captured in the fall. These fish may have originated from upstream waterbodies. The composition of fish communities inhabiting upstream waterbodies was not assessed in 2006 or 2007.

4.2.3 Tributary B

Tributary B enters the right downstream bank of the Mattagami River, approximately 500 m upstream of Island Falls. Restricted stream flow and channel conditions (i.e. shallow boulder gardens, organic debris accumulations) made it unlikely that any of the target species could access the stream beyond the lower 20 m. As a result, sampling effort was not carried out in the upstream reaches. To determine the extent of spawning activity in the mouth area, egg mats were deployed and monitored throughout the field program; no eggs were collected during this period. Heavy amounts of sediment were observed coming from upstream in Tributary B and resulted in significant accumulation of silt on substrates at the mouth of the tributary. As a result, the substrate is unsuitable for egg deposition by the target species. No adult fish were observed in the stream during this study and it is highly unlikely that target species utilize Tributary B for spawning.

Stantec (2007) did not encounter adult fish or collect eggs in Tributary B in the spring of 2006. Juvenile white suckers and cyprinids were captured in the stream during the fall of 2006. It is assumed that these fish originated from upstream sources. However, fish community composition in upstream waterbodies fish was not assessed.

4.3 Area C

4.3.1 Loon Rapids

Significant netting effort was applied at the base of Loon Rapids to determine the extent of lake sturgeon spawning. No adult lake sturgeon or lake sturgeon eggs were captured at Loon Rapids during the spring 2007 fisheries investigation. Although no white suckers were captured in the area, egg mats deployed at the base of the rapids collected white sucker eggs. These eggs were deposited during spawning events that occurred between May 18 and May 21, 2007.

Adult northern pike and walleye were captured, but the state of maturity (ripe/spent) for these fish could not be determined based on external examination. Since these fish were captured late in the study (when water temperatures were fairly high) and if they spawned at Loon Rapids, it must have occurred prior to the survey.

Stantec (2007) captured small numbers of walleye (including one ripe female) and northern pike (including one ripe female), and a large number of white suckers (including 10 ripe males and females) in the spring of 2006, but it is unclear exactly where these fish may have been captured.

Based on available data (Stantec 2006, Golder 2007) it is apparent that white suckers spawn in the area downstream of Loon Rapids. It is possible that walleye and northern pike also spawn in the area, but this has not been confirmed in field studies completed to date.

4.3.2 Davis Rapids

Based on the large amount of potential spawning habitat, and the presence of walleye, northern pike and white suckers in spawning condition it is likely that spawning occurs at this location. Although egg mats were deployed in the lower third of the rapids, they were unsuccessful in collecting eggs. It was not feasible to set egg mats in the upper two thirds of the Davis Rapids due to shallow water and high velocities; however, suitable spawning habitat, conducive to spawning activity by all target species appears to be available in this section. Due to the difficulty in accessing and deploying gear, it may not be possible to confirm the extent of habitat utilization and egg deposition in the upper sections.

4.3.3 Rat Creek

Substrate, cover and flow conditions near the upstream limit of fish passage in Rat Creek in 2007 appears to provide suitable spawning habitat conditions for northern pike, walleye and white sucker. White sucker, in particular, appear to find conditions within Rat Creek more favourable for spawning than the main stem of the Mattagami River (i.e. based on the large number of adults captured). Similar results were also reported by Stantec in the 2006 assessment. Low numbers of walleye and northern pike captured in both the 2006 and 2007 studies may be indicative of low utilization of Rat Creek as a spawning area by these species.

Observations of relatively high sediment loads that at times plugged the egg mat media likely reduced the capture efficiency of the mats and could account for the lack of collection success. Although no eggs were captured, given that suitable spawning habitat is accessible and species presence it appears that three of the four target species spawn in Rat Creek.

5.0 SUMMARY

The distribution of target species documented in areas A, B and C was fairly consistent between the 2006 Stantec study and the present investigation. With respect to the Island Falls site, the four target species were captured near the base of the falls. Also, walleye, northern pike and white sucker eggs were collected at the base of the falls in 2007. Lake sturgeon spawning activity at Island Falls has not been confirmed, although ripe males have been captured at the site. At present, the question as to whether or not a viable population of lake sturgeon inhabits the reach below Island Falls remains unanswered. In both studies the area immediately downstream of Island Falls was the only location where lake sturgeon were captured.

Habitat in the lower sections of the North Muskego River, Pullen Creek and Bradburn Creek was assessed in 2007. These tributaries were not included in the 2006 Stantec study. Northern pike and white suckers likely spawn in each of the tributaries. Ripe white suckers and walleye eggs were captured at the chute located approximately 4 km upstream of the mouth of the North Muskego River.

Walleye and white suckers were captured near the base of Yellow Falls in 2006. In the present study, ripe male and female white suckers and eggs were collected, confirming that this species spawns near the base of the falls. There was no evidence that walleye were present or spawned below Yellow Falls in 2007.

Target species or eggs were not collected or observed in either Tributary A or Tributary B, during the 2006 or 2007 studies. Under the conditions observed in 2007, only small portions of the lower reaches of these tributaries were accessible to spawning fish. Based on the results of two studies, it is highly unlikely that the target species spawn in these systems.

Ripe fish (walleye, northern pike and white suckers) were captured at Loon Rapids in the spring of 2006. Adult white suckers were not encountered in 2007; however, eggs were retrieved from egg mats at this location. Walleye and northern pike were captured at Loon Rapids in 2007. Based on fish distribution and egg collection data collected during 2006 and 2007, and the availability of suitable habitat, it appears that three of four target species may spawn at this location.

A large amount of what appears to be suitable spawning substrate occurs at the Davis Rapids site. Walleye, northern pike and white suckers were captured in the area, but eggs were not collected. Flow conditions limited assessment efforts to the lower third of the rapids in 2007.

White suckers, walleye and northern pike were captured in Rat Creek in the spring 2006 and 2007 studies. However, eggs were not retrieved from egg mats deployed in Rat Creek in 2007. It

appears that walleye, northern pike and white sucker spawn in lower Rat Creek. This conclusion is based on the presence of suitable spawning habitat in several discrete areas within the lower 400 m of the Creek.

6.0 CLOSURE

We trust that the information presented in this report meets your requirements. Should you have any questions or concerns, please do not hesitate to contact the undersigned.

GOLDER ASSOCIATES LTD.



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REPORT ON

**LAKE STURGEON DISTRIBUTION IN THE
UPPER MATTAGAMI RIVER
SUMMER 2007**

Submitted to:

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1.0 INTRODUCTION

This report summarizes results of a netting assessment completed by Golder Associates Ltd. (Golder) related to lake sturgeon (*Acipenser fulvescens*) distribution in the upper Mattagami River relative to the proposed Island Falls Hydroelectric Project (the Project). Field work was carried out in August and September 2007 subsequent to Golder's *Spring 2007 Fish Habitat Utilization Survey, Mattagami River* (Golder 2007).

Golder understands that this report will serve to provide additional information to the Department of Fisheries Oceans (DFO) and the Ontario Ministry of Natural Resources (MNR) to facilitate their review of the Project and to inform discussions relating to mitigation, compensation and monitoring requirements for the Project.

2.0 METHODOLOGY

Lake sturgeon were targeted by using small and large mesh gill nets to discern which reaches of the Mattagami River they inhabited. Field crews also angled to capture fish. Biological information was collected on all captured lake sturgeon and incidentally captured walleye (*Sander vitreus*) and northern pike (*Esox lucius*). Tissue samples were also collected from captured walleye and northern pike for methyl mercury analysis. This data will be used to supplement mercury body burden data collected Stantec Consulting Limited (Stantec) in 2006.

Field work was focused within the three distinct areas:

Study Area A: At the confluence of Bradburn Creek and the Mattagami River and at two areas downstream of Island Falls (Figure 1).

Study Area B: At the reach located midway between Yellow Falls and Island Falls (Figure 2).

Study Area C: Near the confluence of Rat Creek and the Mattagami River; directly downstream of Loon Rapids and at a location approximately 2 km upstream of Loon Rapids known as “Indian Point” (Figure 3).

3.0 RESULTS AND DISCUSSION

Field work was completed by one two-person field crew between August 31 and September 7, 2007. Large-mesh gill nets (229-254-305 mm) were utilized to target adult lake sturgeon while smaller-mesh nets (76 to 114 mm) were set to target juveniles. Gill nets were set for four hour periods during the day or for 24 hours overnight at designated sampling locations, usually the deepest sections/pools within Study Areas A, B and C. Fork length (mm) and total weight (g) was recorded for each lake sturgeon captured along with any observations related to external health. A pectoral fin ray section (approximately 1 cm from near the proximal end of the fin) was surgically removed as an aging structure. Aging structures were dried, placed in labeled envelopes and shipped to North/South Consultants Limited (North/South Consultants) in Winnipeg, Manitoba for analysis. These samples were aged along with ten lake sturgeon samples collected from Study Area A during the spring 2007 survey by Golder (Golder 2007). A Floy™ tag was attached to the dorsal side of each lake sturgeon (left posterior side of dorsal fin), and the number recorded, before each fish was live-released. Biological information related to captured lake sturgeon and Floy™ tag numbers are presented in Appendix A.

A 50 g tissue sample was collected for methyl mercury analysis from walleye and northern pike captured in the gill nets and angling. Biological data for these fish including total length (mm), total weight (g), sex data and general health assessment information were recorded and an aging structure collected (dorsal spines for walleye and scales for northern pike). Aging structures were dried, placed in labeled envelopes and shipped to North/South Consultants for analysis. Any additional fish species captured, [i.e. smallmouth bass (*Micropterus dolomieu*)] were live released and noted on field data sheets.

Netting locations were chosen based on habitat suitability models of preferred summer habitat for lake sturgeon (Ontario Hydro 1998); on previous sampling locations chosen by Stantec in 2006 and on local knowledge of the Mattagami River, as it related to historical commercial harvests. The same netting gear was deployed in each of the study areas in deep pools or the deepest water existing within each of the study areas. Table 1 summarizes netting effort expended during this field study and catch results from both netting and angling.

TABLE 1
CATCH SUMMARY AND SPECIES COMPOSITION
MATTAGAMI RIVER, SUMMER 2007

Capture Method	Location Code	Mesh Size (inches)	Total Effort (Panel Hours)	Catch (Species and Quantity)						
				Lake Sturgeon	White Sucker	Longnose Sucker	Cisco	Northern Pike	Small Mouth Bass	Walleye
STUDY AREA A (Downstream of Island Falls)										
Gill Net	GNA01	12", 12"	35.5	-	-	-	-	-	-	-
Gill Net	GNA02	9", 10", 12"	52.5	-	-	-	-	-	-	-
Gill Net	GNA03	10"	17.0	-	-	-	-	-	-	-
Gill Net	GNA04	10", 10", 10"	48.0	1	-	-	-	-	-	-
Gill Net	GNA05	4.5"	27.5	-	1	-	-	-	-	-
Gill Net	GNA06	10", 10", 10"	69.0	-	-	-	-	-	-	-
Gill Net	GNA07	12", 12"	46.0	-	-	-	-	-	-	-
Gill Net	GNA08	10"	23.0	-	-	-	-	-	-	-
Gill Net	GNA09	9", 10", 12"	69.0	-	-	-	-	-	-	-
Gill Net	GNA10	4.5", 3", 4"	87.0	-	4	2	1	1	-	-
Gill Net	GNA11	4.5", 3", 4"	85.5	-	-	-	-	-	-	-
Gill Net	GNA12	9", 10", 12"	61.0	-	-	-	-	-	-	-
Gill Net	GNA13	9", 10", 12"	60.0	1	-	-	-	-	-	-
Gill Net	GNA14	12", 12"	41.0	-	-	-	-	-	-	-
Gill Net	GNA15	10"	20.5	-	-	-	-	-	-	-
Gill Net	GNA16	4.5", 3", 4"	79.5	-	-	-	-	-	-	-
Gill Net	GNA17	4.5", 3", 4"	75.5	-	-	-	-	-	-	-
	TOTAL	-	897.5	2	5	2	1	1	-	-
Angling	ANA02	-	-	-	-	-	-	8	-	-
Angling	ANA03	-	-	-	-	-	-	-	1	-
Angling	ANA07	-	-	-	-	-	-	-	-	7

Capture Method	Location Code	Mesh Size (inches)	Total Effort (Panel Hours)	Catch (Species and Quantity)						
				Lake Sturgeon	White Sucker	Longnose Sucker	Cisco	Northern Pike	Small Mouth Bass	Walleye
	TOTAL			-	-	-	-	8	1	7
STUDY AREA B										
(Downstream of Yellow Falls)										
Gill Net	GNB01	10", 10", 10"	58.5	-	-	-	-	-	-	-
Gill Net	GNB02	12", 12"	39.0	-	-	-	-	-	-	-
Gill Net	GNB03	10"	19.0	-	-	-	-	-	-	-
Gill Net	GNB06	4.5", 3", 4"	76.5	-	-	-	-	-	-	-
	TOTAL	-	193.0	-	-	-	-	-	-	-
Angling	ANB01	-	-	-	-	-	-	1	2	3
STUDY AREA C										
(Downstream of Davis Rapids)										
Gill Net	GNC01	10", 10", 10"	67.5	-	-	-	-	-	-	-
Gill Net	GNC02	12", 12"	42.0	-	-	-	-	-	-	-
Gill Net	GNC03	9", 10", 12"	68.25	-	-	-	-	-	-	-
Gill Net	GNC04	10"	24.0	-	-	-	-	-	-	-
Gill Net	GNC05	4.5", 3", 4"	81.75	-	-	-	-	-	-	-
	TOTAL	-	283.5	-	-	-	-	-	-	-
Angling	ANC01	-	-	-	-	-	-	3	-	-
STUDY AREA C										
(Downstream of Loon Rapids)										
Gill Net	GNC06	10", 10", 10"	57.5	-	-	-	-	-	-	-
Gill Net	GNC07	10"	22.0	-	-	-	-	-	-	-
Gill Net	GNC08	9", 10", 12"	57.25	-	-	-	-	-	-	-
Gill Net	GNC09	12", 12"	45.0	-	-	-	-	-	-	-
Gill Net	GNC10	4.5", 3", 4"	78.25	-	-	-	-	-	-	-
	TOTAL	-	260.0	-	-	-	-	-	-	-
Angling	ANC02	-	-	-	-	-	-	1	1	2

Golder Associates

Capture Method	Location Code	Mesh Size (inches)	Total Effort (Panel Hours)	Catch (Species and Quantity)						
				Lake Sturgeon	White Sucker	Longnose Sucker	Cisco	Northern Pike	Small Mouth Bass	Walleye
STUDY AREA C										
(Indian Point, Upstream of Loon Rapids)										
Gill Net	GNC11	10", 10", 10"	71.0	6	-	-	-	-	-	-
Gill Net	GNC12	12", 12"	50.0		-	-	-	-	-	-
Gill Net	GNC13	9", 10", 12"	63.0	5	-	-	-	-	-	-
Gill Net	GNC14	10"	24.0	3	-	-	-	-	-	-
Gill Net	GNC15	4.5", 3", 4"	75.0		-	-	-	-	-	-
	TOTAL	-	283.0	14	-	-	-	-	-	-
Angling	ANC07	-	-		-	-	-	4	2	4

A total of 31 fish representing seven species (lake sturgeon, cisco (*Coregonus artedii*), northern pike, longnose sucker (*Catostomus catostomus*), white sucker (*Catostomus commersoni*), smallmouth bass and walleye) were captured in Study Area A (Island Falls and downstream to Bradburn Creek). Northern pike, smallmouth bass and walleye were captured in all of the reaches examined. A summary of biological data for lake sturgeon, northern pike and walleye is summarized in Table 2. Meristic data and ages of fish captured in Study Areas A, B and C, August and September 2007, are presented in Appendix B.

TABLE 2
SUMMARY OF TOTAL CATCH AND BIOLOGICAL INFORMATION COLLECTED
FOR LAKE STUREGEON, WALLEYE AND NORTHERN PIKE
MATTAGAMI RIVER, SUMMER 2007

Study Area	Species	n	Fork length (mm)				Age (yrs)				Weight (g)			
			Mean	Min	Max	S.D.	Mean	Min	Max	S.D.	Mean	Min	Max	S.D.
A	Lake Sturgeon	2	1137.0	1134.0	1140.0	-	22.0	22.0	22.0	-	12350	12300	12400	-
	Northern Pike	12	477.2	374.0	719.0	109.6	4.6	3.0	7.0	1.2	771.9	300.00	2500.0	649.9
	Walleye	7	341.0	236.0	432.0	72.1	5.3	3.0	8.0	2.2	460.8	130.0	780.0	246.6
B	Northern Pike	1	425.0	-	-	-	5.0	-	-	-	460.0	-	-	-
	Walleye	3	287.7	264.0	323.0	33.2	3.3	2.0	4.0	1.2	250.0	165.0	380.0	123.7
C	Lake Sturgeon	14	1155.7	1000.0	1309.0	112.0	20.2	11.0	28.0	5.3	13628	8600	18300	3579.8
	Northern Pike	8	478.2	407.0	580.0	74.3	5.9	4.0	8.0	1.2	738.4	432.0	1300.0	368.3
	Walleye	5	357.0	331.0	383.0	36.8	6.2	4.0	8.0	1.5	380.5	360.0	401.0	29.0

Notes: n – number S.D. – Standard Deviation

Sixteen lake sturgeon were captured during the 2008 summer survey. Two individuals were captured downstream of Island Falls. No lake sturgeon were captured in between Island and Yellow Falls (Study Area B) or in gill nets set at Loon Rapids, and at the mouth of Rat Creek near Davis Rapids. This is consistent with netting projects completed in the spring of 2006 and 2007 by Stantec and Golder, respectively. No lake sturgeon have been captured between Loon Rapids and Island Falls in any field studies associated with the project. Both lake sturgeon

captured in Study Area A were estimated to be 22 years of age. Lake Sturgeon captured below Island Falls during the spring of 2007 were 12 to 20 years of age (Golder 2007). Lake Sturgeon captured above Loon Rapids, at Indian Point, ranged in age between 11 and 28 years.

Anecdotal information suggests that the commercial lake sturgeon fishery focused on several different sections of river throughout its 70 year history. In the 1940s, most lake sturgeon were harvested below Smooth Rock Falls (Yvan Arenauult, pers. comm. 2007). In the 1950s, most lake sturgeon were being harvested between Loon Rapids and Lower Sturgeon Falls G.S. (Glen McNay, pers. comm. 2007). Lake sturgeon were rarely harvested during these periods, between SRF and Loon Rapids. The pools located at the mouths of Bradburn and Rat Creeks were targeted once every two or three years. Neither of the ex-commercial fishers recalled harvesting lake sturgeon between Island Falls and Yellow Falls. Although netting effort was expended in the pools associated with Bradburn and Rat Creeks in 2007, no lake sturgeon were captured. The high abundance of lake sturgeon upstream of Loon Rapids, within the pool at Indian Point relative to other reaches, is consistent with information provided by both ex-commercial fishers.

Walleye, northern pike and smallmouth bass were captured in all of the reaches fished. The presence of these three species in each of the study areas was also documented by Stantec in 2006 (Stantec 2007).

4.0 LIMITATIONS

This report was prepared for the exclusive use of Yellow Falls Power LP. The report, which specifically includes all tables, figures and appendices, is based on data and information collected by Golder Associates Ltd. and is based solely on the conditions at the Site at the time of the work, supplemented by historical information and data obtained by Golder Associates Ltd. as described in this report. No assurance is made regarding the accuracy and completeness of these data.

Parts of this report rely on third party information, which was assumed to be factual and accurate. Golder Associates Ltd. therefore accepts no responsibility for the accuracy of the information by third parties.

Golder Associates Ltd. has exercised reasonable skill, care and diligence to assess the information acquired during the preparation of this assessment, but makes no guarantees or warranties as to the accuracy or completeness of this information. This report is based upon and limited by circumstances and conditions acknowledged herein, and upon information available at the time of the site investigations.

Any use which a third party makes of this report, or any reliance on, or decisions to be made based on it, are the responsibilities of such third parties. Golder Associates Ltd. accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

5.0 CLOSURE

We trust that the information presented meets your current requirements. Should you have any questions or concerns, please do not hesitate to contact the undersigned.

Yours very truly,

GOLDER ASSOCIATES

Brian Grant,

6.0 REFERENCES

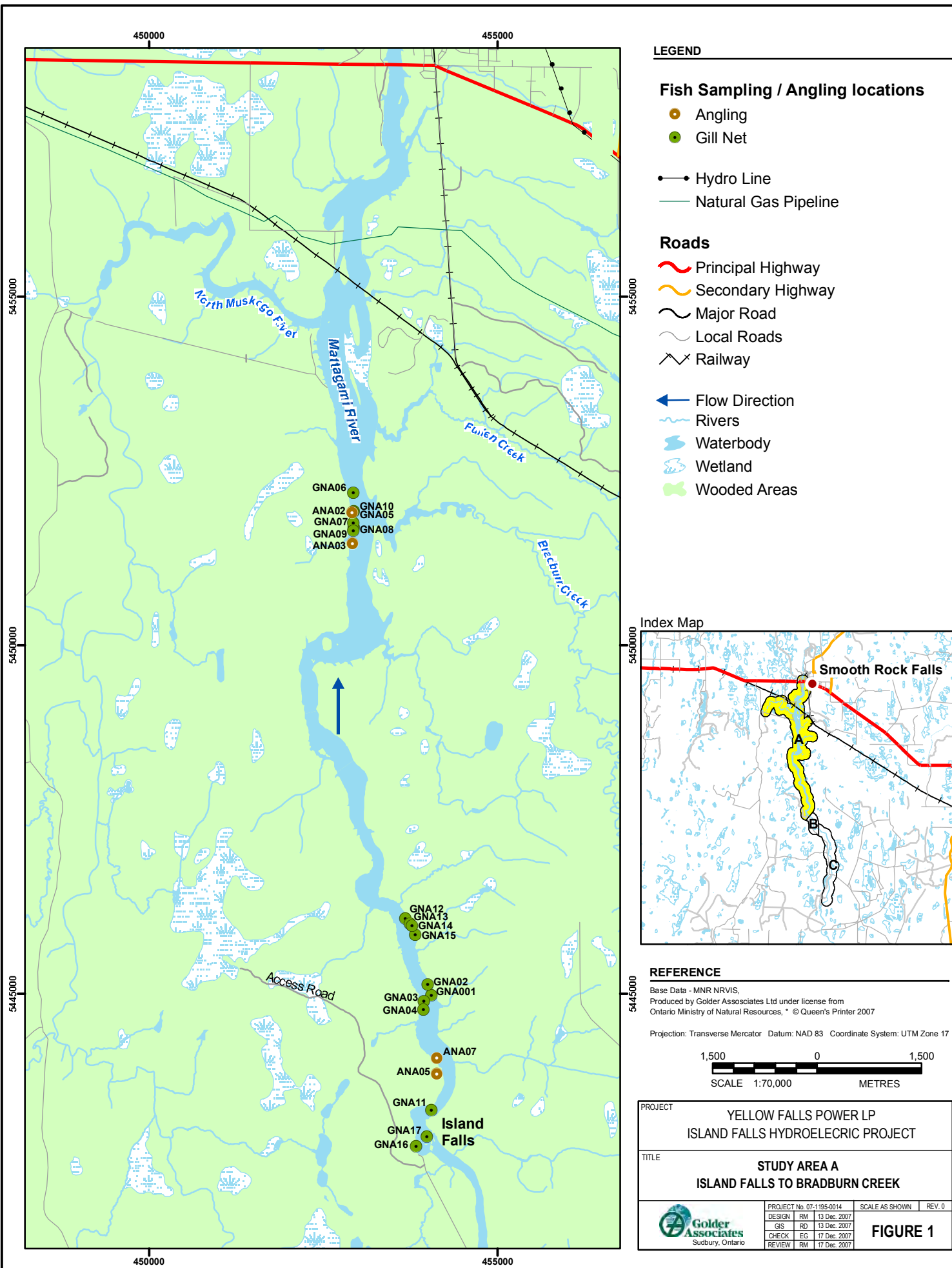
Arseneault, Yvan. July 26, 2007. Personal Communication.

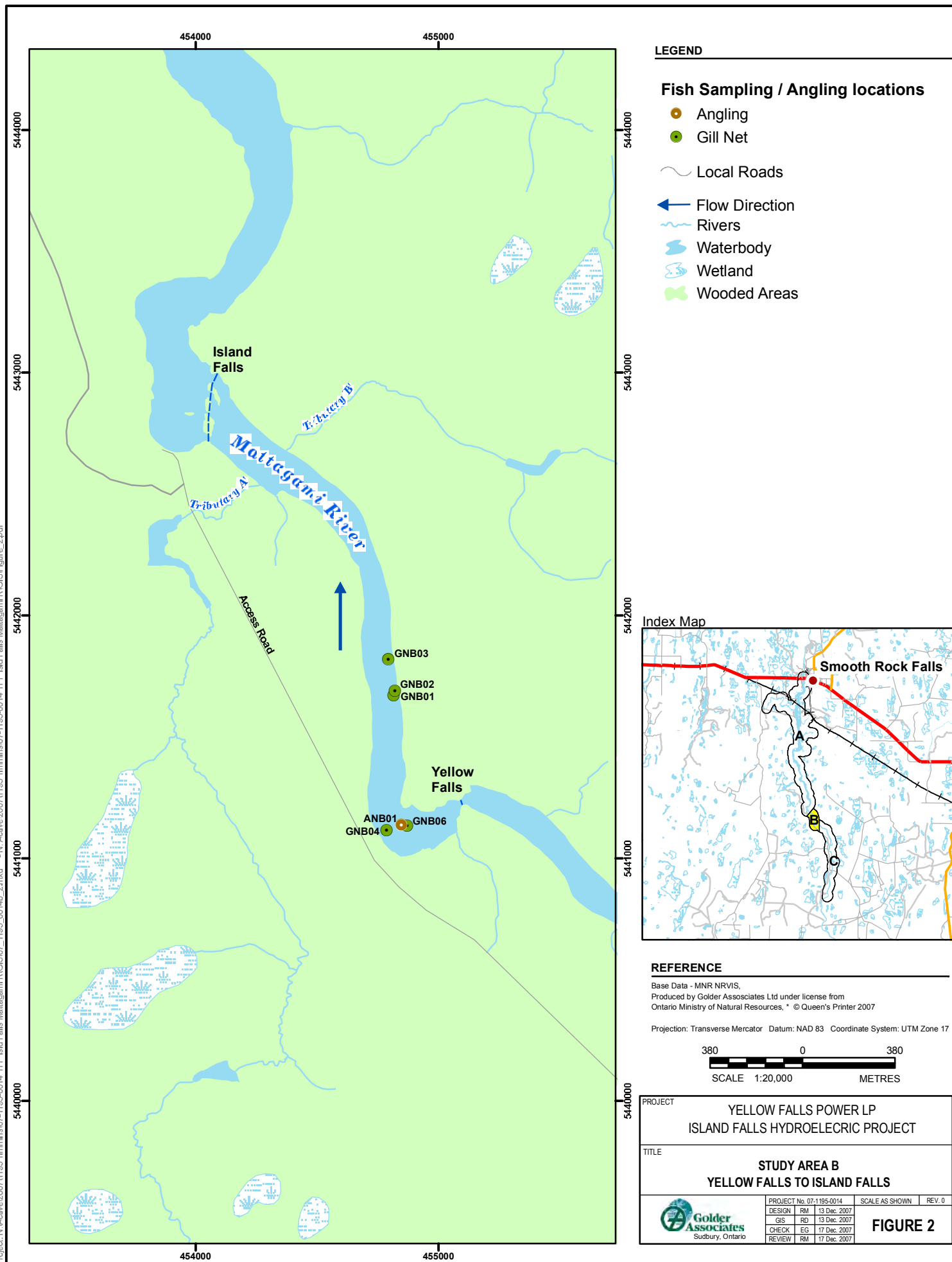
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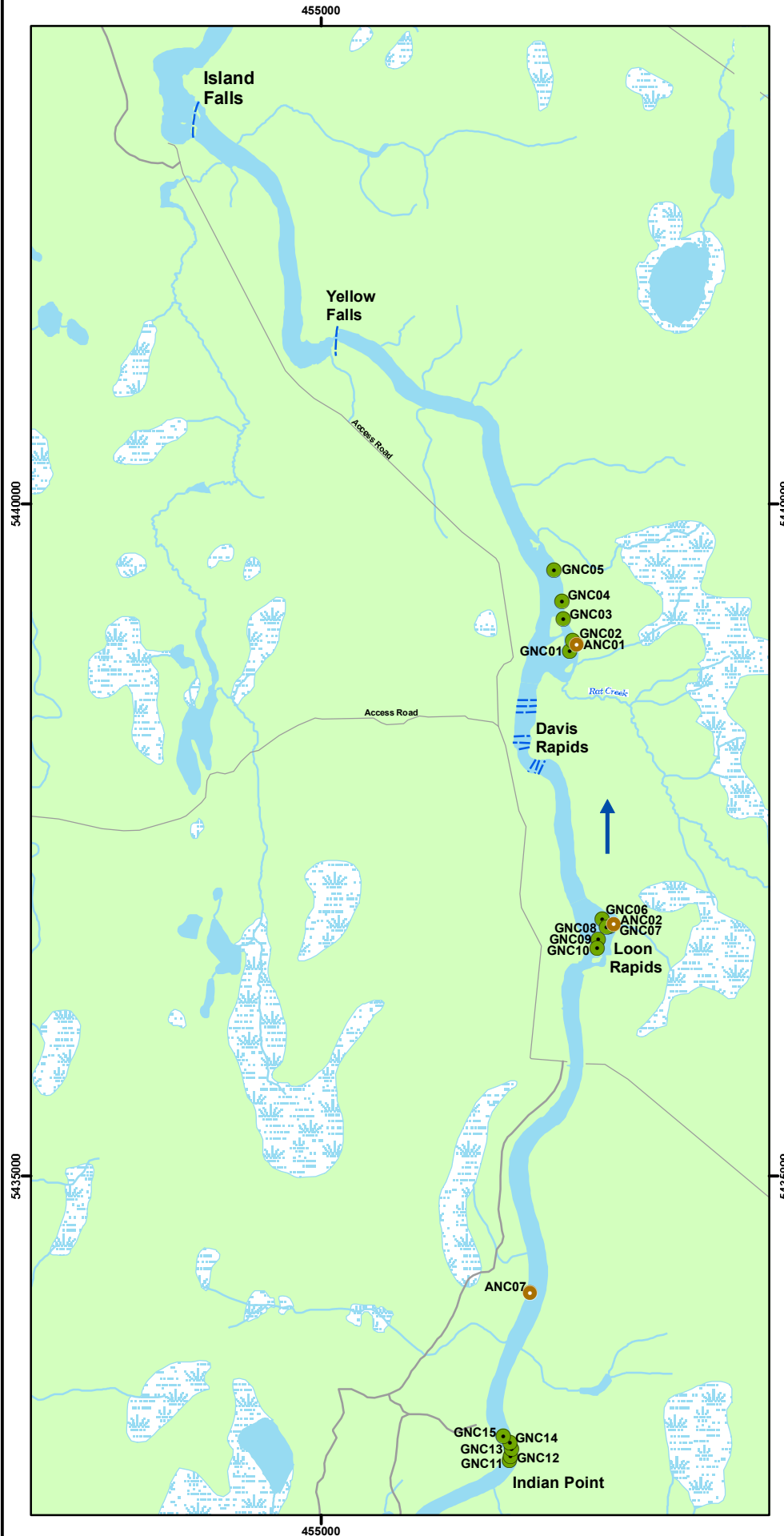
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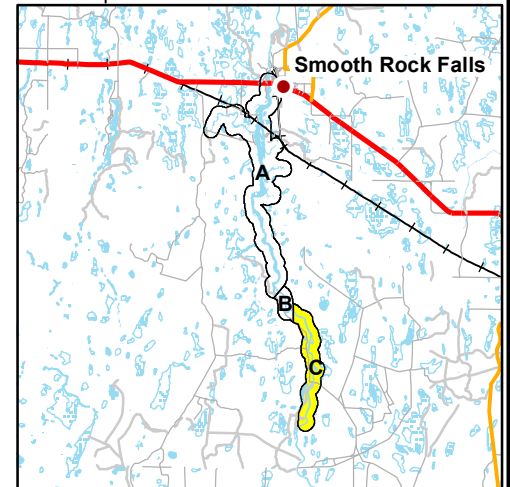


LEGEND

Fish Sampling / Angling locations

- Angling
- Gill Net
- Local Roads
- Flow Direction
- Rivers
- Waterbody
- Wetland
- Wooded Areas

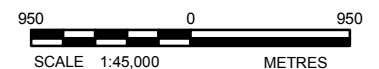
Index Map



REFERENCE

Base Data - MNR NRVIS,
Produced by Golder Associates Ltd under license from
Ontario Ministry of Natural Resources, * © Queen's Printer 2007

Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 17



PROJECT		YELLOW FALLS POWER LP ISLAND FALLS HYDROELECTRIC PROJECT	
TITLE		STUDY AREA C NDIAN POINT To YELLOW FALLS	
	PROJECT No.	07-1195-0014	SCALE AS SHOWN
	DESIGN	RM 13 Dec 2007	REV. 0
	GS	RD 13 Dec 2007	
	CHECK	EG 17 Dec 2007	
REVIEW		RM 17 Dec 2007	

FIGURE 3

APPENDIX A

BIOLOGICAL DATA AND FLOY™ TAG NUMBERS

BIOLOGICAL DATA AND FLOY™ TAG NUMBERS

Study Area	Season	Gill Net ID	Floy Tag No.	Fork Length (mm)	Weight (kg)	Sex	Stage	Maturity	Age Structure	Age (yrs)
A	Spring	GN-38	0801	1144	10.9	Male	Adult	Ripe	Right pectoral fin	20
	Spring	GN-38	0802	878	5.5	Male	Adult	Ripe	Right pectoral fin	12
	Spring	GN-38	0803	1188	9.7	Male	Adult	Ripe	Right pectoral fin	14
	Spring	GN-38	0804	1041	8.6	Male	Adult	Ripe	Right pectoral fin	21
	Spring	GN-38	0805	1043	9.0	Male	Adult	Ripe	Right pectoral fin	20
	Spring	GN-38	0806	1091	11.8	Unknown	Adult	Unknown	Right pectoral fin	20
	Spring	GN-53	0807	1112	11.2	Unknown	Adult	Unknown	Right pectoral fin	NA
	Spring	GN-53	0808	1160	12.3	Male	Adult	Ripe	Right pectoral fin	20
	Spring	GN-53	0809	1190	13.2	Unknown	Adult	Unknown	Right pectoral fin	NA
	Spring	GN-59	0810	1094	10.1	Male	Adult	Ripe	Right pectoral fin	20
	Summer	GNA04	0813	1134	12.3	Unknown	-	Mature	Left pectoral fin	22
	Summer	GNA13	0814	1140	12.4	Unknown	Adult	Mature	Right pectoral fin	22
B	No lake sturgeon captured during 2007 spring or summer field programs									
C	Summer	GNC14	0815	1200	14.8	Unknown	Adult	Unknown	Left pectoral fin	23
	Summer	GNC14	0816	1000	9.2	Unknown	Adult	Unknown	Left pectoral fin	13
	Summer	GNC14	0817	1032	8.6	Unknown	Adult	Unknown	Left pectoral fin	11
	Summer	GNC13	0818	1004	9.0	Unknown	Adult	Unknown	Left pectoral fin	15
	Summer	GNC13	0820	1300	18.3	Unknown	Adult	Unknown	Left pectoral fin	24
C	Summer	GNC13	0821	1251	16.7	Unknown	Adult	Unknown	Left pectoral fin	23
	Summer	GNC13	0822	1200	16.1	Unknown	Adult	Unknown	Left pectoral fin	19
	Summer	GNC13	0823	1309	17.4	Unknown	Adult	Unknown	Left pectoral fin	NA
	Summer	GNC11	0824	1234	16.2	Unknown	Adult	Unknown	Left pectoral fin	25

Study Area	Season	Gill Net ID	Floy Tag No.	Fork Length (mm)	Weight (kg)	Sex	Stage	Maturity	Age Structure	Age (yrs)
	Summer	GNC11	0825	1024	9.2	Unknown	Adult	Unknown	Left pectoral fin	16
	Summer	GNC11	0983	1162	13.2	Unknown	Adult	Unknown	Left pectoral fin	23
	Summer	GNC11	0984	1041	10.4	Unknown	Adult	Unknown	Left pectoral fin	NA
	Summer	GNC11	0985	1200	15.3	Unknown	Adult	Unknown	Right pectoral fin	22
	Summer	GNC11	0986	1223	16.4	Unknown	Adult	Unknown	Left pectoral fin	28

Notes: NA = not available

APPENDIX B

ADDITIONAL INFORMATION FOR LAKE STURGEON SAMPLED DURING THE 2007 SUMMER FIELD SURVEY

**MERISTIC DATA AND AGES OF FISH CAPTURED IN STUDY AREAS A, B AND C
AUGUST AND SEPTEMBER 2007**

Species	Fork Length (mm)	Weight (g)	Sex	Age (year)	Capture Method	Area
Cisco	610	400	U	-	Gill Net	A
Lake Sturgeon	1134	1230	U	22	Gill Net	A
Lake Sturgeon	1140	1240	U	22	Gill Net	A
Longnose Sucker	420	900	U	-	Gill Net	A
Longnose Sucker	402	700	U	-	Gill Net	A
Northern Pike	431	502	M	5	Angling	A
Northern Pike	353	300	M	3	Angling	A
Northern Pike	535	1200	M	7	Angling	A
Northern Pike	374	500	M	4	Angling	A
Northern Pike	419	400	M	4	Angling	A
Northern Pike	375	300	M	5	Angling	A
Northern Pike	371	396	F	5	Angling	A
Northern Pike	433	515	M	4	Angling	A
Northern Pike	622	1400	U	-	Angling	A
Northern Pike	416	400	U	-	Angling	A
Northern Pike	478	850	U	-	Angling	A
Northern Pike	719	2500	U	-	Gill Net	A
Small Mouth Bass	268	320	U	-	Angling	A
Small Mouth Bass	280	380	U	-	Angling	A
Small Mouth Bass	265	355	U	-	Angling	A
Small Mouth Bass	335	700	U	-	Angling	A
Walleye	402	665	U	7	Angling	A
Walleye	251	160	U	3	Angling	
Walleye	432	780	U	6	Angling	A
Walleye	236	130	M	3	Angling	A
Walleye	330	445	M	8	Angling	A
Walleye	356	505	M	7	Angling	A
Walleye	290	240	U	3	Angling	A
White Sucker	409	1120	U	-	Gill Net	A
White Sucker	418	1200	U	-	Gill Net	A
White Sucker	460	1500	U	-	Gill Net	A
White Sucker	404	700	U	-	Gill Net	A
White Sucker	403	900	U	-	Gill Net	A
Walleye	264	165	M	2	Angling	B
Northern Pike	425	460	M	5	Angling	B
Small Mouth Bass	254	275	U	-	Angling	B
Small Mouth Bass	264	320	U	-	Angling	B
Walleye	323	380	M	4	Angling	B
Walleye	276	205	M	4	Angling	B
Lake Sturgeon	1200	1148	U	23	Gill Net	C
Lake Sturgeon	1000	9.2	U	13	Gill Net	C

Species	Fork Length (mm)	Weight (g)	Sex	Age (year)	Capture Method	Area
Lake Sturgeon	1032	8.6	U	11	Gill Net	C
Lake Sturgeon	1004	9	U	15	Gill Net	C
Lake Sturgeon	1300	10.3	U	24	Gill Net	C
Lake Sturgeon	1251	16.7	U	23	Gill Net	C
Lake Sturgeon	1200	16.1	U	19	Gill Net	C
Lake Sturgeon	1309	17.4	U	Not ageable	Gill Net	C
Lake Sturgeon	1234	16.2	U	25	Gill Net	C
Lake Sturgeon	1024	9.2	U	16	Gill Net	C
Lake Sturgeon	1162	13.2	U	23	Gill Net	C
Lake Sturgeon	1041	10.4	U	Not ageable	Gill Net	C
Lake Sturgeon	1200	15.3	U	22	Gill Net	C
Lake Sturgeon	1223	16.4	U	28	Gill Net	C
Northern Pike	495	910	M	6	Angling	C
Northern Pike	460	680	F	6	Angling	C
Northern Pike	500	810	F	7	Angling	C
Northern Pike	407	480	F	5	Angling	C
Northern Pike	530	920	F	6	Angling	C
Northern Pike	454	570	M	4	Angling	C
Northern Pike	580	1300	F	8	Angling	C
Northern Pike	420	470	M	5	Angling	C
Small Mouth Bass	237	230	U	-	Angling	C
Walleye	403	630	F	7	Angling	C
Walleye	332	340	M	4	Angling	C
Walleye	382	490	F	8	Angling	C
Walleye	331	360	M	6	Angling	C
Walleye	383	401	F	6	Angling	C

TECHNICAL MEMORANDUM



Golder Associates Ltd.

1010 Lorne Street
Sudbury, ON, Canada P3C 4R9

Telephone: 705-524-6861
Fax Access: 705-524-1984

TO:	Scott Hossie	DATE:	September 30, 2008
EMAIL:	SHossie@canhydro.com	JOB NO:	08-1195-0016
FROM:	John Seyler	EMAIL:	jseyler@golder.com
RE:	METHYL MERCURY [Hg] IN WALLEYE UPSTREAM AND DOWNSTREAM OF THE PROPOSED YELLOW FALLS HYDROELECTRIC PROJECT		

INTRODUCTION

At the request of Yellow Falls Power LP (YFP), Golder Associates Ltd. (Golder) collected and submitted walleye (*Stizostedion sanders*) tissue samples for laboratory analysis of methyl mercury [Hg] content. The collection of tissue samples was completed concurrent with the 2008 spring spawning assessment upstream and downstream of the proposed Yellow Falls Hydroelectric Project (the Project).

Comments received from Environment Canada (EC) on baseline aquatic assessment work completed in 2006, when the Project location was originally proposed at Island Falls, indicated that an inadequate number of walleye tissue samples were collected and analyzed for Hg content up and downstream of the Project location. EC further recommended that the Metal Mining Environmental Effects Monitoring (EEM) Guidance Document (EC 2002) be used as a guide in assessing baseline [Hg] in fish tissue.

METHODS

During the summer of 2007, Golder collected tissue samples from 12 walleye, using overnight gillnets and angling. These samples were collected in conjunction with a netting program designed to define lake sturgeon (*Acipenser fulvescens*) distribution up and downstream of the proposed Project (Golder 2008). A 50 g flesh sample was collected as a flank fillet from each captured fish and assigned a unique identity number. Flesh samples were wrapped in foil and frozen immediately after collection. Samples were shipped frozen on dry ice for analysis by Flett Research Ltd. (Flett) in Winnipeg, Manitoba. Data included with each fillet sample included wet



weight of fillet, total length (mm) and sex of the target species.

In May 2008, Golder field crew harvested tissue from walleye upstream and downstream of Yellow Falls. Walleye were captured using experimental gillnets, set overnight and angling. Capture effort was expended at locations where walleye were known to congregate in the spring. These included the base of Island Falls, the base of Loon Rapids and the base of Davis Rapids. The objective of this study was to capture 40 small (300 to 400 mm) male walleye from both upstream and downstream of the proposed Project. The targeted number of walleye were to be grouped in composite samples, each consisting of eight fish (i.e. 5 upstream composite samples x 8 fish and 5 downstream composite samples x 8 fish) as per EEM guidelines (EC 2002).

Each fish was assigned a unique identity number, measured (fork length), weighed and sacrificed on a clean cutting board using a clean filet knife. The sex and state of maturity of each fish was recorded. Aging structures (dorsal spines and scales) were collected from each fish. Approximately 50 g (wet weight) of flesh was collected from the thickest portion of the fillet. Each tissue sample was placed in a labeled (identity number) plastic bag and frozen. As fish were captured/sampled, they were placed in a larger bag labeled either 'Upstream 1-5' or 'Downstream 1-5'. Composite samples of tissue samples, each consisting of eight individual fish were created.

At the end of the field program, samples were transferred in a frozen state to Golder's Sudbury office and then to Flett. At the laboratory, 1 g from each replicate within each composite sample was blended and analyzed for [Hg] ng/g wet weight and dry weight.

Historical data related to [Hg] accumulation in walleye within the section of the Mattagami River between Loon Rapids and Smooth Rock Falls was provided by the Ontario Ministry of the Environment (MOE). Analyses of these data has been previously published as part of MOE's sport fish contaminant program. These data sets are presented in Appendix A.

Analyses of [Hg] data was completed using SYSTAT 11(SPSS 2007). Relationships between [Hg] and total length were established using the non-linear model:

$$[\text{Hg}] \text{ (ng/g)} = \text{Total Length (mm)}^b \cdot a$$

Analysis of Variance (ANOVA) was used to establish relationships between mean lengths and ages of walleye captured upstream and downstream of the proposed Project in 2008.

RESULTS AND DISCUSSION

During the spring of 2008, field crews were on site at the target locations and actively fishing throughout the walleye spawning period. Walleye were not present in large numbers at locations

other than at the base of Island Falls. A total of 36 walleye were captured below Island Falls and four below Yellow Falls. Tissue samples from these fish were used to make up five composite samples representing the baseline condition, downstream of the Project. Walleye proved extremely difficult to capture upstream of the Project despite extensive netting and angling effort. A total nine walleye were captured at Loon Rapids and none at Davis Rapids. Thus, only a single composite sample representing the baseline condition upstream of Yellow Falls could be amassed. Due to low capture numbers, tissue was collected from both male and female walleye. Table 1 summarizes length, weight and age data from sacrificed walleye.

TABLE 1
BIOLOGICAL DATA FOR WALLEYE CAPTURED
THE PURPOSES OF METHYL MERCURY SAMPLING, 2008

Capture Location	Composite Sample ID	Fish Number	Sex	Fork Length (mm)	Weight (g)	Age (yrs)
Yellow Falls	Downstream 1	24	Male	324	400	6
		23	Male	330	410	5
		22	Female	450	1150	6
		20	Female	425	800	7
Island Falls		43	Male	341	390	5
		42	Male	336	415	5
		41	Male	357	445	5
		40	Male	332	370	5
Mean				361.9	547.5	5.5
Minimum				324	370	5.0
Maximum				450	1150	7.0
Standard Error				17.0	99.3	0.1
Standard Deviation				48.1	280.8	0.8
Island Falls	Downstream 2	6	Male	421	950	10
		7	Male	435	900	8
		10	Male	475	1600	11
		11	Male	325	350	7
		12	Male	320	250	6
		13	Male	347	390	7
		14	Male	358	450	6
		15	Male	345	410	6
Mean				378.3	662.5	7.6
Minimum				320	250	6.0
Maximum				475	1600	11.0
Standard Error				20.3	162.0	0.2
Standard Deviation				57.5	458.1	1.9
Island Falls	Downstream 3	16	Male	345	430	5
		17	Male	386	580	5
		18	Male	352	450	6
		19	Male	340	420	6
		20	Male	360	510	6
		21	Male	365	540	7

Capture Location	Composite Sample ID	Fish Number	Sex	Fork Length (mm)	Weight (g)	Age (yrs)
		22	Male	383	590	7
		23	Male	365	580	7
Mean				362.0	512.5	6.1
Minimum				340	420	5.0
Maximum				386	590	7.0
Standard Error				5.8	25.1	0.1
Standard Deviation				16.5	70.9	0.8
Island Falls	Downstream 4	24	Male	370	520	7
		25	Male	429	930	8
		26	Male	373	530	7
		27	Male	345	400	6
		28	Female	350	495	6
		29	Male	370	470	6
		30	Male	322	335	5
		31	Male	388	670	6
Mean				368.4	543.8	6.4
Minimum				322	335	5.0
Maximum				429	930	8.0
Standard Error				11.3	65.2	0.1
Standard Deviation				31.9	184.4	0.9
Island Falls	Downstream 5	32	Male	375	680	5
		33	Male	348	450	4
		34	Male	363	495	7
		35	Male	359	425	6
		36	Male	428	850	9
		37	Male	344	625	7
		38	Male	450	1200	11
		39	Male	377	480	6
Mean				380.5	650.6	6.9
Minimum				344	425	4.0
Maximum				450	1200	11.0
Standard Error				13.6	93.3	0.3
Standard Deviation				38.3	263.9	2.2
Loon Rapids	Upstream	26	Male	434	650	6
		27	Male	341	500	7
		41	Male	370	500	5
		59	Male	310	250	5
		60	Male	360	500	7
		61	Male	360	450	5
		62	Male	378	600	7
		64	Female	421	710	9
Mean				371.8	520.0	6.4
Minimum				310	250	5.0
Maximum				434	710	9.0
Standard Error				14.3	49.7	0.2
Standard Deviation				40.3	140.6	1.4

Failure to capture the targeted number of walleye from the area, upstream of Yellow Falls, precluded statistical ANOVA of [Hg] between the upstream and downstream areas. Table 2 summarizes the mean values of the 2008 composite samples. An ANOVA was conducted to compare mean lengths and ages of walleye making up each of the composite samples. There were no significant differences in the mean lengths of walleye making up the upstream and downstream samples ($df(5,42)$, $p=.910$) nor in the mean ages of walleye ($df(5,42)$, $p=.108$). The Mercury concentration of walleye captured at Loon Rapids, the upstream composite sample, was 455 ng/g while the mean mercury concentration of walleye captured below Yellow Falls was 456 ng/g.

TABLE 2
SUMMARY DATA FOR WALLEYE COMPOSITE SAMPLES AND METHYL
MERCURY CONCENTRATIONS (ng/g)

Composite Sample ID	Mean Fork Length (mm)	Mean Weight (g)	Mean Age (yr)	CH ₃ Hg as Hg (ng/g) Wet Weight
Downstream 1	361.9	547.5	5.5	461
Downstream 2	378.3	662.5	7.6	508
Downstream 3	362.0	512.5	6.1	430
Downstream 4	368.4	543.8	6.4	427
Downstream 5	380.5	650.6	6.9	453
Mean Values (d/s)	370.2	581.6	6.5	456
Loon Rapids (u/s)	371.8	520.0	6.4	455

In 2007, Golder collected tissue from a total of four walleye below Island Falls, three between Island Falls and Yellow Falls and five upstream of Yellow Falls. Table 3 summarizes biological and [Hg] analyses for individual fish within these data sets.

TABLE 3
BIOLOGICAL AND [Hg] (ng/g) DATA FOR INDIVIDUAL WALLEYE
SAMPLED BY GOLDER (2007) BY LOCATION

Sample Location	Total Length (mm)	Weight (g)	Age (yr)	CH ₃ Hg as Hg (ng/g) Wet Weight
Below Island Falls	402	665	7	469
	251	160	3	159
	445	330	8	566
	240	290	3	153
Between Island and Yellow Falls	323	380	4	239
	276	205	4	122
	264	165	2	137
Upstream of Yellow Falls	403	630	7	179
	332	340	4	130
	382	490	8	332
	331	360	6	274
	383	515	6	321

Using the 2007 data set, non-linear regression analysis of [Hg] vs total length yields the equation:

$$[\text{Hg}] \text{ ng/g} = \text{total length (mm)}^{1.953} \cdot 0.0027 \quad (\text{mean corrected R-square} = 0.608)$$

Consumption guidelines recommend that women of child bearing age and children under 15 years of age limit consumption of sport fish containing mercury concentrations greater than 0.26 parts per million (ppm) (MOE 2007). Given the relationship established for walleye within the study area, walleye greater than 356 mm in total length currently exceed this guideline. For the general population, consumption restrictions begin at levels above 0.61 ppm. Walleye greater than 552 mm in total length exceed this guideline within the study area.

Sport fish contaminant sampling has been completed within the study area since 1977. However, variable sample sizes, dates (year) and the size ranges of walleye captured precludes comparisons using ANOVA. The following walleye [Hg] data sets, provided by the MOE sport fish contaminant laboratory, were modeled using non-linear regression:

- Smooth Rock Falls to Island Falls (1996), (N=15) yielding the equation

$$[\text{Hg}] \text{ ng/g} = \text{total length (mm)}^{-0.10} \cdot 1.019 \quad (\text{mean corrected R-square} = 0.573)$$

- Smooth Rock Falls to Island Falls (1990), (N=38) yielding the equation

$$[\text{Hg}] \text{ ng/g} = \text{total length (mm)}^{1.187} \cdot 0.3730 \quad (\text{mean corrected R-square} = 0.504)$$

- Smooth Rock Falls to Island Falls (1977), (N= 12) yielding the equation

$$[\text{Hg}] \text{ ng/g} = \text{total length (mm)}^{2.290} \cdot 0.00039 \quad (\text{mean corrected R-square} = 0.401)$$

- Loon Rapids (1977), (N=13) yielding the equation

$$[\text{Hg}] \text{ ng/g} = \text{total length (mm)}^{2.044} \cdot 0.0018 \quad (\text{mean corrected R-square} = 0.637)$$

Figure 1 illustrates regression equations for the 1977 data sets from Loon Rapids and the Mattagami River near Smooth Rock Falls. These data suggest that methyl mercury accumulation in walleye in these areas was similar, historically.

FIGURE 1
METHYL MERCURY (ng/g) ACCUMULATION IN WALLEYE, LOON RAPIDS AND
SMOOTH ROCK FALLS; 1977 (MOE DATA)

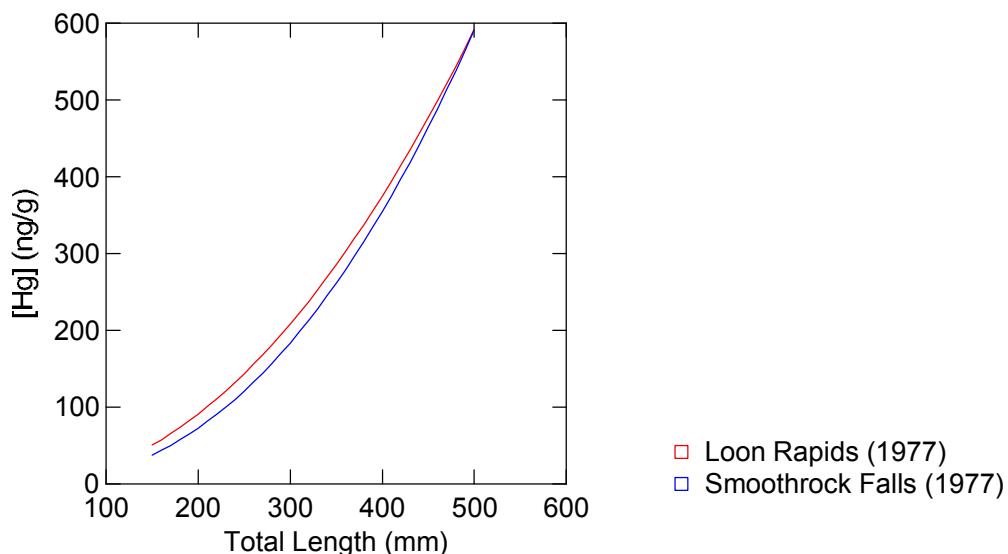
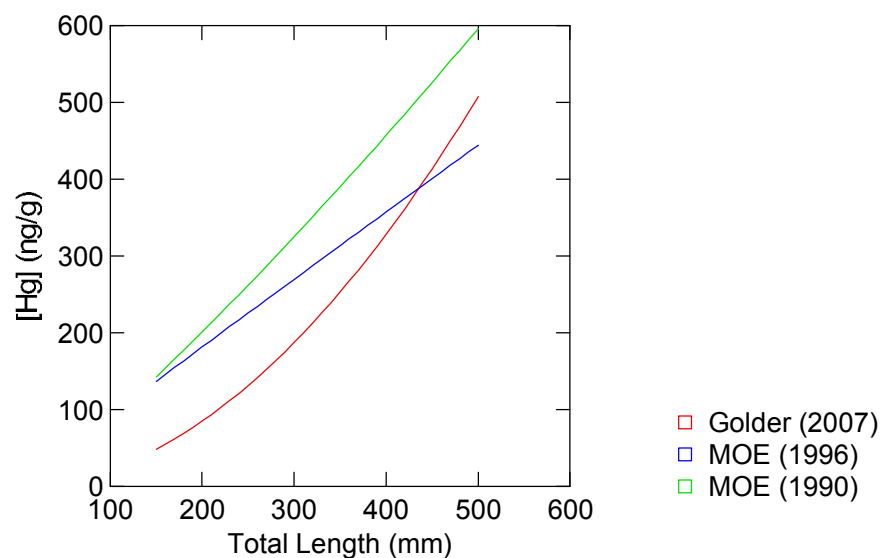


Figure 2 illustrates regression equations for the Golder (2007), MOE (1996) and MOE (1990) data sets. These relationships appear to differ over the timeframe between sampling periods. However, whether or not this may be due to chemical (i.e. water chemistry) or biological (i.e. walleye rate of growth) changes within the study area is uncertain.

FIGURE 2
FIGURE 1. METHYL MERCURY (ng/g) ACCUMULATION IN WALLEYE,
MATTAGAMI RIVER 2007, 1996 AND 1990



Methyl mercury concentrations in walleye inhabiting the Mattagami River upstream and downstream of the proposed Project appear to have been similar based upon historic data. This is not surprising given that downstream drift likely plays an important role in the biology of the fish community of riverine systems like the Mattagami River. The sample size recommended within the EEM guidelines to assess differences in contaminant concentrations between two geographic areas (i.e. upstream vs. downstream) was not attained in 2008, despite extensive fishing effort, expended at known and suspected walleye spawning areas during the spawning period. However, the existing data set, upstream and downstream combined, will suffice as a baseline against which potential changes in methyl mercury concentrations may be statistically compared.

LIMITATIONS

This report was prepared for the exclusive use of Yellow Falls Power LP. The report, which specifically includes all tables, figures and appendices, is based on data and information collected by Golder Associates Ltd. and is based solely on the conditions at the Site at the time of the work, supplemented by historical information and data obtained by Golder Associates Ltd. as described in this report. No assurance is made regarding the accuracy and completeness of these data.

Parts of this report rely on third party information, which was assumed to be factual and accurate. Golder Associates Ltd. therefore accepts no responsibility for the accuracy of the information by third parties.

Golder Associates Ltd. has exercised reasonable skill, care and diligence to assess the information acquired during the preparation of this assessment, but makes no guarantees or warranties as to the accuracy or completeness of this information. This report is based upon and limited by circumstances and conditions acknowledged herein, and upon information available at the time of the site investigations.

Any use which a third party makes of this report, or any reliance on, or decisions to be made based on it, are the responsibilities of such third parties. Golder Associates Ltd. accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

CLOSURE

We trust that the information presented meets your current requirements. Should you have any questions or concerns, please do not hesitate to contact the undersigned.

Yours very truly,

GOLDER ASSOCIATES LTD.

Senior Biologist

JS/KT/ljs

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APPENDIX A

**HISTORICAL BIOLOGICAL AND [Hg] DATA FOR WALLEYE
ANALYZED AS PART OF SPORT FISH CONTAMINANT
SAMPLING PROGRAM (MOE)**

**HISTORICAL BIOLOGICAL AND [Hg] DATA FOR WALLEYE ANALYZED AS PART
OF SPORT FISH CONTAMINANT SAMPLING PROGRAM (MOE)**

Location	Sample Date	Length (cm)	Weight (g)	Sex	Value
Mattagami River SRF to Is.F.	05-JUL-1996	65.2	3000	F	0.72
Mattagami River SRF to Is.F.	05-JUL-1996	56.5	1875	F	0.44
Mattagami River SRF to Is.F.	05-JUL-1996	53.9	1800	F	0.6
Mattagami River SRF to Is.F.	05-JUL-1996	46	1050	M	0.66
Mattagami River SRF to Is.F.	05-JUL-1996	45.9	1175	F	0.25
Mattagami River SRF to Is.F.	05-JUL-1996	42.6	800	F	0.44
Mattagami River SRF to Is.F.	05-JUL-1996	42.2	775	F	0.25
Mattagami River SRF to Is.F.	05-JUL-1996	42	1075	?	0.4
Mattagami River SRF to Is.F.	05-JUL-1996	42	760	?	0.28
Mattagami River SRF to Is.F.	05-JUL-1996	35	450	M	0.4
Mattagami River SRF to Is.F.	05-JUL-1996	34	400	?	0.24
Mattagami River SRF to Is.F.	05-JUL-1996	30.3	250	?	0.31
Mattagami River SRF to Is.F.	05-JUL-1996	28.7	220	?	0.26
Mattagami River SRF to Is.F.	05-JUL-1996	24.5	150	?	0.21
Mattagami River SRF to Is.F.	05-JUL-1996	20	140	M	0.21
Mattagami River SRF	01-JAN-1977	70.6	3518	F	1.9
Mattagami River SRF	01-JAN-1977	72.2	3420	F	1.7
Mattagami River SRF	01-JAN-1977	64.7	2966	F	0.94
Mattagami River SRF	01-JAN-1977	43.6	845	F	0.68
Mattagami River SRF	01-JAN-1977	45.2	857	F	1.4
Mattagami River SRF	01-JAN-1977	46	1019	F	0.56
Mattagami River SRF	01-JAN-1977	41	635	M	0.72
Mattagami River SRF	01-JAN-1977	38.1	482	F	0.48
Mattagami River SRF	01-JAN-1977	41.1	664	F	0.35
Mattagami River SRF	01-JAN-1977	47.6	903	M	1.4
Mattagami River SRF	01-JAN-1977	44.1	832	F	0.89
Mattagami River SRF	01-JAN-1977	36.4	477	F	0.27
Mattagami River SRF	09-JUL-1990	45.4	1010	?	0.61
Mattagami River SRF	09-JUL-1990	47.1	990	?	0.52
Mattagami River SRF	09-JUL-1990	43.7	780	?	0.43
Mattagami River SRF	09-JUL-1990	53.3	1530	?	0.62
Mattagami River SRF	09-JUL-1990	40.7	680	?	0.48
Mattagami River SRF	09-JUL-1990	47.5	1320	?	0.59
Mattagami River SRF	09-JUL-1990	43	820	?	0.39
Mattagami River SRF	09-JUL-1990	44.4	980	?	0.83
Mattagami River SRF	09-JUL-1990	44.4	880	?	0.59
Mattagami River SRF	09-JUL-1990	43.7	840	?	0.4
Mattagami River SRF	09-JUL-1990	42.4	820	?	0.61
Mattagami River SRF	09-JUL-1990	48.2	1040	?	0.57
Mattagami River SRF	09-JUL-1990	45.1	920	?	0.4
Mattagami River SRF	09-JUL-1990	42	730	?	0.42
Mattagami River SRF	09-JUL-1990	46.7	1000	?	0.43

Location	Sample Date	Length (cm)	Weight (g)	Sex	Value
Mattagami River SRF	09-JUL-1990	43.6	970	?	0.9
Mattagami River SRF	09-JUL-1990	45.7	1100	?	0.48
Mattagami River SRF	09-JUL-1990	51.7	1240	?	0.56
Mattagami River SRF	09-JUL-1990	34.1	580	?	0.23
Mattagami River Is.F.	04-JUL-1990	50.2	1410	?	0.77
Mattagami River Is.F.	04-JUL-1990	48	1380	?	1
Mattagami River Is.F.	04-JUL-1990	41.6	660	?	0.57
Mattagami River Is.F.	04-JUL-1990	51.8	1620	?	2.4
Mattagami River Is.F.	04-JUL-1990	50.6	1390	?	0.84
Mattagami River Is.F.	04-JUL-1990	36.5	500	?	0.56
Mattagami River Is.F.	04-JUL-1990	29.4	240	?	0.32
Mattagami River Is.F.	04-JUL-1990	29.6	280	?	0.41
Mattagami River Is.F.	04-JUL-1990	30.2	260	?	0.42
Mattagami River Is.F.	04-JUL-1990	27.7	220	?	0.4
Mattagami River Is.F.	04-JUL-1990	22.5	110	?	0.27
Mattagami River Is.F.	04-JUL-1990	28.6	200	?	0.32
Mattagami River Is.F.	04-JUL-1990	32.8	340	?	0.46
Mattagami River Is.F.	04-JUL-1990	31.2	280	?	0.39
Mattagami River Is.F.	04-JUL-1990	25.4	160	?	0.4
Mattagami River Is.F.	04-JUL-1990	27.8	210	?	0.18
Mattagami River Is.F.	04-JUL-1990	49.9	1330	?	0.6
Mattagami River Is.F.	04-JUL-1990	33.1	390	?	0.21
Mattagami River Is.F.	04-JUL-1990	23	120	?	0.13
Mattagami River Loon Rapids	01-JAN-1977	27.9	170	M	0.26
Mattagami River Loon Rapids	01-JAN-1977	31.5	256	M	0.2
Mattagami River Loon Rapids	01-JAN-1977	44.5	832	M	0.41
Mattagami River Loon Rapids	01-JAN-1977	41.6	624	F	0.34
Mattagami River Loon Rapids	01-JAN-1977	40.5	582	F	0.29
Mattagami River Loon Rapids	01-JAN-1977	33.5	361	M	0.19
Mattagami River Loon Rapids	01-JAN-1977	54.7	1567	F	0.81
Mattagami River Loon Rapids	01-JAN-1977	35.3	327	M	0.3
Mattagami River Loon Rapids	01-JAN-1977	36.5	375	M	0.38
Mattagami River Loon Rapids	01-JAN-1977	36.9	398	M	0.63
Mattagami River Loon Rapids	01-JAN-1977	41.2	630	F	0.51
Mattagami River Loon Rapids	01-JAN-1977	45	908	F	0.46
Mattagami River Loon Rapids	01-JAN-1977	28.9	170	M	0.15

Notes:

SRF – Smooth Rock Falls

Is.F. – Island Falls

Appendix G3

Summary of Aquatic Sampling 2006- 2007



Stantec



**YELLOW FALLS HYDROELECTRIC
PROJECT**
**Aquatic Sampling Summary 2006-
2008**

File No. 160960168

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1.0 Introduction

Yellow Falls Power Limited Partnership (“YFP”) is proposing to build, own, and operate the Yellow Falls Hydroelectric Project (the “Project”) a 16 megawatt (“MW”) run-of-the-river hydroelectric generating station at Yellow Falls on the Mattagami River, approximately 18 km upstream from the Town of Smooth Rock Falls, Ontario (see **Figure 1.1**).

In 2005, YFP retained Stantec Consulting Ltd (“Stantec”) to conduct an Environmental Assessment (“EA”) which is consistent with the requirements of Ontario Regulation 116/01 (“O. Reg. 116”); the *Electricity Projects Regulation* under the *Ontario Environmental Assessment Act* (“OEAA”), the *Canadian Environmental Assessment Act* (“CEA Act”), and the 1990 Ontario Ministry of Natural Resources *Waterpower Program Guidelines* (“WPPG”).

As part of the EA process, Stantec completed a baseline Aquatic Assessment for the Project in 2006 based on a work plan developed with input from the Ontario Ministry of Natural Resources (“MNR”) and the Department of Fisheries and Oceans (“DFO”) (Stantec, 2007). That work documented distributions of four key species (lake sturgeon, white sucker, walleye, northern pike) between Loon Rapids and Smooth Rock Falls. The field program also documented the distributions of forage fish species and benthic macroinvertebrates, characterized physical habitat in the study area, and quantified mercury concentrations in tissues of large-bodied fishes (walleye, white sucker).

In 2007, Golder Associates Ltd. (“Golder”) was retained by YFP to continue the baseline inventory, and to supplement the data obtained during the 2006 studies (Golder, 2007a,b, 2008a). Studies in 2007 specifically focused on confirming spawning locations and adult habitats of lake sturgeon.

The Draft EA Report produced by Stantec in November 2007 included separate descriptions of the 2006 and 2007 field work. Some reviewers of the Draft EA report indicated that a summary and comparison of the 2006 and 2007 aquatic investigations could be informative. This report provides the requested summary of the aquatic investigations.

Following release of the Draft EA Report, the location of the dam and powerhouse for the Project was subsequently moved from Island Falls to Yellow Falls (2 km upstream) on the basis of consultation agencies and community stakeholders. The dam and powerhouse relocation was undertaken by YFP to address stakeholder interest raised regarding the recreational use of Island Falls by the local community.

Additionally, it was anticipated that relocating the dam and powerhouse from Island Falls to the base of Yellow Falls would also be consistent with the Draft MNR fisheries management goals, which are (MNR, 2007):

1. *The maintenance of current native species biodiversity within the Mattagami River segment enclosed by the Smooth Rock Falls and Lower Sturgeon hydrogeneration facilities. Smallmouth bass, an introduced species, will not be considered to be part of the native biodiversity.*
2. *The maintenance of existing habitat diversity within the Mattagami River segment enclosed by the Smooth Rock Falls and Lower Sturgeon hydrogeneration facilities.*
3. *The maintenance of opportunities for a diversified and sustainable angling experience for all species presently angled within the Mattagami River segment enclosed by the Smooth Rock Falls and Lower Sturgeon hydrogeneration facilities.*

This report provides a summary of 2006 and 2007 aquatic investigations as they pertain to the current Project concept with the dam and powerhouse located at Yellow Falls.

1.1 REPORT STRUCTURE

The objective of this Summary of Aquatic Sampling is to provide a synthesis and analysis of sampling data from 2006 and 2007 field work coupled with information presented in existing literature and previous fisheries studies (McKinley and Sheehan, 1990; Payne, 1987; Acres International, 1996; ESG, 2000; Acres, 1990; Stantec, 2004; Stantec, 2007a).

This report presents:

- A summary of methods used during 2006 and 2007 aquatic sampling (**Section 2.0**);
- A summary description of fish habitats, and their utilization by the four key species (**Section 3.0**)
- A summary of current benthic invertebrate community and potential effects of the Project (**Section 4.0**)
- A summary of mercury concentrations in tissues of large-bodied fish species (**Section 5.0**)

Detailed reporting is provided in **Appendices G1** and **G2** of the Yellow Falls Hydroelectric Project Environmental Assessment Report

1.2 STUDY AREA

The headpond of the proposed Yellow Falls Hydroelectric Project will occupy an approximately 5.7 km stretch of the Mattagami River between Yellow Falls and Loon Rapids. The headpond will inundate an area of approximately 71 hectares ("ha") and will have a total area (including the 89 ha area of existing river stretch) of approximately 160 hectares.

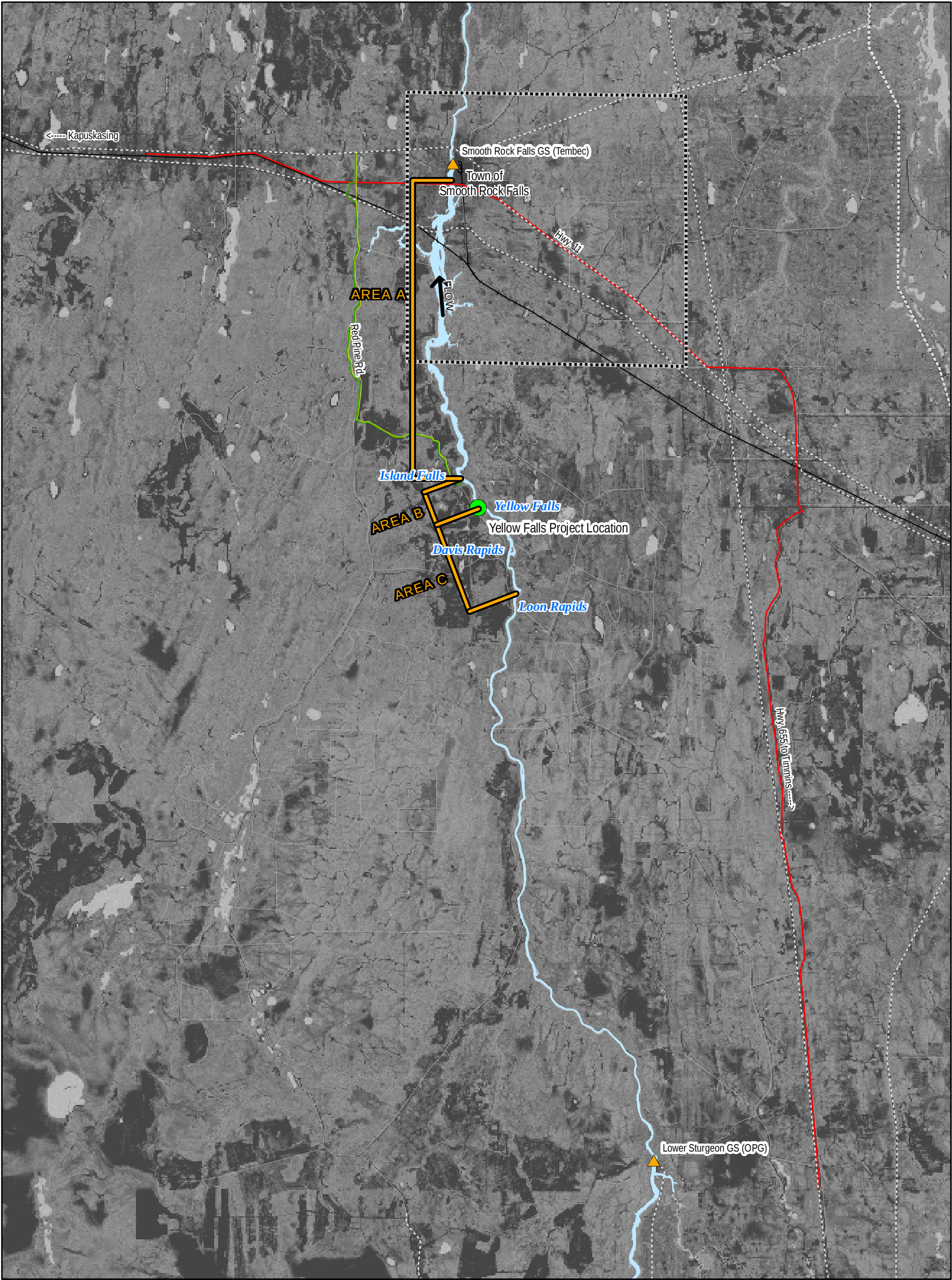
The proposed Project will be located between Lower Sturgeon Generating Station ("GS") and Smooth Rock Falls GS. Yellow Falls is an existing falls feature presenting an impassable barrier to upstream fish movement.

The 2006-2007 Aquatic Study Area ("Study Area") encompasses reaches of the Mattagami River that are potentially affected by the proposed Project. These reaches include the area of inundation extending from Yellow Falls to Loon Rapids, and the area of potential downstream effects from Yellow Falls to the Town of Smooth Rock Falls. On the basis of the existing environmental and topographic features, coupled with the Project design, the Study Area was divided into three distinct areas for evaluation (see **Figure 1.1**)

- **Area A** is generally defined as the 16 km stretch of river between the Town of Smooth Rock Falls and Island Falls. The 500-m reach immediately downstream of Island Falls, where sampling was focused, consisted of two main plunge pools associated with the falls, a deep pool, a shallow shoal, and a run.
- **Area B** is defined as the approximate 2 km stretch of river between Island Falls and the proposed powerhouse/dam structure at Yellow Falls. This area contains a riffle section approximately 100 m upstream of Island Falls, a large run section, and Yellow Falls
- **Area C** is defined as the approximately 6 km stretch of river from Yellow Falls upstream to Loon Rapids encompassing the upper reach of the headpond area (i.e., maximum upstream area of proposed inundation). Major features include a long run section, Davis Rapids, two large islands, and Loon Rapids.

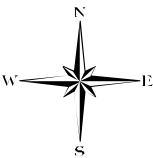
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Source:
Airphoto: LANDSAT 7, 2002.
Base Map: LIDS, 2006.

- Study Area
- Yellow Falls Project Location
- Proposed Transmission Line
- Proposed Access Road
- Smooth Rock Falls Town Limits
- Existing 115 kV Power Line



0 1 2 3 4
Kilometers
1:200,000

Key Map



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FIGURE NO. 1-1

STUDY AREA

Initiated: October, 2007
Revised: October, 2008

2.0 Water Quality

Water quality measurements were taken in 2006 and 2007 at locations throughout Areas A, B, and C. Surface waters in the mainstem Mattagami River, and its major tributaries (Rat Creek, Bradburn Creek, Pullen Creek, North Muskego River) have similar quality including basic pH (pH > 6.7), and a conductivity of between 65 and 100 (see Tables C3-1 and C3-2 in Stantec, 2007, and 3-1 in Golder, 2007b). Water temperatures did not vary appreciably among locations. Data presented in Golder (2007b; Figures 3-2 through 3-5) showed that water temperatures in Areas A, B and C in the mainstem were similar to water temperatures in the major tributaries. In both 2006 and 2007, water temperatures were suitable for lake sturgeon spawning (11 to 16°C) between about May 10 and May 21. Spring water temperatures were demonstrated to be somewhat influenced, however, by air temperatures: a cold front in May of 2007 caused a drop in water temperatures, causing lake sturgeon spawning movements to cease in the vicinity of Island Falls.

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3.0 Fish and Fish Habitat

This section presents a summary of studies conducted to document physical habitat within Areas A, B and C. Surveys in 2006 (Stantec, 2007) occurred between April and October. Dominant substrates of the mainstem Mattagami River were classified as bedrock, silt, sand, boulder, cobble, gravel or clay, while habitats were classified as shallows, pool, riffle, run/flat or falls. Water depths, velocities and other channel dimensions (wetted width, bankfull width) were also recorded in the mainstem and tributaries in 2006 (Rat Creek, Tributaries A, B). These data were used as inputs to habitat suitability index models for lake sturgeon, white sucker, walleye and northern pike. The suitability indices were used to estimate the suitability of habitats for each of these four key species before and after Project construction. Water temperatures in each area were recorded daily in the spring to determine when spawning of the four key species could be considered likely to occur.

Field studies by Golder (2007b) were carried out between May 4 and 21, 2007. The foci of these studies were the tributaries flowing into the lower reach Area A (i.e., Bradburn Creek, Pullen Creek and the North Muskego River); and the mainstem Areas A, B, C with emphasis on the bases of each of the major falls (Yellow, Island, Davis, Loon). Water temperatures in each location were recorded with data loggers during the spring event.

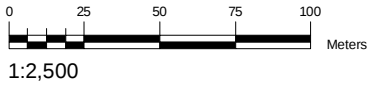
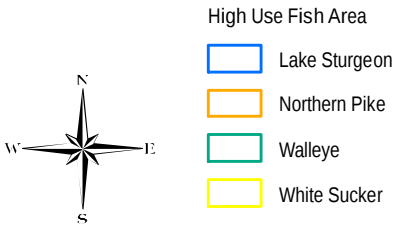
Illustrative relative abundances of fish catch locations in Areas A and B are provided in **Figures 3.1 to 3.4**. Highlights of the assessment of physical habitats for each of the areas of specific interest are provided in the subsequent sections.

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Source:
Airphoto: LANDSAT 7, 2002.
Base Map: LIDS, 2006.



Key Map



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FIGURE NO. 3.1

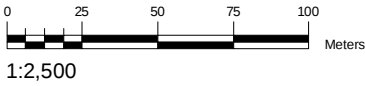
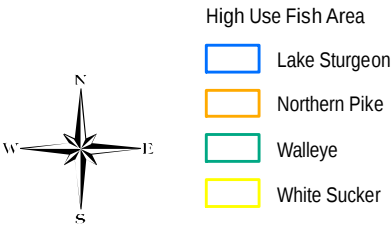
**SPRING 2007 - AREA A
HIGH FISH USE AREA**

Initiated: January 28, 2007
Revised: January 30, 2009

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Source:
Airphoto: LANDSAT 7, 2002.
Base Map: LIDS, 2006.



Key Map



PREPARED FOR:
YELLOW FALLS LP
ENVIRONMENTAL ASSESSMENT REPORT

FIGURE NO. 3.2

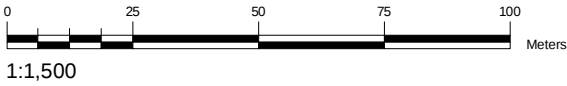
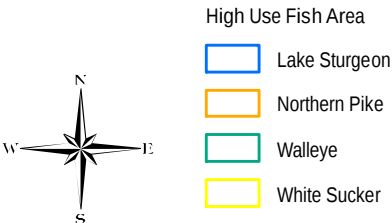
SUMMER 2007 - AREA A
HIGH FISH USE AREA

Initiated: January 28, 2007
Revised: January 30, 2009

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Source:
Airphoto: LANDSAT 7, 2002.
Base Map: LIDS, 2006.



Key Map



PREPARED FOR:
YELLOW FALLS LP
ENVIRONMENTAL ASSESSMENT REPORT

FIGURE NO. 3.3

SPRING 2007 - AREA B
HIGH FISH USE AREA

Initiated: January 28, 2007
Revised: January 30, 2009

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Source:
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Base Map: LIDS, 2006.

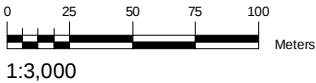
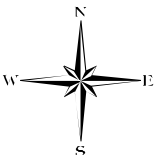
High Use Fish Area

Lake Sturgeon

Northern Pike

Walleye

White Sucker



Key Map



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YELLOW FALLS LP
ENVIRONMENTAL ASSESSMENT REPORT

FIGURE NO. 3.4

SUMMER 2007 - AREA B
HIGH FISH USE AREA

Initiated: January 28, 2007
Revised: January 30, 2009

3.1 AREA A

Area A is located downstream of the proposed Project. Habitat conditions are not anticipated to be affected by the Project. However, habitat characteristics were investigated for the purpose of understanding the nature and extent of the habitat available for the target species.

3.1.1 Mainstem (Island Falls)

Island Falls represents the upstream limit of influence by the Smooth Rock Falls Generating Station (“GS”) headpond. Island Falls is characterized by a series of four bedrock-controlled falls/chutes of varying widths located on a broad river bend. The combination of the four chutes and exposed channel bedrock creates an area of high velocity outwash water characterized by turbulent flow and strong eddy currents that gradually transitions to slower and more uniform flows (i.e., flats) downstream of the falls. River depths in the immediate vicinity (downstream) of Island Falls ranged from approximately 2 to 6 m, with a shallow exposed shoal located towards the left downstream bank between Chutes 3 and 4. Water depths increase to approximately 10 to 17 m, at 100 to 200 m respectively downstream of Island Falls. Substrate at Island Falls is dominated by coarse boulder and cobble material within the outwash areas of each chute. Bedrock is the predominant substrate type on the immediate downstream side of each chute.

As per United States Geological Survey (“USGS”) habitat suitability models, the base of Island Falls is considered to be highly suitable for spawning by lake sturgeon, and of low suitability for northern pike, walleye and white sucker. HSI models considered the area of poor suitability for white sucker because there are no riffles with coarse sand or gravel. Models also consider the area poor spawning habitat for pike because of the absence of vegetated shallows. The HSI models predicted the area to be poor walleye spawning because of the “small” amount of suitable area relative to the total area.

Lake sturgeon, white sucker, walleye and northern pike were present at the base of Island Falls in both 2006 and 2007. In 2006, it was noted that most pike were ‘spent’ at the time of capture indicating they had recently spawned. Preferred spawning temperatures for pike are cooler (4 to 11°C) than water temperatures at the time of capture (> 10°C). Northern pike eggs were also collected in the study area, confirming that spawning had occurred in the vicinity. The presence of spent pike and of eggs in egg mats suggests that spawning does occur in the area.

Walleye were the most abundant species in Area A. Between April 29 and May 10, 2006, the majority of the 100+ adult walleye captured were sexually ripe, suggesting that walleye were likely using Area A for spawning. Ripe walleye were also caught on May 6 and 10, 2007. A small number of juvenile walleye were also captured in this area reflecting the additional use of this area for rearing for this species.

Ripe white suckers were collected at the base of Island Falls in both 2006 and 2007, with catch-per-unit-effort (“CPUE”) about three times higher in 2007 than in 2006. The higher CPUE in 2007 reflected the setting of nets in areas anticipated to produce fish, contrasting 2006 when nets were set in order to identify productive areas. Most white suckers were caught within 500

m of Island Falls. Most fish were captured in 2 to 3 m of water, in areas with coarse substrate (primarily large cobble and small boulder). Spawning fish were generally captured in gill nets set along the eddy lines of outwash areas at Island Falls. These data indicate white sucker were utilizing Area A for spawning purposes.

Mature sturgeon were collected at the base of Island Falls in spring of both 2006 and 2007. Total numbers of fish have been considered to be relatively low (50+ in 2006, 35+ in 2007), while the proportion of the netted individuals being ripe has been low (approximately 20% in 2007). Others (Payne, 1987; Acres, 1990; McKinley and Sheehan, 1990) have reported similar catch densities for this same area. The low numbers appear to be sustainable given the time period over which these numbers have been reported, and given that specimens of younger age-classes (e.g., 3+) have recently (2006) been caught. All lake sturgeon captures occurred in the vicinity of Chutes 1 and 2, suggesting that is a critical area for spawning. Egg mat deployment in 2007 did not collect any Lake sturgeon eggs below Island Falls. It was considered possible that sturgeon did not spawn in 2007 because of poor weather, or that spawning occurred after the egg survey was completed (i.e., after May 21, 2007).

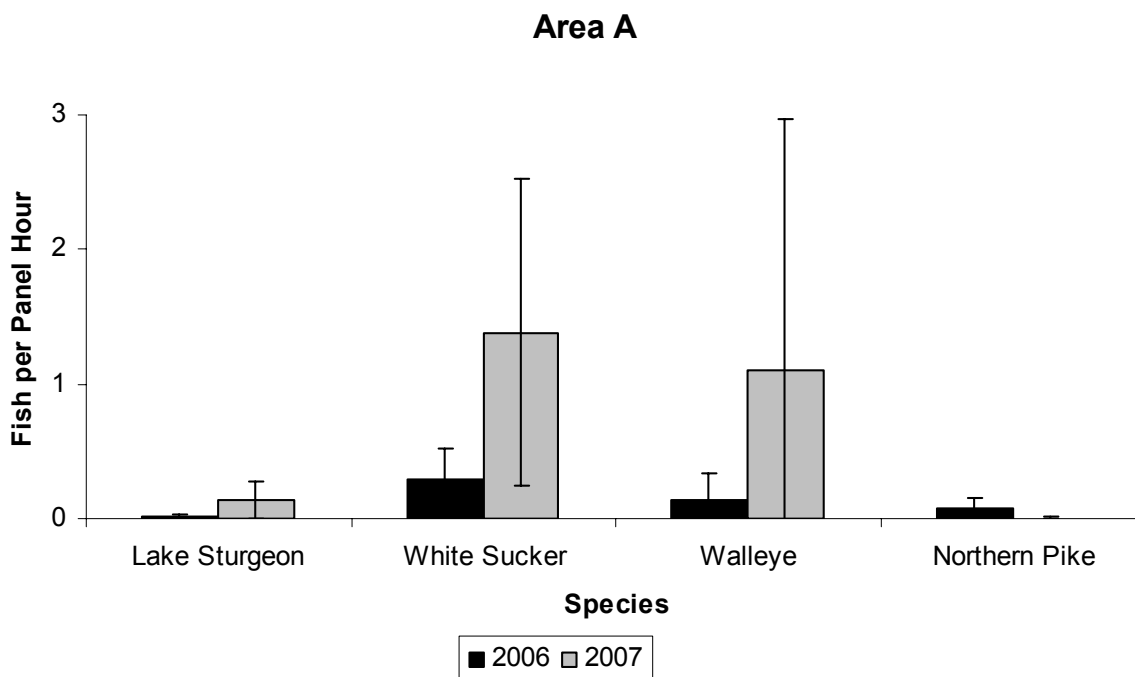


Figure 3.5 Catch per unit effort in Area A – 2006 and 2007

3.1.2 Bradburn Creek

Bradburn Creek is situated between Smooth Rock Falls and Island Falls. The lower reach of Bradburn Creek is inundated by the headpond created by the Smooth Rock Falls GS. This reach consists of flat, slow-moving water that is dominated by a clay/silt/sand substrate. Depths

in this reach typically ranged from less than 1 to 4 m. Inundation results in large contiguous areas of submerged shoreline vegetation that provide a range of in-stream and overhead cover habitat types. Submergent vegetation was abundant along channel margins and in small shallow bays. Habitat features commonly associated with walleye, white sucker and lake sturgeon spawning activity (i.e., coarse substrates, moderate/fast velocity water) were not observed in Bradburn Creek.

Northern pike and white sucker were the only two target species captured (adults of both species). The only non-target species captured in Bradburn Creek was yellow perch. Fish were typically captured in shallow water (~ 2 to 4 m), with the exception of fish captured in a hoop net set near the mouth of Bradburn Creek at a depth of 6.5 m, where substrates were comprised of a mixture of fine-grained material, and coarse-grained material (small and large cobble, small boulder). The substrate at most capture locations was dominated by fine-grained materials (clay/silt, sand).

Large, contiguous areas of suitable northern pike spawning habitat (i.e., submerged shoreline vegetation) were observed in the lower reach of Bradburn Creek. Not surprisingly, spent male and female northern pike were captured in the surveyed section. Despite the presence of ripe white sucker in the area, no suitable spawning habitat (i.e., riffles/rapids with coarse substrate) was observed.

3.1.3 Pullen Creek

Pullen Creek enters the Mattagami River from the east, approximately 10 km downstream of Island Falls. Pullen Creek is influenced by the dam at Smooth Rock Falls (i.e., lower reach inundated for a distance of approximately 1 km). The inundated portion of Pullen Creek is characterized by flat, slow moving water with water depth (spring) ranging from 1.7 to 3.6 m. Similar to Bradburn Creek, substrates are dominated by clay/silt/sand. Side channels and pockets of open water marsh were also observed within the lower reach. Upstream of the headpond influence, the creek features a meandering channel, approximately 3 to 5 m wide, that is frequently obstructed by woody debris piles and root wads. Substrates in this reach consist primarily of clay/silt with minor, interspersed gravel and small cobble deposits. Depths were typically <0.5 m. The presence of numerous log jams and debris piles suggest that access to the reach upstream of the reservoir influence by target species for the purpose of spawning is unlikely.

White sucker and walleye were captured in the lower reach of Pullen Creek, between May 9 and 10, 2007. Ripe white suckers (males and females) were captured on May 9, 2007, at various locations within Pullen Creek. One ripe female walleye was captured on May 9, 2007. Sturgeon and pike were not collected.

Despite the presence of ripe suckers and walleye, "suitable" spawning habitats for these two species were not identified anywhere in the creek. Egg mats were, therefore, not deployed within the lower reach of Pullen Creek.

3.1.4 North Muskego River

The North Muskego River, which enters the Mattagami River approximately 10 km downstream of Island Falls, is the largest tributary to the Smooth Rock Falls GS headpond. Mesohabitat was characterized (May 4 to 16, 2007) within selected areas between the mouth and the first upstream barrier; an approximate 2- to 3-m high bedrock controlled falls/chute located approximately 4 km upstream from the confluence with the Mattagami River. This falls/chute was considered to be an impassable barrier to fish under the flow conditions observed in May 2007 and during 2006 sampling.

Below the falls/chute, the river was characterized by flat, slow moving water with an average depth of 4 to 6 m. The substrate consisted primarily of clay, silt and sand. At the upper limit of the headpond, the channel narrowed, depth decreased and the substrate became coarser (cobble/boulder).

One ripe male northern pike was captured on May 13, 2007. Spent males and females were captured at this location on subsequent sampling days. The site was located at the mouth of a shallow bay, where the shoreline was dominated by submerged terrestrial vegetation and the substrate consisted of silt and organic debris.

Ripe white suckers (males and females) were captured below the falls/chute and further downstream on May 5, 6 and 12, 2007.

Ripe walleye (three males and one female) were captured on May 6, 2007, near the mouth of the River. These individuals were likely migrating upstream towards the falls/chute. Subsequent walleye captures were spent males or females.

Egg mats (deployed between May 5 and 17, 2007) were placed across the base of the bedrock falls/chute at the upper limit of the headpond influence. Eggs captured at this site on May 12, 2007, confirmed the occurrence of a spawning event. A total of 43 eggs were collected on two of the ten mats deployed. Although the falls/chute provided habitat conditions suitable for lake sturgeon spawning, neither adult lake sturgeon nor sturgeon eggs were encountered at this location.

The survey data suggests that much of the North Muskego River is suitable for northern pike spawning. This assessment is based on the wide availability of preferred habitat types along the river banks, in small bays, and in several small tributaries. The outwash of the falls/chute that is located 4 km upstream of the river mouth provides suitable spawning habitat spawning for white sucker, walleye and lake sturgeon. Ripe white suckers were captured below the falls/chutes. Although no ripe adult walleye were captured, walleye eggs were collected below the chute. No lake sturgeon adults or lake sturgeon eggs were encountered in North Muskego River.

3.2 AREA B

3.2.1 Mainstem

The most prominent feature in the mainstem of Area B is Yellow Falls. Yellow Falls is formed by a bedrock outcrop on the Mattagami River. At high flows, the falls are characterized by a series of individual chutes. The falls is considered an impassable barrier to upstream fish migrations on the basis the 2007 passability assessment (**Appendix G1-II** in Stantec, 2007). The estimated elevation drop from the top to bottom of the falls is approximately 6 to 8 m. Velocities through various chutes, in combination with the vertical drop are considered too excessive for most fish including sturgeon and the other target species (white sucker, pike, walleye).

The main habitat features below the falls were an outwash area (characterized by turbulent flow and depths in the range of 2 to 3 m) and downstream rapids section. The rapids feature mainly coarse substrates (small to large boulders) and typically exceed 1 m in depth. They are bordered on both sides by rapid/riffle complexes with substrates consisting of a mixture of small and large cobble and boulders and depths ranging from 0.4 to 0.7 m.

Flow velocities are slower downstream of the falls while channel depth is greater, producing a flat run. A large backwater pool is situated on the left downstream bank at the point where the channel bends sharply to the right. The pool is 3 to 4 m deep with primarily large and small cobble substrate.

White sucker and walleye have been consistently collected in Area B, with white sucker being caught at the base of the falls in 2006 and 2007. Based on 2006 and 2007 sampling, no target species other than white sucker appear to spawn at the base of Yellow Falls.

No northern pike were captured in Area B during the spring 2006 or 2007 sampling periods. No northern pike eggs were recovered with egg mats in 2007. The absence of adult pike and eggs in spring suggest that northern pike do not use this area for spawning. A total of 41 northern pike were captured in Area B during the summer/fall 2006 sampling period, with one recapture. Most (78%) northern pike were adults, ranging in age from 3 to 7 years. A single YOY and eight juveniles were also collected, suggesting this area provides nursery habitat.

A total of 10 walleye were captured from Area B in spring 2006, of which 8 were adult and 2 were juvenile. Of the eight adults, only one was ripe. More walleye were collected in summer/fall of 2006 based on a greater fishing effort. Of the total of 34 total walleye captured in the summer/fall, 28 were adults and five were juveniles. No juvenile or adult walleye, or eggs of walleye were collected in the vicinity of Yellow Falls during spring 2007. These data confirm the general lack of use of this area by this species for spawning.

White sucker was the only target species caught at the base of Yellow Falls in 2006 and 2007, with many in spawning condition. Most white suckers were captured in shallow (1 to 2 m) water, in areas with coarse substrate (predominantly small and large cobble with some small boulder). Fish considered to be in spawning condition were typically captured along the edge of the main

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rapid complex, and within pool and flat areas downstream of Yellow Falls. The CPUE for white sucker was 0.04 fish per 50' panel hour; almost double the CPUE observed in Area A. White sucker eggs were collected in Area B, and the timing of the collections suggested that spawning occurred between May 12 and May 21 in 2007. Eggs were generally collected on mats deployed on the left and right downstream banks of the river, in rapid/riffle habitat. The egg collection sites were located approximately 50 to 100 m downstream of Yellow Falls. Egg deposition depths ranged from 0.6 to 1.3 m at velocities ranging between 0.01 and 0.17 m/s. The presence of coarse substrate (large cobble and small boulder dominant) provided large interstitial spaces and protection from high flow velocities. It is unknown whether white suckers spawning below the falls are permanent residents of the reach, or migrate from downstream sections below Island Falls to access Yellow Falls to spawn.

No lake sturgeon were captured from Area B in 2006 or 2007 in either the spring or summer/fall sampling periods. This result was consistent with data discussed by Payne (1987), Acres (1990) and McKinley (1990). Area B does not appear to be used by lake sturgeon at any time of year.

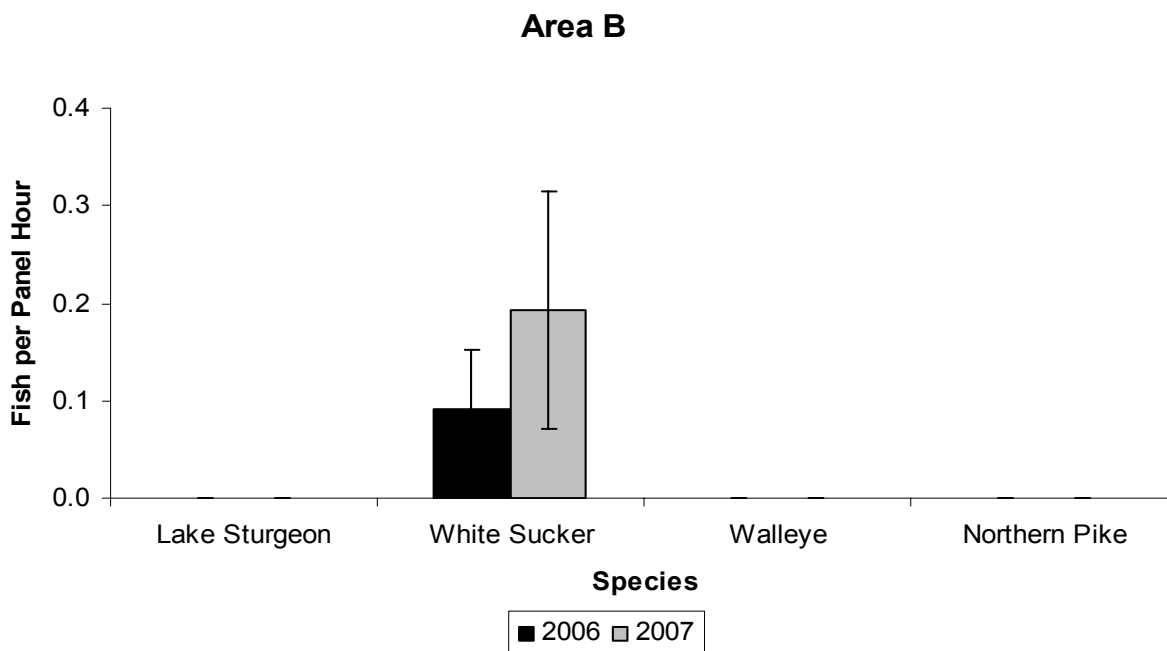


Figure 3.6 Catch per unit effort in Area B (base of Yellow Falls) in 2006 and 2007

3.2.2 Tributary A

Tributary A is located on the left downstream bank of the Mattagami River, approximately 500 m upstream of Island Falls. Habitat assessment was completed in the section extending from the confluence with the Mattagami River to approximately 200 m upstream, on May 9, 2007. This reach consists of a series of stepped boulder gardens and riffle/pool complexes terminating in a series of three bedrock ledges. The ledges, which are situated approximately 200 m upstream

of the mouth, were considered to be impassable to upstream fish migration. In general, water depth ranged from 0.1 to 0.3 m and channel width varied between 2 and 3 m. In the fast flowing section located near the mouth, the substrate consisted of large cobble. Based upon flow conditions in the tributary and river elevation at the time of the survey, fish passage beyond the lower 10 m of the stream by any of the target species was considered to be unlikely.

Spring 2006 sampling failed to capture adult fish in Tributary A. A juvenile walleye, several juvenile white suckers and numerous cyprinids were captured in the fall of 2006. These fish may have originated from upstream watercourses. In spring 2007, none of the key species was observed in this tributary. Egg mats were deployed and monitored throughout the 2007 field program but no eggs were captured. . The results of the two years of survey suggest that this tributary is likely not used as a spawning area for the four key species. The lower reaches of this tributary appears to be used by juveniles of white sucker and walleye, and by smaller cyprinids.

3.2.3 Tributary B

Tributary B enters the right downstream bank of the Mattagami River, approximately 500 m upstream of Island Falls. Habitat assessment, which occurred on May 14, 2007, concentrated on the lower 500 m of the stream. The lower portion of the reach featured a confined channel that was dominated by a terraced boulder garden. Beyond this section the channel widened into a broader floodplain with a well defined channel and it was characterized by a series of breached beaver dams. Channel width varied from 2 to 3 m on average and depths were relatively shallow (0.1 to 0.3 m). A shallow boulder garden and an organic debris jam at the mouth of the tributary appeared to create impassable conditions for fish at the observed flows. The substrate immediately below this barrier consisted of a thick layer of extremely soft silt. Based on the presence of in-stream obstructions successful fish passage by target species beyond the lower 20 m of the stream at the time of the survey was unlikely.

No adult fish were encountered in Tributary B in the spring of 2006. Juvenile white suckers and cyprinids were captured in the stream during the fall of 2006. Egg mats were deployed and monitored throughout the 2007 field program but no eggs were captured. No fish were observed in the tributary during the 2007 field program. This tributary provides habitat to juvenile suckers and cyprinids, potentially produced from upstream sources. The data suggest that the mouth of this tributary is not used by any of the four key species for spawning.

3.3 AREA C

3.3.1 Davis Rapids

Davis Rapids are situated immediately downstream from a sharp, river bend to the right (when facing downstream). The section consists of a linked series of riffle/run, flat, riffle and riffle/boulder gardens. Cobble and boulder substrates are predominant in this location.

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In 2006, netting effort at Davis Rapids occurred on 15 dates between April 29 and June 5. In 2007, netting effort at Davis Rapids occurred between May 5 and May 13, 2007. All of the target species, with the exception of lake sturgeon, were captured in the surveyed section. 8 walleye, and 68 white sucker were captured in 2006. 2 pike were also caught on May 9 and 12.

In 2007, mature northern pike were captured on May 9, May 11 and May 13, 2007; these individuals were determined to be in a post-spawn (spent) condition. Ripe white sucker (both sexes) and walleye (males) were caught between May 7 and May 13, 2007. Fish (all species) were typically captured in shallow waters ranging from 1 to 2 m deep. The substrate at the capture locations consisted primarily of large cobble and small boulder.

Eggs were not collected in the area due to shallow, high water velocity and safety concerns. Therefore, it was not possible to confirm spawning activity at Davis Rapids by target species. Consequently, use of netting gear and egg mat deployment was limited to the lower third (approximately 100 m) of Davis Rapids. It is possible that target species were able to ascend into and spawn in the upper 200 m of the rapids. However, no fish were identified in the upper 200 m section based on observations made from vantage points along the shoreline.

Based on the large amount of potential spawning habitat, and the presence of walleye, northern pike and white suckers in spawning condition it is likely that spawning occurs at this location. Although egg mats were deployed in the lower third of the rapids, they were unsuccessful in collecting eggs. Due to the difficulty in accessing and deploying gear, it may not be possible to confirm the extent of habitat utilization and egg deposition in the upper sections.

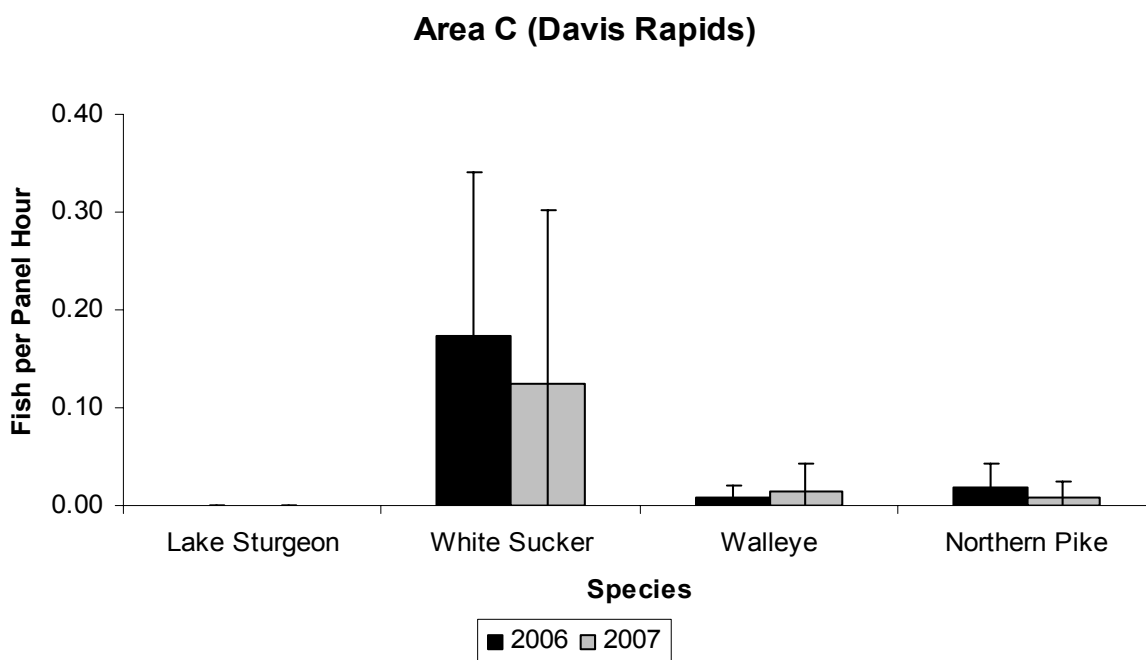


Figure 3.7 Catch per unit effort in Area C (base of Davis Rapids) in 2006 and 2007

3.3.2 Loon Rapids

Loon Rapids consists of a bedrock chute (left downstream bank) and two side channels (mid-channel and right downstream bank). The side channels were comprised of a terraced series of rapid/riffles over bedrock and coarse substrate. Water depths below the chute/rapids varied from less than 1 m to over 8 m.

In 2006, fishing effort (gill nets) was applied on 20 dates between April 30 and June 5, 2006. A total of 19 white sucker and 9 walleye were caught. Fishing effort (gill nets, hoop nets and angling) was applied at Loon Rapids between May 10 and May 20, 2007. Northern pike and walleye were the only species captured in the surveyed area. Captured northern pike and walleye were assessed, but maturity (ripe/spent) could not be readily determined on the basis of an external examination. Capture locations were limited to the rapid/riffle and riffle complexes along the right downstream bank of Loon Rapids, as well as below the outwash area of the main rapid/chute. Substrates in these locations primarily composed of large cobble and small boulder, although some locations featured a more varied mix of fine and coarse substrates.

Egg mats were deployed between May 14 and May 21, 2007. Eggs were captured during spawning events that occurred between May 16 and May 21, 2007. Substrate composition at egg recovery locations was comprised of either cobble and boulder, or bedrock. One mat set location featured a gravel and small cobble substrate. All of the eggs sent for identification were white sucker eggs. Although adult walleye and northern pike were captured near Loon Rapids, none of the eggs sent for identification were associated with these species. Lake sturgeon eggs were not collected at Loon Rapids.

Significant netting effort was applied at the base of Loon Rapids to determine the extent of lake sturgeon spawning. No adult lake sturgeon or lake sturgeon eggs were captured at Loon Rapids during the spring 2006 or 2007 fisheries investigation.

Based on available data, it is apparent that white suckers spawn in the area downstream of Loon Rapids. It is possible that walleye and northern pike also spawn in the area, but this has not been confirmed in field studies completed to date.

Lake sturgeon do not appear to use Area C for spawning. Indeed, sturgeon do not appear to be present in this reach, despite the presence of potential habitat. However, fishing effort was expended at upstream locations to determine the extent of upstream lake sturgeon presence. Adult lake sturgeon were successfully collected approximately 2 km upstream of Loon Rapids by Golder in 2007. Previous studies (Payne, 1987; McKinley and Sheehan, 1990; Stantec, 2004) also documented sturgeon in this reach upstream of Loon Rapids.

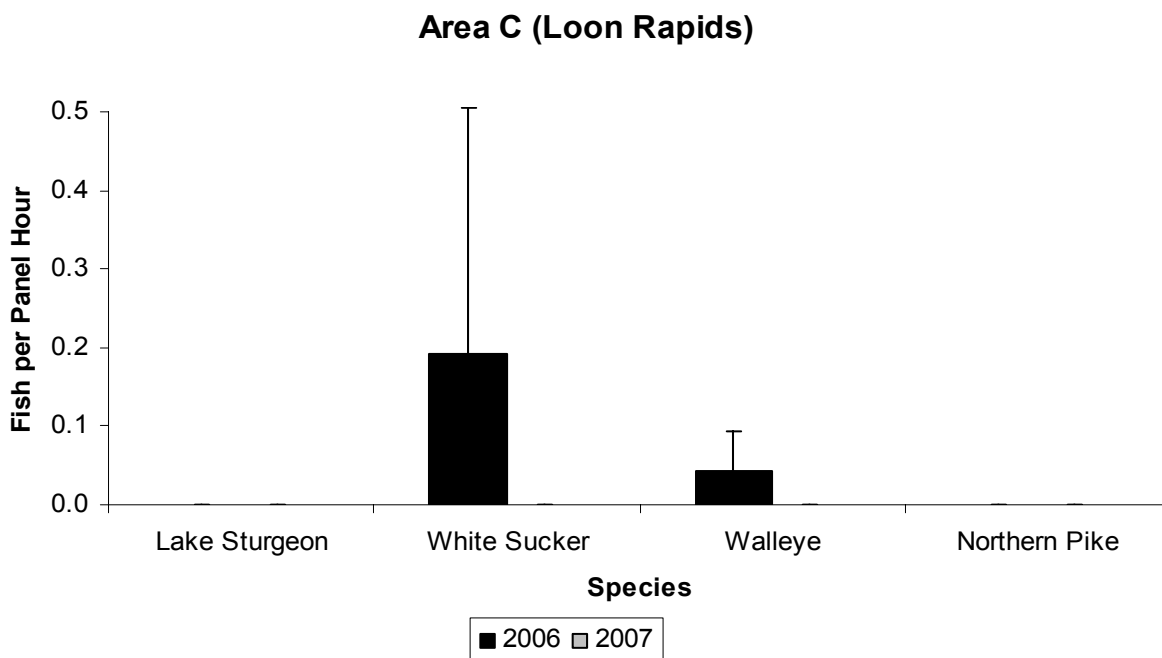


Figure 3.8 Catch per unit effort in Area C (base of Loon Rapids) in 2006 and 2007.

3.3.3 Rat Creek

Rat Creek drains into the Mattagami River on the east side (right downstream bank) immediately downstream of Davis Rapids. Habitat evaluation was carried out from the mouth to a point approximately 400 m upstream (limit of boat-accessible travel). It was observed that selected portions of the creek have been scoured to reveal coarse substrates (i.e., cobble and mixed size boulder).

Northern pike, white sucker and walleye were captured in Rat Creek a short distance from the confluence with the Mattagami River. A single ripe male northern pike was recorded in the catch. White suckers were well-represented in the catch between May 7 and 9, 2007. Fish were captured in relatively shallow, ranging from 1 to 1.5 m. Substrates at the capture locations consisted primarily of cobble and small boulder, but also contained a minor clay/silt and gravel component. Lake sturgeon were not captured in Rat Creek.

Egg mats were deployed in Rat Creek between May 6 and May 11, 2007, at locations deemed suitable for walleye and white sucker spawning, but no eggs were collected.

Substrate, cover and flow conditions near the upstream limit of fish passage in Rat Creek appears to provide suitable spawning habitat conditions for northern pike, walleye and white sucker. White sucker, in particular, appear to find conditions within Rat Creek more favourable for spawning than the main stem of the Mattagami River (i.e., based on the large number of adults captured in 2006 and 2007).

4.0 Benthic Invertebrates

4.1 INTRODUCTION

A benthic community survey of the Mattagami River and its tributaries (tributaries A, B, and Rat Creek) was conducted in the summer/fall of 2006 as part of the initial baseline inventory by Stantec. Three benthic macro-invertebrate sample replicates were collected from 27 sites within the Study Area. A variety of sampling methods and equipment were used depending on the physical characteristics of each site, including Petit Ponar grabs (8 sites), Eckman dredges (3 sites), Surber samplers (3 sites), and artificial substrate rock cages (12 sites). For samplers with a fixed area, benthic data were converted to density per square metre. The results of the benthic analysis represent background or baseline data to be used to determine the current status of the study area and as a point of comparison to future benthic sampling programs both during and after the proposed construction.

4.2 SUMMARY OF FINDINGS

The benthic community in depositional areas within the main channel of the Mattagami River was typical for a northern river in Ontario, with community composition varying as expected among types of substrate. There were no rare, endangered or otherwise unusual species observed in the survey.

Artificial substrates were used to sample fast-flowing waters. The gear was put in place in early August 2006, and retrieved approximately 6 weeks later in mid September 2006. The benthic community associated with the rock-filled baskets was dominated by caddisflies (Trichoptera) and midges (Chironomidae) (**Figure 4.1**). Sphaeriidae clams, mayflies (Ephemeroptera) and stoneflies (Plecoptera) were subdominant in the rock-filled baskets. The presence of stoneflies in these samples is interesting because they are typically present in cold- or cool-water systems.

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Benthic Invertebrates

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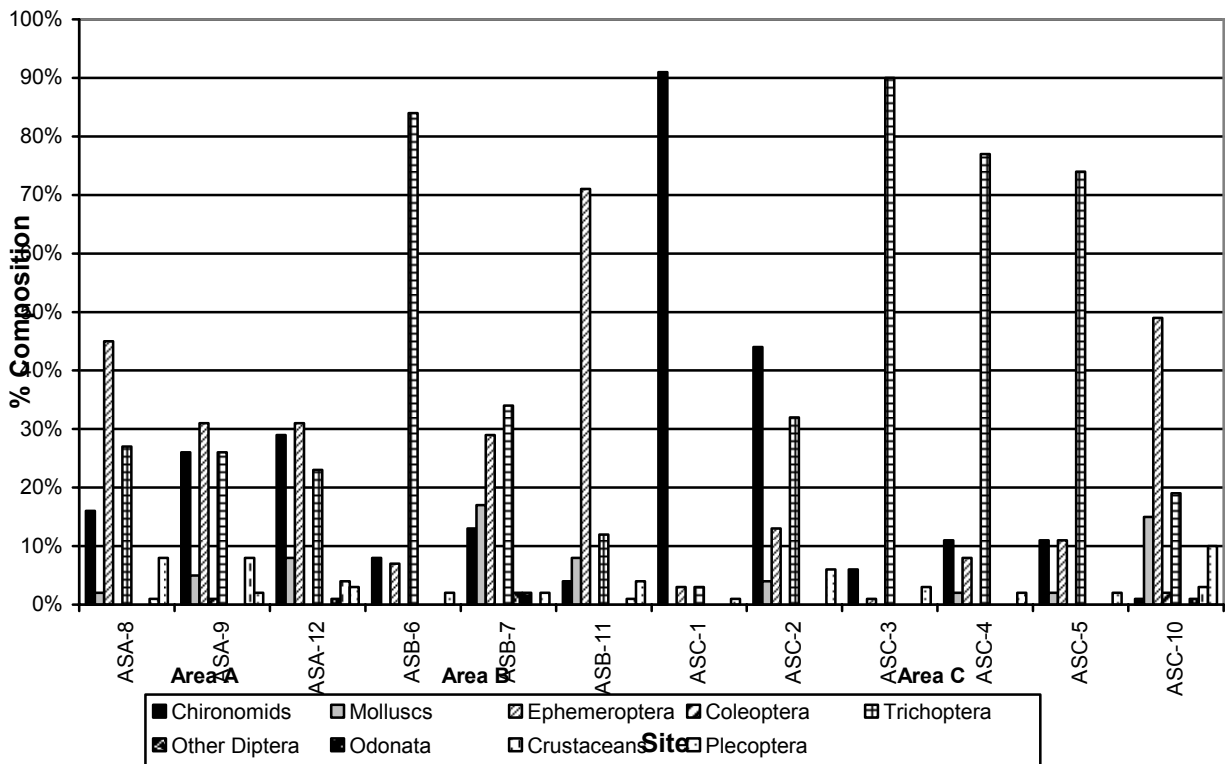


Figure 4.1 Benthic Community Composition Variations in Artificial Substrates Incubated in the Mattagami River

Soft substrata in the mainstem of the Mattagami River were sampled using Petite Ponar grabs. Soft substrata were dominated numerically by chironomids, mayflies and Mollusca (clams), each often comprising over 20% of the fauna. Oligochaete worms were typically < 10% of the fauna, as were caddisflies and Odonata (dragonflies, damselflies).

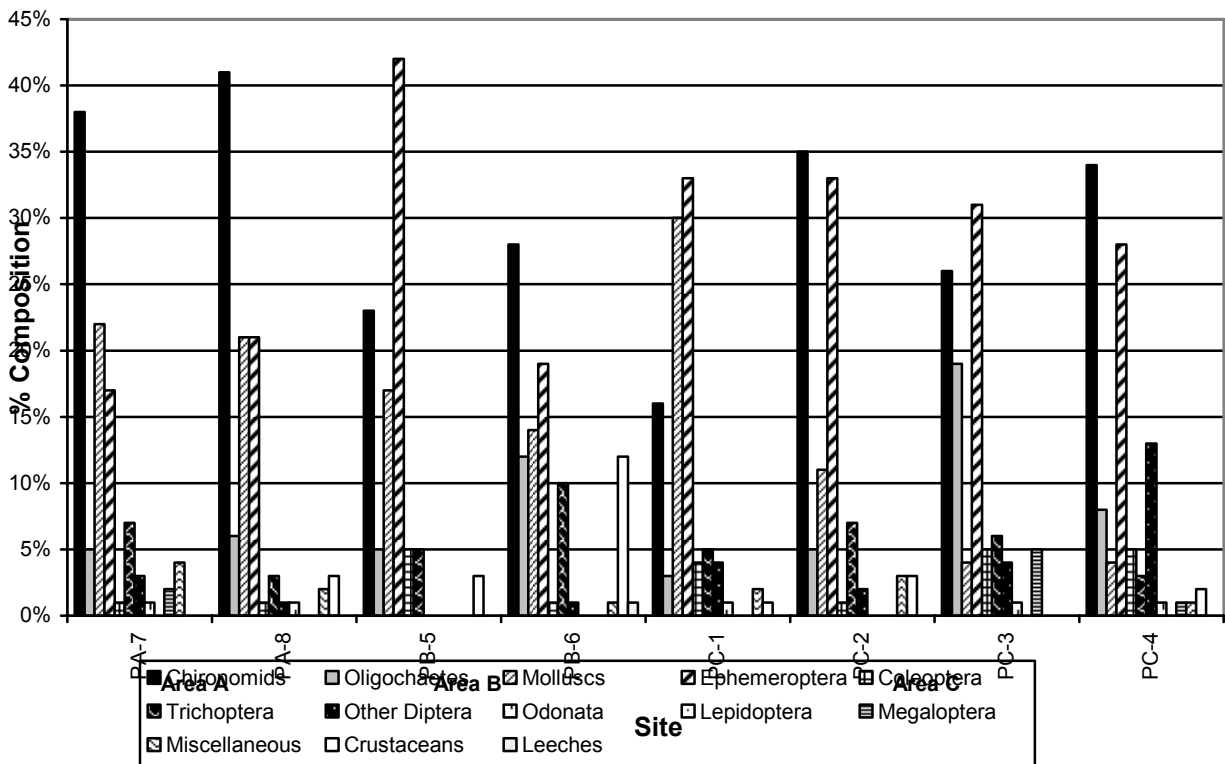


Figure 4.2 Benthic Community Composition Variations in Soft Substrata.

Eckman grabs were used to sample fine substrata in the Tributaries, while Surber samplers were used to sample larger substrata at the confluence of the tributaries with the mainstem. Soft substrata in the tributaries was generally dominated by chironomids and fingernail clams, with mayflies, oligochaete worms, caddisflies and miscellaneous Diptera being sub-dominant numerically.

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Benthic Invertebrates

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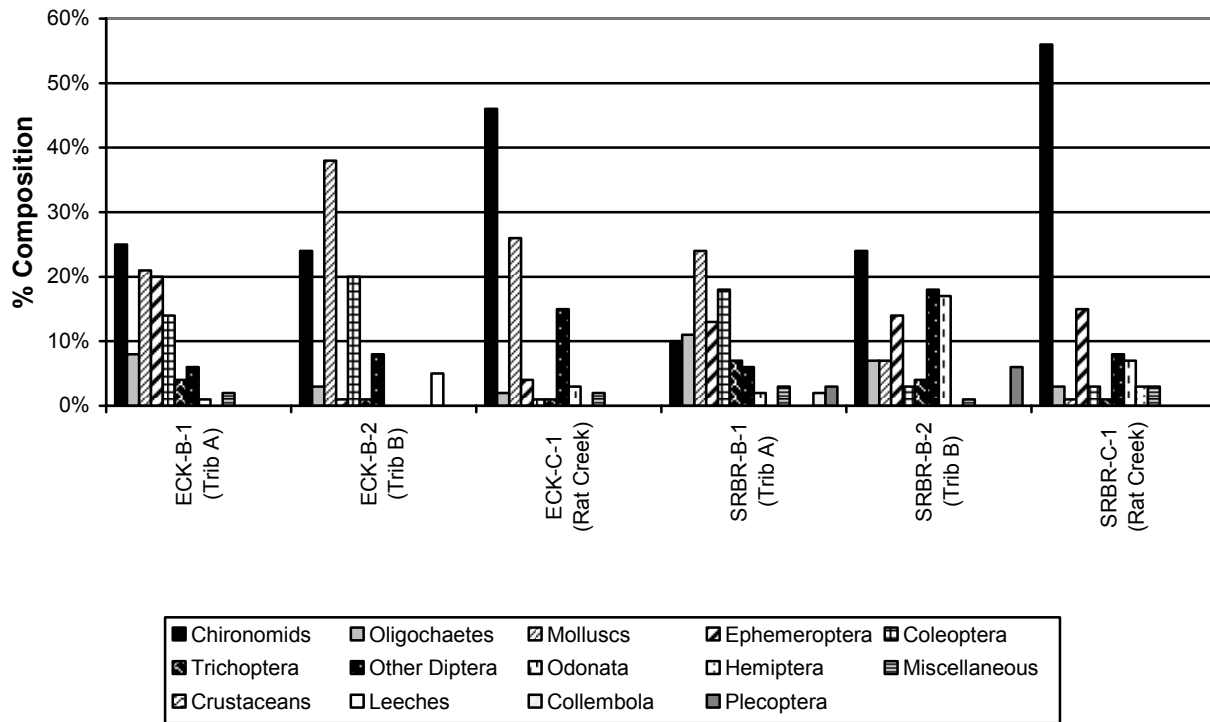


Figure 4.3 Benthic Community Composition Variations in Mattagami River Tributaries

5.0 Methyl Mercury Assessment

5.1 OVERVIEW

Methyl mercury analyses in large-bodied fishes have been conducted in both 2006 and 2007. White sucker (n=16) and walleye (n=13) were collected from three areas in 2006, between late September and mid October (Stantec, 2007). Tissue plugs of muscle were collected using a non-lethal methodology. Samples were frozen and shipped to Flett Laboratories for analysis. A total of 12 walleye were collected in the summer of 2007 by Golder (2008b). A 50 g muscle sample was collected from each fish, then frozen and shipped to Flett Laboratories for analysis.

Environment Canada's comments on the baseline work indicated that additional walleye tissue samples should be collected and analyzed for Hg content up and downstream of the proposed Project location. EC further recommended that the Metal Mining Environmental Effects Monitoring (EEM) Guidance Document (EC, 2002) be used as a guide in assessing baseline Hg in fish tissue.

Golder conducted the sampling as specified by the metal mining EEM program in May 2008. In that program, 36 walleye were captured below Island Falls, and four were collected below Yellow Falls. Tissue samples from these fish were used to make up five composite samples representing a baseline condition downstream of the project. A total of nine walleye were captured at Loon Rapids, while none were captured at Davis Rapids. Only a single composite, therefore, was amassed for the upstream location.

Historical data related to Hg accumulation in walleye within the section of Mattagami River between Loon Rapids and Smooth Rock Falls was provided by the Ontario Ministry of the Environment ("MOE").

5.2 RESULTS AND DISCUSSION

Concentrations of mercury in walleye (the principal sport fish) caught in the vicinity of the headpond have generally varied with fish total length. Concentrations in 2006 were lower than other years, potentially because of the time of year (autumn), when summer growth might have "diluted" body burdens. Concentrations of mercury in the muscle of an average 40-cm fish have typically been approximately 400 ng/g (or less, and below the total restriction guideline of 520 ng/g for women of child-bearing age and young children; **Figure 9**).

This section of the Mattagami River has about average or lower mercury concentrations in fish when compared to other sections, and other rivers in the region. Many other locations in the Moose River Basin have concentrations high enough (in some cases upwards of 900 ng/g) to warrant restrictions on consumption.

Wildlife consumers of aquatic organisms can also experience mercury accumulation. One recent paper (Arch. Env. Cont. Tox., 2006, 51:661-672) has indicated that the "safe"

concentration of mercury in the diet of bald eagles is between 270 and 2,660 ng/g. Concentrations below 2,660 ng/g would be considered levels that pose a limited risk of impairment, while concentrations below 270 ng/g would be levels that pose no risk of impairment. The critical concentration range for river otters was between 660 and 3,290 ng/g.

A 40-cm fish is large, and would be about the upper size range for consumption by both otter and eagles. Present and anticipated future concentrations of mercury in fish flesh (likely between 500 and 1,000 ng/g) are expected to be close to the lower value for otters, and certainly not near the upper value. Assuming that otters only consumed large fish (worst-case assumption), there would be a low likelihood of impairment resulting from mercury. Considering that otters consume foods other than large fish, the risks of future ill health to otters post inundation of the headpond can be considered to be quite low. The risks of ill health to eagles as a result of eating large fish from the headpond can also be considered low, particularly when considering that eagles will spend much of the year in a different location (i.e., will migrate), will consume prey other than large fish when in the vicinity of the project, and will very likely consume prey from areas outside the headpond.

Concentrations of mercury in the flesh of piscivorous fish generally increase by two to three times background after inundation of a headpond. Such increases in mercury concentration in the muscle of fish would produce concentrations of between ~ 800 and 1,200 ng/g, above the total restriction for women of child-bearing age as well as the general restriction for the general population. Concentrations will likely increase early in the life of the headpond (e.g., years one to ten), but will decline over time (e.g., years 10 to 20) after inundation.

Concentrations will likely increase early in the life of the headpond (e.g., years one to ten), but will decline over time (e.g., years 10 to 20) after inundation. The net effect of methyl mercury bioaccumulation in fish flesh is likely to be limited to the headpond and may result in a reduction in the use of the natural resource in that area.

Concentrations of mercury in fish flesh are not anticipated to increase in downstream fish populations, including those more regularly angled downstream of Yellow Falls.

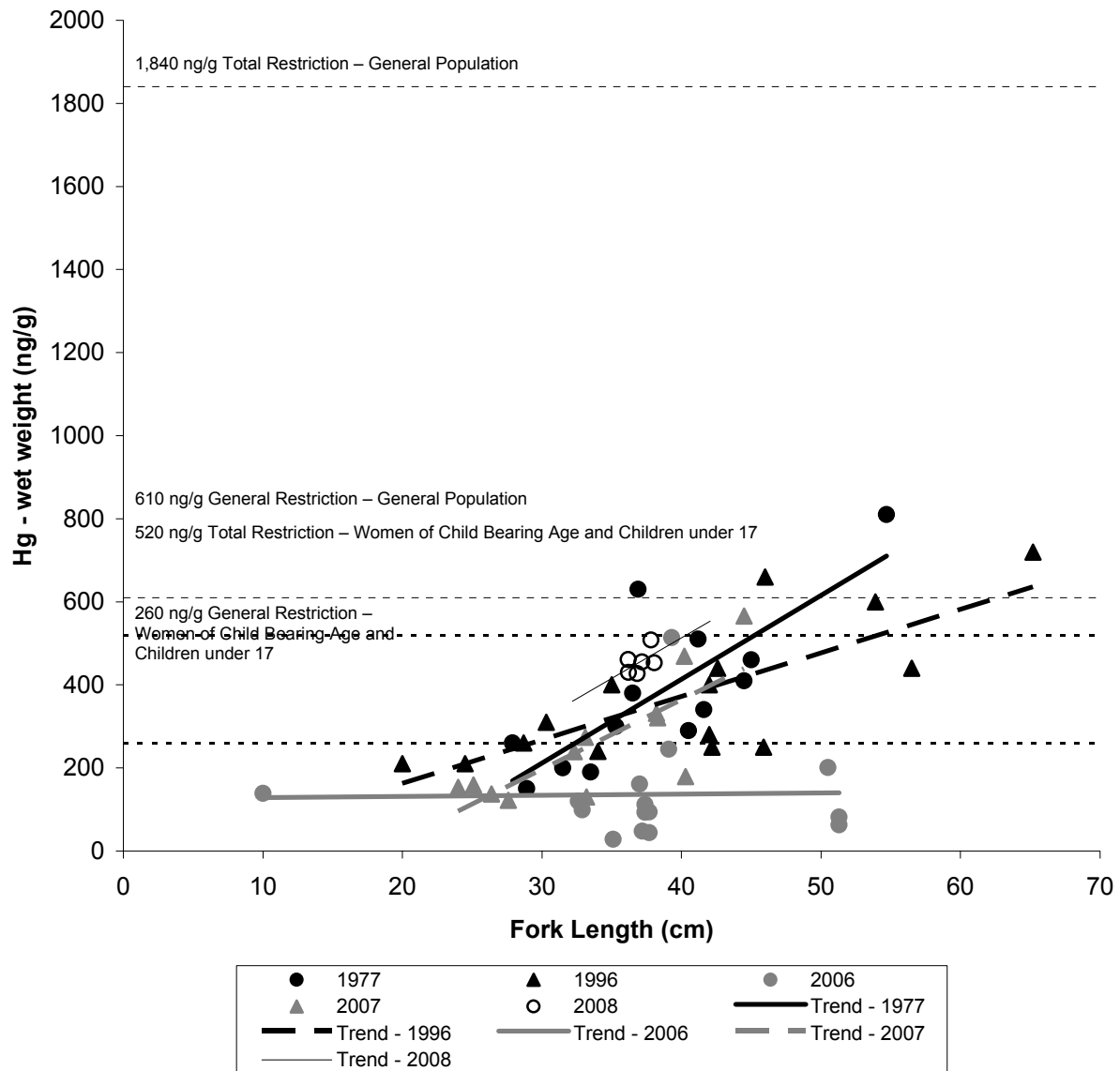


Figure 5.1 Methyl Mercury Concentrations in Walleye Filets (1977 to 2008)

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6.0 Key Conclusions

Key conclusions of aquatic sampling indicate that:

Water Quality

- Water quality in the sampled stretch of the Mattagami is generally good
- Water temperature may have an influence on presence of spawning fish, particularly lake sturgeon

Area A

- Area A exhibited relatively high abundance of walleye
- Area A was the only location throughout the Study Area where lake sturgeon were captured
- Certain chutes of Island Falls may provide spawning habitat for several of the target species

Area B

- Relatively few fish were captured in Area B. Only white sucker and small numbers of walleye have been consistently collected. No lake sturgeon were captured between Island Falls and Yellow Falls
- White sucker may spawn at the base of Yellow Falls

Area C

- Area C also exhibited relatively high abundance of white sucker. Walleye and northern pike are also present in Area C.
- No lake sturgeon were captured in Area C.

Benthic Invertebrates

- Benthic communities are fairly typical for a northern river in Ontario. There were no rare, endangered, or otherwise unusual species observed in the survey.

Methyl Mercury

- Concentrations of mercury in the flesh of piscivorous fish generally increase by two to three times background after inundation of a headpond. Such increases in mercury concentration in the muscle of fish would produce concentrations of between ~ 800 and 1,200 ng/g, above the total restriction for women of child-bearing age as well as the general restriction for the general population.
- Concentrations will likely increase early in the life of the headpond (e.g., years one to ten), but will decline over time (e.g., years 10 to 20) after inundation.
- Concentrations of mercury in fish flesh are not anticipated to increase in downstream fish populations, including those more regularly angled downstream of Yellow Falls.

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8.0 Glossary of Terms

Definitions related to morphology and substrates are adapted from MNR *Manual of Instructions – Aquatic Habitat Inventory*, 1984.

Term	Definition
2-year flow event	Flow event predicted to occur once in every 2 years
50-year flow event	Flow event predicted to occur once in every 50 years
100-year flow event	Flow event predicted to occur once in every 100 years
Allochthonous	Referring to nutrients and organic debris within an aquatic system that originated outside of that system.
Anoxia	The depletion of oxygen in a substance (water, sediment, soil).
Bedrock	All exposed rock with no overburden
Benthic	Pertaining to or associated with the substrate below a body of water.
Benthic macroinvertebrate/ invertebrate	Macroscopic (visible to the naked eye) organisms without backbones living in or on the substrate of a river, lake, pond, etc.
Benthos	Organisms living in and around the substrate below a body of water.
Biomass	The total mass of organisms within a given area. Typically this is limited to fauna.
Boulder	Rock over approximately 25 cm (10 inches) in diameter.
Clay	A material of inorganic origin with a greasy feel between the fingers and no apparent structure.
Cobble/Rubble	Rock material between 8 cm (3 inches) and 25 (10 inches) cm in diameter
Collector	A trophic strategy whereby the organism concentrates food particles before consumption. Collectors include gatherers and filter feeders.
CPUE	Catch Per Unit Effort. The number or weight of fish caught using a particular method or gear over a particular time period.
Density	The total number of organisms within a specified area.
Depositional	Describing a habitat or environment where entrained sediment particles fall and collect on the bottom as water velocities become too slow to keep them entrained.
Detritus	Dead, decaying woody and herbaceous plant material
Diversity	The number of distinct taxa in a given area or environment.
Emergence	A stage in the life cycle of many aquatic insects which takes place after transformation into the adult form, characterized by the adult extracting itself from the pupal case (a cocoon-like form) and leaving the aquatic environment, usually by flying away.
Epilimnial	Referring to the layer of water above the thermocline in a body of freshwater.
Erosional	Describing a habitat or environment where the substrate is being entrained and removed, usually by increased water velocity.
Falls	An abrupt vertical or near vertical drop of river water over a precipice. The tailwater is usually turbulent and deep.
Fauna	Members of the Animal Kingdom.
Fecundity	A measure of an organism's ability to reproduce and produce offspring.
Filter Feeder	A trophic strategy whereby the organism uses various anatomical or constructed structures to trap suspended particles from the water column to attain nutrients.

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Term	Definition
Gatherer	A trophic strategy whereby the organism acquires nutrients from organic deposits or films on the surface of the substrate.
Gravel	Rock material between 0.2 cm (1/8 inch) and 8 cm (3 inches)
Hyporheic	Referring to a zone or area in a body of water where groundwater and surface water mix.
Impoundment	The mass of relatively still water that collects behind a structure that restricts the flow of water in a river, stream or creek. The water behind a dam is an example of an impoundment. Also called headpond or area of inundation.
Lacustrine	Pertaining to, produced by or inhabiting a lake or lakes.
Lentic	Referring to still water, such as lakes, ponds and impoundments.
Lotic	Referring to flowing water, such as rivers streams and creeks.
Morphology	The structure and form of a stream channel e.g.: Riffles, pools, runs and shallows.
Nymph	A stage or stages in the life cycle of many aquatic insects after the egg stage and before the adult stage.
Pelagic	Referring to open water, far removed from the substrate or structure.
Plankton/Limnoplankton	Microscopic organisms living within the water column. Limnoplankton refers to plankton living in standing water such as a lake or impoundment.
Pools	Deep, slow moving bodies of water. Because of the appreciable decrease in current speed through the pool, the bottom is often composed of silt, debris and sand.
Production/Productivity	The increase in biomass for a particular area within a particular period of time.
Riffles	Shallow, swift flowing sections of streams where the water surface is broken and in many cases gravel, rubble, or boulders break the surface.
Riverine	Pertaining to, produced by or inhabiting a river or rivers.
Runs/Flats	Shallow (relative to pools), slow (relative to riffles) moving sections of water. The bottom is usually relatively featureless (bathymetrically) and composed of rock, silt or fine sand.
Sand	Material of crystalline rock origin less than 0.2 cm (1/8 inch) but large enough to be palpable as grit.
Scraper	A trophic strategy whereby the organism uses various anatomical structures to remove attached periphyton or algae from surfaces to be used as a food source.
Sedimentation/Siltation	A process by which entrained particles in the water column fall to the substrate and collect. It is usually associated with a reduction in water velocity.
Shallows	For the purpose of this study, Stantec Consulting Ltd. defined Shallows as areas having a depth less than approximately 2 metres. They are areas with little flow, frequently within 3 metres of shore, or surrounding an island. Substrate is predominantly fine grained particles such as sand, silt, clay mixed with sparse gravel or cobble.
Shredder	A trophic strategy whereby the organism breaks or chews larger organic debris into smaller organic debris to attain nutrients.
Silt	An inorganic material of various origins finer than sand (i.e., not large enough to be palpable as grit)
Substrate	The inorganic and/or organic material that forms the bed of the watercourse e.g.: Boulder, bedrock, etc.
Succession	The predictable ordered progression of the life cycles of all taxa in a benthic community relative to one another.
Taxa Richness	The number of distinct taxa in a given area or environment.

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Term	Definition
Taxon/Taxa	A distinct named group of organisms at any particular level. For example, all organisms of a particular species, group of species, genus or group of genera can be considered a taxon. Taxa is the plural form of taxon.
TDS	Total Dissolved Solids. The dissolved matter found in water comprised of mineral salts and small amounts of other inorganic and organic substances.
Thermocline	The boundary layer between the warmer well-mixed surface water and colder deeper water in lacustrine environments.
TKN	Total Kjeldahl Nitrogen
LT50	median lethal time Statistically derived average time interval during which 50% of a given population may be expected to die following acute administration of a chemical or physical agent (radiation) at a given concentration under a defined set of conditions.
YOY	Young-of-Year

Appendix G4

Fish Habitat Compensation Plan

Yellow Falls Hydroelectric Project Fisheries Compensation Plan

Prepared For:
**Fisheries and Oceans Canada
and
Ministry of Natural Resources**

Prepared By:
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09 October 2008

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Attachment A: Spawning Habitat Criteria

1.0 Introduction

Yellow Falls Power Limited Partnership (“YFP”) is proposing to build, own, and operate a 16 megawatt (“MW”) run-of-river¹ waterpower project at Yellow Falls, approximately 18 km upstream from Smooth Rock Falls, Ontario. This hydroelectric generating station would be sited between the Lower Sturgeon Hydroelectric Generating Station (“GS”) operated by Ontario Power Generation (“OPG”) and the Smooth Rock Falls GS operated by Tembec Industries Incorporated (“Tembec”).

This Fisheries Compensation Plan (“Compensation Plan”) has been developed based on extensive studies conducted as part of the provincial Environmental Screening Process under the *Electricity Projects Regulation* (Ontario Regulation 116/01), the Ministry of Natural Resources (“MNR”) Waterpower Program Guidelines, and the *Canadian Environmental Assessment Act*. Specifically, this Compensation Plan is based upon Aquatic Assessment works conducted in 2005, 2006, and 2007 by Stantec Consulting Ltd. (Stantec, 2007) and Golder Associates (Golder, 2007). Technical reports detailing these assessments and their results are provided as **Appendices G1** and **G2** to the Yellow Falls Hydroelectric Project Environmental Assessment Report (the “EA Report”) (Stantec, 2008).

These detailed reports provide the supporting information for this Compensation Plan, and should be reviewed in association with this report. Approval of appropriate compensation and mitigation measures is required prior to Project construction. To this end, the evaluation and development of compensation measures described herein has been undertaken in consultation with the Department of Fisheries and Oceans (“DFO”) and the MNR.

1.1 Regulatory Background

The federal Minister of Fisheries and Oceans has the legislative responsibility for the administration and enforcement of the *Fisheries Act*. Subsection 34(1) of the *Fisheries Act* defines fish habitat, and Section 35 (2) states that:

- (1) No person shall carry out any work or undertaking that results in the harmful alteration, disruption, or destruction of fish habitat
- (2) No person contravenes subsection (1) by causing the alteration, disruption or destruction of fish habitat by any means or under any conditions authorized by the Minister or under regulations made by the Governor in Council under this Act.

These provisions allow the DFO to implement a guiding policy of “no net loss of the productive capacity of fish habitats” (“NNL”) by which compensation for habitat alteration is required. Under the NNL policy, the DFO strives to balance unavoidable habitat losses with habitat replacement on a project-by-project basis. Compensation is defined in the DFO Habitat Policy as: “the replacement of natural habitat, increase in the productivity of existing habitat, or maintenance of fish production by artificial means in circumstances dictated by social and economic conditions where mitigation techniques and other measures are not adequate to maintain habitats for Canada’s fisheries resources” (DFO, 2006).

¹ “Run-of-river” describes hydroelectric power generation that does not affect river flow by storing or releasing water from a headpond or reservoir; save the initial filling and any subsequent draining of the headpond and some attenuation of flow in large flood events.

The DFO's preferred options for habitat compensation are as follows (DFO, 2006).

1. Create or increase the productive capacity of like-for-like habitat in the same ecological unit
2. Create or increase the productive capacity of unlike habitat in the same ecological unit
3. Create or increase the productive capacity of habitat in a different ecological unit
4. As a last resort, use artificial production techniques to maintain a stock of fish, deferred compensation or restoration of chemically contaminated sites.

Through this hierarchy of preferences, the principle offers flexibility in the search for solutions by both fisheries managers and the proponents of works and undertakings that may threaten fish habitats (DFO, 1986).

The MNR also has responsibilities related to fisheries. The MNR is the provincial agency responsible for the protection and management of Ontario's natural resources, including the management of fisheries. The *Fish and Wildlife Conservation Act* provides the legislative authority for MNR's management and protection of sport fish and wildlife in Ontario. The legislation allows MNR to issue regulations and permits regarding use of fish and wildlife, as well as to provide enforcement. The MNR is also responsible for implementation of the *Public Lands Act* and the *Lakes and Rivers Improvement Act* and for enforcing certain provisions of the *Fisheries Act* (DFO, 1998).

The MNR has developed several management objectives for the reach of the Mattagami River located between the Lower Sturgeon and Smooth Rock Falls Generating Facilities. These management objectives include:

- The maintenance of current native species biodiversity
- The maintenance of existing habitat diversity
- Maintenance of opportunities for a diversified and sustainable angling experience for all species presently angled within the reach

1.2 Project Description

The proposed Project consists of a powerhouse containing two 8 MW turbines (16 MW total) that are closely coupled to the intakes (i.e. short penstock contained within the powerhouse structure), concrete dam, spill facilities and related infrastructure across the Mattagami River at Yellow Falls. Additional information is provided in **Section 2.0** of the **EA Report** (Stantec, 2008).

Major Project activities include construction, operation, and decommissioning of key components; including the following:

- Main access road (includes permanent upgrades to 14 km of existing Red Pine Road, 9.4 km of new road)
- Three new bridges
- Concrete batch plant
- Intake and powerhouse (close-coupled)
- Gated spillway

- Retaining wall
- Service building (including septic and potable water supply using water filtered from the powerhouse)
- Generating equipment
- Controls and communication devices
- Headpond (extending approximately 6 km upstream)
- Electrical 115 kV transmission line (approximately 25 km in length)
- 13.8 to 115 kilovolt (kV) substation
- Interconnection with existing Hydro One 115 kV transmission line

As proposed, the Project will result in a headpond approximately 6 km in length from Yellow Falls upstream to Loon Rapids, with a surface area of approximately 160 hectares ("ha"). The headpond will expand the existing river surface area by approximately 71 ha and will be maintained at a near-constant 244 m above sea level ("asl"), with minor fluctuations of between 0.2 to 0.3 m as required by river flow. An increase in water depth of approximately 12 m will occur immediately upstream of the facility, tapering off to no change in water depth at the headpond terminus.

2.0 Fisheries

2.1 Study Area Characteristics

The following description is a summary of the information provided in **Section 4.0, EA Report**. Further detailed information and associated references are provided therein.

The Study Area is located in the Mattagami River Watershed, a sub-watershed of the Moose River Basin. The Moose River flows into James Bay and its major tributaries include the Mattagami, Abitibi, Kwataboahegan, Missinaibi, and North French Rivers. Major tributaries of the Mattagami River include the Kapuskasing and Groundhog Rivers (Buttle et al., 1998).

The headwaters for the Mattagami River stem from Lake Mesomikenda, southwest of Gogama, Ontario (MNR et al., 2004). The Mattagami River flows approximately 443 km north to its confluence with the Missinaibi River to become part of the Moose River.

The largest tributary of the Mattagami River in the Study Area is the North Muskego River, which enters the Mattagami River approximately 4.5 km upstream of the Town of Smooth Rock Falls, approximately 14 km downstream of the Project. Other named tributaries include Aubin Creek, Bradburn Creek, Dargavel Creek, Jocko Creek, Pullen Creek, Rat Creek, Thorburn Creek, and White Caribou River.

The Mattagami River supports eight generating stations (“GS”), seven of which are operated by Ontario Power Generation (“OPG”), with the remaining GS operated by Tembec Industries Inc. (“Tembec”). The Lower Sturgeon GS (operated by OPG) is located at the southern limit of the Study Area, while the Smooth Rock Falls GS (operated by Tembec) is located at the northern limit.

A fish sanctuary has been designated by the MNR from Lower Sturgeon GS to the northern boundary of Mahaffy Township to address recreational angling during walleye spawning season. No fishing is allowed from 1 April to 14 June (MNR, 2005). The Project is not located within the fish sanctuary.

2.2 Fisheries Assessment Findings

During the environmental assessment activities for the Project, in-field aquatic assessment workplans were developed for the Project in consultation with the MNR and the DFO (**Appendix G1, Appendix VII, EA Report**). It was determined that four species of specific interest (“target species”) would be the focus of the assessment. The target species included lake sturgeon (*Acipenser fulvescens*), white sucker (*Catostomus commersoni*), pike (*Esox lucius*), and walleye (*Sander vitreus*). For the purposes of the aquatic assessments, the Study Area was divided into three evaluation areas. These areas were delineated as follows:

- **Area A** is generally defined as the 16 km stretch of river between the Town of Smooth Rock Falls and Island Falls.
- **Area B** is defined as the approximate two kilometre stretch of river between Island Falls and Yellow Falls.
- **Area C** is defined as the approximate seven kilometre stretch of river from Yellow Falls upstream to Loon Rapids encompassing the upper reach of the headpond (i.e. the maximum upstream extent of inundation).

Aquatic assessments conducted for the Project (Stantec, 2006a; Golder 2007, Golder 2008 see **EA Report, Appendices G1 and G2**) have provided of a large amount of information related to the use of the Study Area by the four target species and the habitat characteristics currently present within the Study Area. Key findings are provided in the following sections, while a full description is provided in **Appendix G** of the EA Report.

2.2.1 Fish Populations

The aquatic assessments undertaken for the Project (**Appendix G1, Appendix III; and Appendix G2 of the EA Report**) resulted in the following key findings related to target species populations:

- Sampling efforts in 2005, 2006, and 2007 indicate the presence of 29 species of fish in Areas A, B and C, including Rat Creek and Tributaries A and B. Overall, 10 large-bodied fish species and 19 small-bodied fish species were captured.
- Northern pike, walleye and white sucker are present in all three areas, although numbers vary by species, as well as seasonally. Consistent with other studies, lake sturgeon were only caught below Island Falls (McKinley and Sheehan, 1990; Payne, 1987).
- Age data for white sucker, northern pike and walleye indicate healthy populations, while lake sturgeon age data indicate an aging population, with poor recruitment.
- The presence of natural barriers (i.e. Yellow Falls) likely limits upstream migration of target species within the study area. Walleye, northern pike and white suckers have been captured in low numbers in reaches between Yellow Falls and the headpond terminus.
- Lake sturgeon were identified within the Area A only, no lake sturgeon were identified upstream of Island Falls in Areas B and C. A total of 67 Lake Sturgeon were caught below Island Falls during the 2006 assessment works, 10 Lake Sturgeon were caught below Island Falls during the Spring 2007 assessment works, and 2 Lake Sturgeon were captured below Island Falls during the Summer 2007 assessment works.
- Lake sturgeon congregate below Island Falls in the spring, but no spawning activity was documented in field studies.
- Discussions with local fishers indicate that Lake Sturgeon abundance is higher, upstream of the Study Area. In August 2007, field crews captured fourteen lake sturgeon from a pool located 2 km upstream from Loon Rapids (outside of the upstream limit of inundation) in a single large mesh gill net (Golder, 2008). This upstream component of the lake sturgeon population may be the source of juvenile fish below Island Falls (i.e. through downstream drift).
- Lake sturgeon are listed by the Committee on the Status of Endangered Wildlife in Canada ("COSEWIC") as a species of special concern in the Southern Hudson Bay/James Bay area (COSEWIC, 2007), but have not yet been listed under the *Species at Risk Act* ("SARA"). The Natural Heritage Information Centre ("NHIC") ranks lake sturgeon as vulnerable (S3), but the species is considered to be "not at risk" by the Committee on the Status of Species at Risk in Ontario ("COSSARO") since a risk category has yet to be assigned by the MNR (MNR, 2006).

2.2.2 Habitat Characteristics

The aquatic assessments (**Appendix G1, Appendix IV of the EA Report**) conducted for the Project also resulted in the following key findings related to habitat characteristics

- Pool and run habitats dominate the area between impoundments at Smooth Rock Falls (downstream of the Project) and Lower Sturgeon Falls (upstream of the Project). Abundances of these morphological features within the Study Area are generally similar to occurrences elsewhere in the middle reaches of the Mattagami River.
- Five areas of high-velocity morphology (riffles or falls) occur in this approximately 60 km reach from Lower Sturgeon to Smooth Rock Falls, three of which fall within the Project footprint, including Loon Rapids, Davis Rapids, and Yellow Falls. The other two areas of fast-water occur at the base of Lower Sturgeon GS and at Island Falls.
- The three riffles and falls features make up approximately 21% of the morphology within the Project foot print. The remaining 79% of footprint is a mix of run (46%), pool (9%) and shallows (11%).

The Project will alter fish habitat in the Mattagami River and will require authorization from the DFO. Formation of the headpond will increase the river area, and there is therefore a net gain in the quantity of aquatic habitat. However, the lentic nature of the headpond, and alteration of riffle habitats within the headpond requires consideration.

3.0 Habitat Compensation

3.1 Compensation Options Evaluation

Several potential compensation options have been identified, including:

- Habitat creation within the Mattagami River main channel within the headpond
- Habitat creation immediately downstream of Island Falls
- Habitat creation in downstream tributaries
- Habitat creation in upstream tributaries
- Fish passage structures
- Funding of fisheries management initiatives

This list of options was developed based on the findings of the aquatic assessment work undertaken, with consideration for DFO's hierarchy of preferences under its NNL Policy, as well as the limitations presented by the quality of existing habitats and low accessibility of much of the river. The potential benefits and limitations of each of these options are described **Table 3-1**.

Table 3-1: Mitigation/Compensation Options

Compensation Option	Potential Benefits	Potential Limitations
Install Riffle/Run Habitat in Mattagami River Main Channel within Headpond • Installation of artificial structures such as riffle beds, large woody debris. • Target species: walleye (spawning), white sucker (spawning) lake sturgeon (spawning)	• Portions of Loon and Davis Rapids may be utilized by walleye and suckers to spawn but given the low numbers of ripe fish captured during spring field studies, spawning events involve few individuals. No lake sturgeon activity has been documented within the headpond. Creation of riffle habitat will provide spawning habitat for all target species within the footprint of the Project • Creation of riffle habitat will benefit benthic invertebrate production within the headpond. • Highest ranking preference under DFO No-Net-Loss Policy. • Mitigation provided in close proximity to existing habitats • Headpond accessible during construction (headpond clearing activities).	• Water velocity in headpond will be on the low end of the desired range (15-70 cm/s) • Deep-water characteristics of headpond limit the opportunity for construction of riffle features within the majority of the headpond area • Requirement to construct new access roads and related watercourse crossings to install and maintain new habitat features may result in significant environmental impacts, as well as significant construction costs • Long-term stability of some mainstem constructed habitats may be difficult to maintain due to high flow and ice conditions, resulting in significant long-term maintenance costs, and reduced likelihood of long term success.
Install Riffle/Run Habitat in Mattagami River Main Channel immediately downstream of Island	• Aquatic Inventory identified that the base of Island Falls is used to some extent for lake sturgeon, white sucker, pike and	• Potential for damage or destruction of artificial structures by high flows and ice, resulting in uncertain long-

Table 3-1: Mitigation/Compensation Options

Compensation Option	Potential Benefits	Potential Limitations
Falls • Installation of artificial habitat structures and/or spawning substrate. • Target species: lake sturgeon (spawning), white sucker (spawning), pike (spawning), walleye (spawning)	walleye spawning, therefore habitat constructed below Island Falls may benefit populations of all target species through an increase in spawning area • Structures are constructed in a reach of the river that will not experience changes in water depth as a result of the Project, thus creating more predictable outcomes • Provides compensation for riffle habitat inundated at Loon Rapids and Davis Rapids	term success • Located outside of the Project footprint • Flow characteristics at the site must be understood to ensure maximum benefit • Structures would be constructed in habitat currently utilized by fish populations, potentially reducing the net gain associated with this option, and creating the potential for negative effects on existing habitat. • Environmental impacts associated with construction and maintenance of new access roads and related watercourse crossings
Install Habitat in Downstream Tributaries • Installation/construction of artificial spawning structures. • Target species: white sucker (spawning and rearing), walleye (spawning and rearing), sturgeon (spawning)	• Provides habitat in the vicinity of the Project • All target species have been found between Island Falls and Smooth Rock Falls GS (any constructed habitat would be accessible by all target species) • One tributary (North Muskego River) is accessible via existing trails which may facilitate construction and maintenance of compensation measures • Through bathymetric investigations conducted in summer 2008 an existing bedrock outcrop in the North Muskego River (approximately 4km upstream from the confluence with the Mattagami River) has been identified as a potentially suitable location for habitat improvement measures. • Habitat improvement at the North Muskego River location will not impact or result in alteration of existing, suitable habitat. Improvement measures will result in net gain in spawning, nursery and feeding habitat of target species and enhance invertebrate production.	• Environmental impacts associated with construction and maintenance of new access roads and related watercourse crossings • Potential for additional construction costs due to need for new access road construction.

Table 3-1: Mitigation/Compensation Options

Compensation Option	Potential Benefits	Potential Limitations
	Lower flows (relative to the Mattagami) increase the potential for long term stability and success of installed structures	
Install Habitat in Rat Creek - Installation of artificial structures within the tributary entering the Mattagami River headpond - Target species: white sucker (spawning and rearing), walleye (spawning and rearing)	- Provides habitat within the footprint of the Project - Aquatic Inventory identified potential spawning activity within Rat Creek which flows into the headpond - Increase in potential spawning habitat	- Field investigations have concluded that the section of Rat Creek located above the head pond terminus consists of flat, meandering channel. Numerous beaver impoundments are present and beaver activity may impede fish accessibility to improvement areas or compromise improvement structures. - Access to Rat Creek on the east side of the Mattagami River would require extensive access road construction. - Environmental impacts associated with construction of new access roads and related watercourse crossings are potentially significant - Increased cost of construction due to access limitations during construction - Access roads and watercourse crossings will need to be maintained in order to facilitate maintenance and monitoring - Utilization of structures by fish is not certain - Quality of existing habitat may result in a low net increase in habitat productivity
Install Habitat in tributaries upstream of Loon Rapids - Installation of artificial structures within tributaries entering the Mattagami River upstream of the Project headpond - Target species: white sucker	- Increase in potential spawning habitat - Accessible by Sturgeon population identified upstream of Loon Rapids (Golder 2008)	- Environmental impacts associated with construction of new access roads and related watercourse crossings are potentially significant - Increased cost of construction due to access limitations during construction

Table 3-1: Mitigation/Compensation Options

Compensation Option	Potential Benefits	Potential Limitations
(spawning and rearing), walleye (spawning and rearing), Sturgeon (spawning)		• Access roads and watercourse crossings will need to be maintained in order to facilitate maintenance and monitoring • In-field evaluation of all tributaries upstream of Loon Rapids (2008) revealed limited opportunity for habitat construction due to the high quality of existing habitats, unsuitable width/depth characteristics, “flashy”, intermittent nature of many tributaries – insufficient flows, and inappropriate gradients
Stocking of juvenile fish • Introduction of juvenile fish within or in the vicinity the Project in order to mitigate potential reductions in fecundity and to bolster recruitment. To be implemented and monitored over several years. • Target species: lake sturgeon	• Direct benefit to lake sturgeon, potential driver for increased numbers and population recovery in this reach of the Mattagami. • Guarantees improved genetic diversity if native stock are used as a seed. • Predictable long-term costs and planning requirements • Reduced risk of investment in compensation structures that may not function as intended or be utilized by fish. • Repeated stocking of juvenile fish (past larval drift stage) will increase proportion of young fish and mitigate the effects of larval drift and poor recruitment. • Potential opportunity for ongoing First Nations involvement and local community.	• Requires proponent to continue a regular long-term stocking and monitoring program. Stocking would likely be required for one full reproductive cycle (i.e. 7-15 years) • Monitoring of stocking plan effects may be difficult in the short term due to difficulties in capturing yearling fish. • Assessment of stocking success will be delayed as survival of stocked fish difficult to assess until they recruit into the spawning component of the population. • Dependent upon the availability of suitable habitat within the Project Area to support the population. • Factors impeding recovery/dictating current abundance of lake sturgeon in this section of the Mattagami River are not clearly understood. Survival of stocked is fish uncertain. • low preference by agencies as a compensation measure
Provide Fish Passage	• Provide passage for fish to areas above Yellow Falls	• No proven fish passage design for lake sturgeon over a 15 m rise

Table 3-1: Mitigation/Compensation Options

Compensation Option	Potential Benefits	Potential Limitations
- Natural channel or denil fishway - Target species: all	- Removal of a natural barrier allowing access to the reach of river between Yellow Falls and Lower Sturgeon - Potential for increased genetic diversity within previously fragmented fish populations (due to removal of Yellow Falls as a barrier)	in elevation. - Fishways have mixed results in providing consistent upstream passage for walleye. - Uncertain development time for structure - Significant costs of construction - Aquatic sampling evidence from 2006 indicates that lake sturgeon do not currently move up Island Falls, and that with the exception of suckers there is limited upstream movement of any target species past Island Falls. Island Falls will remain as a barrier, significantly reducing the effectiveness of any fishway at Yellow Falls.
Compensation through funding of fisheries management initiatives - Proponent provides financial funding to management initiatives within the Mattagami River local or regional watershed, ideally benefiting species potentially affected by the project. - Target species: To be determined	- Funding is strategically directed to appropriate management goals as determined by agencies involved. - Reduced risk of investment in compensation structures that may not function/be utilized by fish. - Specific potential benefits are related to the goals of the management initiative being funded. - Costs are understood/predictable	- Funded initiatives may not directly benefit the Mattagami River or the Project Site - Low preference as a compensation measure - Discussions with MNR did not identify any existing fisheries management initiatives in the area

3.2 Compensation Options Discussion

Evaluation of potential compensation options (**Table 3-1**) identified benefits and limitations associated with the identified compensation options. As discussed in **Section 1.1** of this report, the DFO's preferred compensation option is a like-for-like compensation measure, undertaken as close as possible to the Project location. Further, the MNR's management goals for this reach of the Mattagami River include the maintenance of biodiversity within the river. Accordingly, in the case of the Project, highly desirable compensation options would:

1. result in creation of spawning/riffle habitats as compensation for riffle areas inundated as a result of the Project – providing like-for-like compensation and creating morphological diversity within this reach of the Mattagami River

2. be located within the headpond, or in as close proximity as possible to the Project footprint

This section further discusses the suitability of the identified compensation options based on the Project design, MNR management goals, and DFO NNL policy.

3.2.1 Habitat Construction – Mattagami River Tributaries

As a result of on-going discussions between YFP representatives and the DFO and MNR, an in-field evaluation was undertaken of the tributaries entering the Mattagami River between Lower Sturgeon GS and Smooth Rock Falls in 2008. The purpose of the investigations was to identify any potential options within these tributaries.

These investigations included an assessment of tributary gradient, flows (i.e. intermittency, volume), and existing habitat quality. Preferred candidates for habitat compensation efforts generally possess several key characteristics:

- Moderate gradients
- Hard tributary bottoms
- Moderate summer flows i.e. must not be dry or intermittent during summer) and,
- Width greater than 4 metres
- Low existing habitat value
- Accessible for construction and maintenance.

The assessment confirmed that opportunities for habitat construction within the tributaries were very limited and only one potential candidate site was identified. Tributaries possessing appropriate channel and flow characteristics generally contained existing higher-quality habitat, reducing the effectiveness of any habitat construction efforts. Among those tributaries with existing low habitat value, a number of them proved to be of insufficient gradient and too deep, whereas many of the remainder were too small and did not provide sufficient flows.

The majority of the tributaries investigated were not located in close proximity to existing or proposed roads or trails and would therefore require the construction and maintenance of access trails specifically for habitat construction activities. Undertaking habitat construction within tributaries that are located in remote areas (i.e. not adjacent to existing or proposed roads/trails) could result in significant environmental effects associated with the construction and maintenance of new access roads and bridges. New access roads would result in increased fragmentation, vegetation clearing and disturbance as well as significant increases in cost of construction and maintenance.

Habitat utilization within many of the small tributaries is unknown and the alteration of existing habitat could potentially alter its suitability or current value for resident fish species.

The single potential tributary candidate site was identified on the North Muskego River, located downstream of the Project. This site consists of an existing riffle area and an adjacent bedrock shelf. This site experiences year-round flows, is of sufficient gradient and width to support habitat construction initiatives, and is located in close proximity to an existing road and trail network. This potential compensation site is discussed in **Section 3.3** of this report.

3.2.2 Habitat Construction - Headpond

Undertaking habitat compensation measures within the footprint of the Project is a preferred compensation option under the DFO's NNL policy. However, construction of riffle habitat within a headpond is generally limited as a result of the deep-water characteristics of the headpond.

During discussions with DFO and MNR following release of the Draft EA, further evaluation of potential headpond compensation possibilities was undertaken. As anticipated, the predominant deep-water conditions significantly limited the potential for construction of spawning habitats, with the exception of one area within the headpond that will experience inundation to depths of 0-1.0 metres following headpond creation. This site appears to provide suitable water depths following Project construction to allow construction of spawning habitat. This headpond compensation candidate site is discussed further in Section 3.3 of this report.

3.2.3 Fish Passage – Yellow Falls

The provision of fish passage over the proposed facilities was also considered. Under existing conditions, regular upstream fish passage is not believed to occur over Yellow Falls (**see Yellow Falls Passability Assessment – Appendix G1, Appendix II of the EA Report**). Based on the results of the aquatic assessment fieldwork, it appears that only white sucker may be currently moving upstream over Island Falls (but not upstream over Yellow Falls). As a result of the existing barrier to upstream migration at Yellow Falls, and the limited upstream passage by target species over Island Falls, there is limited benefit to the provision of upstream passage at Yellow Falls as mitigation to maintain current access and habitat use patterns.

Since the provision of fish passage is not necessary as mitigation due to existing barriers, the use of fish passage as compensation for habitat changes was also considered. There could be a potential benefit, particularly to lake sturgeon, in providing of gaining access upstream of Yellow Falls. However, a review of fishways (both naturalized and denil) has determined that the success of fishway structures can be difficult to predict, and that no fishway has been developed over a facility the size of the proposed dam that has successfully provided passage for lake sturgeon. As a result of the unpredictability of success of a fish passage structure for key species, as well as the absence of significant upstream movement over Islands Falls and the absence of upstream movement at Yellow Falls under current conditions, a fish passage structure was dismissed as a viable compensation measure.

3.2.4 Stocking of Yearling Fish

Stocking of young fish has been undertaken in order to supplement existing populations and existing reproduction rates. Stocking activities can benefit populations that are recovering from acute population declines, allowing the population to reach a self-sustaining population level. Stocking may not address existing limitations to fish population growth such as overfishing, habitat limitations, or population effects associated with larval drift. Stocking is generally a long-term activity requiring on-going monitoring, and assessment of stocking success will be delayed as survival of stocked fish difficult to assess until they recruit into the spawning component of the population.

Stocking is not a highly preferred compensation strategy for habitat changes, and is not being proposed for the Project.

3.2.5 Funding of Management Initiatives

As discussed in **Table 3-1**, funding of fisheries management initiatives has been undertaken in the past when habitat compensation at or near the site has not been possible. This measure, however, is not a highly preferred compensation strategy. At this time, compensation through funding of fisheries initiatives is not being proposed for the Project.

3.3 Preferred Compensation Options

3.3.1 Spawning Channel Construction - Headpond

Following inundation, a lentic environment will be created within the Mattagami River between Yellow Falls and Loon Rapids. This creation of riffle habitats is generally not possible within headpond environments due to the deep-water conditions that prevail. In the case of the Project, this deep water condition does prevail throughout the headpond with the exception of one area located on the west bank of the proposed headpond, approximately 1 km upstream (south) of Yellow Falls.

At this location, headpond creation (headpond elevation 244 m) will result in the establishment of an area of shallow water, with water depths varying between 0 metres (exposed ground) and 1 m, surrounding an 'island' of greater elevation. Water depths of 0.5 to 1 m are consistent with the range of ideal water depths for spawning habitat for three of the four target species; walleye, Lake Sturgeon, and white sucker.

Figure 3-1 shows the location and characteristics of the proposed spawning channel. The channel will consist of an excavated channel with a bottom elevation of 243 m. During excavation, 0.5 m bedrock deflectors will be created within the channel to concentrate water flow to the channel margins, inducing turbulent flow within the channel. In the event that bedrock conditions are not suitable for creation of the deflectors, large rocks structures will be anchored in-place to provide the same effect.

Cobble and boulder substrates will be placed downstream of the bedrock barrier. The smaller diameter (80-150 mm) materials will be placed immediately (0-5 m) downstream of the barrier to reduce the potential for their disruption during higher flows. Larger diameter cobble and boulders (150-300 mm), which are more resistant to disruption during high flows, will be placed downstream of the smaller materials. The arrangement of the substrate materials and deflector structures are shown in **Figure 3-1**.

Up to five deflector and substrate structures will be constructed within the channel. All materials placed in the river will be free of fines or sediment, and habitat construction activities will be undertaken outside of in-stream construction restriction periods. The channel will have an area of 7400 m².

Channel construction will be undertaken prior to headpond filling. The spawning channel will be monitored for a period of three years following headpond filling. Monitoring of fish utilization will be undertaken in the spring and will include a visual assessment of stability/condition of the channel, as well as a description of substrate disruption/sedimentation (if any). Utilization of the channel by the target fish species will be determined through visual inspection and deployment of egg mats. Egg mats will be deployed during spring at water temperatures corresponding to spawning temperatures of target species. Captured eggs will be enumerated and identified by species.

Fish caught in the vicinity of the channel will be measured and weighed, identified (to species) and aged using a non-lethal aging structure. Surveys will occur in the spring with an effort to sample at a time when the structures are anticipated to be used by the target fish species.

Benthic invertebrate production within the spawning channel will be assessed in the fall of each of the first three years following channel construction. A qualitative assessment of benthic species present and their relative abundance will be completed. Results of these assessments will be compared to benthic community monitoring taking place elsewhere within the Project footprint.

3.3.2 Improvement of Spawning Habitat at North Muskego River

In the spring of 2007 the North Muskego River was assessed to determine its utilization by the target species. A bedrock outcrop (**Figure 3-2**) and associated rapids, located four kilometres upstream of the Mattagami River mouth was identified as being utilized by spawning walleye and white suckers (Golder, 2007).

In 2008 this location was identified the lone opportunity for potential compensation within the tributaries in the Study Area, due to access restrictions and reduced suitability for construction within the other tributaries. This rapids feature is located in close proximity to existing trails and the Red Pine Road, and is therefore accessible without construction of significant lengths of access roads.

At this location, the potential exists to introduce constructed spawning habitat in association with the rapids feature that currently exists. Based on in-field observation by Golder Associates during the 2007 spawning season, and bathymetric measurements undertaken in 2008, there is opportunity for habitat construction along the margins of the existing rapids feature, adjacent to the shoreline. **Figure 3-3** shows the substrate characteristics and bathymetric conditions at this location.

As shown in **Figure 3-3**, habitat construction is proposed to occur on an existing bedrock shelf which currently contributes limited habitat value. Construction at this location will utilize the backflows and eddies presently occurring over the bedrock shelf, which appear sufficient provide suitable flows for spawning by lake sturgeon, walleye, and white sucker. The target flow depths and substrate size ranges indicated in Attachment A of this report are anticipated to be achieved at this location.

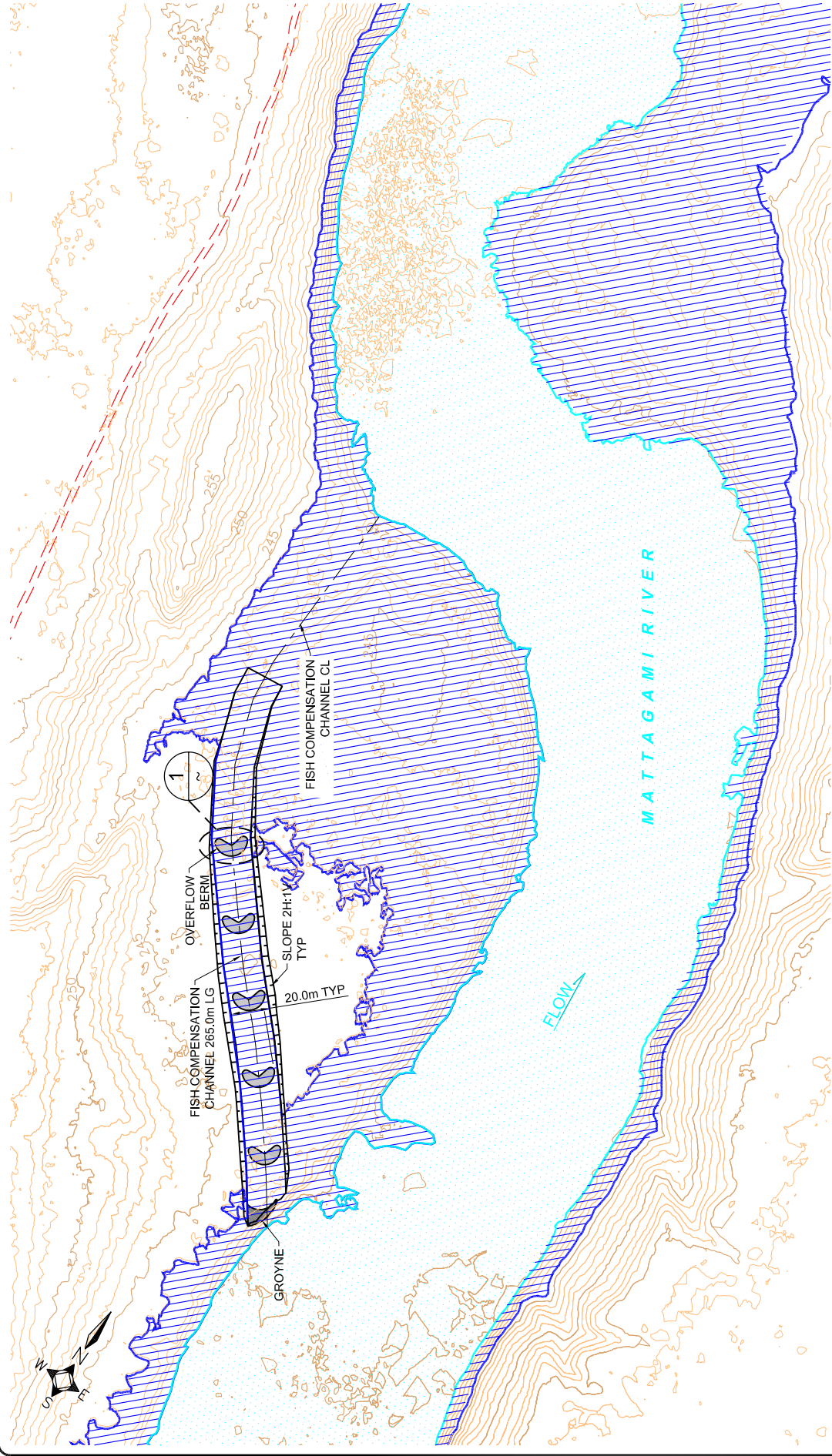
The proposed habitat construction will consist of placement of cobble substrate (80-300 mm diameter) to a variable depth of 0.5 – 2 m below the typical water surface elevation. All materials placed in the river will be free of fines or sediment, and habitat construction activities will be undertaken outside of in-stream construction restriction periods from April 1 to July 15 for walleye, northern pike, lake sturgeon, and other species (DFO, 2008).

The proposed habitat construction in the North Muskego River will provide 930 m² of additional spawning habitat that is suited to all four target species, and that will be accessible to these species during the spawning period. Construction of habitat at this location also reflects the apparent affinity of the local fish populations for tributaries during spawning.

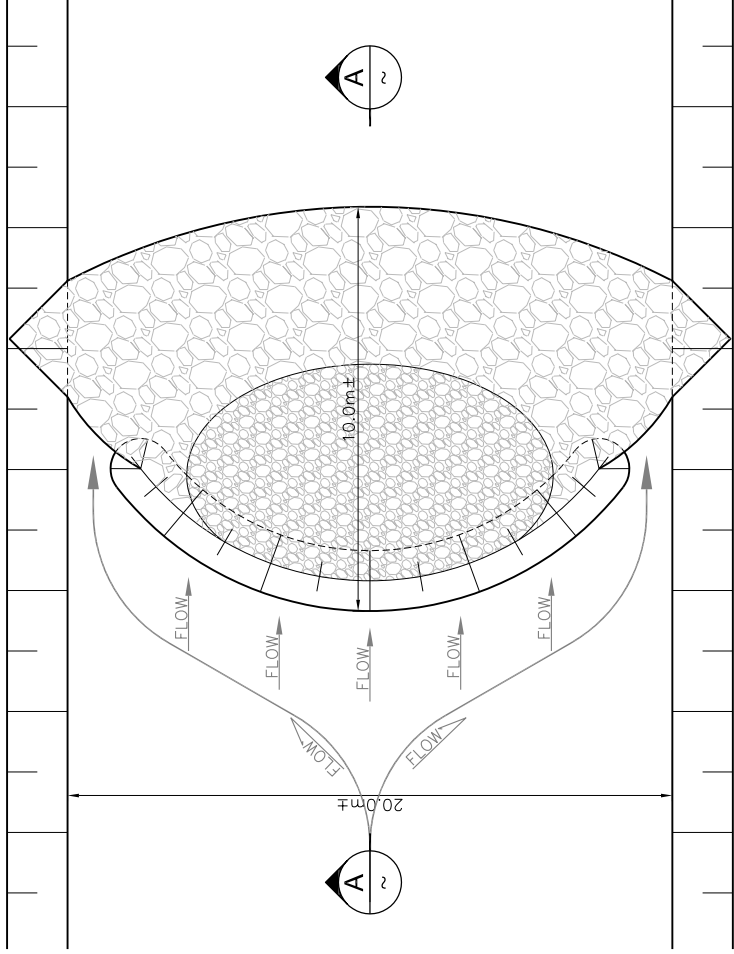
Monitoring of fish utilization will be undertaken in the spring and will include a visual assessment of stability/condition of the channel, as well as a description of substrate disruption/sedimentation (if any). Egg mats will be deployed on the new substrate during spring

at water temperatures corresponding to spawning temperatures of target species. Captured eggs will be enumerated and identified by species.

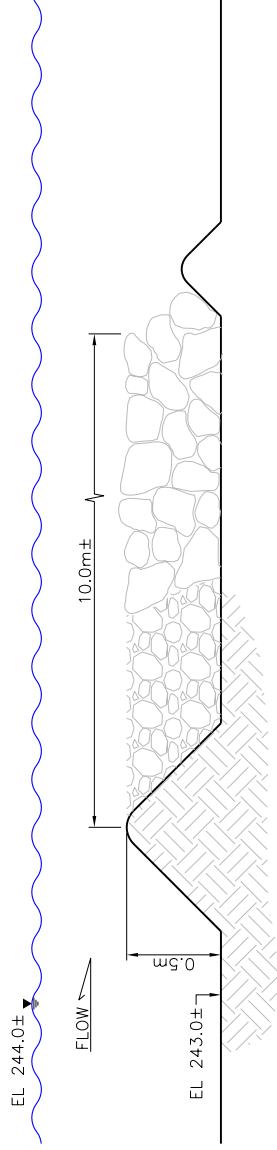
Benthic invertebrate production on new substrate will be assessed in the fall of each of the first three years following channel construction. A qualitative assessment of benthic species present and their relative abundance will be completed.



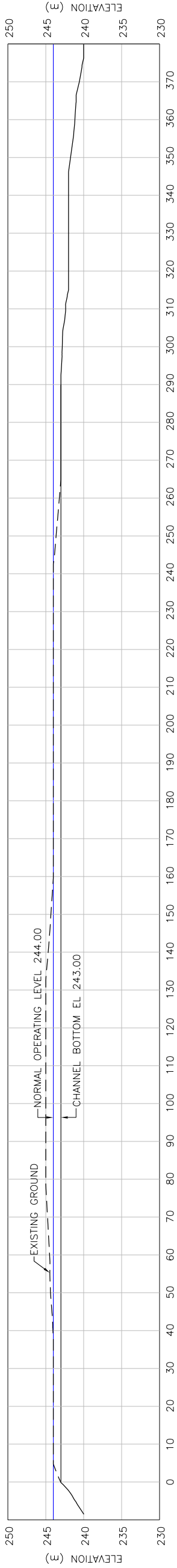
PLAN
1:3000



DETAIL 1
1:250



SECTION A
1:40

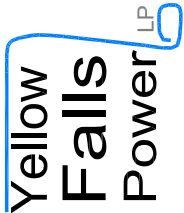
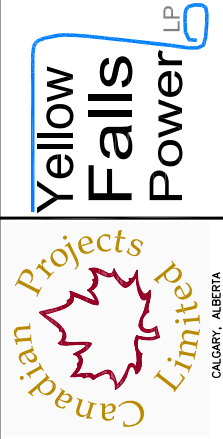


PROFILE
HOR 1:1200
VERT 1:600

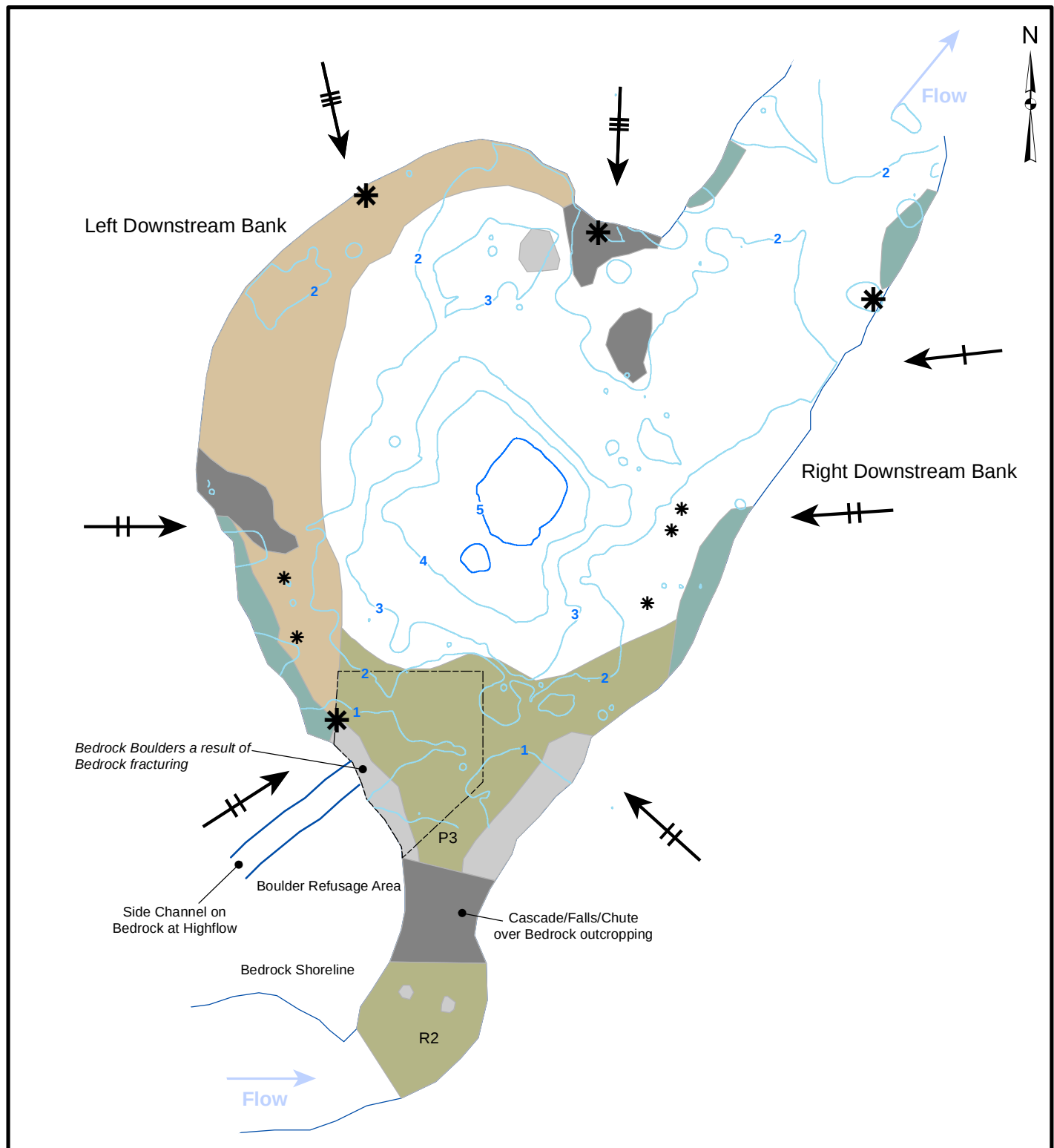
- NOTES**
1. BASE CONTOURS FROM LIDAR SURVEY FLOWN JUNE 2005 BY TERRAPOINT CANADA INC.
 2. ELEVATIONS ARE CANADIAN GEODETIC DATUM.
 3. CONTOUR INTERVAL IS 1m.

LEGEND

- INUNDATED AREA - WATER LEVEL (244.0m)
- EXISTING ROADS



YELLOW FALLS POWER LIMITED PARTNERSHIP		
YELLOW FALLS HYDROELECTRIC PROJECT		PROJECT NUMBER 1032-002
GENERAL		CADD NUMBER 4.3.111
HEADPOND - FISH COMPENSATION		DRAWING NUMBER
PLAN, PROFILE & SECTION		Figure 3.1

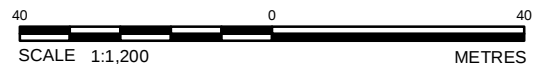


LEGEND

- | | |
|--|---------------------------------|
| * Log | → Intermediate slope (6 to 30%) |
| * Log Jam / Wood Debris | → Steep slope (31 to 70%) |
| 100% Bedrock | → Very steep slope (>70%) |
| Boulders | P1 Highest quality pool habitat |
| 90% Bedrock and 10% silt | P3 Low quality pool habitat |
| 90% Sand 10% silt | R2 Moderate quality |
| Narrow Leaf arrowhead, Richardson's Pondweed | Bathymetry in metres |
| Proposed Fish Habitat Compensation Area (930 m²) | Intermediate |
| | Index |

REFERENCE

Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 17



PROJECT		Yellow Falls Power Yellow Falls Hydroelectric Project	
TITLE		North Muskego River Fish Habitat Compensation Option	
		PROJECT No. 08-1195-0016	SCALE AS SHOWN
		DESIGN RRD 28 Aug. 2008	REV. 0
		GIS RRD 28 Aug. 2008	
		CHECK JS 28 Aug. 2008	
		REVIEW JS 28 Aug. 2008	

FIGURE: 3-3

4.0 Summary

The construction and operation of the Project will result in changes to the physical characteristics of fisheries habitat within the Project footprint. The *Fisheries Act*, as well as DFO and MNR requirements requires the provision of fisheries compensation measures to mitigate and compensate for changes to fish habitat as a result of the Project.

In consultation with DFO and MNR a number of potential compensation measures were evaluated to identify their associated potential benefits and limitations. This evaluation identified key benefits limitations associated with the proposed compensation measures including factors affecting effectiveness, constructability/maintenance, and environmental impacts associated with the compensation measures themselves. In discussions with regulatory agencies the identification of habitat compensation options both within the Project footprint and downstream of the Project was recommended.

Two compensation options were determined to be feasible in terms of constructability and alignment with MNR and DFO requirements. These two options were further refined and described. These measures include construction of a spawning habitat channel within the Project headpond, as well as the construction/improvement of spawning habitat within the North Muskego River (tributary to the Mattagami River), downstream of the Project. Both options will result in enhanced benthic invertebrate production within these areas.

The proposed compensation options provided 'like-for-like' compensation as close as possible to the Project location including the construction of habitat within the Project headpond. The proposed compensation options also provide for new riffle habitat both upstream and downstream of the Project headworks at Yellow Falls with an aim to the maintenance of habitat diversity within this reach of the Mattagami River.

YFP will work with the DFO and the MNR to further refine these compensation measures described in this report during detailed design. MNR and DFO approval of the final compensation measures is required prior to construction of these compensation measures.

5.0 References

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Attachment A
Spawning Habitat Criteria

Habitat Variable	Criteria (Recommendation)
Lake Sturgeon	
Velocity (cm/s)	15-70 cm/s
Depth range (m)	0.3-3.0m, low gradient (~5 percent) slope
Substrate diameter (cm)	8-30 cm
Spawning temperatures (water)	10-16 degrees C
Incubation period	Maintain flows/velocities for 14 days following peak spawning @ water temperature of 16 degrees C (130-160 degree days)
Comments: • Spawning activity takes place over a very short period on the Groundhog River (GHR) at water temperatures ~12.5 degrees C (2004-2006); • Spawning period varied between 2 and 14 days over 16 years on Wolf River (Bruch and Binkowski 2002). Heaviest spawning activity occurs at water temperatures 11.5 – 16 degrees C; • Lake sturgeon eggs are adhesive and tend to adhere to substrate immediately downstream/proximate to where spawning activity occurs; • Lake sturgeon tend to return to exactly same discrete locations to spawn/deposit eggs despite the fact that suitable habitat conditions may exist and be accessible nearby; • Date of hatch is temperature dependent; • Fertilized eggs incubate for approximately 8-11 days @ water temperatures ~16 degrees C following the peak of spawning activity (GHR); • Incubation times (literature values) 7-14 days;	
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Walleye	
Velocity (cm/s)	30-80 cm/s
Depth (m)	0.3-1.0m
Substrate diameter (cm)	6-25 cm
Spawning temperatures (water)	6-11 degrees C
Incubation period	Maintain flows/velocities for ~21 days following peak spawning water temperatures (170-200 degree days)
Comments - Literature indicates that peak spawning activity occurs at water temperatures ~7-8 degrees C. Spawning generally, ceases at water temperatures > 10-11 degrees C; - Ripe female walleye captured on Kapuskasing River at water temperatures 6-11 degrees C. (April 29- May 10, 2006); - Ripe female walleye captured on Mattagami River at water temperatures 7-10 degrees C (May 4-6, 2007); - Most successful spawning occurs at depth ranges of 0.3-1.0m; - Cobble (64-250mm dia) and gravel (2-64mm dia) provide optimal egg incubation substrates. Note: high walleye egg mortality has been associated with enhancement projects that utilized smaller substrate range in some locations. Gravel beds are not common in mainstem river channels in northeastern Ontario; - Eggs are adhesive for several hours but tend to settle into cracks and crevices between boulders. Siltation of these microhabitats during incubation can cause egg mortality. Maintaining water circulation and aeration are important factors. Note: water velocities in these microhabitats are likely significantly lower than velocities measured in most spawning studies; - Incubation times are dependent on water temperatures, 7-21 days reported. Optimal incubation temperatures ~9-15 degrees C	
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White Sucker	
Velocity (cm/s)	30-90 cm/s
Depth (m)	0.6-2.0m
Substrate diameter (cm)	6-25 cm
Spawning temperatures (water)	8-16 degrees
Comments • White suckers are tolerant to a broad range of environmental conditions and are often described as 'generalists'; • Frequently spawn in same locations as walleye; • Are stronger swimmers than walleye and can access spawning locations by traversing areas with higher water velocities than walleye; • Generally spawn after walleye, at slightly higher water temperatures (8-16 degrees C); • Ripe suckers captured at water temperatures of 9 – 14 degrees C on Mattagami River, throughout 2007 field study; • Suckers are capable and will use wide variety of substrate diameters to spawn including coarse sand. Associated with larger substrate in Mattagami River (2007); • Larval white suckers hatch 10-20 days after peak spawning but may remain in cover provided by substrate for additional 5-10 days.	
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