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Information in support of a recovery potential assessment of Lake Sturgeon, *Acipenser fulvescens* (Western Hudson Bay, Saskatchewan-Nelson River, and Great Lakes-Upper St. Lawrence populations)

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Canada

Foreword

This series documents the scientific basis for the evaluation of aquatic resources and ecosystems in Canada. As such, it addresses the issues of the day in the time frames required and the documents it contains are not intended as definitive statements on the subjects addressed but rather as progress reports on ongoing investigations.

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ABSTRACT

The Lake Sturgeon (*Acipenser fulvescens*) is a large cartilaginous fish found exclusively in North America. In Canada, it is found as far west as the North Saskatchewan River in Alberta, east to the St. Lawrence River estuary, north to the Churchill River, and south to rivers and lakes that border the United States. Like most sturgeon species, Lake Sturgeon populations were affected by historical overharvesting, and habitat loss and alteration. In most areas of its range, Lake Sturgeon populations exist at a fraction of their historical abundance.

The status of the Lake Sturgeon in Canada was assessed by COSEWIC in 2017. Lake Sturgeon populations were divided into four DUs primarily following previously identified Canadian freshwater fish biogeographic zones: Western Hudson Bay (DU1), Saskatchewan-Nelson River (DU2), Southern Hudson Bay-James Bay (DU3), and Great Lakes-Upper St. Lawrence (DU4). The Lake Sturgeon population in DU1 was classified as Endangered because the distribution and abundance of mature individuals had declined significantly. Similarly, Lake Sturgeon in DU2 were classified as Endangered as harvesting and dams have caused historical declines and populations were still not considered secure. Populations in DU3 were classified as Special Concern as populations mainly exist in pristine rivers, although some are impacted by harvesting and dams. Populations in DU4 were classified as Threatened as populations have been impacted by dam construction and historical overharvesting; some populations seem to have not been greatly impacted and others are recovering, but are not yet secure.

A Recovery Potential Assessment (RPA) is developed by Fisheries and Oceans Canada (DFO) to provide information and scientific advice needed to fulfill requirements of the *Species at Risk Act* (SARA), including informing both scientific and socioeconomic elements of the listing decision and permitting activities that would otherwise violate SARA prohibitions, and the development of recovery strategies. This Research Document describes the current state of knowledge of the biology, ecology, distribution, population trends, habitat requirements, and threats to Lake Sturgeon populations in DU1, DU2, and DU4. The information contained in this document may be used to inform the development of recovery documents and for assessing permits, agreements and related conditions, as per sections 73, 74, 75, 77, 78, and 83(4) of the SARA, as well as, to prepare for the reporting requirements of SARA section 55. The scientific information for the RPA also serves as advice to the DFO Minister regarding the listing of the species under the SARA. This assessment updates and consolidates the available scientific data pertaining to the recovery potential of Lake Sturgeon (DU1, DU2, and DU4) in Alberta, Saskatchewan, Manitoba, Ontario, and Quebec.

SPECIES INFORMATION

Scientific Name – *Acipenser fulvescens*

Common Name – Lake Sturgeon

Range in Canada – Alberta, Saskatchewan, Manitoba, Ontario, Quebec

Current COSEWIC Status (Year of Designation)

Western Hudson Bay populations (DU1) – Endangered (2017)

Saskatchewan-Nelson River populations (DU2) – Endangered (2017)

Southern Hudson Bay-James Bay populations (DU3) – Special Concern (2017)

Great Lakes-Upper St. Lawrence populations (DU4) – Threatened (2017)

COSEWIC Reason for Designation

Western Hudson Bay populations

Over three generations, the distribution and abundance of mature individuals has declined dramatically, largely as the result of harvesting and dams.

Saskatchewan-Nelson River populations

Harvesting and dams were the main reasons for historical declines. Although some populations appear to be recovering, the species is not yet secure.

Southern Hudson Bay populations

Some populations are impacted by harvesting and dams, most populations exist in pristine environments, and there are likely many undiscovered populations in this remote area. Potential future development may negatively impact the species if there is no mitigation.

Great Lakes-Upper St. Lawrence populations

Harvesting and dams were the main reasons for historical declines. Some populations appear to have not been greatly impacted and some appear to be recovering, but are not yet secure.

Canada Species at Risk Act – No Status

Alberta *Wildlife Act* – Threatened

Ontario Endangered Species Act – Threatened (Great Lakes – Upper St. Lawrence River and Northwestern Ontario); Special Concern (Southern Hudson Bay/James Bay)

BACKGROUND

The Lake Sturgeon (*Acipenser fulvescens*) is a large freshwater fish belonging to an evolutionarily ancient family. They are native to the Hudson Bay, Great Lakes, and Mississippi drainages in North America. The first assessment of this species by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) was conducted in 2006. Based on COSEWIC's guidelines for recognizing Designatable Units (DUs), Lake Sturgeon in Canada were divided into eight DUs (COSEWIC 2006). COSEWIC assessed Lake Sturgeon again in 2017. Based on an improved understanding of population genetics across the Canadian range, the number of DUs was reduced from eight to four, following national freshwater biogeographic zones (COSEWIC 2017). The four DUs identified in the 2017 COSEWIC assessment include (Figure 1):

- Western Hudson Bay populations (DU1);
- Saskatchewan-Nelson River populations (DU2);
- Southern Hudson Bay-James Bay populations (DU3); and
- Great Lakes-Upper St. Lawrence populations (DU4).

COSEWIC (2017) classified the Western Hudson Bay (DU1) and Saskatchewan-Nelson River populations (DU2) as Endangered, the Great Lakes-Upper St. Lawrence populations (DU4) as Threatened, and the Southern Hudson Bay-James Bay populations (DU3) as Special Concern. Information in this document is intended to be used to evaluate recovery potential for Lake Sturgeon in DU1, DU2, and DU4. As Recovery Potential Assessments are not developed for species of Special Concern, Lake Sturgeon in DU3 are not specifically discussed in this document.

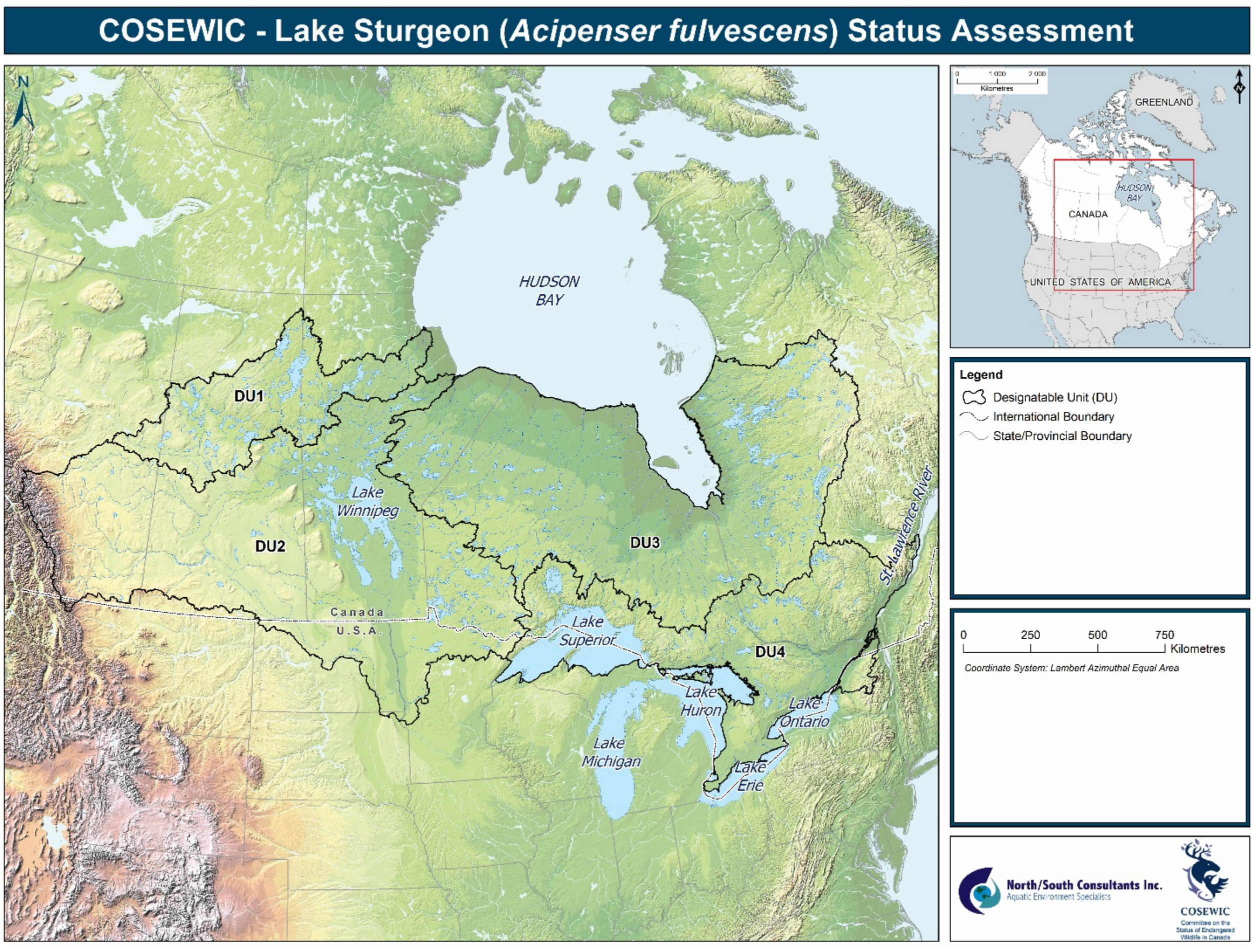

Figure 1. Designatable Units of Lake Sturgeon in Canada (COSEWIC 2017).

SPECIES BIOLOGY AND ECOLOGY

SPECIES DESCRIPTION

COSEWIC (2017) provided a summary of the physical characteristics of Lake Sturgeon. Lake Sturgeon is a large, benthic, freshwater fish that inhabits larger rivers and lakes. Physical characteristics include:

- A large, torpedo-shaped body with a single dorsal fin and a heterocercal tail;
- Cartilaginous vertebrae that lack a centrum and a notochord that extends into the tail;
- An extended snout with a ventral protrusible mouth and four barbels anterior to the mouth; and
- Five rows of lateral bony scutes, which are sharp in juveniles and smooth in adults.

Young Lake Sturgeon have olive, brown, grey, or black blotches, which are lost as they grow larger. Larger juveniles and adults are uniform light to dark shades of grey or brown, with lighter ventral surfaces. Colour can vary among waterbodies.

DISTRIBUTION

A detailed description of the Lake Sturgeon's distribution in Canada was provided in COSEWIC (2017). Lake Sturgeon are found exclusively in North America, in the Hudson Bay, Great Lakes, and Mississippi drainages. Their Canadian range extends from Alberta in the west to Quebec in the east; Churchill River in the north, and the United States border to the south. More specifically, Lake Sturgeon are found as far west as the North and South Saskatchewan rivers in Alberta and as far east as the St. Lawrence River at Saint-Roch-des-Aulnaies in Quebec, where salinity exceeds tolerance levels of the species. In the northwestern extent of their distribution, Lake Sturgeon are found in the Churchill River from Kettle Falls in Saskatchewan to the river's outlet in Hudson Bay, Manitoba. In the northeast, Lake Sturgeon are found in the La Grande, Rupert, Harricana, Nottaway, Broadback, Eastmain, and Opinaca rivers and tributaries on the east side of James Bay. To the south, Lake Sturgeon are found in several waterbodies shared with the United States (e.g., Rainy River, the Great Lakes and St. Lawrence River).

REPRODUCTION

A detailed description of Lake Sturgeon reproduction was provided in COSEWIC (2017). Lake Sturgeon reproduction is characterized by delayed maturation, which allows them to grow to a large size relatively quickly. Males generally mature at a younger age than females, with males maturing between age 12 and 20 and females between age 15 and 30. Males typically spawn every 1–3 years, while females spawn every 2–7 years.

Lake Sturgeon spawn during spring when water temperatures are between 8 and 22°C. Lake Sturgeon are broadcast spawners, with females releasing their eggs into the water column to be fertilized by one or more males. Males typically arrive at the spawning grounds first, and remain for the duration of the spawning period, potentially spawning with multiple females. Female Lake Sturgeon are highly fecund, with a 30 kg fish expected to produce approximately 350,000 eggs. Reproductive senescence has not been reported for Lake Sturgeon.

Fertilized eggs adhere to the substrate and depending on water temperature, will hatch within 5–20 days. After hatching, larvae burrow into the interstitial spaces in the substrate until the yolk-sac is absorbed. Larvae typically emerge from the substrate 10–14 days post-hatch and passively drift downstream to nursery areas.

DIET AND GROWTH

A detailed description of Lake Sturgeon diet and growth is provided in COSEWIC (2017) and Barth et al. (2018) and is summarized in the following section.

Lake Sturgeon are carnivorous benthic generalists, and consume a wide variety of prey. Ontogenetic shifts in diet are characteristic of the species.

Age-0 Lake Sturgeon feed on zooplankton and as they grow larger, the diet expands to include a variety of invertebrates such as insect larvae, amphipods, crayfish, leeches, and molluscs (including Zebra Mussel [*Dreissena polymorpha*]). Juveniles have also been found to consume fish eggs and small fishes. Juveniles typically "graze" on or close to the benthos and consume any small organisms they encounter.

Adult Lake Sturgeon consume similar food items as juveniles; however, the diet may consist of a higher proportion of juvenile fish and fish eggs. Fish are not a major component of the diet in all areas; however, there has been evidence that Lake Sturgeon will selectively feed on fish when they are available.

Lake Sturgeon grow quickly during their first year of life depending on local factors such as temperature, water velocity, and density of conspecifics (McDougall et al. 2018). Growth during the young juvenile phase (i.e., 1–9 years) may be largely dependent on either *in situ* production and/or invertebrate drift as movement during this life-stage is limited in most systems. Factors such as water velocity and density of conspecifics have been suggested as the primary drivers of growth variation at this stage (McDougall et al. 2018). There is a pronounced slowing of growth as Lake Sturgeon reach maturity as growth shifts to a logarithmic-type growth pattern.

PHYSIOLOGY

Lake Sturgeon physiology was summarized in COSEWIC (2006) and COSEWIC (2017). Lake Sturgeon can survive in a broad range of water temperatures. Laboratory studies have shown that juveniles will grow in temperatures ranging from 4–25°C. In northern populations, Lake Sturgeon survive at temperatures of just above 0°C for up to 6 months of the year. Although the upper temperature threshold is unknown, it is thought that temperatures between 28 to 30°C are less suitable. Large Lake Sturgeon have been known to move into brackish water in Hudson Bay and the St. Lawrence River, as long as salinities do not greatly exceed 15 ppt; smaller fish are less salt-tolerant.

SPECIAL SIGNIFICANCE

The Lake Sturgeon has a rich, historical significance to Indigenous peoples. The species was commercially harvested across much of its range during the late 19th and early 20th centuries and is still harvested by Indigenous peoples throughout their Canadian range. At present, the St. Lawrence River commercial fishery in Quebec is the only remaining commercial fishery in North America. Lake Sturgeon are harvested for both their meat and caviar. Additionally, the large size of Lake Sturgeon makes them prized by trophy anglers, mainly for catch-and-release fishing (COSEWIC 2017).

ASSESSMENT – DU1

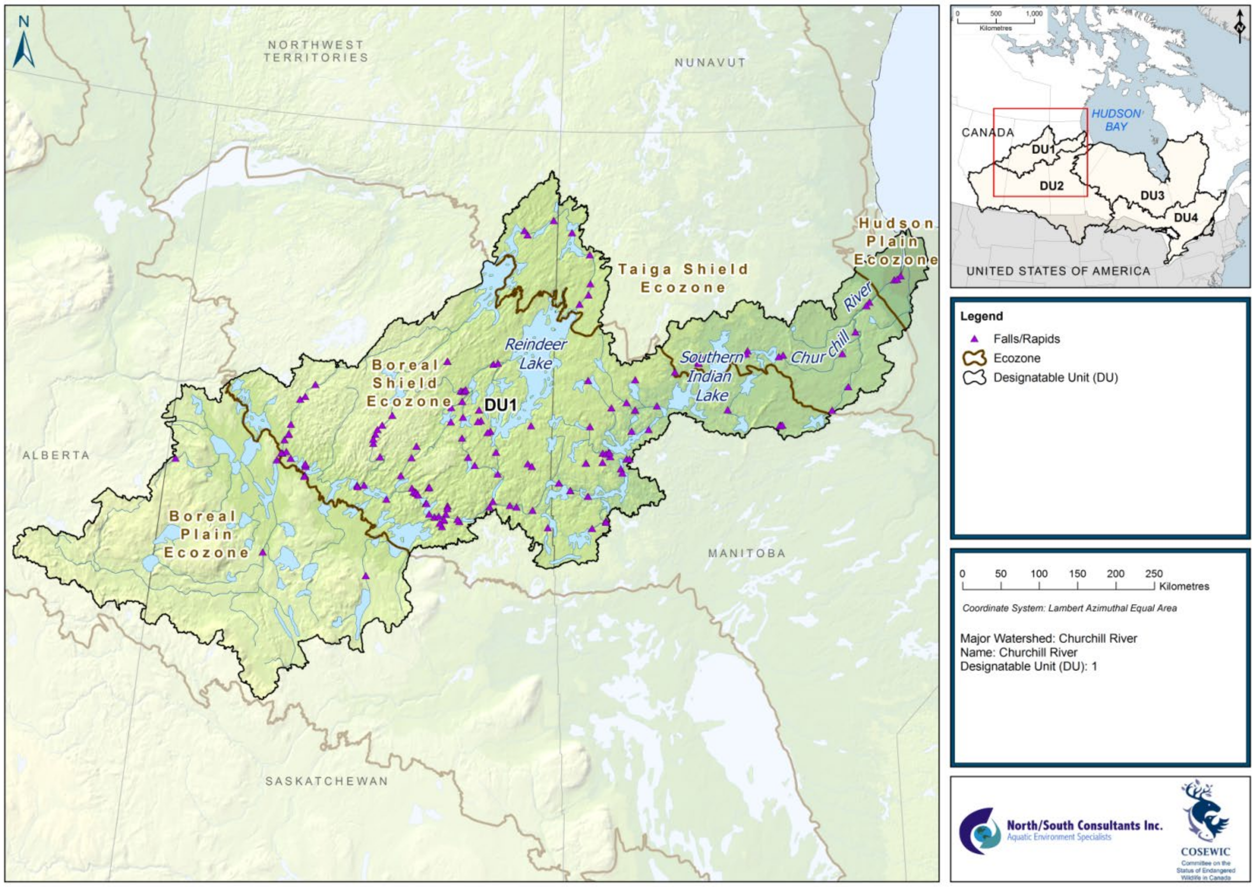

Figure 2. Western Hudson Bay aquatic ecoregion (DU1) showing the terrestrial ecozones and locations of officially named rapids and falls.

HISTORICAL AND CURRENT ABUNDANCE, DISTRIBUTION AND TRENDS

Within the Western Hudson Bay drainage, Lake Sturgeon inhabit the Churchill River drainage in Saskatchewan and Manitoba (Figure 2). Lake Sturgeon may also inhabit northern river systems along the west coast of Hudson Bay, but there have been no studies to corroborate this (Cleator et al. 2010a). Commercial fishing records from Manitoba and Saskatchewan suggest that harvest in DU1 may have contributed to a significant population decline in the Churchill River between 1920 and 1939 (COSEWIC 2006, Cleator et al. 2010a)

COSEWIC (2017) and Cleator et al. (2010a) established three Management Units for DU1 (Figure 3):

- Atik Falls on the Reindeer River and Kettle Falls on the Churchill River to Island Falls Hydroelectric Station (HS) (MU1);
- Island Falls HS to Missi Falls Control Structure (CS) (MU2); and
- Missi Falls CS to the Churchill River Estuary (MU3).

Kettle Falls to Island Falls GS (MU1)

MU1 is comprised of 112 km of river habitat on the Reindeer and Churchill rivers (Barth et al. 2018). Historically, there were reports of Lake Sturgeon below Kettle Falls on the Churchill River and Atik Falls on the Reindeer River (Sawchyn 1975). Harvest records specific to MU1 show small amounts (total of 228 kg) of harvest from Kettle Falls between 1967 and 1986 and a harvest of 39.9 kg from Ourom Lake in 1984 (R. Hlasny, Saskatchewan Ministry of Environment [MOE], unpublished data).

Minimal Lake Sturgeon population assessment work has been conducted in this MU. Lake Sturgeon focused studies have not been conducted upstream of Wintego Rapids, while those conducted between Wintego Falls and Island Falls HS in 2010 and 2011 did not capture any sturgeon (Johnson and Nelson 2011, Nelson and Barth 2011). The last reported Lake Sturgeon catch in this MU occurred downstream of Wintego Rapids in 2002 (Mark Duffy, Saskatchewan DNR, pers. comm.). Based on all available information, Lake Sturgeon abundance in MU1 is considered unknown/low, with an unknown population trajectory (Table 1).

Island Falls HS to Missi Falls CS (MU2)

MU2 spans 430 km of the Churchill River between the Island Falls HS in Saskatchewan to the Missi Falls CS in Manitoba. There is little historical information on the distribution and abundance of Lake Sturgeon in MU2, other than a commercial fishery that occurred between Duck and Pukatawagan lakes circa 1925 (Skaptason 1926). Commercial harvest occurred in MU2 before and during the construction of the Island Falls HS (est 1929), but harvest quantities were not reported (Morin 2002). In 1953, a commercial harvest of approximately 8,500 kg was reported from MU2, but the harvest location remains unknown. Smaller harvests were also reported for the Churchill River between 1953 and 1990, but it is suspected that these harvest quantities were from further downstream in MU3 (Stewart 2009). Reports of Lake Sturgeon in MU2 have been rare since the early 1980s. Isolated captures of large Lake Sturgeon occurred in Granville Lake in 1986 and Pukatawagan Lake in 2003 (Manitoba Hydro and the Province of Manitoba 2015). The capture of a single juvenile in Hughes Lake during an index gillnetting study suggests that Lake Sturgeon may be reproducing in the Hughes Lake/Eden Lake section of MU2 (Manitoba Conservation and Water Stewardship [MCWS], unpublished data). Currently, abundance is considered low with an unknown trajectory (Table 1; COSEWIC 2017).

Missi Falls to Churchill River Estuary (MU3)

MU3 consists of a 440 km long stretch of the Churchill River extending from Missi Falls to the estuary. Due to natural habitat breaks and distinct Lake Sturgeon abundance patterns, COSEWIC (2017) subdivided MU3 into three reaches. The reaches are discussed from upstream to downstream in the following sections.

Missi Falls CS to The Fours

Other than unpublished Manitoba Fisheries Branch Records, there is little historical information on Lake Sturgeon distribution and abundance in the stretch of the Churchill River between Missi Falls CS and The Fours.

Since 2008, several fisheries investigations have been conducted in the reach of the Churchill River between Missi Falls CS and The Fours. Index netting conducted in Partridge Breast, Northern Indian, Fidler, and Billard lakes between 2008 and 2013 resulted in the capture of a single Lake Sturgeon in Billard Lake (CAMP 2017). Further, a targeted Lake Sturgeon study conducted in a 45 km stretch of this reach in 2010 resulted in the capture of one Lake Sturgeon at the outlet of Billard Lake (NSC 2011, Manitoba Hydro and the Province of Manitoba 2015). In

2017, a study targeting adults and juveniles in Billard and Fidler lakes failed to capture any Lake Sturgeon (Ambrose and McDougall 2018).

The Fours to Swallow Rapids (including the Little Churchill River Confluence)

Lake Sturgeon are found throughout the stretch of river between The Fours and Swallow Rapids. Lake Sturgeon in this reach also use the Little Churchill River, and movements have been reported between Recluse Lake and the Churchill River (MacLean and Nelson 2005, Blanchard et al. 2014, CAMP 2014, Manitoba Hydro and the Province of Manitoba 2015, Ambrose and McDougall 2018, D. Macdonald, MCWS, pers. comm). Through the capture of larvae in drift nets, spawning was confirmed in the Little Churchill River, but not in the Churchill River mainstem (NSC 2012).

Small quantities of Lake Sturgeon were commercially harvested near the confluence of the Little Churchill River between 1977 and 1987 (Manitoba Fisheries Branch, unpublished data). Harvest peaked in 1980 when 1,202 kg were harvested, but harvests declined in subsequent years (Manitoba Hydro and the Province of Manitoba 2015). The population of adult Lake Sturgeon was estimated to be 2,005 (95% CI: 1,441–2,569) in 2005, 986 (95% CI: 777–1,252) in 2014, 959 (95% CI: 773–1,192) in 2015, and 1,372 (95% CI: 1,129–1,668) in 2016 (Maclean and Nelson 2005, Ambrose et al. 2017, Ambrose and McDougall 2018). The abundance of all Lake Sturgeon (both adult and juvenile) was estimated to be 1,837 in 2014 (95% CI: 1,568–2,151), 1,647 in 2015 (95% CI: 1,386–1,958), and 2,122 in 2016 (95% CI: 1,829–2,474) (Ambrose et al. 2017). Based largely on data collected from this reach of MU3, adult abundance is considered medium and the population trajectory unknown (Table 1).

Swallow Rapids to Churchill River estuary

There is little to no historical information on Lake Sturgeon distribution and abundance in the Churchill River between Swallow Rapids and the estuary. In 1993, surveys of resource users in the town of Churchill indicated that small numbers of Lake Sturgeon were present in deep holes close to town (Remnant and Bernhardt 1994, Manitoba Hydro and the Province of Manitoba 2015). More recently, small numbers of adults and juveniles were captured downstream of Swallow Rapids in 2013, but these fish may have moved downstream from the higher density reach further upstream (Blanchard et al. 2014). In 2017, a study targeting Lake Sturgeon upstream of the Churchill Weir yielded no Lake Sturgeon captures (Ambrose and McDougall 2018), and an index netting program conducted during the same month captured two juvenile Lake Sturgeon (Manitoba Hydro unpublished data in Ambrose and McDougall 2018). Adult and juvenile abundance in this reach of MU3 is considered low and although juveniles have been captured, it is unknown if recruitment due to spawning within this reach of MU3 is occurring.

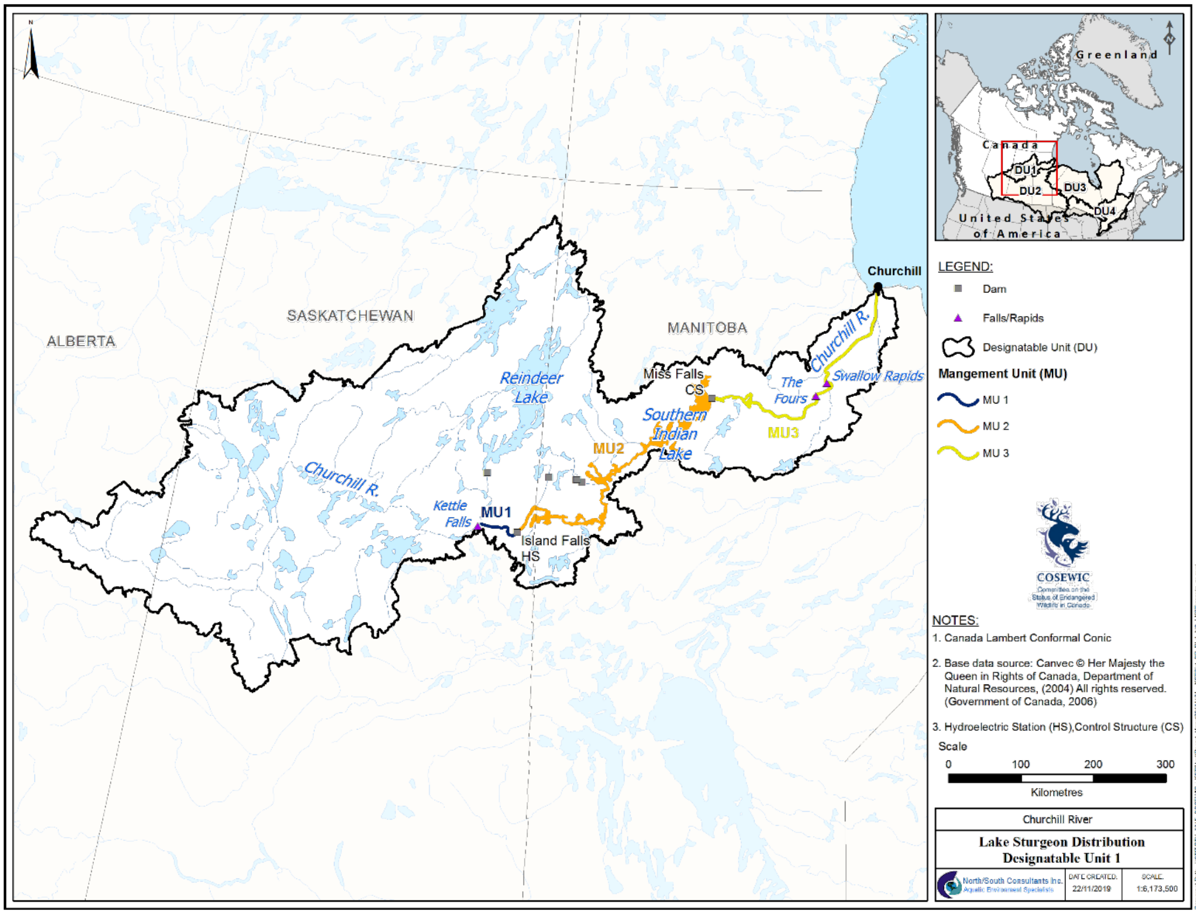

Figure 3. Lake Sturgeon distribution in the Churchill River (DU1), showing the location of current management units.

Population Status Assessment

As part of the 2017 assessment, COSEWIC (2017) assessed adult and juvenile abundance, recruitment and population trajectory for each Lake Sturgeon MU in Canada based on a survey provided to pre-COSEWIC meeting participants. For the purposes of this RPA, some of the categories used in the COSEWIC (2017) document to describe abundance were modified and provided in Table 1 as explained below:

- Adult abundance was assessed as: Extirpated: < 10 individuals; Low: 10–1,000 individuals; Medium: 1,001–5,000 individuals; High: > 5,000 individuals; or Unknown.
- Population trajectory was assessed as: Increasing (an increase in abundance over time), Stable (no change in abundance over time), Decreasing (a decrease in abundance over time) or Unknown. Population trajectories were derived during the 2017 COSEWIC assessment. Sources consulted during the determination of population trajectories can be found in Table 2 of the COSEWIC document (COSEWIC 2017).
- Population estimates were provided where they exist or designated Not Derived (ND).

Abundance categories and associated ranges were based on updated population modelling (van der Lee and Koops 2021) that assessed cumulative extinction probabilities for five different growth patterns. In terms of the abundance categories discussed here, population modelling results suggested that the probability of extinction in 500 years was improbable for populations > 5,000, between 0 and 20% for populations of 1,000–5,000 individuals, between 10 and 90% for populations of 50–1,000 individuals, and greater than 95% for populations < 10 individuals.

The assessments for DU1 by MU follow below:

Table 1. Population Estimate, Qualitative Abundance, and Population Trajectory for Lake Sturgeon populations in DU1.

MU	Area	Population Estimate	Qualitative Abundance Category	Population Trajectory
MU1	Atik Falls to Island Falls HS	ND	Unknown	Unknown
MU2	Island Falls HS to Missi Falls CS	ND	Low	Unknown
MU3	Missi Falls CS to the estuary	2,122 (adult and juvenile)	Medium	Unknown

The Adult Abundance and Population Trajectory values were combined in the Population Status Matrix (Table 2) to determine the Population Status (Poor, Fair, Good, Unknown, or Extirpated). The Population Status for MU1 was assessed as Unknown, and for MUs 2 and 3 as Poor (Table 3).

Table 2. The Population Status Matrix combines the Relative Abundance Index and Population Trajectory rankings to establish the Population Status for Lake Sturgeon. The resulting Population Status has been categorized as Poor, Fair, Good, Unknown or Extirpated.

		Population Trajectory			
		Increasing	Stable	Decreasing	Unknown
Adult Abundance	Low	Poor	Poor	Poor	Poor
	Medium	Fair	Fair	Poor	Poor
	High	Good	Good	Fair	Fair
	Unknown	Unknown	Unknown	Unknown	Unknown
	Extirpated	Extirpated	Extirpated	Extirpated	Extirpated

Table 3. Population Status of Lake Sturgeon populations in DU1 by MU.

MU	Area	Population Status
MU1	Atik Falls to Island Falls HS	Unknown
MU2	Island Falls HS to Missi Falls CS	Poor
MU3	Missi Falls CS to the Estuary	Poor

ASSESSMENT – DU2

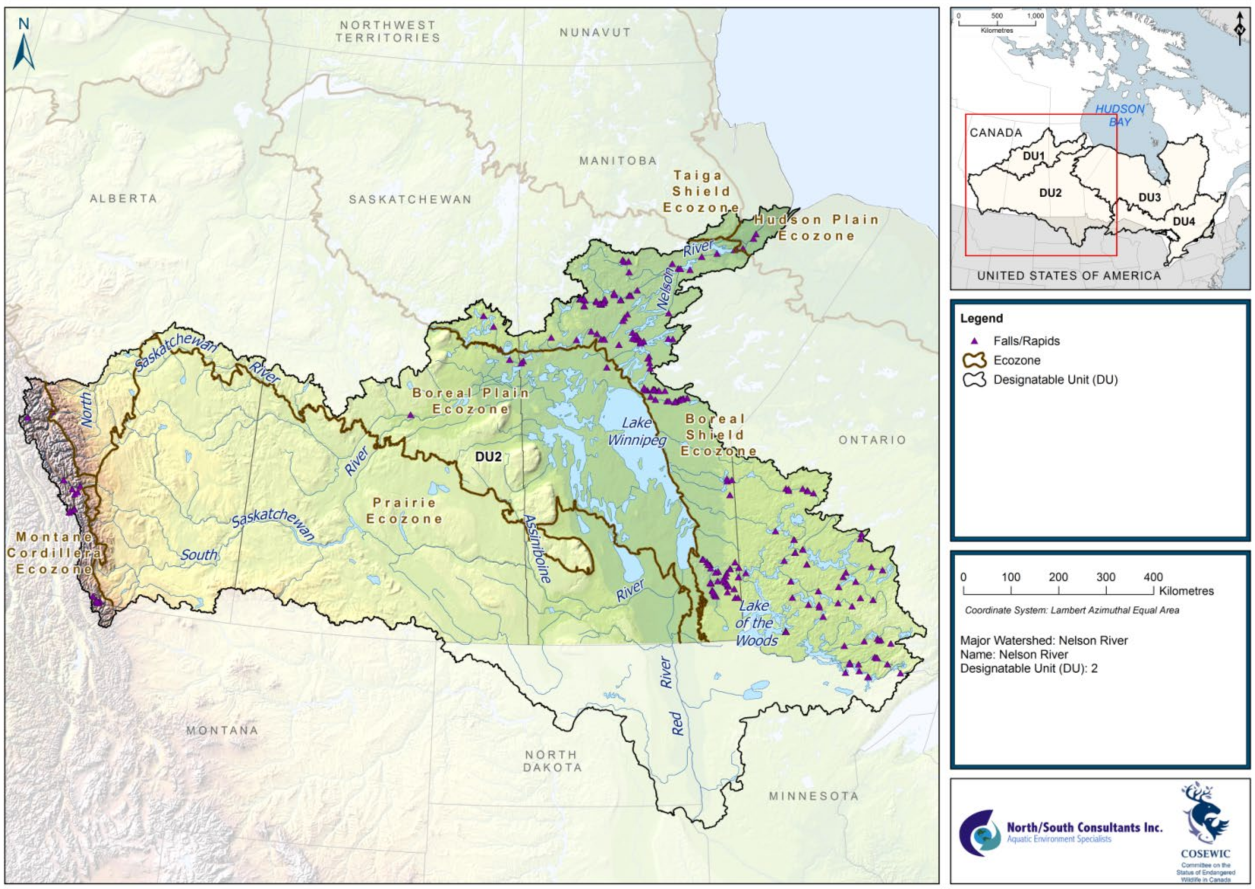

Figure 4. Saskatchewan-Nelson River (DU2) showing the terrestrial ecozones and locations of officially named rapids and falls.

HISTORICAL AND CURRENT ABUNDANCE, DISTRIBUTION AND TRENDS

DU2 is comprised of five previously separate DUs from the 2006 COSEWIC assessment: Saskatchewan River populations (formerly DU2), Nelson River populations (formerly DU3), Red-Assiniboine rivers and Lake Winnipeg populations (formerly DU4), Winnipeg River-English

River populations (formerly DU5), and Lake of the Woods-Rainy River populations (formerly DU6) (Figure 4). Previously identified MUs from each system (Cleator et al. 2010a-e) have been maintained to facilitate integrating new data.

Saskatchewan River Drainage

The Saskatchewan River Drainage was previously designated as DU2. For the purposes of this assessment, it was split into four management units (Figure 5):

- MU1 consists of approximately 1,656 barrier-free river kms including the reach of the North Saskatchewan River from the Bighorn GS to The Forks ~ 1,195 km, the reach of the South Saskatchewan River from Coteau Creek HS to The Forks ~ 358 km and the reach of the Saskatchewan River from The Forks to Nipawin HS ~ 103 km;
- MU2 consists of approximately 1,142 kms of river and lake habitat comprised of 602 kms of the South Saskatchewan River from the confluence of the Bow and Oldman rivers in Alberta to the northern outlet of Lake Diefenbaker in Saskatchewan upstream of Coteau Creek HS, 320 km of the Oldman River upstream of the South Saskatchewan River confluence to the Oldman Dam, 170 km of the Bow River upstream of the South Saskatchewan River confluence to the Bassano Dam, and 50 km of the Red Deer River from the South Saskatchewan River confluence to the Dickson Dam at Red Deer, AB;
- MU3 consists of approximately 70 km of combined riverine and lacustrine habitat between the Nipawin HS and E.B. Campbell HS of which Tobin Lake occupies the final 75%; and
- MU4 consists of 427 kms of combined riverine and lacustrine habitat in the Saskatchewan River between the E.B. Campbell HS and Grand Rapids GS.

MU1: North Saskatchewan River, South Saskatchewan River Downstream of Coteau Creek HS, Saskatchewan River from The Forks to the Nipawin HS

In the North Saskatchewan River, Lake Sturgeon have been observed as far as 10 km upstream of Rocky Mountain House, Alberta, but are most commonly found in the lower 475 km of the river. There are historical records of sturgeon in the Brazeau River, southwest of Edmonton (Nelson and Paetz 1992, Saunders 2006). Watkins (2016) tracked movements of 58 Lake Sturgeon in the North Saskatchewan River and found they used the entire section from Drayton Valley, Alberta, to the Saskatchewan border, some moving more than 925 km. Captures of Lake Sturgeon by anglers have been reported in various locations between the Saskatchewan border and the Forks, most commonly from Lloydminster, North Battleford, and Prince Albert (Figure 5; Smith 2003).

In the South Saskatchewan River, the 100 km long reach immediately downstream of the Coteau Creek HS is presently not considered suitable Lake Sturgeon habitat because of low water temperatures associated with deep water releases from Lake Diefenbaker and the scarcity of suitable food (Smith 2003). Lake Sturgeon have been captured between Saskatoon and The Forks in small numbers (Smith 2003).

In the Saskatchewan River between The Forks and the Nipawin HS, Lake Sturgeon are found at the Forks year-round, and there is evidence of spawning in the North Saskatchewan River approximately 12 km upstream of The Forks (Environnement Illimité Inc. 2012, Pollock 2012, Wishingrad et al. 2014). Both adults and juveniles have been found as far downstream as Codette Lake, upstream of the Nipawin HS (Barth et al. 2018, Braun et al. 2018).

Little is known about the abundance of Lake Sturgeon in MU1 prior to 1991. The most current population estimate (Paul 2013) was derived from angler recapture data in the North Saskatchewan River in Alberta. The estimate split the North Saskatchewan into two sections:

the upstream reach from Drayton Valley to Smoky Lake where the population was estimated at 2,681 individuals, and the downstream reach from Smoky Lake to the Alberta border where the population was estimated at 3,673 individuals (Hegerat and Paul 2013). Lake Sturgeon abundance in both of these reaches is considered medium, and the population trajectory is stable or increasing (Table 4).

The most recent population estimate from the vicinity of The Forks (including the lower stretches of the North and South Saskatchewan rivers and the Saskatchewan River up to Codette Lake) was derived in 2011 and estimated to be 4,197 adults (Pollock 2012). Juvenile Lake Sturgeon have been found in high abundances in the Saskatchewan River at the upstream end of Codette Lake. Targeted juvenile Lake Sturgeon studies conducted during the fall of 2014 and 2015 captured 321 Lake Sturgeon in 11 overnight sets (mean catch-per-unit-effort [CPUE]: 29.2 LKST/overnight set; Henderson et al. 2015c, 2016). Lake Sturgeon abundance in this reach is considered medium, and the population trajectory is classified as stable or increasing (Table 4).

South Saskatchewan River upstream of Coteau Creek HS (MU2)

Little information is available regarding the historical distribution of Lake Sturgeon within MU2. Lake Sturgeon are currently found throughout the Alberta portion of this MU in the South Saskatchewan River, the Oldman River, the Red Deer River, and the Bow River up to the dams that prevent upstream passage (Figure 5; Lacho 2013, Thayer 2016). From 2010 to 2014 a movement study led by the province of Alberta and DFO tagged 123 Lake Sturgeon and monitored their movements in the Oldman, Bow, Red Deer, and South Saskatchewan rivers (1,100 rkm study area; Lacho 2013). Fish moved extensively in the Bow River upstream to Bassano Dam, the Oldman River upstream to the Lethbridge Weir (15 fish moved upstream of the weir) and utilized the entire reach of the South Saskatchewan River from the confluence of the Bow and Oldman rivers downstream to Lake Diefenbaker. Only one fish moved upstream into the Red Deer River (Lacho 2013).

In 2010, a Lake Sturgeon was captured in a pond on a Red Deer golf course which, if it originated in the Red Deer River, would represent the farthest upstream occurrence recorded in the river (ALSRT 2011). Within the Saskatchewan portion of the river, the majority of reported Lake Sturgeon captures are from the area near Leader, approximately 35 km downstream of the confluence of the Red Deer River with the South Saskatchewan River (Smith 2003).

The most recent population estimate derived from tagging information collected by anglers, for the South Saskatchewan River from the confluence of the Bow and the Oldman rivers to the Alberta border suggested that the population was comprised of 6,464 individuals (Paul 2013). Based on these data, Lake Sturgeon abundance in MU2 is considered high, and the population trajectory as stable or increasing (Table 4).

Saskatchewan River Nipawin HS to E.B. Campbell HS (MU3)

There is no historical information specific to Lake Sturgeon in MU3 although this reach has been used as a source for eggs and milt for stocking initiatives in other MUs (Ron Hlasny, Saskatchewan MOE, pers. comm.). Population estimates have not been derived; however, recent studies suggest that an actively recruiting population spawns below the Nipawin HS and uses the Saskatchewan River downstream of Nipawin HS into Tobin Lake (Gillespie et al. 2015). Lake Sturgeon abundance in MU3 is considered low, and the population trajectory unknown (Table 4).

Saskatchewan River E.B. Campbell HS to Cedar Lake (MU4)

In the Saskatchewan portion of MU4, Lake Sturgeon were historically found in Cumberland Lake, the Torch River, Tearing River, and in Namew Lake. Downstream, in Manitoba, Lake

Sturgeon were found from the Saskatchewan border to the Grand Rapids GS (Cleator et al 2010b). Telemetry and mark-recapture studies have suggested Lake Sturgeon use the entire reach and spawn at the E.B. Campbell tailrace, Bigstone Rapids, Torch River, Missipuskiow River, Mossy River, and in the vicinity of the islands located in the north end of Cumberland Lake (Wallace 1999, Gillespie et al. 2015). Recent gillnetting studies conducted between E.B. Campbell and Cedar Lake captured juvenile Lake Sturgeon throughout the reach (Nelson and Johnson 2016, Burnett et al. 2017). Lake Sturgeon focused studies have not been conducted within Cedar Lake proper; however, Lake Sturgeon have been captured in small numbers during experimental gillnetting programs (Jansen and Maclean 2006, Jansen and Dawson 2007).

Prior to the commercial fishery that started in the late 1800s, Lake Sturgeon populations were thought to be large in MU4 (COSEWIC 2017). This MU has been managed since 1994 by the Saskatchewan River Sturgeon Management Board (SRSMB) which is comprised of local First Nations from Saskatchewan and Manitoba, provincial regulators from Manitoba and Saskatchewan, SaskPower, and Manitoba Hydro. Fry and fingerlings were stocked in 1999 and 2000 (Cleator et al. 2010b), but it is uncertain whether these have had any effect on the observed population growth.

The current population estimate, based on mark-recapture data (1994 to 2014), suggests the population is increasing (estimate 3,099 adult Lake Sturgeon) (Nelson 2015). Juvenile Lake Sturgeon were also captured in this stretch of the river in 2015 (n = 149) and 2017 (n = 133) and there appears to have been successful spawning and fairly consistent recruitment in this area since 2002 (Nelson and Johnson 2016, Burnett et al. 2017). Lake Sturgeon abundance in MU4 is considered medium, with an increasing population trajectory (Table 4).

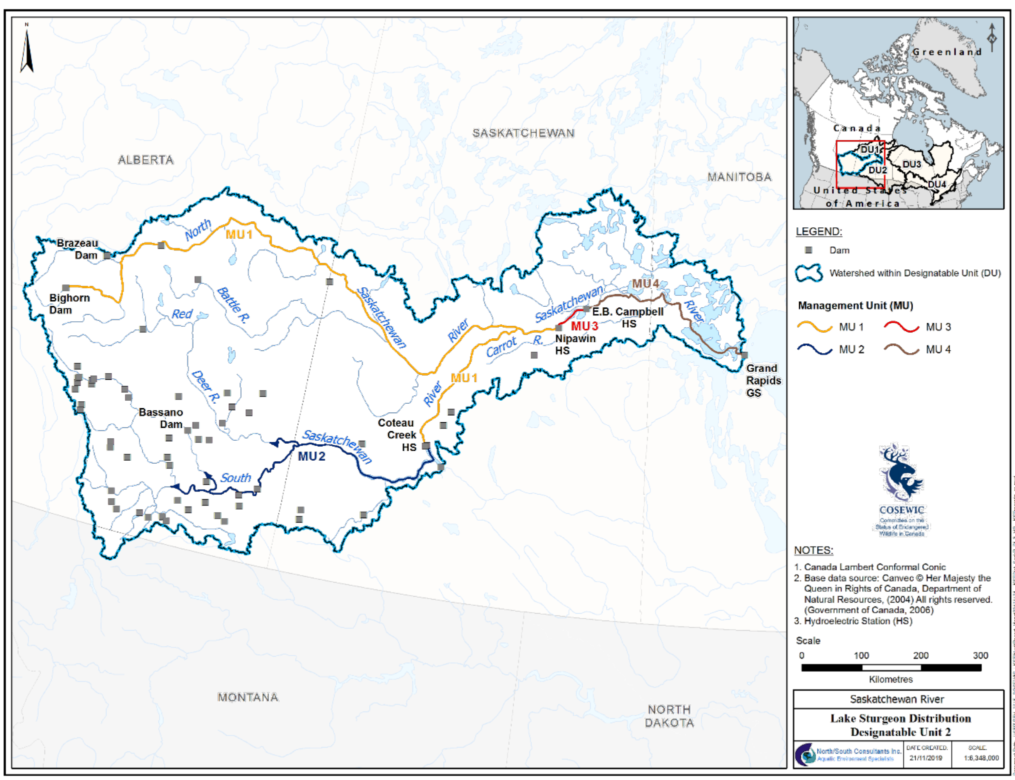

Figure 5. Lake Sturgeon distribution in the Saskatchewan River (DU2), showing the location of current management units.

Assiniboine and Red River Drainages

These drainages were previously assigned to DU4 in the 2006 COSEWIC assessment. In the 2017 COSEWIC assessment, these drainages were considered part of DU2 and subdivided into three management units. However, for the purposes of this assessment and to remain consistent with how MUs have been designated in this document, the MU that included the Red River downstream of Lockport is now considered part a larger MU that includes all of Lake Winnipeg and its inflowing tributaries upstream to impassable barriers. Therefore, the Assiniboine and Red River Drainages are comprised of two distinct management units (Figure 6):

- Assiniboine River and tributaries upstream of the Portage la Prairie Diversion Control Structure (MU1); and
- Red River and tributaries upstream of Lockport, including the Assiniboine River to Portage la Prairie Diversion Control Structure (MU2).

Assiniboine River upstream of the Portage la Prairie Diversion Control Structure (MU1)

Historically, Lake Sturgeon were found in the Assiniboine River and its tributaries. Spawning may have occurred in the Little Saskatchewan River, Souris River, Assiniboine River mainstem downstream of Brandon, and in the Qu'Appelle River. Lake Sturgeon were believed to be completely extirpated from the Assiniboine River circa 1970 (Cleator et al. 2010d).

Between 1996 and 2008, approximately 16,683 Lake Sturgeon (including fry, fingerlings, yearlings, juveniles, and adults) were stocked in the Assiniboine River near Brandon and an additional 15,000 fry were stocked in 2013 (Aiken et al. 2013). Stocked fish have dispersed throughout the river, and have been captured as far upstream as the Qu'Appelle River in Saskatchewan, and as far downstream as Spruce Woods Provincial Park (MCWS 2012).

The abundance of Lake Sturgeon in the Assiniboine River is largely unknown, but appears to be increasing due to stocking. Master angler records have reported 199 adult Lake Sturgeon captures since 2004, including 57 from 2018. In 2013, a Lake Sturgeon inventory was conducted in the Assiniboine River to determine the success of the stocking effort. Twenty-three juvenile and seven adults were captured in the vicinity of Brandon, Manitoba (Aiken et al. 2013). The oldest stocked fish would currently be sexually mature (i.e., 22 years old) but, to date, there is no evidence that stocked fish are reproducing. Lake Sturgeon abundance in this area is considered low, and the population trajectory is increasing due to stocking (Table 4).

Red River and tributaries upstream of Lockport, including the Assiniboine River to Portage la Prairie Diversion Control Structure (MU2)

Little historical information specific to Lake Sturgeon exists for the Assiniboine River downstream of the Portage la Prairie Diversion Control Structure (MU2). Lake Sturgeon have recently been captured by anglers on the Assiniboine River within the Winnipeg city limits (Barth et al. 2018). Stocking occurred in the lower Assiniboine River near Whitehorse Plains in 1997 (Cleator et al. 2010d).

Similar to the Assiniboine River, historical information for the Red River is limited. Lake Sturgeon likely spawned in the Roseau, Rat, La Salle, and Seine rivers. By the mid-1900s, Lake Sturgeon were considered extirpated from the Red River (Cleator et al. 2010d). Stocking on the US portion of the Red River drainage has been underway since 1997 and captures have been reported throughout the Red River in Manitoba in recent years (MCWS 2012).

The current abundance of Lake Sturgeon in MU2 is poorly understood as there has been no Lake Sturgeon-focused research conducted in recent years (Barth et al. 2018). Angler reports of Lake Sturgeon captures have increased over the last decade, some of which are known stocked fish (MCWS 2012). To date, there is no conclusive evidence of stocked fish reproducing in the river, although these fish are approaching the age of maturity (Barth et al. 2018). Lake Sturgeon abundance in this area is low, and the population trajectory is increasing due to stocking (Table 4).

Lake Winnipeg and inflowing Tributaries

Lake Winnipeg and Tributaries Downstream of Impassable Barriers (MU1)

Historically, Lake Sturgeon were present in Lake Winnipeg and its associated tributaries in large numbers. Between 1876 and 1989, 3,221,958 kg (marketed weight) of Lake Sturgeon were harvested from Lake Winnipeg, with harvest peaking in 1900 at 445,110 kg (Harkness 1980). Specific harvest locations are unknown and there are no historical abundance data specific to Lake Winnipeg tributaries. Lake Sturgeon are currently present in Lake Winnipeg, but there are no current abundance data available for Lake Winnipeg proper (Barth et al. 2018).

Lake Sturgeon are known to inhabit the lower Winnipeg River between the Pine Falls GS and Lake Winnipeg. A study conducted in 2013 captured 54 Lake Sturgeon in this river reach and found that Lake Sturgeon continue to spawn downstream of the Pine Falls GS (Lowdon and Queen 2013). It is likely that several hundred fish occupy this area (D. Watkinson, DFO, pers. comm.). Additionally, a movement study led by DFO in 2016 captured and tagged 42 Lake Sturgeon below the Pine Falls GS (D. Watkinson, DFO, pers. comm.). To date, Lake Sturgeon movement has been mostly restricted to the Winnipeg River and Traverse Bay, with limited movement around Elk Island in the south basin of Lake Winnipeg. As of spring 2019, after 2+ years of monitoring, only two fish have made extensive movements into the lake (D. Watkinson, DFO, pers. comm.).

Lake Sturgeon are known to be present in the Red River downstream of the St. Andrews Lock and Dam in Lockport, although little historical information exists for this area. Lake Sturgeon were considered extirpated from the Red River by the mid-1900s (Cleator et al. 2010d). Stocking on the U.S. side of the Red River drainage has been underway since 1997. Over the past decade, angler reports of Lake Sturgeon catches downstream of Lockport, including fish stocked in Minnesota, have increased (Barth et al. 2018). Lake Sturgeon have also been observed during electrofishing surveys below the St. Andrews Lock and Dam (D. Watkinson, DFO, pers. comm.). Results from a recent movement monitoring study in the Red River suggest that Lake Sturgeon move throughout the entire reach between Lockport and Lake Winnipeg, with the St. Andrews Lock and Dam likely acting as a barrier to upstream movement (D. Watkinson, DFO, pers. comm.). One Lake Sturgeon tracked in the lower Red River during the first year of the study (2016) and two additional fish tagged in 2017 have remained in the river (D. Watkinson, DFO, pers. comm.).

Several unregulated tributaries, including the Bloodvein, Pigeon, Berens, and Poplar rivers flow from the east into Lake Winnipeg and are known to contain Lake Sturgeon populations between Lake Winnipeg and the most downstream set of impassable falls or rapids. The downstream reaches of these rivers have not been affected by industrial development, although subsistence harvest occurs in each tributary (MCWS 2012). Two juvenile Lake Sturgeon were captured as part of a fisheries assessment conducted in a small section of the Pigeon River, 8 km upstream of Lake Winnipeg in 2014, indicating recruitment is occurring (NSC 2014). Commercial harvest in Lake Winnipeg would have undoubtedly affected populations that used the downstream reaches for spawning. There is no historical or current abundance data specific to these tributaries.

Overall, Lake Sturgeon abundance in MU1 is considered low, with an unknown population trajectory, although the population in the Red River is increasing due to stocking (Table 4).

Lake Winnipeg East Side Tributaries Upstream of Impassable Barriers (MU2)

As previously mentioned, although Lake Sturgeon are reported to be present within the tributaries on the east side of Lake Winnipeg, there is little contemporary information regarding abundance or population trajectory upstream of impassable barriers on these rivers. With the exception of the Ontario portion of the Berens River system, these rivers have not been subject to commercial harvest or affected by industrial development, although subsistence harvest occurs in each tributary (MCWS 2012).The only population estimate from MU2 comes from the Round Lake portion of the Pigeon River, which was estimated to have a population of 800–1,050 fish between 1996–1998, with very few spawning females (Block 2001). The upper Berens River in Ontario was sampled in 2010, and 11 Lake Sturgeon were captured (Haxton et al. 2014b). Population trajectories for the east side tributaries upstream of impassable barriers are currently classified as unknown (Table 4).

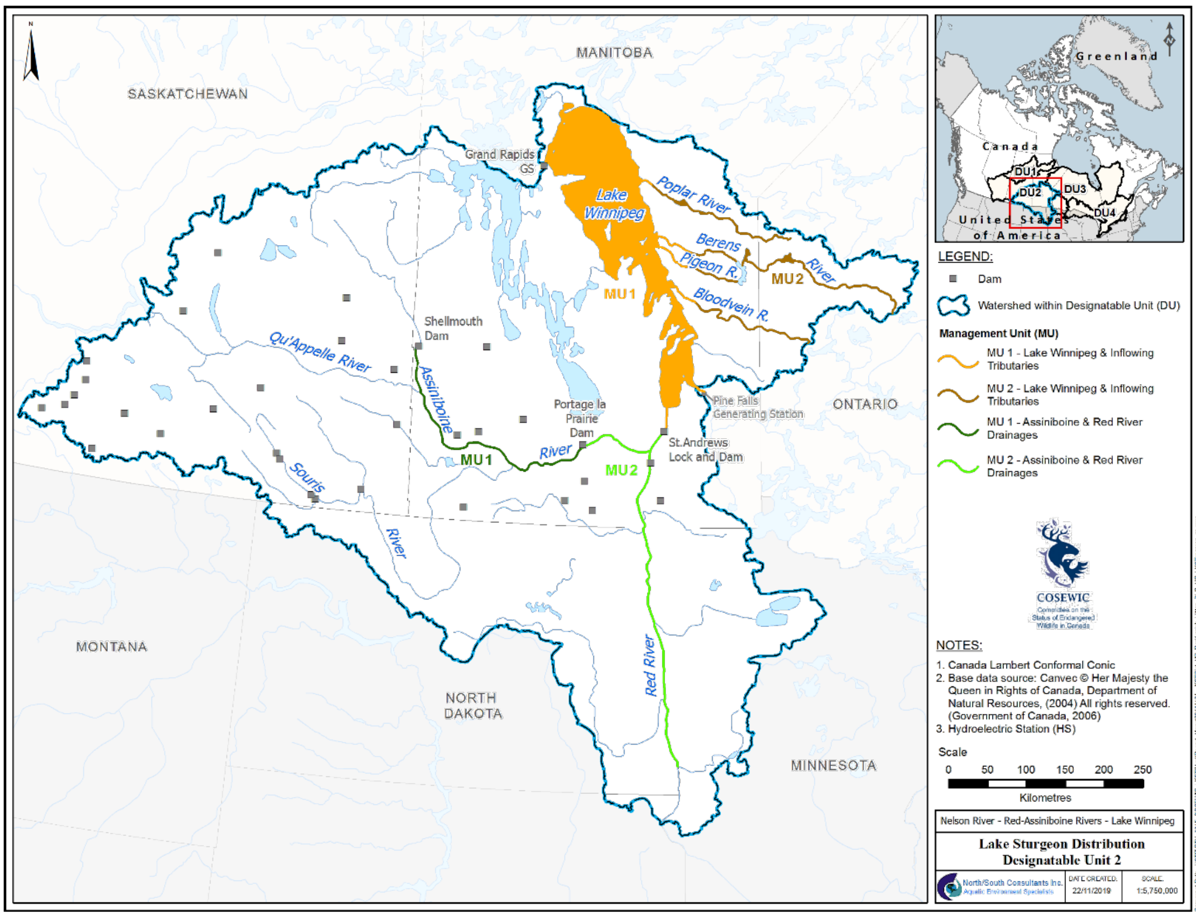

Figure 6. Lake Sturgeon distribution in the Red-Assiniboine Rivers-Lake Winnipeg (DU2), showing the location of current management units.

Winnipeg River-English River

In the COSEWIC 2006 assessment, the Winnipeg-English rivers were designated as a distinct DU (DU5). In the 2017 COSEWIC assessment, these rivers were considered part of DU2 and divided into nine MUs (Figure 7):

- Wabigoon River (MU1) – the main tributary of the English River;
- English River: Manitou Falls GS–Caribou Falls GS (MU2). Includes a chain of seven lakes and spans a distance of 142 km;
- Winnipeg River: Norman GS–Whitedog Falls GS (MU3). A 45 km reach that contains a mixture of riverine and lake/reservoir habitats;
- Winnipeg/English River: Caribou Falls GS and Whitedog Falls GS–Pointe du Bois GS (MU4). A 81 km reach of river/lake/reservoir of which 46 km is located in Manitoba and 35 km in Ontario;
- Winnipeg River: Pointe du Bois GS–Slave Falls GS (MU5). A small reservoir reach 10 km long;
- Winnipeg River: Slave Falls GS–Seven Sisters GS (MU6). A 41 km long reach defined by a series of upstream lakes and a downstream reservoir separated by hydraulic gradients of low to moderate severity;
- Winnipeg River: Seven Sisters GS–MacArthur GS (MU7). A 35 km long reach that includes Lac du Bonnet;
- Winnipeg River: MacArthur GS–Great Falls GS (MU8). A small reservoir reach, only 8.5 km long; and
- Winnipeg River: Great Falls GS–Pine Falls GS (MU9). A 20 km long reach consisting of a mix of riverine and reservoir habitat.

Wabigoon River (MU1)

There are no confirmed current or historical records of Lake Sturgeon occurring in the Wabigoon River (Barth et al. 2018). Lake Sturgeon abundance and population trajectory are both unknown (Table 4).

English River: Manitou Falls GS–Caribou Falls GS (MU2)

Little historical or current information for MU2 exists, although Lake Sturgeon were known to occur historically below Manitou Falls GS as well as in Lake St. Joseph (Cleator et al. 2010e). The reach was sampled briefly in 2011 and 2012 and both juveniles and adults were captured (J. Peacock, Ontario Ministry of Natural Resources and Forestry (OMNRF), pers. comm.). Lake Sturgeon abundance in this area is considered low, and the population trajectory is unknown (Table 4).

Winnipeg River: Norman GS–Whitedog Falls GS (MU3)

During the 1890s, hydroelectric development began in the Winnipeg River in Ontario. The Norman GS was constructed at the outlet of Lake of the Woods in 1898 and the Kenora Dam followed in 1906. In addition, the Kenora Pulp and Paper Mill began its operations in this reach in 1924. Between 1924 and 2005, mill operations resulted in the deposition and accumulation of wood fibre, wood chips, and bark on the bottom of the river (McKenzie 1930, Gill et al. 2018). At the downstream extent of this reach, the Whitedog Falls GS was built in 1957. Likely due to the combination of harvest, hydro development, and the pulp and paper industry the Lake Sturgeon population in this reach had all but disappeared by 1965 (Harris et al. 2000). Over the next 35 years (between 1965 and 2000), there were 12 documented records of Lake Sturgeon from this river reach (Harris et al. 2000).

Some focused Lake Sturgeon work has occurred in this MU since the early 2000s. No Lake Sturgeon were captured in gill nets set over a six-year period in the early 2000s (Cleator et al. 2010e). Intensive gill netting in 2008 and 2009 resulted in the capture of two adult sturgeon downstream of the Norman Dam, while no Lake Sturgeon were captured in gillnetting conducted in this area in 2014 (Cleator et al. 2010e, Johnson et al. 2014). In addition, hatchery-reared Lake Sturgeon (Rainy River brood stock) have been released in MU3, but it is not known if these fish survived (J. Peacock, OMNRF, pers. comm.). Most recently, in 2017 and 2018, adult Lake Sturgeon from the Rainy River have been tagged with acoustic transmitters and released into this MU (J. Peacock, OMNRF, pers. comm.). Lake Sturgeon abundance in this area is considered low, and the population trajectory is increasing due to adult translocations (Table 4).

Winnipeg/English River: Caribou Falls GS and Whitedog Falls GS–Pointe du Bois GS (MU4)

Although specific harvest locations are largely unknown, the Manitoba portion of the Winnipeg River was subject to a large commercial harvest in the early 1900s. A Lake Sturgeon conservation closure that makes harvest illegal was established from the Manitoba/Ontario border downstream to the Pine Falls GS in 1994 and it remains in place today (Barth et al. 2018).

Little historical information exists specific to MU4. Eaglenest Lake was at one time reported to be the best Lake Sturgeon fishing ground in southern Manitoba (McLeod 1943). As recently as the 1970s, large quantities of Lake Sturgeon were domestically harvested from Eaglenest Lake (B. Burgess, Pine Island Lodge owner, pers. comm.).

Numerous Lake Sturgeon focused studies have been conducted on both the Ontario and Manitoba side of the MU (McDougall and Barth 2015, Henderson et al. 2015b, 2018). Studies suggest that there is a population that is recruiting as a result of spawning downstream of the Caribou Falls GS, with minimal contribution resulting from spawning below the Whitedog GS, Boundary Falls, or Lamprey Rapids (Peacock 2014, Henderson and McDougall 2015, McDougall and Barth 2015). Harvest for subsistence purposes is known to occur in this MU (J. Peacock, OMNRF, pers. comm.). Lake Sturgeon abundance in this area is considered low, and the population trajectory is unknown (Table 4).

Winnipeg River: Pointe du Bois GS–Slave Falls GS (MU5)

Little is documented about Lake Sturgeon in this reach prior to the early-1990s, and it is unknown if Lake Sturgeon were commercially harvested from MU5. Since then, extensive environmental monitoring in relation to the Pointe du Bois GS Spillway Replacement Project and academic research indicate that Lake Sturgeon are found throughout the reach (Henderson and McDougall et al. 2017, 2018, Barth et al. 2018).

The first population estimate for MU5 was derived in the mid to late 1990s, and although confidence intervals were wide, mean annual estimates suggested that 360–1,100 adults were present (Block 2001). The most recent estimate suggested 2,323 and 2,929 adults in 2008 and 2009 and 6,967, 7,547, and 10,286 juveniles for 2013, 2014, and 2015, respectively (McDougall et al. 2017).

Juvenile gill netting conducted in fall 2016, 2017, and 2018 shows three consecutive years of recruitment failure in MU5 despite successful spawning, egg deposition, hatch, and drift in each year (Henderson and McDougall 2017; 2018, Murray et al. 2017, Gillespie and MacDonell 2018). It is suspected that the reservoir may be at or near carrying capacity. At present, Lake

Sturgeon abundance in MU5 is considered high, and the population trajectory is stable (Table 4).

Winnipeg River: Slave Falls GS–Seven Sisters GS (MU6)

A long-term monitoring program was initiated in this reach by Manitoba Fisheries Branch during the early 1980s and although Lake Sturgeon are present throughout the reach, this monitoring program has largely focused on Nutimik and Numao lakes (Block 2001, MCWS 2012). Results suggest that the population ranged from 3,333 to 10,571 fish between 1993 and 1999 (Barth et al. 2018). Population estimates for the same area between 2007 and 2014 ranged from 4,391 to 9,919 adults and from 21,418 to 34,960 adult and juveniles combined (D. Kroeker, MCWS, pers. comm.). Estimates are characterized by wide confidence intervals assumed to be influenced by the relatively low rate of recapture, as opposed to actual dramatic fluctuations in adult population sizes (McDougall et al. 2017). Recent increases in population estimates seem to be attributable to the conservation closure (conservation closure restricts all harvest) established in 1994 (D. Kroeker, MCWS, pers. comm.). Abundance of Lake Sturgeon within MU6 is high and the population trajectory is classified as stable or increasing (Table 4).

Winnipeg River: Seven Sisters Falls GS–MacArthur GS (MU7)

Large historical commercial harvests of Lake Sturgeon (e.g., 78,835 kg from Lac du Bonnet in 1910/11) suggest the species was abundant historically in MU7 (Cleator et al. 2010e). Recent angler reports and targeted studies show that Lake Sturgeon are still present throughout the reach (Hrenchuk 2011, Struthers et al. 2017, D. Kroeker, MCWS, pers. comm.). Stocking has occurred in MU7 at least three times between 1996 and 2002 (Cleator et al. 2010e). Although a formal population estimate has never been derived, based on angler captures, academic research, and results of unpublished MCWS experimental netting programs, the adult population is likely comprised of at least several hundred individuals (Barth et al. 2018). The high number of juveniles captured in this reach indicates that successful recruitment is occurring (Hrenchuk 2011, D. Kroeker, MCWS, pers. comm.). Abundance of Lake Sturgeon is considered medium, with an increasing trajectory due to large numbers of juveniles (Table 4).

Winnipeg River: MacArthur GS–Great Falls GS (MU8)

No historical information specific to MU8 is available. Experimental gill netting below McArthur Falls in 2003 yielded a total of two Lake Sturgeon in five net sets (D. Kroeker, MCWS, pers. comm.). More recently, twelve adults were captured in 13 gillnet sets during summer/fall 2010, 14 adults were captured in nine overnight sets downstream of the McArthur Falls GS during spring 2011, 88 juveniles representing several cohorts were captured in 16 sets in fall 2011, and three adults were captured in ten sets during fall 2015 (McDougall 2011, Murray and Gillespie 2011, Henderson and McDougall 2012, McDougall and Gillespie 2012). In spring 2016, 39 adult Lake Sturgeon were captured in 13 gillnet sets, including two pre-spawn males (Henderson and McDougall 2016). At present, the abundance of Lake Sturgeon within MU8 is considered low, with an increasing trajectory given the abundance of juveniles captured in 2011 (Table 4).

Winnipeg River: Great Falls GS–Pine Falls GS (MU9)

Little is known about Lake Sturgeon populations in this reach historically. Gillnetting investigations conducted at Whitemud Falls in 2003 found evidence that successful reproduction and recruitment was occurring (K. Kansas, MCWS, pers. comm.). Between 2006 and 2016, several studies have been conducted in the MU (see Barth et al. 2018). These studies suggest that the abundance of Lake Sturgeon is low, with the population trajectory unknown (Table 4).

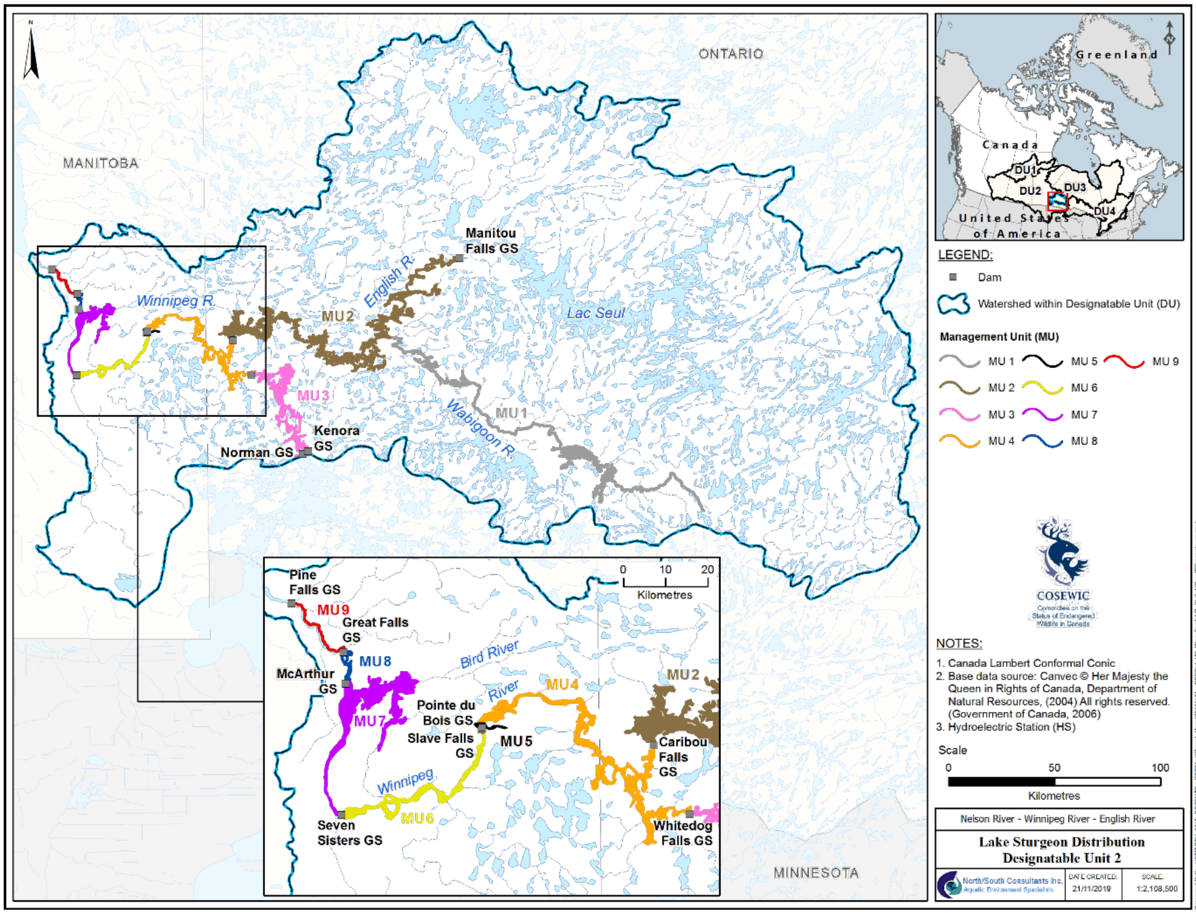

*Figure 7. Lake Sturgeon distribution in the Winnipeg River-English River (*within *DU2), showing the location of current management units.*

Lake of the Woods–Rainy River

The Rainy River–Lake of the Woods system consists of numerous lakes and rivers in northwestern Ontario and parts of northern Minnesota. Large lakes include Lac la Croix, the Namakan Reservoir, Rainy Lake, and Lake of the Woods. The region is connected via two main rivers: the Namakan River which connects Lac la Croix with the Namakan Reservoir and Rainy Lake, and the Rainy River which connects Rainy Lake with Lake of the Woods. In the 2006 COSEWIC assessment this system was designated as a distinct DU (DU6) and assessed as special concern. In the 2017 COSEWIC assessment, the Lake of the Woods-Rainy River systems was considered part of DU2 (endangered status) and divided into five MUs (Figure 8):

- Sturgeon Lake–Lac la Croix system (MU1) – includes the Maligne River connecting Sturgeon Lake and Lac la Croix;
- Namakan River (MU2) – a 30 km long stretch of river including three small lakes connecting Lac la Croix and the Namakan Reservoir;
- Namakan Reservoir (MU3) – the 260 km^2 reservoir includes five lakes: Kabetogama, Namakan, Sand Point, Crane, and Little Vermilion lakes as well as their associated tributaries;

- Rainy Lake and tributaries (MU4) – Rainy Lake from the dam at the outlet of the Namakan Reservoir to the Fort Frances GS at the Inlet of the Rainy River. This MU also includes the Seine River from Sturgeon Falls GS to Rainy Lake and the Big Turtle and Little Turtle rivers; and
- Rainy River from Fort Frances GS to the outlet of Lake of the Woods (MU5) – the 3,850 km^2 Lake of the Woods including the 131 km long Rainy River downstream of Fort Frances GS.

Sturgeon Lake–Lac la Croix System (MU1)

There are historical records of a small subsistence fishery on Sturgeon Lake and a commercial fishery on Lac la Croix (Solomon and Baljko 2011). Although commercial harvest did not occur on Sturgeon Lake, licenses were issued for the Maligne River from 1959 to 1968, which may have affected the population (Solomon and Baljko 2011).

Currently, Lake Sturgeon are present in Sturgeon Lake, and movement data indicate that they move throughout the lake, but do not or cannot move downstream to Lac La Croix. Lake Sturgeon are also currently present within Lac La Croix (Solomon and Baljko 2011).The mean population estimate for Sturgeon Lake using data collected from 2008 to 2010 was 2,048 individuals (Solomon and Baljko 2011). Based on the age composition of the catch, recruitment is considered to have occurred fairly consistently over the last 50 years (Solomon and Baljko 2011). Sturgeon have also been found in nearby Wolsey and McAcree lakes, but their abundance has not been estimated (Solomon and Baljko 2011). Abundance in MU1 is considered medium, and the population trajectory is considered unknown (Table 4).

Namakan River (MU2)

Lake Sturgeon is known to occur throughout the Namakan River system from the outlet of Lac La Croix downstream to the Namakan Reservoir (McLeod 2008a, McLeod and Martin 2015). There is no record of commercial fishing on the Namakan River proper (Barth et al. 2018). Bill Lake appears to be important habitat for juvenile Lake Sturgeon (Trembath 2013). A study of Lake Sturgeon populations in the river that included acoustic telemetry as well as genetic analysis indicated that both upstream and downstream movements occur over natural rapids in the river and therefore fish in the river represented a single population (Welsh and McLeod 2010).

CPUE data from the Namakan River suggests the number of adults and juveniles in the river is medium-high (McLeod 2008a). This river was part of a quantitative assessment that suggests adult abundance is high and juvenile abundance is medium, relative to other unregulated rivers (Haxton et al. 2014b). A population estimate derived for Little Eva Lake in 2007 estimated the population size at 2,729 individuals (McLeod 2008b). Lake Sturgeon abundance is classified as medium with an unknown population trajectory (Table 6).

Namakan Reservoir (MU3)

Commercial fishing licenses existed in the Namakan Reservoir from 1916 to 2001 and harvest data was collected from 1924 to 1999 (McLeod 2008a). There is no current population estimate for MU3, but adult Lake Sturgeon have been captured throughout the reservoir (Shaw et al. 2012; 2013). Although there is little known about the juvenile population in the reservoir, ageing data has indicated that there is fairly consistent recruitment in MU3 (Shaw et al. 2012). Both abundance and population trajectory are unknown (Table 6).

Rainy Lake and tributaries (MU4)

Historically, commercial harvest of Lake Sturgeon occurred throughout Rainy Lake in both Canadian (until 1990) and U.S. (until 1940) waters (Adams et al. 2006). A population of Lake

Sturgeon still exists within Rainy Lake, but it has not been studied extensively. Lake Sturgeon have been studied within the South Arm of Rainy Lake and are also known to be present in Redgut Bay and the North Arm (Adams et al. 2006). Lake Sturgeon are present and known to be recruiting due to spawning in the Seine River (Adams et al. 2006, McDougall and Cooley 2013, Aiken and Cooley 2017, Barth et al. 2018). Lake Sturgeon are also present in other tributaries to Rainy Lake including and Big and Little Turtle rivers and Little Turtle Lake (Jackson and Braithwaite 2017). Telemetry data indicates that Lake Sturgeon likely spawn at Kettle Falls, the Pipestone River and in the Rat River (Adams et al. 2006). Movement between the Seine River and the South Arm of Rainy Lake was limited (Adams et al. 2006).

Between 2002 and 2004, 322 Lake Sturgeon were captured in the South Arm of Rainy Lake using gill nets (Adams et al. 2006). There has been no focused work conducted on the juvenile segment of the Rainy Lake population (Barth et al. 2018). Lake Sturgeon abundance in Rainy Lake and its tributaries is classified as medium with an unknown population trajectory (Table 4).

Rainy River from Fort Frances GS to the outlet of Lake of the Woods (MU5)

Lake Sturgeon were once extremely abundant in Lake of the Woods and, although populations were heavily impacted by commercial fishing, are still found throughout the reach (Barth et al. 2018). Commercial harvests in Lake of the Woods were large, peaking at 809,000 kg in 1893 and totaling > 4 million kg from 1892–1898 (Carlander 1942). By the 1930s populations had declined to near extirpation (Mosindy 1987). Commercial fishing was closed on the American side in 1941 and on the Canadian side in 1995 (OMNRF 2009).

Three population estimates for Lake Sturgeon > 999 mm in MU5 have been calculated in recent years. Mean estimates were 16,910 individuals in 1990, 59,050 in 2004, and 92,286 in 2014, although the 2004 and 2014 estimates were characterized by very low numbers of recaptures and wide confidence intervals (Mosindy and Rusak 1991, Stewig 2005, Heinrich and Friday 2014). Also in the MU, the number of spawning adults downstream of Fort Frances and International Falls on the Rainy River was estimated at 2,635 individuals in 2012 and 3,157 in 2013 (T. Pratt, DFO, pers. comm.). The abundance of Lake Sturgeon in MU5 is considered high and the population trajectory is classified as increasing (Table 4).

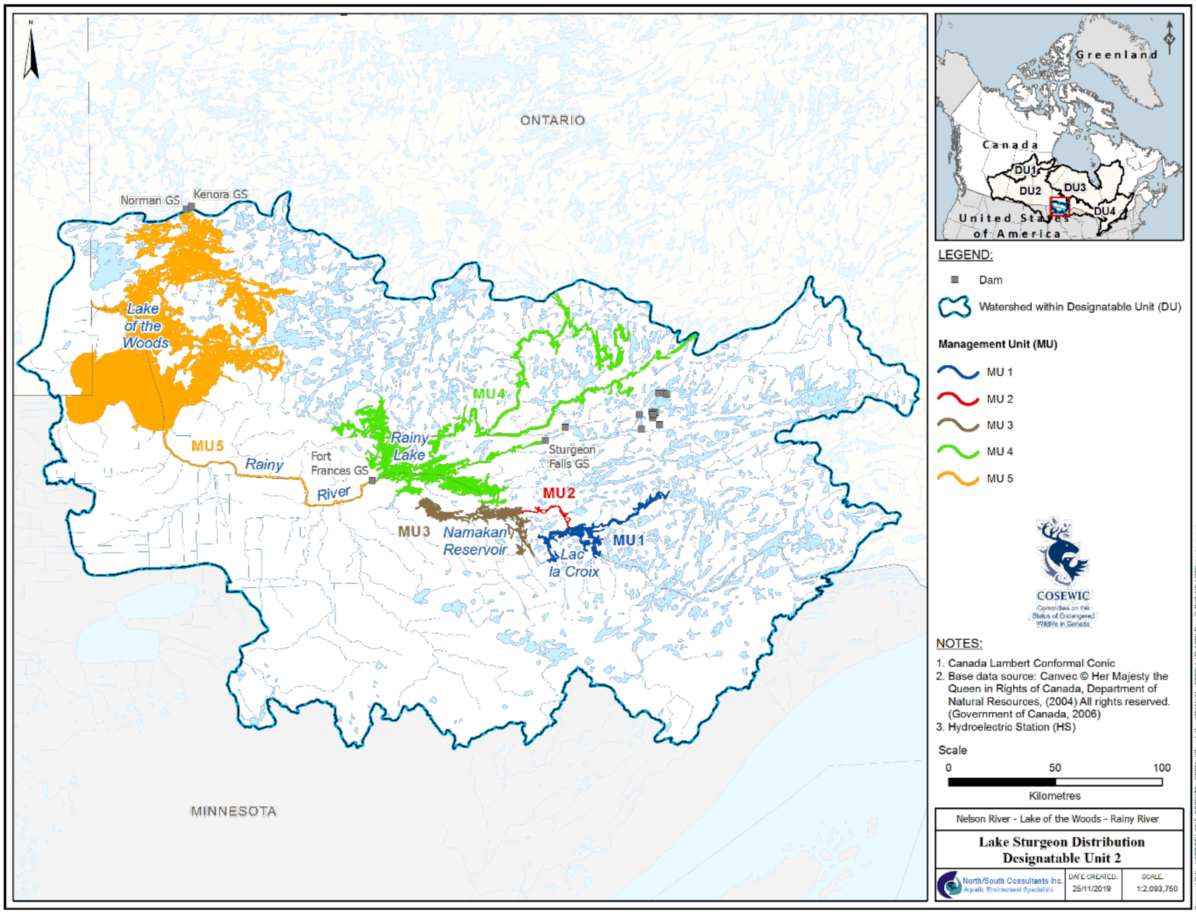

Figure 8. Lake Sturgeon distribution in the Lake of the Woods-Rainy River (within *DU2), showing the location of current management units.*

Nelson River

The Nelson River originates at the north end of Lake Winnipeg and flows 660 km to its outlet at Hudson Bay. Five hydroelectric generating stations have been built on the river which from upstream to downstream include: Jenpeg (1979); Kelsey (1961); Kettle (1974); Long Spruce (1979); and Limestone (1992). An additional station is currently under construction at Gull Rapids (Keeyask GS) located between the Kelsey GS and Kettle GS at the upstream end of Stephens Lake (the Kettle GS reservoir).

Lake Sturgeon were historically abundant throughout the Nelson River. Between 1832 and 1891, harvest was estimated at 40,450 kg annually (Stewart 2009). Commercial harvest of Lake Sturgeon for shipment south began in the Nelson River in 1902 and from 1902 to 1909, large quantities were harvested. The fishery was closed for the first time in 1910, and re-opened and closed several times over the next eight decades. The commercial fishery was closed for the last time in 1991 (Barth et al. 2018).

The Nelson River was designated as a distinct DU in the 2006 COSEWIC assessment. In the 2017 COSEWIC assessment, the river was considered as part of DU2 and was divided into six MUs (Figure 9):

- Playgreen Lake–Whitemud Falls (MU1) and Whitemud Falls–Kelsey GS (MU2): a 380 km long stretch of the Nelson River, including the relatively large and shallow Playgreen and Cross lakes;
- Kelsey GS–Kettle GS; lower Burntwood River between First Rapids and Split Lake (MU3): a 150 km stretch of the Nelson River, including several large lakes (Split, Clark, Gull and Stephens) separated by high-gradient riverine sections. A hydroelectric generating station is currently under construction at Gull Rapids between Gull and Stephens lakes;
- Kettle GS–Long Spruce GS (MU4): the 16 km-long reservoir of the Long Spruce GS, characterized by a riverine upstream section and lacustrine-like downstream section;
- Long Spruce GS–Limestone GS (MU5): the 23 km-long reservoir of the Limestone GS, characterized by a riverine upstream section and lacustrine-like downstream section;
- Limestone GS–Hudson Bay (MU6): 100 km of moderate gradient riverine habitat that enters Hudson Bay at the Nelson River estuary.

Playgreen Lake–Whitemud Falls (MU1)

Lake Sturgeon were present throughout MU1 prior to the start of the commercial fishery in 1903. By the time the commercial fishery was closed permanently in 1991, Lake Sturgeon populations in MU1 were believed to be virtually extirpated (Barth et al. 2018).

In an effort to recover populations, stocking was undertaken in MU1 starting in the mid-1990s (Cleator et al. 2010c). The effectiveness of the stocking program was evaluated during studies conducted in five consecutive years (2012, 2013, 2014, 2015, and 2016) (McDougall and Nelson 2017, Barth et al. 2018). Juvenile Lake Sturgeon captures in the Sea Falls to Sugar Falls reach increased each sampling year: from 91 in 2012, to 152 in 2013, 172 in 2014, 539 in 2015, and 605 in 2016 (McDougall and Pisiak 2012; 2014, McDougall and Nelson 2015; 2016; 2017, Barth et al. 2018). All fish captured could be linked back to stocking events.

Lake Sturgeon also exist in Cross Lake and downstream of the Jenpeg GS (Henderson et al. 2015d, Bell et al. 2016). During fish community assessments conducted in Cross Lake between 1992 and 2008 only one Lake Sturgeon was captured despite considerable effort (Henderson et al. 2015d). However, a spawning assessment conducted during spring 2014 and 2015 provided evidence of natural recruitment occurring downstream of the Jenpeg GS (Bell et al. 2016). Twenty-six adult Lake Sturgeon were captured in 2014 and 22 were captured in 2016; fish in spawning condition were captured in both years (Henderson et al. 2015d, Bell et al. 2016). Juvenile Lake Sturgeon were captured in Cross Lake in 2015 during targeted surveys (Bell et al. 2016). Further, Little Playgreen Lake in MU1 was sampled in 2014 and 30 juvenile Lake Sturgeon were captured (Burnett and McDougall 2015).

The abundance of Lake Sturgeon in MU1 is classified as low, with an increasing population trajectory due to stocking (Table 4).

Whitemud Falls–Kelsey GS (MU2)

Lake Sturgeon were abundant in MU2 prior to the start of the commercial fishery in the early 1900s (Barth et al. 2018). Lake Sturgeon populations declined over the next several decades and a conservation closure was invoked in the Landing River area of MU2 in 1991 to conserve stocks.

Data collected from 1993–2000 and 2006–2014 were used to derive a Peterson population estimate for adults in the vicinity of the Landing River. The population showed a decreasing trend from 1993 to 2000, but since 2006, the population appears to be rebounding, with the most recent estimate at 3,257 adult individuals (D. Macdonald, MCWS, pers. comm.).

Adult and juvenile fish have recently been captured in the Sipiwesk Lake to Kelsey GS reach of MU2 (D. Macdonald, MCWS, unpublished data). Targeted gill netting downstream of Bladder Rapids in spring 2018 resulted in the capture of 21 Lake Sturgeon, including both adults and juveniles (NSC, unpublished data).

Lake Sturgeon abundance in MU2 is classified as medium, with an increasing population trajectory (Table 4).

Kelsey GS–Kettle GS; lower Burntwood River between First Rapids and Split Lake (MU3)

Commercial harvest of Lake Sturgeon on the lower Nelson River (between the Kelsey GS and the Nelson River estuary) began when the rail line was extended to Gillam in 1917 (MacDonell 1997). The Nelson River fishery opened and closed several times until 1991 (Barth et al. 2018). Lake Sturgeon are currently found throughout the reach (Legge et al. 2017, Barth et al. 2018, Burnett et al. 2018, Lacho et al. 2018). Genetic analysis indicates that there are three distinct populations within MU3: one in the Burntwood River, one in the Nelson River below the Kelsey GS, and one in the Nelson River between Clark Lake and the Kettle GS. Genotype-by-sequencing using single nucleotide polymorphisms (SNPs) was conducted on samples from adult and juvenile Lake Sturgeon collected in the Nelson River between 2005 and 2012. The results of the analysis suggest that these distinct populations existed in the Nelson River before the construction of hydroelectric dams (Gosselin et al. 2015).

Adult population estimates have been derived for the three Lake Sturgeon populations present in this MU based on mark-recapture data collected since 2001. The 2017 population estimate for the Nelson River in the vicinity of the Kelsey GS was 592 individuals (Lacho et al. 2018). For the Burntwood River, the population estimate in 2017 was 561 individuals (Lacho et al. 2018). For the Nelson River between Clark Lake and Gull Rapids, the 2018 population estimate was 820 individuals (Holm and Hrenchuk 2019). Downstream of Gull Rapids (Stephens Lake), populations were deemed too low to develop meaningful estimates prior to 2017; however, the abundance of adult Lake Sturgeon appears to have increased in this area over the last decade while the Keeyask GS has been under construction. For the first time, a population estimate of 296 adults was derived for this area in 2018 (Holm and Hrenchuk 2019). The overall abundance estimate calculated for both the Nelson River between Clark Lake and Gull Rapids and for Stephens Lake is low with a stable or increasing trend between 2001 and 2018 (Holm and Hrenchuk 2019).

Studies focused on the juvenile segments of the three populations in MU3 suggest juveniles are present at low-moderate abundances (Barth et al. 2018). A stocking program (25 year commitment) was initiated in 2013 for the Burntwood River and the Nelson River upstream and downstream of the Keeyask GS to mitigate potential effects of GS construction (Barth et al. 2018). Juveniles are considered to be in low abundance in the Nelson River in the vicinity of the Kelsey GS and in the Burntwood River (Barth et al. 2018). Juvenile population estimates were calculated based on data collected between 2010 and 2018 for the Nelson River between Birthday and Gull Rapids and for Stephens Lake. The juvenile population estimate in 2018 was 4,133 between Birthday and Gull rapids and 1,101 for Stephens Lake (Burnett and Hrenchuk 2019).

The abundance of Lake Sturgeon including all areas of MU3 is classified as medium, with a stable or increasing population trajectory (Table 4).

Kettle GS–Long Spruce GS (MU4)

No historical information exists specific to Lake Sturgeon in MU4. Data collected since 1985 indicate that Lake Sturgeon are present within the reach (Barth et al. 2018). More recently, both adult and juvenile Lake Sturgeon have been captured at the base of the Kettle GS, and juveniles were captured in the middle portion of the reach (Barth et al. 2018).

Based on data collected from 1985–2013, the abundance of Lake Sturgeon in MU4 is low and it is unknown if recruitment has occurred within the reach since the Long Spruce GS was built (Barth et al. 2018). Lake Sturgeon younger than the reservoir have been captured, however, downstream movement from upstream populations has been documented (Gosselin et al. 2015, Lacho et al. 2015). The population trajectory in MU4 is unknown (Table 4).

Long Spruce GS–Limestone GS (MU5)

No historical information exists specific to Lake Sturgeon in MU5. Based on data collected from 1985–2013, Lake Sturgeon are known to be present within the reach but their abundance is low and it is unknown if recruitment has occurred since the Limestone GS was built (Barth et al. 2018). Similar to MU4, Lake Sturgeon younger than the reservoir have been captured, however, downstream movement from upstream populations has been documented (Gosselin et al. 2015, Lacho et al. 2015). The population trajectory in MU4 is currently classified as unknown (Table 4).

Limestone GS–Hudson Bay (MU6)

Little historical information specific to MU6 is available. Harvest records post-1970 show almost no harvest from the reach primarily due to access difficulties (Stewart 2009). Environmental studies beginning in the mid-1980s suggest that the Lake Sturgeon population is the most abundant population in the Nelson River, and one of the largest populations in Manitoba (Barth et al. 2018). The most recent adult population estimate based on data collected between 1996 and 2013 is 8,413 individuals (Henderson et al. 2014). Juvenile Lake Sturgeon were captured in large numbers in a single area in the vicinity of Jackfish Island (Ambrose et al. 2010) and a single juvenile was captured in the Hudson Bay estuary with limited effort, suggesting this area may provide nursery habitat (Holm and Bernhardt 2011). In summary, the abundance of Lake Sturgeon in MU6 is high with a stable population trajectory (Table 4).

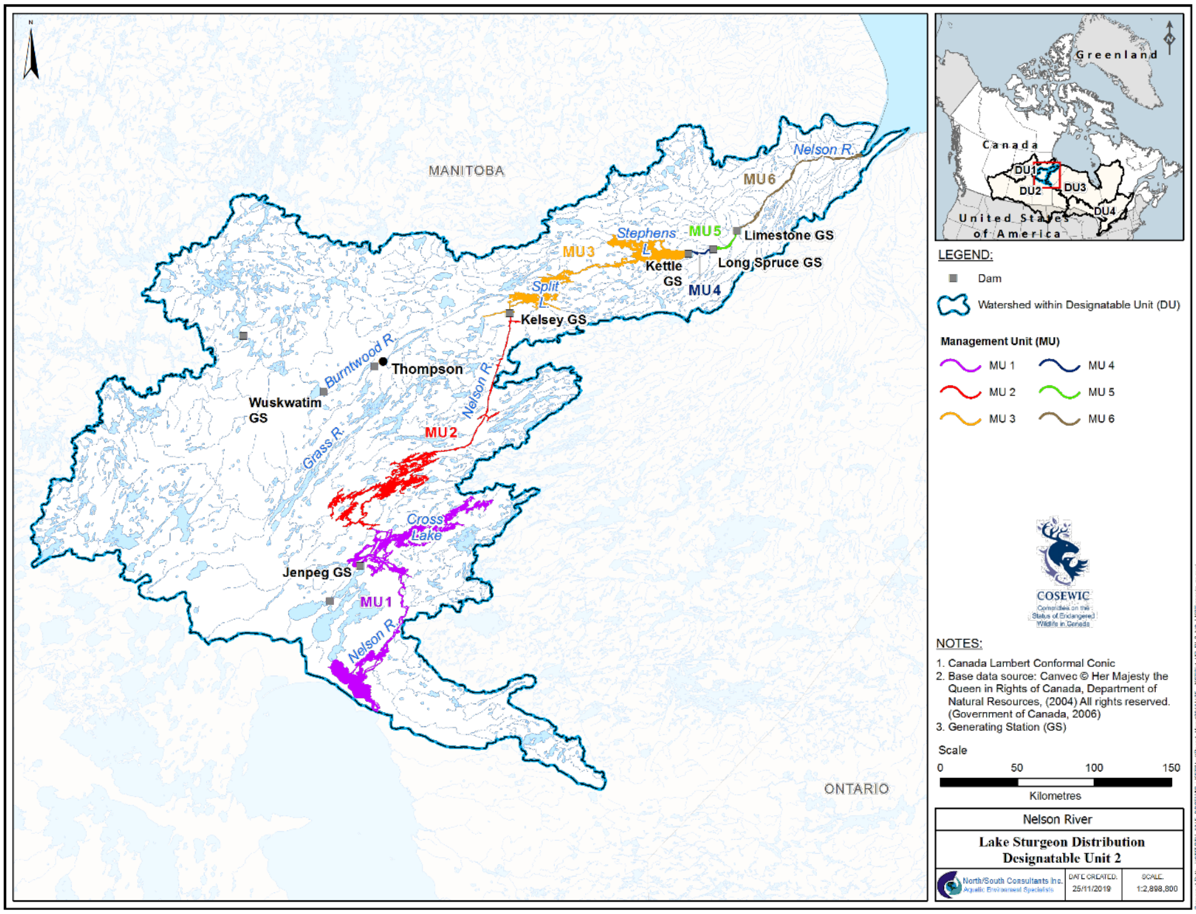

Figure 9. Lake Sturgeon distribution in the Nelson River (DU2), showing the location of current management units.

Population Status Assessment

The population status for Lake Sturgeon populations in DU2 was assessed as described for DU1 (see page 8) (Table 4).

Table 4. Abundance, recruitment, and population trajectory for Lake Sturgeon populations in DU2.

Saskatchewan River

MU	Area	Population Estimate	Qualitative Abundance Category	Population Trajectory
MU1	North Sask. River (Drayton Valley to Smoky Lake)	2,681	Medium	Unknown
	North Sask. River (Smoky Lake to Alberta border)	3,673	Medium	Stable/Increasing
	AB/SK border to Nipawin	4,197 (adults)	Medium	Stable/Increasing

MU	Area	Population Estimate	Qualitative Abundance Category	Population Trajectory
MU2	South Sask. River: confluence of Oldman and Bow rivers to AB border	6,464	High	Stable/Increasing
MU3	Sask. River: Nipawin to E.B. Campbell HS	ND	Low	Unknown
MU4	Sask. River: E.B. Campbell to Cedar Lake	3,099 (adults)	Medium	Increasing

Assiniboine and Red River Drainages

MU	Area	Population Estimate	Qualitative Abundance Category	Population Trajectory
MU1	Assiniboine River upstream of Portage Diversion	ND	Low	Increasing (stocking)
MU2	Assiniboine River downstream of Portage Diversion and Red R. upstream of Lockport	ND	Low	Increasing (stocking)

Lake Winnipeg and Tributaries

MU	Area	Population Estimate	Qualitative Abundance Category	Population Trajectory
MU1	Lake Winnipeg and tributaries downstream of impassable barriers	ND	Low	Unknown (Potentially increasing due to stocking in Red River)
MU2	East side tributaries upstream of impassable barriers	ND	Low	Unknown

Winnipeg River – English River

MU	Area	Population Estimate	Qualitative Abundance Category	Population Trajectory
MU1	Wabigoon River	ND	Unknown	Unknown
MU2	English River: Upstream of Caribou Falls GS	ND	Low	Unknown

MU	Area	Population Estimate	Qualitative Abundance Category	Population Trajectory
MU3	Winnipeg River: Norman/Kenora dams – Whitedog Falls GS	ND	Low	Increasing (stocking)
MU4	Winnipeg River: Whitedog Falls to Pointe du Bois GS including English R. downstream of Caribou Falls GS	ND	Low	Unknown
MU5	Winnipeg River: Pointe du Bois GS – Slave Falls GS	2,929 (adults) 10,286 (juveniles)*	High	Stable
MU6	Winnipeg River: Slave Falls GS – Seven Sisters GS	34,960 (adults and juveniles)	High	Stable/Increasing
MU7	Winnipeg River: Seven Sisters GS – MacArthur Falls GS	ND	Medium	Increasing
MU8	Winnipeg River: MacArthur Falls GS – Great Falls GS	ND	Low	Increasing
MU9	Winnipeg River: Great Falls GS – Pine Falls GS	ND	Low	Unknown

Lake of the Woods – Rainy River

MU	Area	Population Estimate	Qualitative Abundance Category	Population Trajectory
MU1	Sturgeon Lake -Lac La Croix	2,048 (Sturgeon Lake)	Medium	Unknown
MU2	Namakan River: Little Eva Lake	2,729	Medium	Unknown
MU3	Namakan Reservoir: Namakan, Sand Point, Little Vermillion lakes	ND	Unknown	Unknown
MU4	Rainy Lake and Tributaries	ND	Medium	Unknown
MU5	Lake of the Woods/Rainy River downstream of Fort Frances GS	92,286	High	Increasing

Nelson River

MU	Area	Population Estimate	Qualitative Abundance Category	Population Trajectory
MU1	Playgreen Lake-Whitemud Falls	ND	Low	Increasing (stocking)
MU2	Whitemud Falls-Kelsey GS	3,257 (adults; Landing River)	Medium	Increasing
MU3	Kelsey GS-Kettle GS	2,269 (adults)	Medium	Stable/Increasing
MU4	Long Spruce Forebay	ND	Low	Unknown
MU5	Limestone Forebay	ND	Low	Unknown
MU6	Limestone GS – Hudson Bay	8,413	High	Stable

*population is believed to be near/at carrying capacity

The Adult Abundance and Population Trajectory values were combined in the Population Status Matrix (Table 2) to determine the Population Status (Poor, Fair, Good, Unknown, or Extirpated) (Table 5). Five MUs are ranked Good, five are ranked Fair, 13 are ranked Poor, and the population status of two MUs is Unknown.

Table 5. Population Status of Lake Sturgeon populations, resulting from an analysis of both the Adult Abundance and Population Trajectory in DU2.

Saskatchewan River

MU	Area	Population Status
MU1	North Saskatchewan River downstream of Drayton Valley and Saskatchewan River upstream of Nipawin	Good
MU2	South Saskatchewan River: confluence of Oldman and Bow rivers to AB border	Fair
MU3	Saskatchewan River: Nipawin to E.B. Campbell HS	Poor
MU4	Saskatchewan River: E.B. Campbell to Cedar Lake	Fair

Assiniboine and Red River Drainages

MU	Area	Population Status
MU1	Assiniboine River upstream of Portage Diversion	Poor
MU2	Assiniboine River downstream of Portage Diversion and Red River upstream of Lockport	Poor

Lake Winnipeg and Tributaries

MU	Area	Population Status
MU1	Lake Winnipeg and tributaries downstream of impassable barriers	Poor
MU2	East side tributaries upstream of impassable barriers	Poor

Winnipeg River – English River

MU	Area	Population Status
MU1	Wabigoon River	Unknown
MU2	English River: upstream of Caribou Falls GS	Poor
MU3	Winnipeg River: Norman/Kenora dams – Whitedog Falls GS	Poor
MU4	Winnipeg River: Whitedog Falls to Pointe du Bois GS including English River downstream of Caribou Falls GS	Poor
MU5	Winnipeg River: Pointe du Bois GS – Slave Falls GS	Good
MU6	Winnipeg River: Slave Falls GS – Seven Sisters GS	Good
MU7	Winnipeg River: Seven Sisters GS – MacArthur Falls GS	Fair

MU	Area	Population Status
MU8	Winnipeg River: MacArthur Falls GS – Great Falls GS	Poor
MU9	Winnipeg River: Great Falls GS – Pine Falls GS	Poor

Lake of the Woods – Rainy River

MU	Area	Population Status
MU1	Sturgeon Lake-Lac La Croix System	Poor
MU2	Namakan River: Little Eva Lake	Poor
MU3	Namakan Reservoir: Namakan, Sand Point, Little Vermillion lakes	Unknown
MU4	Rainy Lake and Tributaries	Poor
MU5	Lake of the Woods/Rainy River downstream of Fort Frances GS	Good

Nelson River

MU	Area	Population Status
MU1	Playgreen Lake-Whitemud Falls	Poor
MU2	Whitemud Falls-Kelsey GS	Fair
MU3	Kelsey GS-Kettle GS	Fair
MU4	Long Spruce Forebay	Poor
MU5	Limestone Forebay	Poor
MU6	Limestone GS – Hudson Bay	Good

ASSESSMENT – DU4

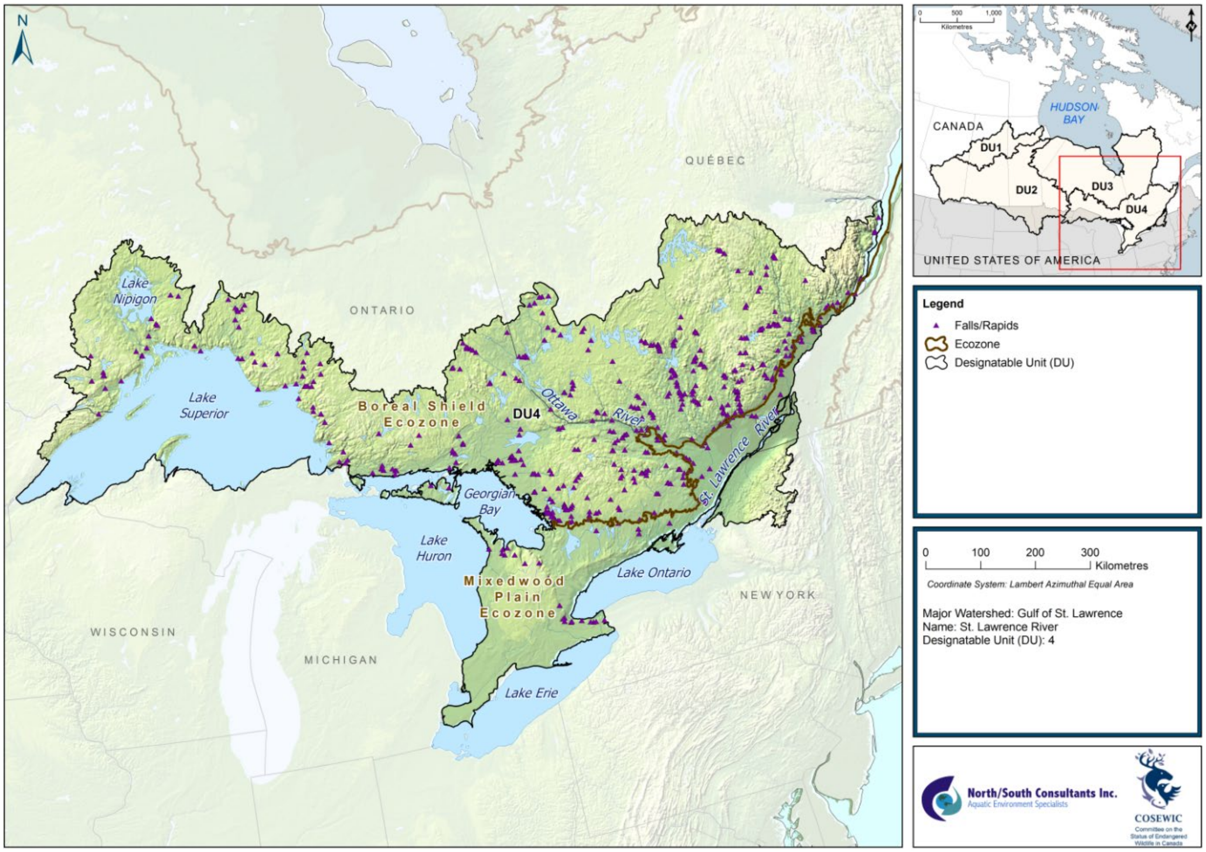

Figure 10. DU4 (Great Lakes–Upper St. Lawrence) showing the terrestrial ecozones and locations of officially named rapids and falls.

HISTORICAL AND CURRENT ABUNDANCE, DISTRIBUTION, AND TRENDS

DU4 includes the Great Lakes and St. Lawrence River basins, comprising 250,000 km^2 from the northwest arm of Lake Superior to the upper St. Lawrence River estuary (Figure 10; Mailhot et al. 2011). This area was designated as DU8 during the 2006 COSEWIC assessment. Historically, Lake Sturgeon were widespread throughout DU4 (Barth et al. 2018).

Within DU4, 12 MUs were established by Pratt (2008), based on genetic structure and barriers to movement, these included: (1) Western Lake Superior, (2) Lake Nipigon, (3) Eastern Lake Superior, (4) Northern Lake Superior, (5) Lake Huron North Channel, (6) Lake Nipissing, (7) Georgian Bay–Lake Huron, (8) Lake Huron/Erie Corridor, (9) Lower Niagara River, (10) Eastern Lake Ontario–Upper St. Lawrence River, (11) Ottawa River Watershed, and (12) Lower St. Lawrence River (COSEWIC 2017). However, to maintain consistency within this document in terms of how MU boundaries were established, the Ottawa River Watershed (considered as a single MU by Pratt 2008) was divided into seven MUs (based on barriers to upstream movement similar to the Winnipeg River for example), increasing the number of MUs in DU4 to 20 (Figures 11–16; DFO 2021a).

The Great Lakes and their tributaries historically supported very large populations of Lake Sturgeon. Based on predictive models, Lake Sturgeon biomass in the 1800s may have been as high as 25 million kg in this area (37 kg per ha); however, this number may be an underestimate as populations may have already been in decline by this time (Haxton et al. 2014a). By the mid-

19th century, Lake Sturgeon became a very valuable commercial species, targeted for both their meat and caviar (Barth et al. 2018). Between 1860 and 1910, unregulated harvests yielded very large catches of Lake Sturgeon, with a peak harvest in 1885 of 3,175,146 kg (Baldwin et al. 2009). By the end of this 40-year period of unregulated harvest, Lake Sturgeon populations in the Great Lakes had collapsed (Harkness and Dymond 1961, Auer 1999).

Similarly, the St. Lawrence River and its tributaries are thought to have supported abundant Lake Sturgeon populations. In the 1900s, commercial harvest, increased pollution, and hydroelectric development led to dramatic decreases in Lake Sturgeon abundance. The lower St. Lawrence River commercial fishery was one of the largest in North America, yielding 150 tonnes annually in the 1980s (Mailhot et al. 2011). Populations were determined to be in decline by 1987, and quotas began to be introduced. Currently, a commercial Lake Sturgeon fishery still exists on the lower St. Lawrence River, with strict quotas and size limits introduced to protect spawning adults and juveniles (Dumont and Mailhot 2013).

Western Lake Superior (MU1)

Within MU1 Lake Sturgeon were historically present in the Pigeon and Kaministiquia rivers. (COSEWIC 2017). There is little information about the population in the Pigeon River, but the Kaministiquia River population has been well-studied and is considered stable (COSEWIC 2017).

Pigeon River

Little historical information exists specific to Lake Sturgeon in the Pigeon River. There is currently thought to be an extant population, however, little is known about its distribution. Lake Sturgeon have access to the lower 3 km of the river between Lake Superior and High Falls, which is a natural barrier to fish movement (Barth et al. 2018).

There is very little contemporary information about the abundance of Lake Sturgeon in the Pigeon River. Surveys suggest that the river is not used for spawning and that a very small numbers of sub-adults and adults currently reside in or intermittently use the Pigeon River; nothing is known about potential trends (E. Isaac, Grand Portage Band, pers. comm., T. Pratt, DFO, pers. comm.). Abundance is classified as extirpated and the population trajectory is unknown (Table 6).

Kaministiquia River

Lake Sturgeon inhabit the lower 47 km of the Kaministiquia River from Lake Superior upstream to Kakabeka Falls, a naturally occurring 39 m tall waterfall that is a barrier to upstream fish movement. The falls are a known spawning location (Welsh et al. 2008, Friday 2013). A pulp and paper mill built on the river in 1906 released effluent that caused habitat degradation and fish kills in the lower Kaministiquia River (D. Gibson, Ontario Power Generation, pers. comm.).

Lake Sturgeon reside in the Kaministiquia River year-round, with few reports of recaptures from other Lake Superior tributaries. Based on microsatellite DNA sequencing, Lake Sturgeon from the Kaministiquia River are genetically distinct from other Lake Superior spawning populations (Welsh et al. 2008, Friday 2013).

No specific historical harvest data exists for the Kaministiquia River, but commercial harvest in Lake Superior may have impacted Lake Sturgeon populations in the river.

The Kaministiquia River Lake Sturgeon population was estimated at 196 individuals in 2001 (M. Friday, OMNRF, unpublished data). In 2015, the estimated population size for Lake Sturgeon >999 mm FL in the river was 557 (95% CI: 341–895; M. Friday, OMNRF, pers. comm.). Larval fish were captured in the Kaministiquia River in 2006, 2012, 2013, and 2015 (M. Friday, OMNRF, unpublished data). Larval drift data was used to estimate that the number of sturgeon that spawned in the river between 2005 and 2017, the number of sturgeon ranged from 33 to 169 (M. Friday, OMNRF, pers. comm.).

In 2010 Lake Sturgeon were targeted with gill nets in large mesh (38, 51, 64, 76, 89, 102, 114, and 127 mm stretched mesh) and extra-large mesh (204, 230, 255, and 306 mm stretched mesh), resulting in CPUEs of 0.29 and 0.38 fish per net night, respectively (Haxton et al. 2014b). Netting at the mouth of the river in Lake Superior found low abundances of juveniles (0.06 fish/net) (Haxton et al. 2014b). Currently, the abundance of Lake Sturgeon in this river is classified as low with an increasing population trajectory (Table 6).

Lake Nipigon (MU2)

Lake Nipigon, a large lake located entirely within Ontario, is connected to Lake Superior by the Nipigon River which is dammed by three hydroelectric generating stations. Spawning is suspected to occur in Lake Nipigon and its inflowing tributaries, however, few studies have been conducted in this area (Barth et al. 2018).

Commercial harvest in Lake Nipigon peaked in 1921 at ~ 42,000 kg and by 1926 the population had collapsed (Swainson 2001). Currently, it is believed Lake Sturgeon are still present in Ombabika Bay (north end of Lake Nipigon) at a low abundance and have an unknown population trajectory (Table 6). Between 2006 and 2009, the Anishinabek/Ontario Fisheries Resource Centre (A/OFRC) captured 135 Lake Sturgeon in Ombabika Bay (T. Pratt, DFO, pers. comm.). Lake Sturgeon also inhabit the Little Jackfish River, which flows into Ombabika Bay. During an environmental assessment for the proposed Little Jackfish River hydroelectric development (approximately 12.5 km upstream of Omabika Bay), after two years of study, Lake Sturgeon were found in the river but mature sturgeon were not captured upstream of the proposed development (OPG and SENES Consultants, 2011). In the Namewaminikan River (enters Lake Nipigon on the eastern shore), both abundance and population trajectory are unknown (Table 6).

Northern Lake Superior (MU3)

Tributaries of northern Lake Superior with historical Lake Sturgeon populations include the Wolf, Black Sturgeon, Nipigon, Gravel, Prairie, Pic, White, and Michipicoten rivers. Lake Sturgeon are believed to be extirpated in the Wolf River and the population within the Gravel River is considered unknown/extirpated (Pratt 2008). The remaining five tributaries (Black Sturgeon, Nipigon, Pic, White, Prairie and Michipicoten rivers) appear to currently support populations (Pratt 2008).

Black Sturgeon River

Lake Sturgeon are found in the 17 km of the Black Sturgeon River downstream of the Black Sturgeon Dam; Lake Sturgeon in this stretch of river are not considered river residents, as they leave the river after spawning to overwinter in Lake Superior (Friday 2005). A small population exists in the lakes and rivers upstream of the dam, which may be functionally extinct (T. Haxton, OMNRF, pers. comm.). Currently, spawning is believed to occur below the Black Sturgeon Dam, which blocks access to up to 80% of the historical spawning habitat available for Lake Sturgeon in the river (Bobrowicz 2012).

Multiple studies have indicated that Lake Sturgeon abundance in the Black Sturgeon River is low. Population estimates carried out in 2003, 2004, and 2015 estimated the abundance of adult spawning Lake Sturgeon below the Black Sturgeon dam to be 89, 96, and 24, respectively (M. Friday, OMNRF, pers. comm.). In 2010, three Lake Sturgeon were captured upstream of the dam (CPUE of 0.16 fish per net night), suggesting that a remnant population exists in this area (Haxton et al. 2014b). A juvenile survey of selected Lake Superior tributaries conducted in 2011 resulted in a CPUE of 2.4 sturgeon/net in Black Bay (where the Black Sturgeon River enters Lake Superior), the third highest CPUE of all the Canadian tributaries (T. Pratt, DFO, pers. comm.). Currently, Lake Sturgeon abundance in the Black Sturgeon River is considered low and the population trajectory is unknown (Table 6).

Nipigon River

Three hydro-electric generating stations operate on the Nipigon River in the 50 km between its origin at Lake Nipigon and its confluence with Lake Superior. Little is known about Lake Sturgeon in the lower Nipigon River historically. Lake Sturgeon distribution is currently restricted to the 11.5 km between the Alexander GS and Lake Superior (Barth et al. 2018).

Abundance in the lower reach of the river is presently believed to be low (no more than 20 individuals) and it is unknown if recruitment has occurred due to spawning in the river over the last decade (Barth et al. 2018). Three years of spring sampling between 2013 and 2015 led to the capture of 17 adult Lake Sturgeon in the lower Nipigon River between the Alexander GS and Lake Helen, but CPUE values were very low (Avery 2015). One large juvenile/sub-adult was also captured in Lake Helen during sampling, but it is unknown if it immigrated from a nearby tributary or was a product of natural recruitment in the Nipigon River (Avery 2015). Egg deposition was reportedly observed immediately downstream of the Alexander GS spillway in 2013 (OMNRF unpublished data). A larval drift study conducted downstream of the Alexander GS in 2015 did not yield any Lake Sturgeon eggs or larvae (Henderson et al. 2015a). Most recently, a study sampling Lake Sturgeon in Lake Superior tributary mouths failed to capture juveniles at the mouth of the Nipigon River (DFO 2016). The population trajectory in the Nipigon River is currently unknown (Table 6).

Prairie River

Lake Sturgeon were believed to be extirpated in the Prairie River as of 2008 (Pratt 2008). However, a juvenile Lake Sturgeon survey conducted during the summer of 2015 captured six juveniles near the mouth, suggesting that Lake Sturgeon may still inhabit the River (A/OFRC 2015c). Abundance and population trajectory for the river are both unknown (Table 6).

Pic River

Lake Sturgeon inhabit the lower 103 km of the Pic River between Lake Superior and the naturally occurring Manitou Falls. Lake Sturgeon are known to move between the Pic River and the White River (Ecclestone 2012b), as well as the Pic River and the Nipigon River (Barth and Henderson 2017).

Like most other Lake Superior tributaries, there is no historical harvest information specific to the Pic River but it is likely the population was influenced by harvest on Lake Superior. Contemporarily, little is known about the abundance of adults or juveniles within the river, as neither a population estimate nor a focused juvenile study has been conducted. The adult segment of the population is likely comprised of at least several hundred individuals, as over the three-year period from 2007–2010 a total of 159 Lake Sturgeon were captured within the Pic River (Ecclestone 2012a). The abundance of Lake Sturgeon in the Pic River is classified as low, with an unknown population trajectory (Table 6).

The Little Pic River, approximately 35 km east of the Pic River, is another tributary of Lake Superior that could support a spawning population of Lake Sturgeon. A juvenile Lake Sturgeon assessment conducted during the summer of 2014 captured seven juveniles at the mouth of the

Little Pic River (A/OFRC 2015c). It is possible however, that these fish were spawned in a nearby tributary (such as the Pic River) and moved to this location.

White River

Lake Sturgeon only have access to the lower 4.5 km of the White River as the naturally occurring Chigamiwinigum Falls prevents upstream movement. Historical harvest records are not available from the White River, but the number of fish using the river to spawn may have been affected by harvest in Lake Superior. Contemporarily, Lake Sturgeon abundance in the White River is low. In 2010, 10 Lake Sturgeon were captured in eight overnight gillnet sets. A subsequent two-year study (2011 to 2012) conducted to assess the population characteristics of Lake Sturgeon in the White River yielded low CPUE values, capturing 144 individual fish (Ecclestone 2012b). Due to the proximity of the White River to the Pic River, Lake Sturgeon movement between the two is common with the rate of immigration believed to be 15% annually (Ecclestone 2012b). Abundance is classified as low and the population trajectory is unknown (Table 6).

Michipicoten River

The 110 km long Michipicoten River empties into the northeast arm of Lake Superior. There are four generating stations on the river. The Hollingsworth GS is located at the southern end of Whitefish Lake and controls flow through all three downstream stations. Lake Sturgeon currently have access to 17 km of the river upstream of Lake Superior, as the most downstream station (Scott Falls GS) acts as a barrier preventing upstream movement (Barth et al. 2018).

Several studies have suggested adult abundance in the Michipicoten River is low. In 2011, gillnetting carried out near the mouth of the river captured eight Lake Sturgeon yielding a CPUE of 0.33 sturgeon/304.8 m net night (Schloesser et al. 2014). An additional eight Lake Sturgeon (five juvenile and three ripe males) were captured in the 17 km reach from Scott Falls GS to Lake Superior in 2012; CPUE was very low (Ecclestone 2012c). CPUE was even lower in 2013 and only three Lake Sturgeon were captured with similar effort (A/OFRC 2014a). A recent study, conducted in 2015, successfully caught one female and in 2016 eggs and larvae were collected downstream of Scott Falls GS (Natural Resource Solutions Inc., pers. comm.). Abundance is thought to be low and the population trajectory is unknown (Table 6).

Eastern Lake Superior (MU4)

Historically in MU4, the Batchawana, Chippewa, Harmony, and Goulais rivers, as well as Stokely Creek supported Lake Sturgeon populations. Lake Sturgeon are believed to be extirpated in the Harmony River and Stokely Creek and their status in the Chippewa River is unknown (Pratt 2008). MU4 supports two populations that are thought to be stable (COSEWIC 2017). Historical harvest data specific to MU4 does not exist.

Batchawana River

The Batchawana River is approximately 95 km in length, however, sturgeon are limited to the lower 11 km of river downstream of Batchawana Falls (a natural barrier to fish movement) (Barth et al. 2018). There is no historical harvest data specific to the Batchawana River. The river is estimated to currently support a population of approximately 4,400 Lake Sturgeon, including juveniles (T. Pratt, DFO, pers. comm.). Abundance in the river is classified as medium, with a stable population trajectory (Table 6).

Goulais Bay/River

Goulais Bay is located in the southeast corner of Lake Superior. The Goulais River is 67 km long and empties into Goulais Bay. No hydroelectric development exists on the river and greater than 50 km of connected habitat exists before upstream movement is restricted by natural falls (Whiteman Falls) (Pratt et al. 2014). Studies have shown that Lake Sturgeon spawn in the river and juveniles have been captured in the bay, suggesting successful recruitment has been occurring for a number of years (Barth et al. 2018).

As of 2008, the spawning population of Lake Sturgeon in the Goulais River was estimated at < 50 individuals (S. Greenwood, pers. comm., in Pratt 2008). However, between 2010 and 2012, a juvenile-targeted mark/recapture study in Goulais Bay captured 531 juveniles, yielding a juvenile population estimate of 4,977 individuals (Pratt et al. 2014). The population in this area is currently classified as low and the population trajectory is considered to be stable or increasing (Table 6).

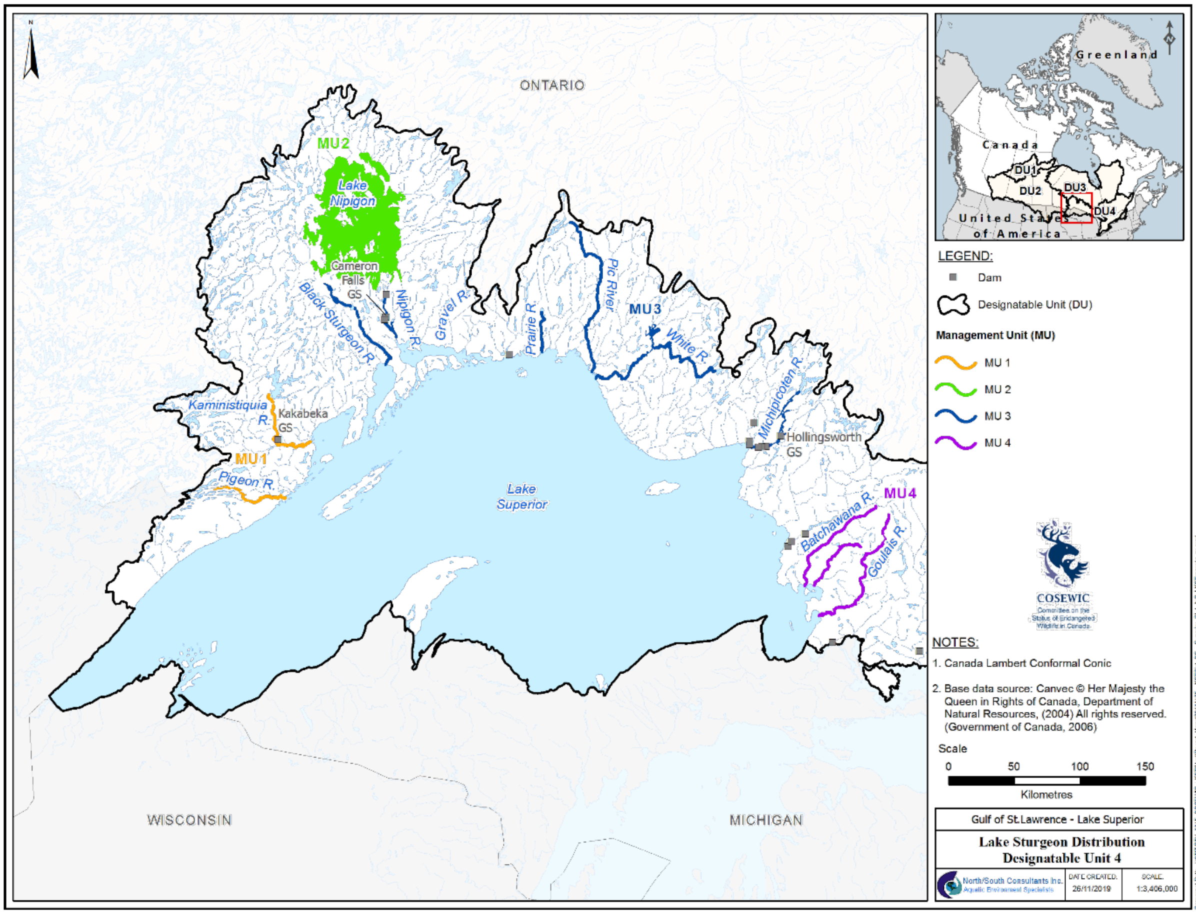

Figure 11. Lake Sturgeon distribution in the Lake Superior basin (within DU4), showing the location of current management units.

Lake Huron North Channel (MU5)

The North Channel of Lake Huron is believed to have nine tributaries that historically supported Lake Sturgeon populations. Lake Sturgeon are considered extirpated in four of these (Serpent, Root, Echo, and Blind rivers) with the remaining five tributaries (St. Marys, Garden, Thessalon, Mississagi, and Spanish rivers) all supporting populations (Pratt 2008). No historical data exist for Lake Sturgeon populations in MU5.

St. Marys River

The 112 km-long St. Marys River connects Lake Superior with Lake Huron. The river has been heavily impacted by anthropogenic factors such as shipping, pulp and paper mills, sewage treatment, and shoreline development. Lake Sturgeon have been caught throughout the river (Barth et al. 2018).

Lake Sturgeon abundance in the St. Marys River is believed to be low. From 2000 to 2007, set lines captured 192 unique Lake Sturgeon (recapture rate of 16%) and the population was estimated at 505 sub-adult and adult individuals (95% CI: 388–692) (Bauman et al. 2011). An acoustic telemetry study conducted between 2016 and 2018 found that Lake Sturgeon overwintered in Lake George and spent the rest of the year moving between the north channel of the St. Marys River and Lake George, suggesting the population in the St. Marys River is distinct from other Lake Sturgeon populations in Lake Superior and Lake Huron (Sumner 2018). The population trajectory in the St. Marys River is unknown (Table 6).

Garden River

The Garden River is a high-gradient river which flows through Lake George before entering the St. Marys River. Since 2012, focused Lake Sturgeon work has confirmed a small population exists in the river (Nahwegahbow 2015). Spawning studies conducted during spring 2013 and 2015 captured adult Lake Sturgeon as well as larvae (A/OFRC 2014b; 2015b, Nahwegahbow 2015). Larval drift surveys and an acoustic telemetry study conducted between 2016 and 2018 identified a Lake Sturgeon spawning location at the Garden River waterfalls and likely also at Murphy's Rapids (Brooks et al. 2017; Sumner 2017, 2018). Both abundance and the population trajectory are unknown (Table 6).

Mississagi River

The 270 km long lower Mississagi River is a large river which empties into the North Channel of Lake Huron. Lake Sturgeon inhabit the lower 31 km of the river, as the Red Rock GS blocks further upstream movements (Barth et al. 2018).

A population consisting of at least several hundred individuals is believed to exist in the Mississagi River (Tremblay 2013). Although CPUE values were low, 154 and 140 individuals were captured during studies conducted in 2011 and 2012, respectively (Tremblay 2013). The river is an important tributary for spawning Lake Sturgeon within Lake Huron (Tremblay 2013). Abundance in the river is classified as low and the population trajectory is unknown (COSEWIC 2017).

Spanish River

The Spanish River flows into the North Channel of Lake Huron at Spanish Bay. Lake Sturgeon have access to 52 km of river before the Espanola pulp and paper dam blocks upstream movement (Barth et al. 2018).

Historically, Lake Sturgeon in the Spanish River were harvested by members of the Sagamok Anishnawbek and a small number are still harvested annually (Gillies 2010). Spawning studies conducted between 2003 and 2009 captured a total of 157 Lake Sturgeon, suggesting the Spanish River supports a spawning population (Gillies 2010). The age structure of captured Lake Sturgeon suggests a fairly young population (mean age approximately 12 to 13 years old) with sex ratios skewed heavily towards males (Barth et al. 2018). Currently, Lake Sturgeon abundance is low and the population trajectory unknown (Gillies 2010).

Lake Nipissing (MU6)

Lake Nipissing is the fifth largest inland lake within Ontario. Similar to other populations within Ontario, Lake Sturgeon stocks in the lake were diminished by historical commercial harvest. The Lake Sturgeon commercial harvest from Lake Nipissing peaked at 86,000 kg in 1903 (OMNRF 2009). Populations in Lake Nipissing and associated river systems declined from ~ 85,000 individuals in the early 1900s to less than 10,000 by about the early 1930s, as a result of overfishing by commercial fisheries. A small fishery remained on the lake from 1971–1982 with annual catches averaging 4,725 kg (OMNRF 2009). Lake Nipissing still supports a Lake Sturgeon population and spawning is believed to occur within the lake and in two of its tributaries (Sturgeon and South rivers) (Golder Associates Ltd. 2011). Between the years of 1992 and 1995, drift nets captured a total of 5,147 larval Lake Sturgeon in the Sturgeon River, confirming that Lake Sturgeon were reproducing (Commanda 2018). Pratt (2008) and OMNRF (2009) indicated that Lake Sturgeon stock assessments had determined that successful recruitment was occurring and that populations may be increasing. In contrast, Commanda (2018) found that results of fisheries surveys did not indicate an increasing population in Lake Nipissing, and indicated that a standardized sampling protocol was necessary to accurately estimate Lake Sturgeon population size in the lake. A 2008 mark-recapture study conducted on two tributaries of the lake estimated the adult population in the South River to be 410 (95% CI: 361–460) and were inconclusive for the Sturgeon River (Commanda 2011). In 2015, larval drift nets set at the South River captured only one larval Lake Sturgeon (Commanda 2018). Netting between 1991 and 2012 at the South and Sturgeon rivers captured a total of 748 Lake Sturgeon (Commanda 2018). There was virtually no Lake Sturgeon work conducted in the lake after 2012, with the exception of the 2015 larval drift study at South River. Currently, Lake Sturgeon abundance in Lake Nipissing is considered to be low, with an unknown population trajectory (Table 6).

Georgian Bay–Lake Huron (MU7)

There are 13 Canadian tributaries and one lake draining into Georgian Bay that historically supported Lake Sturgeon populations. The populations in five tributaries (Seguin, Go Home, Manitou, Saugeen, and Ausable rivers) and Lake Simcoe are considered extirpated (Pratt 2008). Tributaries believed to still have extant populations of Lake Sturgeon include: the French, Key, Magnetawan, Naiscoot, Moon, Severn, Nottawasaga, and Sauble rivers. Population sizes and status are unknown for the Key, French, Naiscoot, Severn, and Sauble rivers. Information for the remaining three tributaries (Magnetawan, Nottawasaga, and Moon rivers) is sparse.

Magnetawan River

Lake Sturgeon are considered extant within the Magnetawan River but the last confirmed Lake Sturgeon sighting was an angler capture in 2014. A targeted Lake Sturgeon netting study in 2009 documented one Lake Sturgeon, although none were captured in 2014 (A/OFRC 2015a). No Lake Sturgeon were observed during spring spawning studies conducted at Deadman’s Rapids in 2016, although habitat appears suitable (EGBSC 2016). Lake Sturgeon abundance and population trajectory are unknown (Table 6).

Nottawasaga River

Adult spring assessments and incidental captures of juveniles have confirmed that Lake Sturgeon are present in the Nottawasaga River. A radio-telemetry project focused on adult movement has documented movement of adults to spawning sites located in the upper portion of the river downstream of the Nicholson dam (OMNRF, unpublished data).

Adult spring assessments conducted from 2010 to 2015 in the Nottawasaga River have captured over 350 individuals (OMNRF, unpublished data). Incidental catches of young juveniles in commercial gear also suggests recruitment is occurring in the river (OMNRF, unpublished data). Lake Sturgeon abundance in the river is classified as medium, with an unknown population trajectory (Table 6).

Moon River

The Moon River is approximately 35 km long and one dam has been constructed on the river. Lake Sturgeon have been observed spawning immediately downstream of Moon Falls, a potential natural barrier to upstream movement (McIntyre 2010). During spawning studies in the area, 16 Lake Sturgeon were observed in 2009 and two were observed in 2010 (McIntyre 2010). Studies between 2012 and 2014 captured eggs and larvae on the spawning grounds (OMNRF, unpublished data). These observations suggest the river is still being used by sturgeon. Abundance is considered low and the population trajectory is unknown (Table 6).

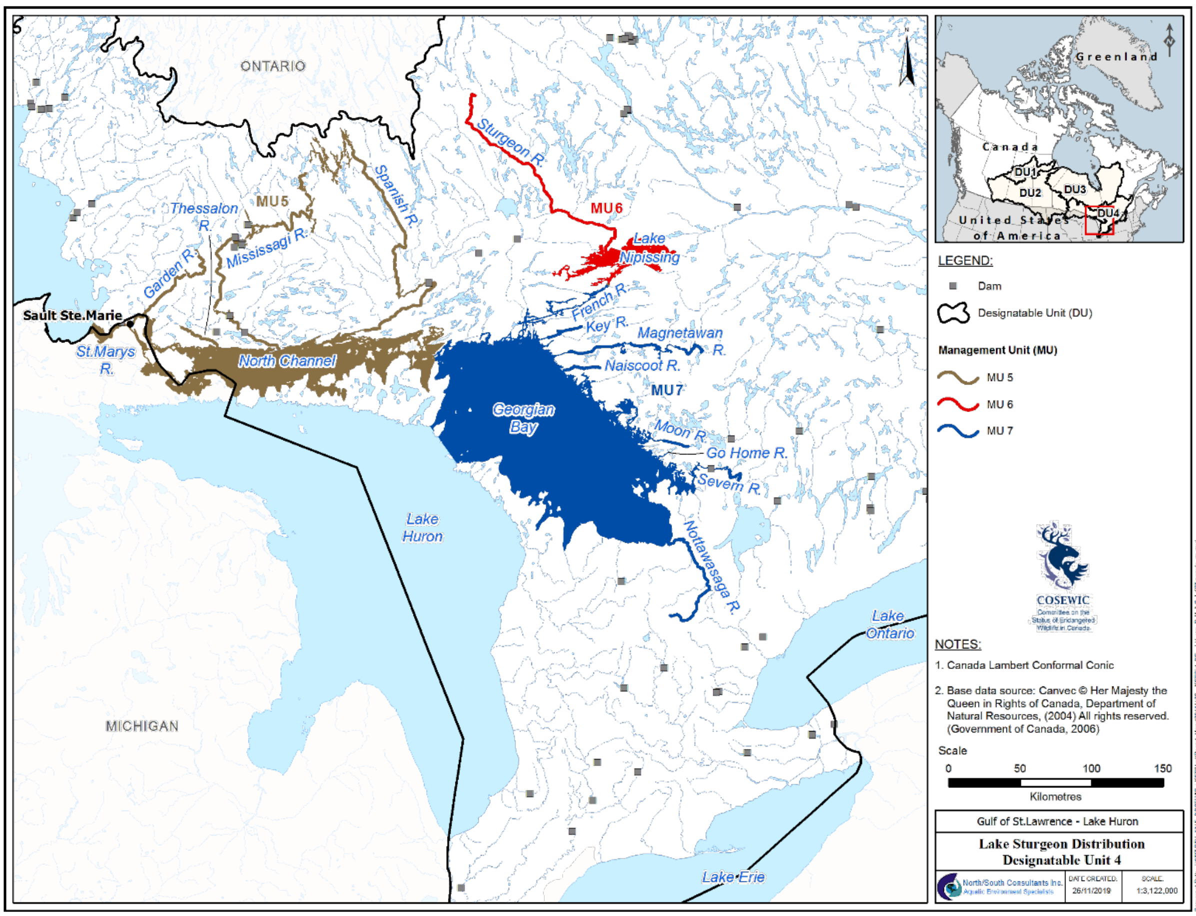

Figure 12. Lake Sturgeon distribution in the Lake Huron basin (within DU4), showing the location of current management units.

Lake Huron/Erie Corridor (MU8)

The Huron/Erie Corridor flows 160 km in a southward direction, connecting Lake Huron and Lake Erie. Lake Sturgeon movement between Lake Huron and Lake Erie is unimpeded (Thomas and Haas 2002). An acoustic telemetry study conducted between 2011 and 2016 found that Lake Sturgeon in MU8 exhibited distinct migration patterns, including year-round river residency and multiple movements among different lakes and rivers (Kessel et al. 2018).

Main Basin–Lake Huron

Lake Huron once supported large numbers of Lake Sturgeon; however, commercial harvest was extensive, peaking at 250,000 kg before collapsing in 1909. Contemporary population estimates based on mark-recapture data collected between 1995 and 2008 in the southern bay of Lake Huron suggested the population was comprised of approximately 30,000 individuals, making this population one of the largest in the Great Lakes (Lake Huron Lake Sturgeon Working Group 2015). Tagging was started again in 2012 with the cooperation of Purdy Fisheries; 941 additional Lake Sturgeon were tagged between 2012 and 2018 (Lake Erie Lake Sturgeon Working Group 2018). The population in the lake is thought to be stable/increasing (Table 6).

St. Clair River

Historically, large quantities of Lake Sturgeon were harvested to supply a caviar factory located on the banks of the river in the town of Algonac, Michigan (Harkness and Dymond 1961). Contemporarily, Lake Sturgeon are known to move throughout the St. Clair River and fish move freely between the river, Lake St. Clair, and the Detroit River. Lake Sturgeon spawn at two locations within the St. Clair River; the Bluewater Bridge in Port Huron and the North Channel near Algonac, Michigan (Manny and Kennedy 2002, Thomas and Haas 2002). A larval drift study conducted in 2013 and 2014 found that larval Lake Sturgeon remained in the St. Clair River rather than drifting downstream into Lake St. Clair; larvae captured in different stages of development suggested that juvenile Lake Sturgeon used the river as nursery habitat (Krieger 2017). Lake Sturgeon are known to heavily use the five km stretch of river in the North Channel of the river between the Chenal A Bout Rond confluence and Pointe aux Tremble (Brooks et al. 2017). Migrating Lake Sturgeon were found to use navigation channels in the lower St. Clair River less often than alternative pathways through the river (Hondorp et al. 2017). An acoustic telemetry study conducted between 2011 and 2016 found that some Lake Sturgeon are year-round residents in the St. Clair River; these fish represent a semi-independent population (Kessel et al. 2018). The population size in the north channel of the St. Clair River is currently estimated at 45,506 individuals (high) and the population trajectory is stable (Table 6).

Lake St. Clair

The St. Clair River drains into Lake St. Clair, which is connected to Lake Erie by the Detroit River. Lake Sturgeon from both the St. Clair and Detroit rivers are known to move into Lake St. Clair (Barth et al. 2018, Kessel et al. 2018).

Similar to the Great Lakes, commercial harvest within Lake St. Clair was high with annual harvest peaking at 2.4 million kg in 1870, but by the mid-1890s the population had declined dramatically (Baldwin et al. 2009). In addition to overfishing, habitat degradation and water quality also affected sturgeon populations within the lake and its tributaries (Thomas and Haas 2002). As with the St. Clair River, estimating Lake Sturgeon abundance in Lake St. Clair is difficult given the lack of barriers to movement and the relatively large size of the population. Historically, estimates suggest the population was comprised of 354,000 individuals; current estimates based on mark-recapture methods put the population at 20,000–40,000 individuals (Hay-Chmielewski and Whelan 1997, Thomas and Haas 2002). Although more recent population estimates have not been completed, abundance is thought to be high and the population trajectory is considered stable in the lake (Table 6).

Detroit River

The Detroit River represents the southern portion of the Huron-Erie Corridor and connects Lake St. Clair to Lake Erie via a 51 km long stretch of river. Lake Sturgeon are known to spawn near Fighting Island, a historical spawning ground that was restored in 2008 (Roseman et al. 2011). Acoustic telemetry has shown that Lake Sturgeon also congregate near Grassy Island, the site of a proposed constructed spawning site (Brooks et al. 2017). Lake Sturgeon were found to migrate more often through the deeper navigation channels than through alternative pathways in the Detroit River (Hondorp et al. 2017). Similar to the St. Clair River, a semi-independent population of Lake Sturgeon is known to reside year-round in the Detroit River (Kessel et al. 2018).

Historically, the Detroit River and the Huron-Erie Corridor were believed to have had an abundant Lake Sturgeon population and may have supported one of the largest populations in the region (Harkness and Dymond 1961, Caswell et al. 2004). Currently, the population in the river is estimated at 4,422 (95% CI: 2,758–6,097) individuals (medium abundance) and the population trajectory is stable (Caswell et al. 2004, Lake Erie Lake Sturgeon Working Group 2018) (Table 6).

Lake Erie

Lake Erie had the highest reported commercial catches on the Great Lakes through the late 19th century, reaching over 2.3 million kg in 1885. Populations had collapsed by the turn of the 20th century, and individuals are infrequently encountered now in the western and eastern basins (Sweka et al. 2018). A spawning location was documented in the upper Niagara River in 2017 (Neuenhoff et al. 2018), indicating that a population was still present in the eastern basin. Lake Sturgeon historically moved into the Grand River from Lake Erie to spawn and were harvested in the river in the late 1800s, but are now considered to be extirpated in the river (Wright and Imhof 2001). Currently, both abundance and population trajectory are unknown (Table 6).

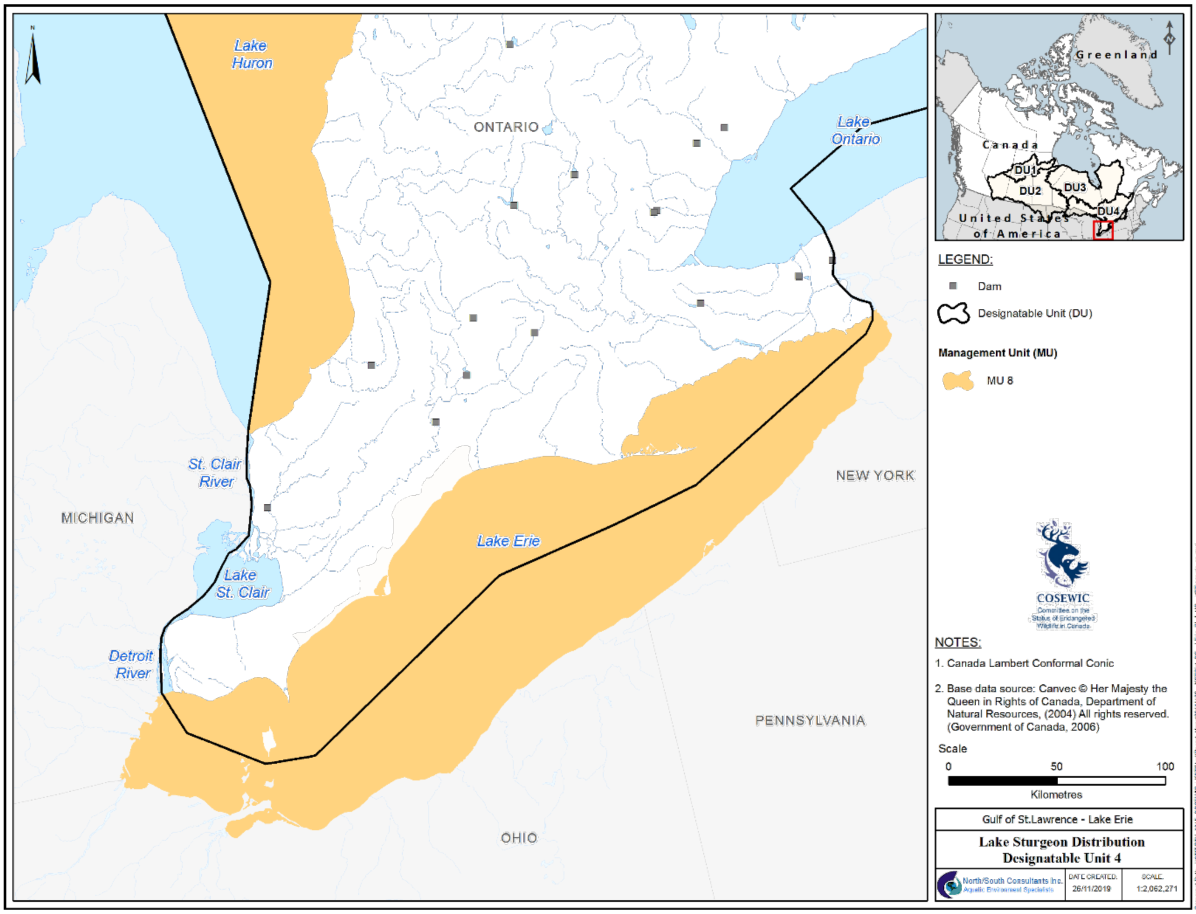

Figure 13. Lake Sturgeon distribution in the Lake Erie basin (within DU4), showing the location of current management units.

Lower Niagara River (MU9)

The 58 km long Lower Niagara River connects Lake Erie and Lake Ontario. Niagara Falls represents a barrier to upstream fish movement. Lake Sturgeon, including juveniles, are known to be present in the river (Barth et al. 2018). An acoustic telemetry study of Lake Sturgeon in the lower Niagara River found that fish used the river on a seasonal basis, entering the river in the spring from Lake Ontario, then returning to the lake to overwinter (Bruestle 2017).

Historically, the Lower Niagara River had an abundant population of Lake Sturgeon. Commercial and recreational harvest occurred on the Lower Niagara River until the early 1940s, but by 1950, Lake Sturgeon abundance was deemed to be very low and the fishery collapsed. A study that used gill nets, setlines, and SCUBA to assess Lake Sturgeon abundance in the area between 1998 and 2000 found that CPUEs were consistently low, although a high proportion of juvenile fish were captured (Hughes et al. 2005). Currently, it is believed that the lower Niagara River Lake Sturgeon population is undergoing natural recovery, with reproduction likely occurring in the river (NYSDEC 2018). The population estimate in the lower Niagara River was estimated at 7,600 in 2016 (95% CI: 5,900–9,800) (NYSDEC 2018). Currently, Lake Sturgeon abundance is classified as high and the population trajectory is increasing (Table 6).

Eastern Lake Ontario-Upper St. Lawrence River (MU10)

The St. Lawrence River flows from Lake Ontario to the Gulf of St. Lawrence. The upper St. Lawrence River is separated from its lower reach by two hydroelectric generating stations: the Moses-Saunders GS upstream (construction completed in 1958) and the Beauharnois les Coteaux GS downstream, including Coteaux 1 to 4 control structures. Before construction of the two generating stations, Lake Sturgeon could move from the St. Lawrence estuary to the outlet of Lake Ontario (Roussow 1955). Lake Sturgeon are currently found in small numbers upstream of the Moses-Saunders GS (Pratt 2008).

The Trent River flows into the Bay of Quinte, approximately 100 km from the start of the St. Lawrence River. Although Lake Sturgeon were present in this river historically, it is currently believed that any sturgeon observed in the river are migrants from other areas (T. Haxton, OMNRF, pers. comm.). Two areas of the Trent River, Percy reach and Frankfurt reach, were extensively netted in 2011 and 2015, respectively. No Lake Sturgeon were captured during these surveys (Haxton 2011, LeBaron and Haxton 2015). In 2016, a study using set lines to target Lake Sturgeon in the Trent River did not capture any Sturgeon (OMNRF 2017). The study was repeated in 2017, and two Lake Sturgeon were captured between Lock 1 and the mouth of the Bay of Quinte. One of the Lake Sturgeon was tagged near the mouth of the Trent River, then moved east into the Upper Bay of Quinte (OMNRF 2018). Pratt (2008) stated that Lake Sturgeon are believed to be extant within the Trent River, but current population size and trajectory are unknown (COSEWIC 2017).

Lake St. Francis (MU11)

Lake St. Francis is the stretch of the St. Lawrence River between the Moses-Saunders GS upstream (construction completed in 1958) and the Beauharnois GS downstream, including Coteaux 1 to 4 control structures (Pratt 2008).

Starting in 1913 with the construction of the Les Cèdres GS, the ability of Lake Sturgeon to migrate upstream to Lake St. Francis has gradually diminished and eventually was almost completely blocked in 1943 when the Coteaux and Iles Juillet water level control structures (spillways associated with the operation of the Beauharnois GS) were completed. The construction of the Coteaux and Iles Juillet control structures reduced the possibility of passage upstream to the St. Charles River and the Soulange Canal. From 1960 to 1965, the St Timothée, Pointe du Buisson and Pointe des Cascades weirs and spill gates were added to maintain water levels for aesthetic reasons. These structures eliminated the possibility of migration through the St. Charles River and eventually blocked access to the main spawning site for Lake Sturgeon below the rapids downstream of Les Cèdres GS at the Pointe du Buisson historical site. Since then, the only way sturgeon can move upstream is through the Locks of Beauharnois and Moses Sanders (St. Lawrence Seaway).

Commercial fishing occurred in the upper St. Lawrence, with catches peaking in Lake St. Francis at 8,700 kg in 1964 (Robitaille et al. 1988). Low abundances of Lake Sturgeon in Lake St. Francis are still evident but CPUE values remain very low and the frequency of sampling stations with sturgeon has not exceeded 4.9% during four surveys conducted in 1996, 2004, 2009 and 2014 (Ministère des Forêts, de la Faune et des Parcs [MFFP], unpublished data). In 2016, one Lake Sturgeon was captured during index netting in Lake St. Francis after a lack of Lake Sturgeon captures since 2008 (OMNRF 2017). Currently, abundance is classified as low and the population trajectory is thought to be stable or declining (Table 6).

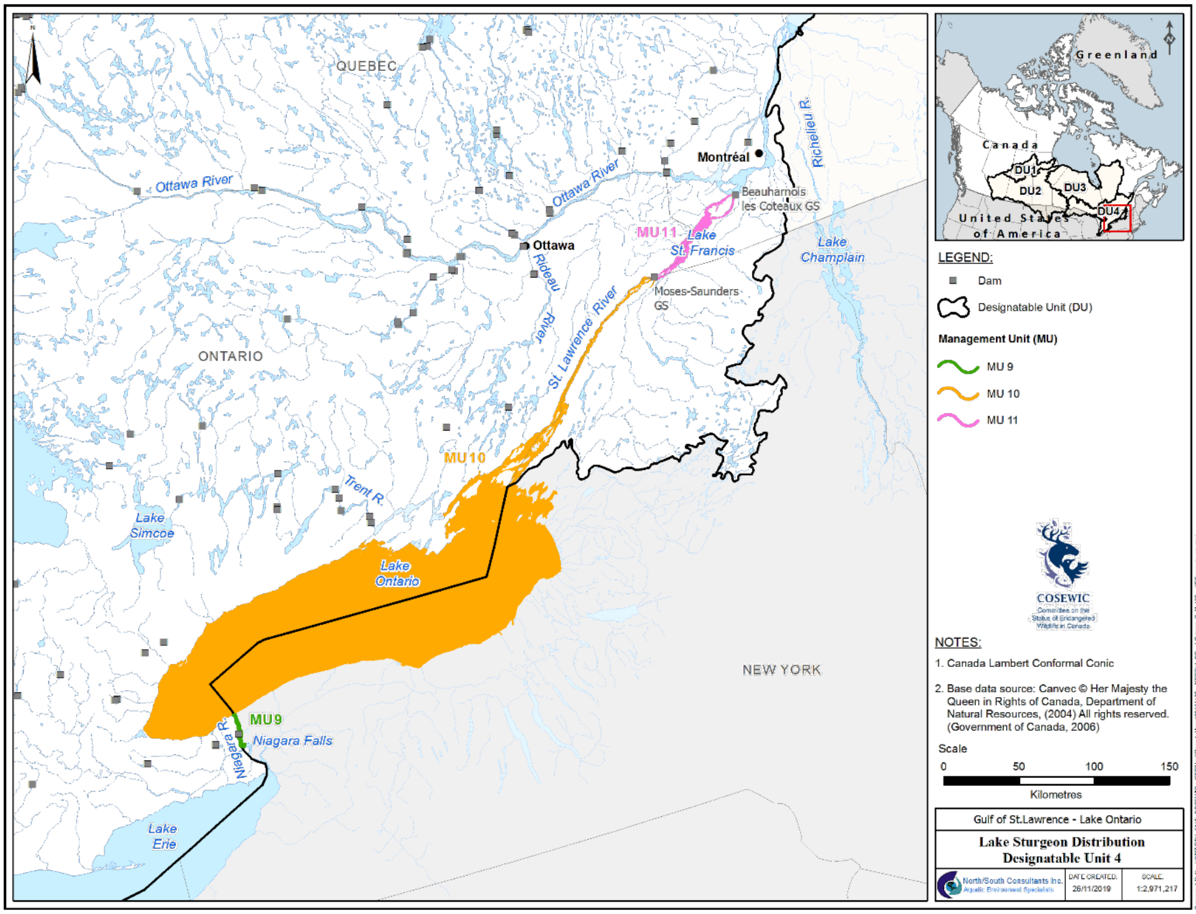

Figure 14. Lake Sturgeon distribution in the Lake Ontario basin (DU4), showing the location of current management units.

Ottawa River Watershed (MU 12 – 19)

The Ottawa River is a highly fragmented river stretching 1,130 km from Lake Capitmitchigama in Québec to its confluence with the St. Lawrence River (Legget 1975). There are nine reaches of the lower Ottawa River separated by either naturally occurring rapids or hydroelectric generating stations. Lake Sturgeon are known to have been present historically in all the reaches and are still found in all reaches but in lower numbers (Barth et al. 2018).

Historically, Lake Sturgeon were abundant in the Ottawa River and its many tributaries with commercial catches peaking at 28,780 kg in 1898 (Dymond 1939). High commercial catch rates, poor water quality and hydroelectric development contributed to a substantial reduction in Lake Sturgeon abundance in the river (Harkness and Dymond 1961). Currently, five populations in MU11 are thought be declining, one is increasing, one is stable, one is stable or increasing, and one is unknown (COSEWIC 2017).

Lake Temiscaming (MU12)

Lake Temiscaming historically supported a commercial fishery, but now Lake Sturgeon are believed to exist in reduced numbers in the lake (Barth et al. 2018). A commercial fishery existed in the Québec portion of Lake Temiscaming until 2012. From 1986 to 2009 commercial catches averaged 118 Lake Sturgeon per year. In 2008, a netting study in the lake captured two

Lake Sturgeon in 52 gillnet sets, suggesting that abundance and recruitment in the lake are low (Haxton 2011). Similarly, during Walleye monitoring conducted by the province of Québec, Lake Sturgeon were only captured infrequently (Barth et al. 2018). Recruitment is occurring in the Montreal River, a tributary in the northern portion of Lake Temiscaming and juvenile Lake Sturgeon are often captured near the confluence (T. Haxton, OMNRF, pers. comm.). Populations in the lake are thought to be declining (Table 6).

Lac la Cave (MU13)

The Lake Sturgeon population within Lac la Cave is believed to be low as no sturgeon were caught during fall Walleye index netting in 1998 or during near shore community index netting in 2004 (Haxton and Findlay 2008). In 2010, a single Lake Sturgeon was caught in 28 net sets, further suggesting Lake Sturgeon abundance is low in the lake (Haxton 2011). Lac la Cave is managed as a winter reservoir which affects productivity for juvenile sturgeon (Haxton and Findlay 2008). The abundance is considered low and functionally extinct (declining) (T. Haxton, OMNRF, pers. comm.).

Holden Lake (MU14)

Similar to the other reaches of the Ottawa River, Holden Lake supported a commercial fishery for Lake Sturgeon. By 1987, a sturgeon harvest was not recorded despite a quota of 800 kg, suggesting abundance was low in the lake by this time (Fortin et al. 1992). Studies carried out in Holden Lake in 1998, 2003, 2004, and 2009 were unsuccessful in capturing Lake Sturgeon (Haxton and Findlay 2008, Haxton 2011). In 2006, twenty-six Lake Sturgeon were captured in gill nets set below the Otto Holden GS (Haxton 2006). Based on these results, the abundance of Lake Sturgeon in Holden Lake is likely low as recruitment is limited but a small spawning population may exist downstream of the Otto Holden GS (Barth et al. 2018). Similar to Lac la Cave, Holden Lake is managed as a winter reservoir. The population in this area is currently thought to be functionally extinct (i.e., declining) (T. Haxton, OMNRF, pers. comm.) (Table 6).

Allumette Lake/Lac Coulonge (MU15)

The Allumette Lake reach is one of the few unimpounded reaches of the Ottawa River; it is split into two zones (upper and lower Allumette Lake) by the Allumette Rapids. Lake Sturgeon reside in both zones of the lake and studies indicate that spawning occurs at the base of the rapids (Haxton 2011). Lac Coulonge is an unimpounded river reach that stretches from Allumette Lake to Lac Du Rocher Fendu (Haxton 2011). The lake is thought to be an important juvenile nursery area, with larger more mature sturgeon eventually migrating upstream into Allumette Lake (Haxton 2011).

Population studies in Allumette Lake have shown that the lake supports a robust Lake Sturgeon population. Between 1998 and 2001, CPUE was highest in both lower (1999: 2.9 sturgeon/net set) and upper (2001: 2.13 sturgeon/net set) Allumette Lake when compared with the other reaches of the Ottawa River (Haxton 2002). Spawning assessments, conducted in 2001, 2004, and 2007, captured a total of 201 Lake Sturgeon (Haxton 2008). In a study conducted between 2008 and 2010, 58 Lake Sturgeon were caught in 44 overnight gillnet sets (Haxton 2011). Currently, abundance is classified as medium and the population in the lake is thought to be stable (Table 6). Similar to Allumette Lake, Lac Coulonge supports a robust Lake Sturgeon population and the population is thought to be stable (Haxton 2011). Data collected between 2008 and 2010 suggested CPUE was highest in Lac Coulonge (approximately 4.2 sturgeon/net set) when compared with other Ottawa River reaches (Haxton 2011). Given that over 700 Lake Sturgeon were captured in over 5-years of study with only 3 recaptures, and a commercial fishery captured approximately 120 Lake Sturgeon per year (Haxton and Findlay 2008), Lake

Sturgeon abundance in this reach is qualitatively assessed as medium, with a stable population trajectory (Table 6).

Lac du Rocher Fendu (MU16)

Lac du Rocher Fendu is controlled at the downstream end by the Chenaux GS and stretches approximately 31 km upstream. Historical spawning grounds are believed to have existed upstream of Portage du Fort, but were flooded by the construction of the Chenaux GS in 1948. Information about Lake Sturgeon in the reach before impoundment is limited (Haxton 2008).

It is believed recruitment within Lac du Rocher Fendu is low due to the lack of available spawning habitat (Haxton 2008). Low CPUE values from 1999 (0.44 sturgeon/net set), 2000 (0.38 sturgeon/net set), and 2009 (0.33 sturgeon /net set), suggest adult Lake Sturgeon abundance in the reach is low (T. Haxton, OMNRF, pers. comm.). The population in this area is believed to be declining (Table 6).

Lac des Chats (MU17)

Lac des Chats stretches 40 km between the Chenaux GS upstream and the Chats Falls GS downstream. Lake Sturgeon have been documented to aggregate below the Chenaux GS during the spawning season and have been captured throughout the lake (Haxton 2008). In 2007, eighteen Lake Sturgeon were sampled below the Chenaux GS and three larvae were captured in drift traps. CPUE in Lac des Chats has varied between study years going from 0.26 sturgeon/net set in 1998 to 0.03 sturgeon/net set in 2009 (Haxton 2002, 2011). More recently, in 2014, 41 Lake Sturgeon were captured during netting in spring and fall (D. Gibson, Ontario Power Generation, pers. comm). Few juveniles are observed in this section of the Ottawa River (T. Haxton, OMNRF, pers. comm). Lake Sturgeon abundance in Lac des Chats is considered low and the population is decreasing (Table 6).

Lac Deschênes (MU18)

Lac Deschênes runs approximately 53 km downstream from the Chats Falls GS to the Chaudière Falls dam. Lake Sturgeon spawn downstream of the Chats Falls GS and are present throughout the lake during the rest of the year (Barth et al. 2018).

Abundance of Lake Sturgeon in Lac Deschênes is thought to be low (T. Haxton, OMNRF, pers. comm.). A spawning study carried out downstream of the Chats GS from 2001–2004 yielded a spawning population estimate of 202 individuals in 2003 (Haxton 2006). A study in 2009, however, only captured seven Lake Sturgeon for a CPUE of 0.22 sturgeon/net set (Haxton 2011). Currently, the population is considered to be decreasing (Table 6).

Lac Dollard des Ormeaux (MU19)

Lac Dollard des Ormeaux is the farthest downstream stretch of the river and is approximately 113 km long, stretching between Chaudiere Falls and the Carillon GS. Both adult and juvenile Lake Sturgeon have been captured in the lake. Lake Sturgeon are also present in the Gatineau River, which is a major tributary of this stretch of the Ottawa River (Barth et al. 2018).

Little is known about Lake Sturgeon populations in Lac Dollard des Ormeaux. In 2009, 41 Lake Sturgeon were captured in the reach (CPUE of 1.46 sturgeon/net set) (Haxton 2011). Recently, effort has been directed at assessing the population size within the Gatineau River system, and in 2015, 10 Lake Sturgeon were captured (CPUE: 0.011 sturgeon/net hours) (Kitigan Zibi Anishinabeg First Nation 2015). Abundance is thought to be low with an increasing population trajectory due to the capture of juveniles (Haxton 2002, 2011, Haxton and Findlay 2008; Table 6).

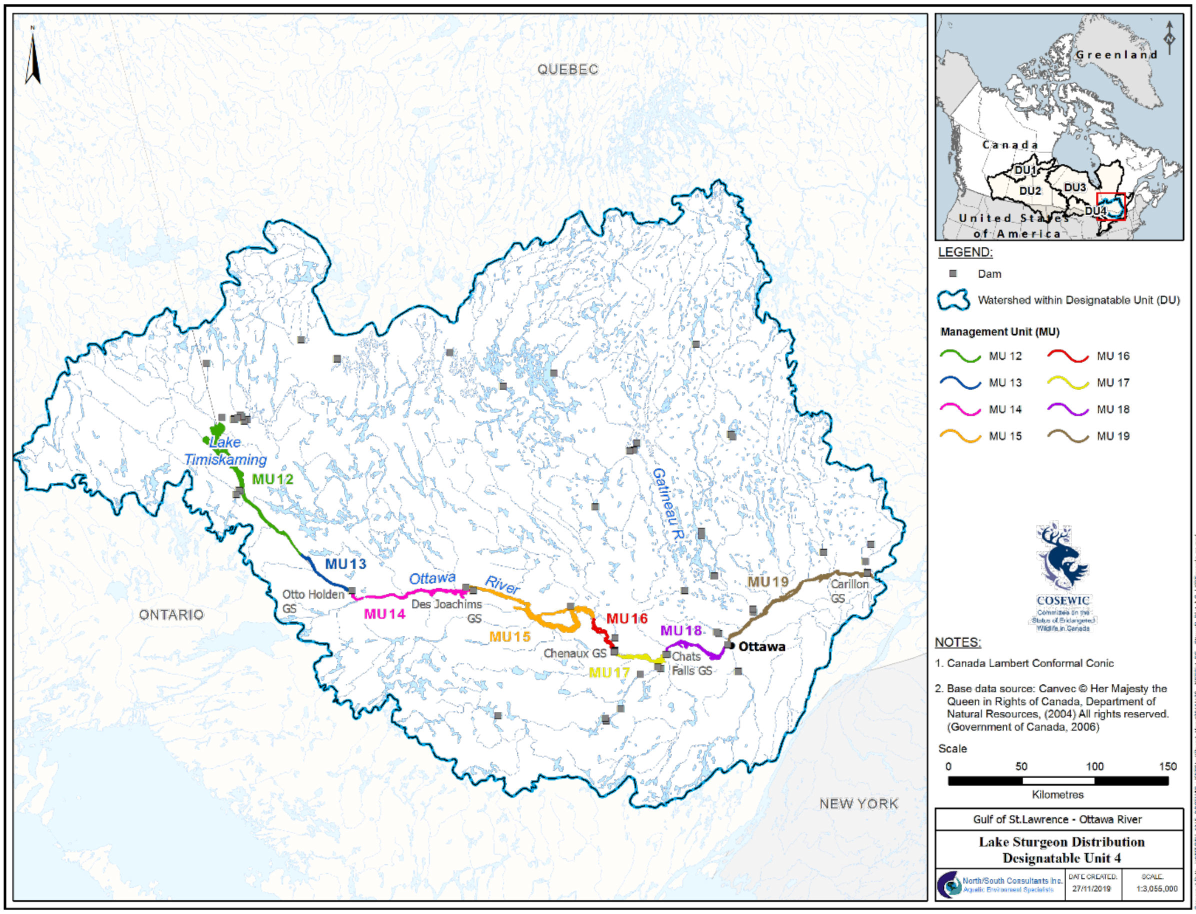

Figure 15. Lake Sturgeon distribution in the Ottawa River (within DU4) showing the location of current management units.

Lower St. Lawrence River (MU 20)

The lower St. Lawrence River stretches approximately 350 km from Lac St. Louis downstream of the Beauharnois and les Coteaux complex to the St. Lawrence estuary downstream of Québec City. Since the early 1960's the St. Thimothé, Pointe du Buisson and Pointe des Cascades mitigating structures associated with the last phase of Beauharnois GS construction have greatly diminished the use of the spawning sites located downstream from les Cèdres and specifically at the historical site of Pointe du Buisson (Jean Caumartin, Hydro Quebec, pers. comm.).

This MU also includes the Ottawa River downstream of the Carillon Dam to the confluence with the St. Lawrence River by Lac des Deux Montagnes, Rivière des Milles Îles and Rivière des Prairies. Lake Sturgeon use the entire 350 km long reach and are known to spawn in the St. Lawrence River and lower sections of St. Lawrence River tributaries below barriers. At least 16 spawning sites have been identified. Spawning tributaries include the Des Prairies, des Mille-Îles, L'Assomption, Ouareau, Richelieu, Saint-François, Saint-Maurice, Batiscan, Chaudière, and Montmorency rivers (Fortin et al. 1992, Ministère des Forêts, de la Faune et des Parcs, unpublished data). The commercial fishery in the St. Lawrence River is concentrated in three areas: Lac St.-Louis, Lac St-Pierre, and the upper estuary (Mailhot et al. 2011).

Historically, the Lake Sturgeon population in the lower St. Lawrence River has been greatly affected by commercial harvest. From 1920 to 1984, commercial harvest remained fairly consistent in the lower St. Lawrence River. A management plan was developed between 1987 and 1991 to reduce the catch, protect spawning adults, and strengthen enforcement, however, the population continued to be overexploited. As a result, new management measures were implemented during the 2000 to 2002 period which included the reduction of the quota to 80 tons, where it has since been maintained (Barth et al. 2018).

In the upstream portions of the river, the abundance of juveniles and sub-adults is increasing as their presence has been documented in a significantly higher proportion of sampling stations in the St. Lawrence River fish monitoring network. Recent studies have shown that the number of Lake Sturgeon spawning grounds is higher than previously expected. Important spawning aggregations were recently observed in five rivers (des Milles Îles, Richelieu, Chaudière, Montmorency and du Sud) (Dumont et al. 2011). Recruitment, although variable, has been occurring on an annual basis since 1984 (COSEWIC 2017). Downstream of the Beauharnois GS, abundance is considered to be very high, with a stable or increasing population trajectory (Table 6). In Lake Champlain, Richelieu River upstream of Chambly Dam, and Missisquoi Bay, both abundance and population trajectory are unknown (Table 6).

Lac des Deux Montagnes

The Lake Sturgeon population of Lac des Deux Montagnes was decimated in the late 1940s by a prolonged anoxic episode caused by high amounts of effluents released into the Ottawa River (Dumont and Mailhot 2013). In 1964, the construction of the Carillon GS submerged spawning areas at Hawkesbury and prevented further upstream movement, except for the possible passage through recreational locks. Sixty years after the anoxic event, Lake Sturgeon are still present in reduced numbers in the lake. Spawning was found to occur at the base of the Carillon Dam on a shoal rehabilitated for Walleye spawning (Rochard et al. 1990). Surveys conducted in the lake in 2010 and 2018 were characterized by low CPUEs, however, the proportion of sampling stations where Lake Sturgeon were captured was relatively high (46% in 2018, MFFP unpublished data). Finally, ten adult Lake Sturgeon of adult size were captured on a man-made spawning ground at the outlet of the lake in May 2016 (D. Hatin, MFFP, unpublished data).

Lake St. Louis

Lake St. Louis supports a valuable Lake Sturgeon population. Average size and weight of Lake Sturgeon in the lake are higher than in the other sections of the St. Lawrence River (Mailhot et al. 2011). A commercial fishery occurs in the Lake with landings of approximately 20 tons per year.

Richelieu River

The Richelieu River is 124 km long and empties into the St. Lawrence River. During the spring, Lake Sturgeon move from the St. Lawrence River into the Richelieu River for spawning. The St. Ours dam is a barrier to upstream movement, but a vertical slot fish-way was built in 2001 and was used by a small number of Lake Sturgeon to move upstream of the dam and reach Chambly Rapids. The St. Ours Dam is not a barrier to upstream movement in early spring because of flow management during the spring flood. After mid-May, the St. Ours Dam prevents upstream movement and the Vianney-Legendre fishway provides access to the reach between the St. Ours Dam and the Chambly Rapids just below the Chambly Dam. Lake Sturgeon cannot reach Lake Champlain except for the possible passage through recreational locks and the Chambly canal. Lake Sturgeon are known to spawn both below the St. Ours Dam (Thiem et al. 2011) and the Chambly Dam. No population estimate is available for the Richelieu River, but estimates of the number of spawners at the base of the St. Ours Dam in 2011 ranged from 285 to 1,282 Lake Sturgeon per day (Thiem et al. 2011).

Rivière des Prairies and Rivière des Milles Îles

Both Rivière des Prairies and Rivière des Milles Îles are channels of the Ottawa River that run north of the St. Lawrence between Montreal and Île Jesus (des Prairies) and Île Jesus and the mainland (des Milles Îles). Dams exist on both water courses. On the Rivière des Prairies the GS was constructed at the end of 1920's while the Rivière des Miles Îles is partially blocked by a weir. The hydraulic characteristics of this area permit use of the upstream and downstream sections by Lake Sturgeon and other fish species since they can access the upstream sections through Lake St. Louis.

Spawning occurs downstream of the Rivière des Prairies GS, probably the largest of 16 confirmed spawning sites on the St. Lawrence River system (Dumont et al. 2011, MFFP, unpublished data). Spawning also occurs in the L'Assomption River, which flows into the Rivière des Prairies near its confluence with the St. Lawrence River (LaHaye et al. 1992).

The estimated number of spawning Lake Sturgeon visiting the Rivière des Prairies GS spawning site on an annual basis from 1994 to 2003 varied from 9,657 in 1996 to 4,170 in 1999 (Dumont et al. 2011). Since the late-1980s Hydro Québec has managed flow to optimize Lake Sturgeon reproduction and is applying special flow management measures to optimize conditions suitable for Lake Sturgeon reproduction and egg incubation. In addition, the surface area of the spawning ground was increased in 1996. The improved population status recently observed in this MU could be, in part, attributable to these measures (Dumont et al. 2011).

In spring, Lake Sturgeon also move from the St. Lawrence River to the upstream end of the Rivière des Milles Îles to spawn. In 2014, a new spawning ground was discovered below the Du Grand Moulin Dam. Nearly 50 Lake Sturgeon in spawning condition and more than 500 eggs were captured by gillnetting and on artificial substrates, respectively (D. Hatin, MFFP, unpublished data).

L'Assomption River

The L'Assomption is a large tributary of the St. Lawrence River that Lake Sturgeon are known to use for spawning. Two spawning grounds have been identified: on the Ouareau River (a tributary to the L'Assomption River) below the impassable Ouareau Dam, and the other on the L'Assomption River below an impassable set of falls. These are relatively small spawning sites that, based on visual observations, support less than 100 spawners each (Limno-Service Inc. 2002, 2003, CARA and MRNF 2007, 2008, 2010, 2011). The shorelines of both rivers are extremely dynamic, being characterized by high riverbanks susceptible to frequent landslides affecting the quality and distribution of spawning habitat. A diversity of other fish species spawn on the same grounds, including Walleye (*Sander vitreus*), suckers, redhorse, bass, and darters. Historically, the L'Assomption River was exposed to sewage effluent, however, a water treatment plant has been constructed to improve water quality. Benefits to Lake Sturgeon due to the water treatment facility have been well documented (Limno-Service Inc. 2002, 2003, Gauthier 2014). Results of a monitoring program, aimed at measuring egg and larval production before and after implementation of the water treatment plants, indicated that egg to free-stage larval survival was next to nil prior to construction of the water treatment facilities. Currently, these rivers produce < 10,000 larvae to the drifting stage annually. Enhancement of the Ouareau spawning ground was undertaken in 2008 to mitigate effects of a large landslide. The success of this enhancement is still being examined (CARA and MRNF 2010, 2011, Gauthier 2014). Finally, specific regulations and surveillance have been implemented in both rivers to reduce the impact of sport fishing during the spawning period.

Lake St. Pierre

In Lake St. Pierre, Lake Sturgeon abundance is high and annual commercial landings are approximately 36 tons/year for the upstream section of the lake and 24 tons/year for the downstream section (Laviolette and Île d'Orléans Bridges). In 2018, law enforcement was increased in Lake St. Pierre in an effort to decrease illegal harvest.

Saint François River

The Saint-François River flows into the St. Lawrence River in the south-west sector of Lake Saint-Pierre. There are a total of 19 GS on this river. The three at the downstream end (Chute Burrows, Chute Hemmings, and Drummondville) are owned by Hydro-Québec. Spawning within the river is known to take place below the Drummondville GS, the farthest downstream GS. Downstream of Drummondville, the abundance of spawners in the Saint-François River in 2018 was estimated at 170 males (95% CI: 94–494), 110 females (95% CI: 34–434) and 110 of unknown sex (95% CI: 34–434) (Bureau environnement et terre d'Odanak 2019). The species is also found upstream of Chute Hemmings (Hydro-Québec, unpublished data). Upstream of Drummondville, a Lake Sturgeon population is isolated on a 60 km section of the river between Drummondville and Windsor dams. Reproduction of Lake Sturgeon was confirmed downstream of Windsor Dam on a spawning ground of ~ 2.7 ha (Roy et al. 2016). Lake Sturgeon are considered to have been extirpated in the section of the Saint-François River between Windsor and Larocque dams (Roy et al. 2016).

Île d'Orléans and Estuary

In the downstream section of the St. Lawrence River, the number of known spawning sites has increased over the years and at least one spawning ground is used by more than 1,000 spawners annually. Interestingly, commercial fishers who target Atlantic Sturgeon (*Acipenser oxyrinchus*) in the estuary have noticed a higher abundance of Lake Sturgeon in their catch in the last few years. Lake Sturgeon have recently been captured near the estuary, in high salinity environments where they were historically absent (L. L'Italien, MFFP, pers. comm.).

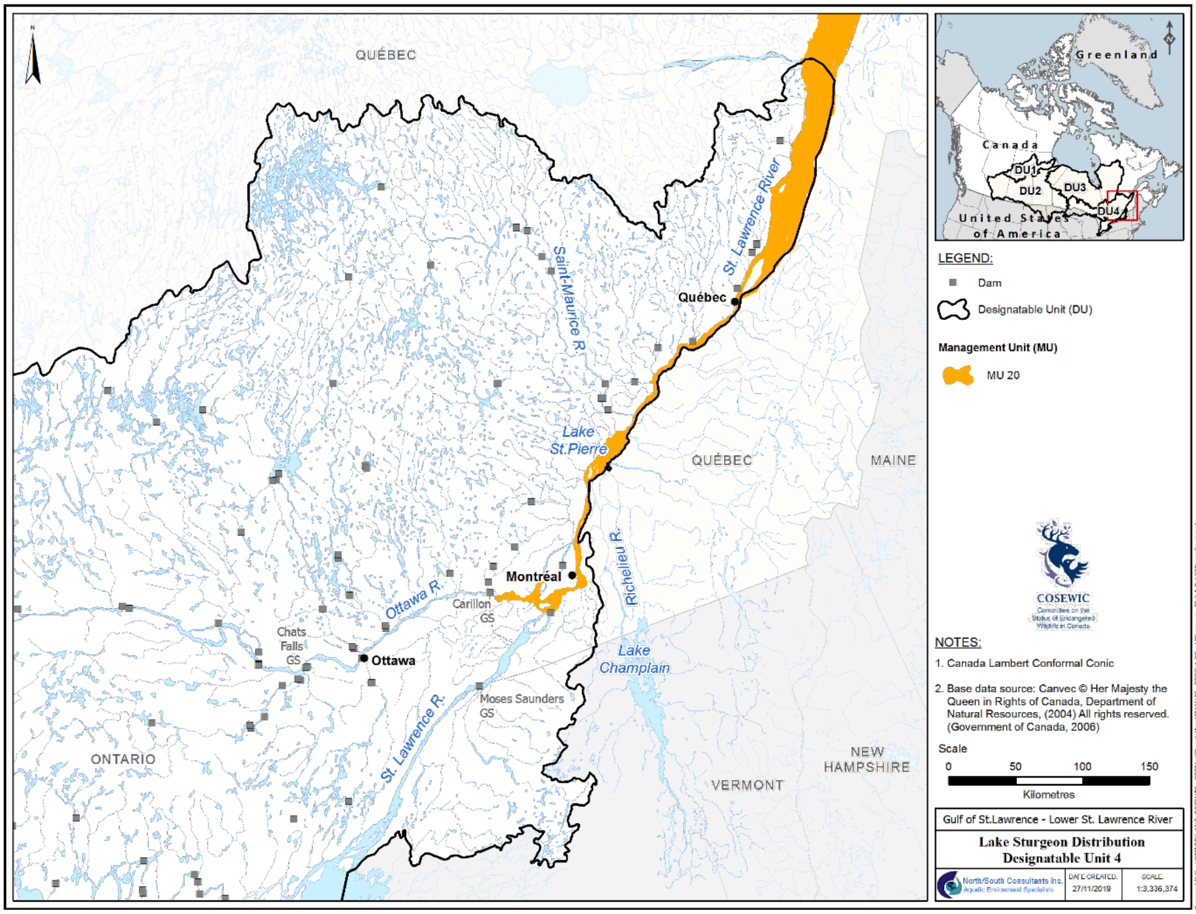

Figure 16. Lake Sturgeon distribution in the Upper St. Lawrence River (DU4), showing the location of current management units.

Population Status Assessment

The population status for Lake Sturgeon populations in DU4 was assessed as described for DU1 (Table 6).

Table 6. Population estimate, qualitative abundance category and population trajectory for Lake Sturgeon populations in DU4 (note areas for which information exists were included in the table).

MU	Area	Population Estimate	Qualitative Abundance Category	Population Trajectory
Western Lake Superior (MU1)	Pigeon River	ND	Extirpated	Unknown
	Kaministiquia River	557	Low	Increasing

MU	**Area**	**Population Estimate**	**Qualitative Abundance Category**	**Population Trajectory**
Lake Nipigon (MU2)	Ombabika Bay	ND	Low	Unknown
	Namewaminikan River	ND	Unknown	Unknown
Northern Lake Superior (MU3)	Black Sturgeon River (below Black Sturgeon dam)	24 (adults)	Low	Unknown
	Nipigon River	ND	Low	Unknown
	Gravel River	ND	Unknown	Unknown
	Wolf River	ND	Extirpated	Unknown
	Prairie River	ND	Unknown	Unknown
	Pic River	ND	Low	Unknown
	White River	ND	Low	Unknown
	Michipicoten River	ND	Low	Unknown
Eastern Lake Superior (MU4)	Batchawana River	4,400 (adults and juveniles)	Medium	Stable
	Chippewa River	ND	Unknown	Unknown
	Harmony River	ND	Extirpated	Unknown
	Stokely Creek	ND	Extirpated	Unknown
	Goulais River/Goulais Bay	<50 (spawning adults); 4,977 (juveniles)	Low	Stable/Increasing
Lake Huron/ North Channel (MU5)	St. Marys River	505 (sub-adults and adults) (95% CI: 388–692)	Low	Unknown
	Garden River	ND	Unknown	Unknown
	Mississagi River (Redrock GS to Lake Huron)	ND	Low	Unknown
	Serpent River	ND	Extirpated	Unknown
	Spanish River (Espanola to Nairn Centre)	ND	Low	Unknown

MU	Area	Population Estimate	Qualitative Abundance Category	Population Trajectory
Lake Nipissing (MU6)	Lake Nipissing	410 (adults in South River)	Low	Unknown
Lake Huron/ Georgian Bay (MU7)	Magnetwawan River	ND	Unknown	Unknown
	Nottawasaga River	ND	Medium	Unknown
	Moon River	ND	Low	Unknown
Lake Huron – Erie Corridor (MU8)	Southern Lake Huron	30,000	High	Stable/Increasing
	North Channel St. Clair River	45,506	High	Stable
	Lake St. Clair	20,000-40,000	High	Stable
	Detroit River	4,422 (95% CI: 2,758 – 6,087)	Medium	Stable
	Lake Erie	ND	Unknown	Unknown
Lower Niagara River (MU9)	Lower Niagara River	7,600 (95% CI: 5,900 – 9,800)	High	Increasing
Eastern Lake Ontario/ Upper St. Lawrence River (MU10)	St. Lawrence River upstream Moses-Saunders GS; Trent River (Percy and Frankford reaches)	ND	Unknown	Unknown
Lake St. Francis (MU11)	Lake St. Francis (upstream Beauharnois GS)	ND	Low	Stable/Declining
Ottawa River (MU 12–19)	Lake Temiscaming (MU12)	ND	Low	Decreasing
	Lac la Cave (MU13)	ND	Low	Decreasing
	Holden Lake (MU14)	ND	Low	Decreasing
	Allumette Lake/ Lac Coulonge (MU15)	ND	Low	Stable
	Lac du Rocher Fendu (MU16)	ND	Low	Decreasing
	Lac des Chats (MU17)	ND	Low	Decreasing

MU	Area	Population Estimate	Qualitative Abundance Category	Population Trajectory
	Lac Deschenes (MU18)	202 (spawning adults)	Low	Decreasing
	Lac Dollard des Ormeaux (MU19)	ND	Low	Increasing
Lower St. Lawrence River (MU20)	Downstream Beauharnois GS and les Coteaux	> 100,000	High	Stable/Increasing
	Lake Champlain and Richelieu River – upstream Chambly Dam and Missisquoi Bay	ND	Unknown	Unknown

The Adult Abundance and Population Trajectory values were combined in the Population Status Matrix (Table 2) to determine the Population Status (Poor, Fair, Good, Unknown, or Extirpated) (Table 7). Three MUs are ranked Good, 15 are ranked Poor, and the population status of two are Unknown.

Table 7. Population Status of Lake Sturgeon populations, resulting from an analysis of both the Adult Abundance and Population Trajectory in DU4.

MU	Area	Population Status
MU1	Western Lake Superior	Poor
MU2	Lake Nipigon	Poor
MU3	Northern Lake Superior	Poor
MU4	Eastern Lake Superior	Poor
MU5	Lake Huron/North Channel	Poor
MU6	Lake Nipissing	Poor
MU7	Lake Huron/Georgian Bay	Unknown
MU8	Lake Huron – Erie Corridor	Good
MU9	Lower Niagara River	Good
MU10	Eastern Lake Ontario/ Upper St. Lawrence River	Unknown
MU11	Lake St. Francis (upstream Beauharnois GS)	Poor

MU	Area	Population Status
MU12	Lake Temiscaming	Poor
MU13	Lac la Cave	Poor
MU14	Holden Lake	Poor
MU15	Allumette Lake/Lac Coulonge	Poor
MU16	Lac du Rocher Fendu	Poor
MU17	Lac des Chats	Poor
MU18	Lac Deschenes	Poor
MU19	Lac Dollard des Ormeaux	Poor
MU20	Lower St. Lawrence River	Good

HABITAT REQUIREMENTS

Lake Sturgeon occupy several distinctly different habitat types in the four freshwater ecozones that comprise their Canadian range (COSEWIC 2017). Habitat use is relatively broad allowing the species to occupy a wide variety of rivers and lakes across North America. For example, available habitats in the Assiniboine River differ considerably when compared to habitats of the St. Lawrence River, Churchill River, Saskatchewan River or those of Great Lakes tributaries. Based on commercial harvest data, Lake Sturgeon populations once existed at high abundances throughout much of their range, thriving in many different habitat types. COSEWIC (2017) provided a summary of the habitat requirements for the species which is summarized below.

Lake Sturgeon spawn in fast-moving water. They may spawn in the same river systems that they inhabit year-round or may move into tributaries to spawn. In most systems, fish congregate downstream of hydraulic features such as falls, rapids, river constrictions, and hydroelectric generating stations. Spawning has been reported at velocities of 0.1 to 2.1 m/s, over a variety of coarse substrates (cobble, boulder, gravel, bedrock, and cinders) and at depths ranging from < 0.3 to 23 m (Table 8).

Successful hatch requires flowing water to provide an aerated environment. Based on one field-laboratory study, water velocities of 0.3 and 0.5 m/s were determined suitable for successful hatch, while lower velocities were deemed inferior due to sedimentation, predation, and fungal infection (COSEWIC 2017).

The understanding of habitat requirements of sturgeon species from hatch to age-1 has improved in recent years. Gravel substrates are considered optimal at the larval yolk-sac stage as they allow larvae to burrow and avoid predation. Following yolk-sac absorption, flow facilitates downstream dispersal. The characteristics of habitat that cue exogenous-feeding larvae to settle remain poorly understood. In shallow Great Lakes tributaries, larvae and age-0 fish are generally observed on sand substrate, which tends to co-occur with low water velocities in these shallow, low-gradient systems (COSEWIC 2017). Laboratory studies have suggested sand is preferred by age-0 Lake Sturgeon, but recruitment seems to be occurring in at least one area (the Great Falls Reservoir on the Winnipeg River, MB) devoid of large, sand-dominated patches (COSEWIC 2017).

Little is known regarding overwintering requirements for age-0 fish, but like larger juveniles, they likely require off-current refuge from flow. Lakes downstream of spawning tributaries in the Great Lakes area, pools, deeper holes, natural lacustrine widenings, and some artificial reservoirs in large rivers all likely provide the appropriate characteristics (COSEWIC 2017).

High annual survival and sustained growth of juvenile and adult life stages have been reported across the diversity of systems (Great Lakes and their tributaries, meandering prairie rivers, Boreal Shield river/lakes, Hudson Bay lowland rivers). Combined with the latitudinal range of the species, it suggests that habitat requirements to support these life-history stages are not strict. Juvenile and adult Lake Sturgeon are likely susceptible to very low levels of predation after age-1. Foraging habitat for small juveniles consists of lotic or lotic-to-lentic transition areas that offer decreasing flows for settling of drifting invertebrates and/or in situ benthic production; however, the reliance on flow to deliver drifting prey items may decrease as individuals age/grow and food-base diversifies (COSEWIC 2017).

RESIDENCE

SARA defines a *residence* as “a dwelling-place, such as a den, nest or other similar area or place, that is occupied or habitually occupied by one or more individuals during all or part of their life cycles, including breeding, rearing, staging, wintering, feeding or hibernating.” (SARA, Section 2.1). DFO (2015) determines the concept of ‘residence’ to apply to a species when it constructs and occupies a dwelling place that is essential for a life history stage, such as spawning or rearing. As Lake Sturgeon do not intentionally modify their habitat during any life-stage, the concept of the SARA definition of residence does not apply to this species.

FUNCTIONS, FEATURES AND ATTRIBUTES

A description of the functions, features, and attributes associated with Lake Sturgeon habitat can be found in Table 8. The habitat required for each life stage has been assigned a function that corresponds to a biological requirement of Lake Sturgeon. In addition to the habitat function, features have been assigned for each life stage. A feature is considered to be the structural component of the habitat necessary for the survival or recovery of the species. Habitat attributes have also been provided, which describe how the features support the function for each life stage. This information is provided to guide any future identification of critical habitat for this species. It should be noted that habitat attributes associated with current records may differ from optimal habitat as Lake Sturgeon may be occupying sub-optimal habitat where optimal habitat is not available.

SPATIAL EXTENT OF HABITAT

Extent of occurrence (EOO) and the index of area of occupancy (IAO) were calculated during the 2017 COSEWIC assessment. The extent of occurrence is defined as the total area, confined within a boundary, which encompasses all the known, assumed, or predicted occurrences of a species (IUCN 2001) and was measured using a minimum convex polygon (COSEWIC 2017). Area of occupancy is defined as the area within the EOO that a species occupies, recognizing that there may be unsuitable or unused habitat within the EOO (IUCN 2001). The IAO was calculated as both discrete (IAO-D), based on a grid over each observation, as well as continuous (IAO-C) based on a continuous stretch of river and lake between observations (COSEWIC 2017). The values for each DU are:

DU1 – Western Hudson Bay: EOO: 911 km^2; IAO-D: 64 km^2; IAO-C: 372 km^2

DU2 – Saskatchewan-Nelson River: EOO: 1,011,515 km^2; IAO-D: 1,224 km^2; IAO-C: 7,884 km^2

DU3 – Southern Hudson Bay-James Bay: EOO: 482,724 km^2; IAO-D: 636 km^2; IAO-C: 3,928 km^2

DU4 – Great Lakes-Upper St. Lawrence: EOO: 852,243 km^2; IAO-D: 3,728 km^2; IAO-C: 126,012 km^2

SPATIAL CONSTRAINTS

DU1 – Western Hudson Bay Populations

The upstream extent of DU1 is bounded by Atik Falls on the Reindeer River and Kettle Falls on the Churchill River, which are impassable barriers to Lake Sturgeon. Island Falls GS is the boundary between MU1 and MU2. MU2 extends to the Missi Falls CS, which blocks upstream fish movement. In MU3, between Missi Falls CS and the Churchill River estuary, rapids occur at The Fours, Redhead Rapids, and Swallow Rapids but it is unknown if these are passable to fish (Figure 3).

DU2 – Saskatchewan-Nelson River Populations

Saskatchewan River System

On the North Saskatchewan River in Alberta, there are no impassable falls or dams that impede Lake Sturgeon movement. In the South Saskatchewan watershed, the Bassano Dam on the Bow River and the Oldman Dam on the Oldman River block upstream Lake Sturgeon movement. The weir in Lethbridge may be characterized as an occasional barrier under certain flow conditions. Moving downstream, dams that create barriers to movements include the Coteau Creek HS (at Gardiner Dam), the Saskatoon Weir, the Nipawin HS (at Francois-Finlay Dam), EB Campbell Dam, and Grand Rapids Dam (Figure 5).

Assiniboine and Red River Drainages

There are two dams on the Assiniboine River, the Shellmouth Dam, and the Portage la Prairie Diversion Control Structure (Figure 6).

Lake Winnipeg and Inflowing Tributaries

The Poplar, Bloodvein, Berens, and Pigeon rivers all have natural barriers that likely block upstream movements. No dams are built on these rivers (Figure 6). On the Red River, the St. Andrews Lock and Dam likely represents a barrier to upstream movement (Figure 6).

Winnipeg River–English River

There are two hydroelectric dams on the English River: Manitou Falls GS and Caribou Falls GS. On the Winnipeg River, there are eight hydroelectric dams that block upstream fish movement (Figure 7).

Lake of the Woods–Rainy River

The Fort Frances GS is the only dam on the Rainy River. On the Seine River, a tributary of Rainy River, upstream movement is blocked by Sturgeon Falls GS (Figure 8).

Nelson River Drainage

The Nelson River drainage was divided into six MUs based on natural and man-made barriers. There are five hydroelectric generating stations that block upstream fish passage on the river (Figure 9).

DU4 – Great Lakes-Upper St. Lawrence Populations

Western Lake Superior (MU1)

The Kaministiquia and Pigeon rivers comprise MU1. On the Kaministiquia River, Lake Sturgeon can move as far upstream as the Kakabeka Falls, 47 km upstream from Lake Superior. On the Pigeon River, the naturally-occurring High Falls (approximately 3 km upstream of the lake) is a barrier to upstream movement (Figure 11).

Lake Nipigon (MU2)

Water control structures exist on several inflowing tributaries to Lake Nipigon, however, the upstream extent of Lake Sturgeon movements within these inflowing tributaries remains poorly understood.

Northern Lake Superior (MU3)

The Black Sturgeon River has one barrier to upstream movement, the Black Sturgeon Dam. On the Nipigon River, there are three generating stations: the Pine Portage GS, Cameron Falls GS, and the Alexander GS. On the Pic River, the naturally occurring Manitou Falls blocks upstream fish movement. The Black and Kagiano rivers are tributaries of the Pic River; upstream movement is blocked on the Black River by the Wawatay GS, while the Kagiano River has naturally occurring falls that create a barrier. On the White River, the naturally-occurring Chigamiwinigum Falls block upstream fish passage. Four hydroelectric generating stations operate on the Michipicoten River, with Lake Sturgeon being restricted to the lowest 17 km of the river downstream of the Scott Falls GS (Figure 11).

Eastern Lake Superior (MU4)

On the Batchawana River, Batchawana Falls creates a natural barrier to upstream movement. The Goulais River has no hydroelectric dams, but natural features block passage 50 km upstream of Lake Superior (Figure 11).

Lake Huron North Channel (MU5)

The St. Marys River has several gates and locks that likely affect Lake Sturgeon movement. The Red Rock GS on the Mississagi River blocks upstream movement farther than 31 km upstream of Lake Huron. On the Spanish River, the Espanola pulp and paper dam 52 km upstream of Spanish Bay blocks upstream sturgeon movement (Figure 12).

Georgian Bay–Lake Huron (MU7)

The Nicholson Dam blocks fish movement in the Nottawasaga River. In the Moon River, Moon Falls is a natural barrier to fish movement (Figure 12).

Lake Huron/Erie Corridor (MU8)

Unlike in many other of the Great Lakes tributaries, Lake Sturgeon movement is unimpeded in MU8, and individuals can move freely from Lake Huron into Lake Erie (Figure 13).

Lower Niagara River (MU9)

Niagara Falls is a barrier to upstream fish movement in MU9 (Figure 14).

Eastern Lake Ontario–Upper St. Lawrence River (MU10 and 11)

The upper St. Lawrence River is separated from the lower reach of the river by two dams: the Moses-Saunders GS upstream, and the Beauharnois GS downstream. Before the construction of these two dams, Lake Sturgeon could move freely between the St. Lawrence estuary and the outlet of Lake Ontario (Figure 14).

Ottawa River Watershed (MU12–19)

The lower Ottawa River has nine reaches, separated by naturally occurring rapids or hydroelectric generating stations. There are seven hydroelectric generating stations on the Ottawa River and an additional 36 dams on its tributaries (Figure 15).

Lower St. Lawrence River (MU20)

MU20 is comprised of the lower St. Lawrence River downstream of the Beauharnois GS, as well as the Ottawa River downstream of the Carillon Dam. Both dams block upstream passage of fish but movement can occur through locks (commercial and recreational, respectively). The Rivière des Prairies has a generating station that blocks upstream movement but fish have access to upstream sections through Lake St. Louis (it is possible for fish to move around). On the L'Assomption River, a set of impassable rapids blocks upstream movement. On the Richelieu River, the St. Ours Dam blocks upstream fish movement, but the addition of a vertical slot fish-way now allows upstream passage up to the Chambly Dam (Figure 16).

The Saint Francois River has a total of 19 hydroelectric GS of different sizes. The Drummondville Dam located the furthest downstream blocks upstream movements.

Table 8. Summary of the essential functions, features and attributes for each life stage of Lake Sturgeon. Numbers in brackets refer to sources cited below.

Life Stage	Function	Feature(s)	Attributes (Observed)	For Identification of Critical Habitat (Inferred)
Spawning / Incubation	Reproduction	• Downstream of hydraulic features such as falls, rapids, river constrictions, and hydroelectric generating stations in tributaries and large river mainstems (1, 2, 3, 4, 5), on shorelines of rivers (6)	• Spawning depth range: < 0.3–23 m (7–12) • Spawning substrate: cobble/boulder/gravel/ bedrock/cinders (7–12) • Spawning Velocity: 0.1–2.1 m/s (7–12) • Spawning water temperature: 8–21.5°C (2–4, 7, 9, 11, 19) • Lake Sturgeon may migrate to spawning habitat • Egg hatch time predicted using a cumulative thermal unit (CTU) (7, 13, 20–22). Incubation complete after 54.7–71.4 CTUs (22). At temperatures between 10–19.9°C, development from fertilization to exogenous feeding occurred at rates of 2–8.3% per day (23).	• Unimpeded access to spawning grounds, including sufficient flow to prevent fish stranding and egg desiccation • Coarse substrate • Sufficient flow to provide oxygenated water for aeration of eggs
Larvae	Cover Feeding	• Following hatch, larvae burrow into gravel substrate to avoid predation until yolk sac is absorbed (13–18) • After yolk sac is absorbed, larvae emerge from the gravel and drift downstream in the flow (7, 13, 21, 22, 24, 25)	• Substrate: gravel post-hatch (13–18) • More active at night than during the day (65) • Temperature: optimal survival between 14–17°C; incipient mortality at 20°C (71)	• Gravel substrate for burrowing larvae to avoid predation • Lower velocity areas to settle out after drift, adequate food to provide drifting invertebrate food items
Young-of-the-year	Cover Feeding Overwintering	• After drifting larvae settle out of the flow, require lower velocity	• Depth range: 0.2–39.0 m (22, 26, 27, 32–34)	• Lower velocity areas, with flow to provide adequate drifting invertebrate food items or substrate with adequate benthic invertebrates

Life Stage	Function	Feature(s)	Attributes (Observed)	For Identification of Critical Habitat (Inferred)
		areas with adequate food (7, 13, 20, 21)	• Substrate: sand or pea-sized substrate after drift (20, 26–28) but may not be a strict habitat requirement (29–31) • Velocity range: 0.15–0.68 m/s (26, 27, 34) • Little is known of overwintering habitat but likely require off-current refuge from flow: lakes, pools, deeper holes, natural lacustrine widenings, artificial reservoirs (27, 34, 35–40) • Temperature: maximum thermal tolerance is uncertain but temperatures above 28–30°C are likely less suitable (41); Lake Sturgeon in northern reaches can survive 0°C for months at a time (41, 42) • Occupies rivers characterized by a wide range of turbidity, clarity, and oxygen levels (43) • Salinity: smaller Lake Sturgeon unlikely to reside in salinities above 15 ppt (44, 45) • Show increased activity after dark (27)	

Life Stage	Function	Feature(s)	Attributes (Observed)	For Identification of Critical Habitat (Inferred)
Juvenile / Adult	Feeding Cover Overwintering	• Habitat requirements not particularly strict as a diversity of habitats are inhabited across their range (46–53) • Require foraging habitat, overwintering habitat with refuge from flow, movement corridors between habitats (2, 3, 46, 49, 54, 55)	• Depth range: 0.2–42.2 m (22, 26, 34, 56–63) • Substrate: variety of substrates ranging from clay to boulder (22, 26, 34, 56–63) • Temperature: maximum thermal tolerance is uncertain but temperatures above 28–30°C are likely less suitable (64); Lake Sturgeon in northern reaches can survive 0°C for months at a time (41, 42) • Occupy rivers characterized by a wide range of turbidity, clarity, and oxygen levels (43) • Salinity: smaller Lake Sturgeon unlikely to reside in salinities above 15 ppt (44, 45); larger fish may be more tolerant (44) • Show increased activity during the night compared to the day in some systems (66, 67, 68) but not all (63, 69, 70)	• Overwintering habitat that offers refuge from flow with adequate foraging habitat • Unimpeded access to foraging, overwintering, and spawning habitat

1. Bajkov 1930
2. Harkness and Dymond 1961
3. Scott and Crossman 1973
4. Priegal and Wirth 1974
5. Auer 1996b
6. Bruch and Binkowski 2002
7. LaHaye et al. 1992
8. Manny and Kennedy 2002
9. Johnson et al. 2006
10. Chiotti et al. 2008
11. Dumont et al. 2011
12. Thiem et al. 2013
13. Auer and Baker 2002
14. Bennett et al. 2007
15. Gessner et al. 2009
16. McAdam and Jonsson 2011
17. Crossman and Hildebrand 2012
18. Hastings et al. 2013
19. Forsythe et al. 2012
20. Kempinger 1988
21. Caroffino et al. 2009
22. Smith and King 2005
23. Eckes et al. 2015
24. D'Amours et al. 2001
25. Verdon et al. 2012
26. Holtgren and Auer 2004
27. Benson et al. 2005
28. Peake 1999
29. McDougall 2011
30. Murray and Gillespie 2011
31. McDougall et al. 2014a
32. Friday 2006
33. Kempinger 1996
34. Keeyask Hydropower Limited Partnership 2012
35. Knights et al. 2002
36. Labadie 2011
37. Barth et al. 2011
38. McDougall et al. 2013
39. Wishingrad et al. 2014
40. Pollock et al. 2015
41. McDougall et al. 2014d
42. McDougall et al. 2014c
43. COSEWIC 2017
44. Lebreton and Beamish 1998
45. Suchy 2009
46. Sunde 1961
47. Fortin et al. 1996
48. Power and McKinley 1997
49. Bruch 1999
50. Adams et al. 2006
51. Vélez-Espino et al. 2006
52. Shaw et al. 2012
53. McDougall et al. 2017
54. Peterson et al. 2003
55. Smith and Baker 2005
56. Lord 2007
57. Environnement Illimite Inc. 2004
58. Hughes 2002
59. Threader et al. 1998
60. Seyler 1997
61. Haugen 1969
62. Block 2001
63. Hay-Chmielewski 1987
64. Lyons and Stewart 2014
65. T. Pratt, DFO, unpublished data
66. Chiasson et al. 1997
67. Lacho 2013
68, Kough et al. 2018
69. Thayer et al. 2017
70. Altenritter et al. 2013
71. Wang et al. 1985

THREATS AND LIMITING FACTORS TO THE SURVIVAL AND RECOVERY OF LAKE STURGEON – GENERAL

Threat categories assessed for Lake Sturgeon followed the IUCN threat categories (IUCN 2012). Threats assessed followed COSEWIC (2017) and include residential and commercial development, transportation and service corridors, invasive and other problematic species and genes, climate change and severe weather, biological resource use (harvest), human intrusions and disturbance (work and other activities), natural system modifications (dams and water management/use and other ecosystem modifications), and pollution (household sewage and urban waste water, industrial and military effluents, and agriculture and forestry effluents).

NATURALLY OCCURRING LIMITING FACTORS

Spawning Habitat

Lake Sturgeon spawning habitat requirements have been well described (see COSEWIC 2017; Table 4) and the presence of flowing water that provides water velocities between 0.1 and 2.1 m/s appears necessary to maintain populations. In some systems (i.e., Great Lakes tributaries, prairie rivers), Lake Sturgeon will travel long distances to find conditions suitable for reproduction (e.g., > 100 km in Great Lakes tributaries and South Saskatchewan River system) (Auer 1996a, Lacho 2013).

Water Temperature

Water temperature is known to limit the habitats that fish populations can exploit. As previously discussed, Lake Sturgeon are known to spawn at water temperatures of 8–22°C, tolerate temperatures from 0–25°C across much of their range, and exist in waterbodies with winter periods that extend to 6 months of the year. This naturally occurring limiting factor is particularly relevant to Lake Sturgeon in DU1. DU1 is at the northern-most extent of the species' range and temperature may be limiting to further northern expansion of the range.

Life History Traits

Several Lake Sturgeon life history traits that allow the species to persist and contribute to the long-term success of the species are considered adaptive, but may also be considered limiting when populations are depressed. These life history traits include longevity, low adult mortality, large size, high fecundity, late age-at-maturity, and periodic spawning. When combined, these traits may limit recruitment at high density (density dependence and cohort suppression) and buffer populations from occasional perturbations (high fecundity and survival), but make the species susceptible to decline from anthropogenic impacts that affect adult survival, such as harvest (van der Lee and Koops 2021). Further, these traits make the species slow to recover in areas where populations exist at low abundances with the long-term population growth rate affected most by adult survival (van der Lee and Koops 2021). Young-of-the-year survival/mortality may also be considered a natural limiting factor, as it has been suggested that population growth rate in sturgeons is highly sensitive to survival at the young-of-the-year age-class (Gross et al. 2002). However, recent population modeling has shown that probability of population decline through chronic harm is most sensitive at the juvenile stage, followed by the adult stage, and least sensitive at the YOY stage (van der Lee and Koops 2021). This finding is supported by rapid decline from historical fishing pressure on adults (Harkness and Dymond 1961) and contemporarily examining the recovery of many populations despite erratic recruitment (McDougall et al. 2014d).

Diseases, Parasites, and Pathogens

Diseases have been detected in Lake Sturgeon but the effect on wild stocks has been largely unstudied. Lake Sturgeon herpesvirus and iridovirus have been detected in Manitoba Lake Sturgeon (MCWS 2012). The Namao virus was discovered in Manitoba after unusual mortalities occurred at two different hatcheries with juvenile fish from the Nelson and Winnipeg river systems, and is associated with morbidity and mortality (Clouthier et al. 2013). There are several parasites that infect Lake Sturgeon. A study of Lake Sturgeon from the Saskatchewan, Nelson, Winnipeg, and Rainy River systems identified 19 species of parasites in Lake Sturgeon, including five specific to Lake Sturgeon, *Crepidostomum auriculatum, Diclybothrium armatum, Spinitectus acipenseri, Truttaedacnitis clitellarius,* and *Polypodium (hydriforma)* (Choudhury and Dick 1993).

Other Factors

Several other factors may naturally limit recruitment in Lake Sturgeon populations. For example, the influence of flow during the spawning season on Lake Sturgeon recruitment has been examined (Nilo et al. 1997, Dumont et al. 2011, McDougall et al. 2014d). Similar to other fish species, the general paradigm for Lake Sturgeon is that higher spring flows will on average produce better year-classes (Nilo et al. 1997, Dumont et al. 2011, DFO 2019), although it should be noted that positive correlations between flow and year-class strength have not been observed in each system studied (McDougall et al. 2014d). In addition, juvenile density, specifically the strength of the year-class during the year previous has been reported as a potential natural limiting factor in the St. Lawrence River (Nilo et al. 1997).

ANTHROPOGENIC THREATS

The following is a general overview of the threat categories assessed. DU-specific information is presented in subsequent sections.

Residential and Commercial Development

COSEWIC (2017) lists residential and commercial development as a potential threat to Lake Sturgeon. Residential and commercial developments are prevalent in DU2 and DU4, but the effects of development are largely in the past, and future impacts of this threat would affect a very small proportion of Lake Sturgeon populations (COSEWIC 2017).

Transportation and Service Corridors

Transportation and service corridors include roads and railroads, which are not considered to pose a significant threat to Lake Sturgeon populations. Channelization and dredging for shipping have the potential to impact Lake Sturgeon populations but impacts remain unknown (COSEWIC 2017).

Invasive and Other Problematic Species and Genes

Distributions of some invasive species are known to overlap with Lake Sturgeon and may impact some populations in DU2 and DU4. In many cases, the net impact of invasive species, are as yet unknown and require further study (COSEWIC 2017).

Measures to control invasive Sea Lamprey *(Petromyzon marinus)* in the Great Lakes basin present a risk to Lake Sturgeon populations.

Climate Change and Severe Weather

Climate change was not specifically identified in Table 2 of COSEWIC (2017), however, some general climate impacts are discussed in terms of the Lake Sturgeon life history and recent population viability modeling results relating to recruitment and adult mortality. For example, climate change will likely impact Lake Sturgeon via extreme weather (such as droughts, extreme temperatures, storms, and flooding) and habitat shifting and alteration. Thayer (2016) studied the effects of an extreme flood event in 2013 in Alberta and found that larger substrate was exposed, potentially improving the quality of spawning habitat.

Biological Resource Use

Harvest

Over-exploitation/harvest is considered a pervasive threat to most sturgeon species, including Lake Sturgeon, as the species is very sensitive to removal of adults and juveniles (Vélez-Espino and Koops 2009, van der Lee and Koops 2021). Further, adult mortality due to harvest is considered a significant threat to Lake Sturgeon populations that exist at low abundances, or are within ~ 10% of recovery targets (Nelson et al. submitted). Harvest may also have an additive effect on recruitment, when the harvest occurs during the spawning period; juvenile recruitment has been shown to be negatively correlated with previous year harvest of adults (Dumont et al. 2011, Mailhot et al. 2011).

Human Intrusions and Disturbances

Work and Other Activities (Salafsky 2008 describes this threat as: *People spending time in or traveling in natural environments for reasons other than recreation, military activities, or research – scientific sampling*)

Scientific sampling is prevalent throughout all DUs and may lead to incidental mortalities. The impact of these mortalities on Lake Sturgeon populations is not considered significant. McDougall et al. (2014b) recommended sampling with gillnets when water temperatures are < 15°C to avoid higher rates of gillnet induced mortality associated with higher water temperatures.

Angling

Catch and release angling for Lake Sturgeon is prevalent in some areas of Canada. Angling has the potential to result in Lake Sturgeon mortality if fish are kept out of water for extended periods or fish are handled improperly. Research aimed at assessing the influence of angling on Lake Sturgeon mortality is currently being conducted in the Winnipeg River, Manitoba.

Natural System Modifications

Dams and Water Management/Use

The impacts of dams and water management on Lake Sturgeon have received considerable attention in the scientific literature and it is well documented that the dam footprint and associated operations can exert negative influences (Houston 1987, Auer 1996a,b, Clarke et al. 2008, Haxton et al. 2014b, Haxton et al. 2015, Pollock et al. 2015, Haxton and Cano 2016, COSEWIC 2017, Smith et al. 2017). The dam itself represents an impassable barrier, isolating populations and preventing upstream movement. Further, downstream movement of Lake Sturgeon through dams with turbines (i.e., entrainment) can cause mortality and injury. There is also risk of impingement at trash racks. Dams are generally constructed at locations characterized by a significant drop in elevation which may correspond with preferred Lake

Sturgeon spawning habitat. Water released through a dam, if drawn from below a thermocline, has the potential to be colder relative to what would occur in nature. Cold-water releases from dams may negatively affect Lake Sturgeon recruitment by significantly increasing egg incubation times and reducing time for YOY to accumulate sufficient energy to survive the winter. Mode of operation is also considered a potential threat to Lake Sturgeon. Run-of-the-river operations were considered to be less of an impact to Lake Sturgeon relative to peaking operations or winter draw downs (Haxton et al. 2015).

Pollution

Due to increasingly strict environmental regulations, the threat that present-day pollution poses to Lake Sturgeon is likely decreasing (COSEWIC 2017). Historically, water pollution caused by the pulp-and-paper industry and agriculture likely contributed to the decline of Lake Sturgeon populations in many areas (Harkness and Dymond 1961, Mosindy 1987, Rusak and Mosindy 1997, Heinrich and Friday 2014). Debris deposited on the bottom of rivers by the pulp-and-paper industry may still affect Lake Sturgeon habitat in some areas of DU2 and DU4 (Gill et al. 2018, T. Haxton, OMNRF, pers. comm.). Sewage treatment facilities and water quality regulations have resulted in marked improvements to the quality of municipal effluent discharge across the species range. Mercury accumulation in Lake Sturgeon is also a concern, caused by the increased availability of methylmercury available when forests or wetlands were flooded during construction of dams (Mergler et al. 2007). Pesticides may also negatively affect Lake Sturgeon if they leach into the water. Chlorpyrifos, a commonly-used organophosphate pesticide, acted as an endocrine disruptor by reducing testosterone production in both male and female Lake Sturgeon at environmentally relevant concentrations (Brandt et al. 2015). The timing of chlorpyrifos application in agriculture, and its resulting entrance into waterways at biologically relevant concentrations, can coincide with Lake Sturgeon spawning period, when the negative impacts on steroidogenesis can affect spawning success (Brandt et al. 2015). In DU4, lampricide applied to Great Lakes tributaries to control Sea Lamprey abundance may also be considered a pollutant (COSEWIC 2017). Effluents discharged from oil refineries and sewage treatment facilities may also impact Lake Sturgeon, although little research has been conducted in this regard.

THREAT ASSESSMENT

Threats to Lake Sturgeon were assessed following the procedure outlined in *Guidance on Assessing Threats, Ecological Risk and Ecological Impacts for Species at Risk* (DFO 2014). According to this document, a threat is defined as “any human activity or process that has caused, is causing, or may cause harm, death, or behavioural changes to a wildlife species at risk, or the destruction, degradation, and/or impairment of its habitat, to the extent that population-level effects occur” (DFO 2014).

Threat assessments conducted for other endangered species in Canada are typically completed by DU, however, for Lake Sturgeon, this procedure was followed for DU1 only. For DU2 and DU4, threats were assessed by zones within each DU. Zones were comprised of several MUs and boundaries were established based on threat similarities among MUs with zones generally corresponding to watersheds within each DU. Five zones were assessed in each of DU2 and DU4.

There is a strong rationale for assessing threats by zone for both DU2 and DU4. These DUs are large, and are comprised of several discrete Lake Sturgeon populations spread across multiple watersheds. As a result, threats can vary by geographic location within each of these DUs; assessing threats by DU was deemed too coarse to provide meaningful resolution. Assessing threats by MU was also considered, however, this approach would have been needlessly repetitious, as many of the threats to Lake Sturgeon were found to be similar among MUs in similar watersheds.

The COSEWIC (2017) threat assessment was used as the basis for the threat assessment presented below. For each DU, each threat assessed as “applicable” in COSEWIC 2017 was included in the assessment; those assessed as not applicable within a DU (in COSEWIC 2017) were not included in the threat assessment for that DU. The following threat categories were assessed: residential and commercial development, transportation and service corridors, biological resource use, human intrusions and disturbance, natural system modifications, invasive and other problematic species and genes, pollution and climate change and severe weather. Information used to assess threats was derived from the COSEWIC 2017 document, the Lake Sturgeon RPA meetings (held in Winnipeg, MB, and Gatineau, QC; DFO 2021a, 2021b), available literature, and expert opinion.

It is important to note that many threats to Lake Sturgeon have been mitigated over the last several decades. For example, with respect to harvest, there is only one active commercial fishery for Lake Sturgeon in Canada which is strictly managed. Historically (circa 1850–1920), many Lake Sturgeon populations were decimated by commercial harvests that were largely unregulated. In addition, water quality has improved in recent decades, attributed largely to legislation and regulations that have resulted in marked improvements to municipal and industrial effluent. Efforts to mitigate and monitor impacts of development (i.e., hydroelectric development) on Lake Sturgeon have also improved over the last several decades.

Threats were assessed for each of DU1, DU2 (five zones) and DU4 (five zones) (Tables 16–26). The Likelihood of Occurrence (Table 9), Level of Impact (Table 10), Causal Certainty (Table 11), Threat Risk (product of Likelihood of Occurrence and Level of Impact; Table 12), Threat Occurrence (Table 13), Threat Frequency (Table 14), and Threat Extent (Table 15) were evaluated for each identified threat.

Table 9. Categories of Likelihood of Occurrence (LO).

Likelihood of Occurrence	Definition
Known or very likely to occur	The threat has been recorded to occur 91–100% of the time
Likely to occur	There is 51–90% chance that this threat is or will be occurring
Unlikely	There is 11–50% chance that this threat is or will be occurring
Remote	There is 1–10% chance that this threat is or will be occurring
Unknown	There are no data or prior knowledge of this threat occurring now or in the future

Table 10. Categories of Level of Impact (LI) linked to a threat.

Level of Impact	Definition
Extreme	Severe population decline (i.e., 71–100%) with the potential for extirpation
High	Substantial loss of population (31–70%) or threat would jeopardize the survival or recovery of the population
Medium	Moderate loss of population (11–30%) or threat is likely to jeopardize the survival or recovery of the population
Low	Little change in population (1–10%) or threat is unlikely to jeopardize the survival or recovery of the population
Unknown	No prior knowledge, literature or data to guide the assessment of threat severity on population

Table 11. Categories of Causal Certainty (CC) linked to a threat.

Causal Certainty	Definition
Very high	Very strong evidence that threat is occurring and the magnitude of impact to the population can be quantified
High	Substantial evidence of a causal link between threat and population decline or jeopardy to survival or recovery
Medium	There is some evidence linking the threat to population decline or jeopardy to survival or recovery
Low	There is a theoretical link with limited evidence that threat is leading to a population decline or jeopardy to survival or recovery
Very Low	There is a plausible link with no evidence that the threat is leading to a population decline or jeopardy to survival or recovery

Table 12. The Threat Risk Matrix combines the Likelihood of Occurrence and Threat Impact rankings to establish the Threat Risk. The resulting Threat Risk is categorized as Low, Medium, High or Unknown.

		Threat Impact				
		Low	**Medium**	**High**	**Extreme**	**Unknown**
Likelihood of Occurrence	**Known**	Low	Medium	High	High	Unknown
	Likely	Low	Medium	High	High	Unknown
	Unlikely	Low	Medium	Medium	Medium	Unknown
	Remote	Low	Low	Low	Low	Unknown
	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown

Table 13. Categories of Threat Occurrence.

Threat Occurrence	Definition
Historical (HIS)	A threat that is known to have occurred in the past and negatively impacted the population
Current (CUR)	A threat that is ongoing, and is currently negatively impacting the population
Anticipatory (ANT)	A threat that is anticipated to occur in the future, and will negatively impact the population

Table 14. Categories of Threat Frequency.

Threat Frequency	Definition
Single	The threat occurs once
Recurrent (REC)	The threat occurs periodically or repeatedly
Continuous (CONT)	The threat occurs without interruption

Table 15. Categories of Threat Extent.

Threat Extent	Definition
Extensive (EXT)	71–100% of the population is affected by the threat
Broad	31–70% of the population is affected by the threat
Narrow (NAR)	11–30% of the population is affected by the threat
Restricted (RES)	1–10% of the population is affected by the threat

Threats and Limiting Factors to the Survival and Recovery of Lake Sturgeon – DU1

As previously discussed, Lake Sturgeon populations in DU1 exist at a fraction of their historical abundance with contemporary recruitment being identified for only one population in the entire DU (Cleator et al. 2010a, COSEWIC 2017, Barth et al. 2018). This remaining population exists in MU3 occupying an approximately 35 km long section of the Churchill River bordered by The Fours and Swallow Rapids, a reach that also includes the confluence with the Little Churchill River.

Lake Sturgeon populations further upstream in MU1 and MU2 of DU1 are considered either extirpated or unknown (Table 1). Although it is possible that a recruiting population could remain in these MU's, as they are large, remote, and largely unstudied, natural recovery is unlikely due to low population sizes. Upstream movement of Lake Sturgeon from the one remaining recruiting population in MU3 into either MU2 or MU1 is not possible due to the Missi Falls CS which acts as a barrier to upstream fish movement.

Threats assessed as either low, medium or high, in MU3 of DU1 include: fishing and harvesting aquatic resources, human intrusions and disturbance (work and other activities), and natural system modifications (dams and water management/use) and these are discussed below.

Biological Resource Use

Fishing & harvesting aquatic resource

Harvest is considered an important threat to Lake Sturgeon, particularly in MU3 of DU1 given the high density of Lake Sturgeon occupying this relatively small section of the Churchill River (COSEWIC 2017). Subsistence harvest currently occurs in MU3, but the quantity of fish harvested is unknown (D. Macdonald, North/South Consultants Inc., pers. comm.). The overall Threat Risk of harvest to the remaining population in the Churchill River (DU1) was assessed as High (Table 16). Based on the population model that accompanies this RPA, even small quantities of harvest (i.e., harvest levels > 4%) can significantly elevate the risk of extinction (van der Lee and Koops 2021).

Human Intrusions and Disturbance

Work and Other Activities

Scientific research, specifically mark/recapture work to derive population estimates, has and continues to occur in MU3. The overall Threat Risk for this activity was assessed as Low given that mortality associated with mark/recapture programs is generally low (e.g., < 2% of juvenile Lake Sturgeon captured in gillnets as reported in McDougall et al. 2014b) (Table 16).

Natural System Modifications

Dams and Water Management/Use

Dams are present in each MU of DU1 and the threat risk posed by dams and water management/use was assessed as High for this DU (Table 16). The population in MU3 specifically has been affected by the Churchill River Diversion and operations at Missi Falls CS since 1976, when 79% of the flow of the Churchill River was diverted into the Nelson River drainage (Split Lake Cree-Manitoba Hydro Joint Studies Group 1996). Presently, a minimum flow of 14.2 m^3/s during the open water period and 42.5 m^3/s during the initial ice cover period at Missi Falls CS is maintained (Manitoba Hydro 2010). Missi Falls CS was built at a set of falls that likely represented a historical barrier to upstream movement and therefore, the most significant impact of Missi Falls CS on Lake Sturgeon in the lower Churchill River is likely habitat loss rather than fragmentation. Water depth in the reach of MU3 between the Fours and Swallow Rapids is greater relative to the other reaches and may represent the most suitable overwintering habitat for Lake Sturgeon in this MU. Therefore, winter flows may be particularly important to sturgeon in this reach.

Climate Change and Severe Weather

Habitat shifting and alteration, Droughts, Temperature extremes, Storms and flooding

The Threat Risk of climate change on Lake Sturgeon in DU1 was assessed as Unknown for each subcategory listed in Table 16 as the Level of Impact was Unknown. The Churchill River is at the northern most extent of the species range, however, how climate change may affect Lake Sturgeon in this area remains unknown.

DU1 Threat Assessment (Churchill River Watershed)

The DU1 threat assessment (Table 16) includes all three MUs in the Churchill River Drainage (Figure 3):

- Zone 1 - Churchill River Drainage:
  - MU1: Kettle Falls to Island Falls GS
  - MU2: Island Falls GS to Missi Falls CS
  - MU3: Missi Falls to Churchill River Estuary

Table 16. Threat assessment for Lake Sturgeon populations in DU1. The threat assessment included all three MUs in the Churchill River watershed (MU1: Kettle Falls to Island Falls GS; MU2: Island Falls GS to Missi Falls CS; MU3: Missi Falls to Churchill River Estuary).

Threat	Likelihood of Occurrence	Level of Impact	Causal Certainty	Threat Risk	Threat Occurrence	Threat Frequency	Threat Extent
Biological Resource Use							
Fishing & harvesting aquatic resources	Known	High	Very High	**High**	HIS/CUR/ANT	REC	NAR
Human Intrusions and Disturbances							
Work & Other Activities	Known	Low	Very Low	**Low**	HIS/CUR/ANT	REC	RES
Natural System Modifications							
Dams and Water Management/Use	Known	High	High	**High**	HIS/CUR	CONT	EXT
Climate Change and Severe Weather							
Habitat shifting & alteration	Known	Unknown	Very Low	**Unknown**	CUR/ANT	CONT	EXT
Droughts	Known	Unknown	Very Low	**Unknown**	CUR/ANT	CONT	EXT
Temperature extremes	Known	Unknown	Very Low	**Unknown**	CUR/ANT	CONT	EXT
Storms & flooding	Known	Unknown	Very Low	**Unknown**	CUR/ANT	CONT	EXT

Threats and Limiting Factors to the Survival and Recovery of Lake Sturgeon – DU2

For the DU2 assessment, an Unknown threat risk was consistently assigned to several threat categories including residential and commercial development, transportation and service corridors, invasive and other problematic species and genes, and climate change and severe weather. This is due to the lack of information from which to assess the level of impact on DU2 populations. Work and other activities associated with scientific research was assessed as a Low threat risk in each of the five zones (Tables 17–21). Similar to DU1, dams and water management/use and biological resource use (harvest) were consistently assessed as a High threat risk in each zone (with the exception of Zone 3 where few dams exist and there is little potential for future development) although some populations are known to be abundant in some relatively short (i.e., < 50 km) river reaches separated by dams. The threat risk for pollution related threats was assessed as Low or Unknown across zones in DU2. Each threat category is discussed below.

Residential and Commercial Development

The effects of residential and commercial development in DU2 are persistent, and cumulative. This threat would directly affect only a very small proportion of the DU2 watershed. Specific impacts at a population level are unknown. Overall, the Threat Risk of residential and commercial development was assessed as Unknown for all five zones in DU2 (Tables 17–21).

Transportation and Service Corridors

The Threat Risk of transportation and service corridors, including roads, bridges, railroads, and utility and service lines was assessed as Unknown for each of the five zones in DU2 (Tables 17–21) as the Level of Impact was Unknown. Dredging (shipping lanes) is currently proposed in the Red River, but its potential impact on Lake Sturgeon is Unknown (COSEWIC 2017).

Biological Resource Use

Fishing & harvesting aquatic resources

Historically, Lake Sturgeon were heavily harvested throughout DU2, leading to dramatic population declines in some waterbodies (COSEWIC 2017). Subsistence harvest occurs throughout DU2 outside of conservation closures, but harvest quantities vary considerably by location. Angling for Lake Sturgeon in DU2 is strictly catch-and-release (Alberta and Saskatchewan) or prohibited (Manitoba and Ontario), although some transboundary populations are subject to a limited legal harvest by anglers in the United States (Lake of the Woods and Rainy River). Conservation closures (where all harvest is restricted) have been established for some areas in Manitoba, including the Winnipeg River and the Landing River area of the Nelson River. Poaching may be an issue in DU2, but the extent to which it occurs is not known. Commercial fishing for other species occurs in some locations of DU2, thus recovering populations may be susceptible as bycatch (COSEWIC 2017). The Threat Risk posed by harvest in DU2 was assessed as High for all five DU2 zones (Tables 17–21). Similar to DU1, harvest was assessed as a High threat risk given that according to population models, even modest harvest quantities (> 4%) may increase extinction risk (van der Lee and Koops 2021).

Human Intrusions and Disturbance

Work and Other Activities

Scientific research has, and continues to be conducted in DU2. It was assessed as a Low threat risk for each of the five zones in DU2 (Tables 17–21).

Natural System Modifications

Dams and Water Management/Use

Dams impact Lake Sturgeon habitat throughout DU2 by destroying spawning habitat, altering flow dynamics, increasing mortality through impingement and entrainment and preventing upstream movement to historical spawning sites. Some populations in DU2 have recovered or are increasing despite past and present impacts of hydroelectric development. For example, some recovering DU2 populations occupy small river reaches separated by dams < 50 km apart (see COSEWIC 2017, Barth et al. 2018). However, future and current dam construction has a high potential for negative population level impacts, especially if left unmitigated. Therefore, the Threat Risk for all but one zone in DU2 was assessed as High (Tables 17, 18, 20, 21). The Threat Risk for Lake Winnipeg and the Eastside tributaries where dams are not present was assessed as Low (Table 19).

Invasive and Other Problematic Species and Genes

Invasive non-native/alien species

Invasive species, specifically the Zebra Mussel, Spiny Waterflea (*Bythotrephes longimanus*), Rusty Crayfish (*Orconectes rusticus*), Common Carp (*Cyprinus carpio*), and Rainbow Smelt (*Osmerus mordax*) may cause changes to ecosystems and impact Lake Sturgeon populations in DU2. One or more invasive species are present in each zone of DU2. Despite the large volume of research on the effects of invasive species in aquatic ecosystems there is little directed research that specifically examines their influence on Lake Sturgeon populations. As such, the overall Threat Risk of invasive species on Lake Sturgeon populations was assessed as Unknown for each of the five zones in DU2 (Tables 17–21). However, the potential for population level impacts is present especially in Lake Winnipeg and tributaries where Zebra Mussel, Spiny Waterflea, Rainbow Smelt, and the Common Carp have been present for several years.

Pollution

Household Sewage and Urban Waste Water, Industrial and Military Effluents, and Agricultural and Forestry Effluents

The Threat Risk of pollution on the survival and recovery of Lake Sturgeon in DU2 was assessed as Low or Unknown in each zone (Table 17–21). Although much of the habitat degradation due to pollution occurred in the past, some localized ongoing impacts remain. Historically, Lake Sturgeon populations in DU2 were impacted by pollution caused by effluents and wood fiber waste associated with the pulp and paper industry as well as agricultural runoff (COSEWIC 2017). Wastewater effluent may also influence populations particularly in highly populated areas where treated municipal wastewater is released into the waterways. This may be of particular importance to the Lake Sturgeon populations in Lake Winnipeg and the Red and Assiniboine rivers where larger volumes of wastewater effluent is known to be released.

Climate Change and Severe Weather

Habitat shifting and alteration, Droughts, Temperature extremes, Storms and flooding

Climate change was assessed as applicable to DU2 populations in COSEWIC (2017). Overall, the Threat Risk of climate change on Lake Sturgeon for each subcategory in all five zones of DU2 (listed in Tables 17–21) was assessed as Unknown as the Level of Impact is Unknown.

DU2 Threat Assessment

Lake Sturgeon populations in most MUs of DU2 are thought to exist at lower abundances relative to what existed historically (COSEWIC 2017, Barth et al. 2018). Also characteristic of DU2 Lake Sturgeon populations is that population status can be highly variable among MUs in different watersheds and among MUs within the same watershed, separated by dams (COSEWIC 2017). For reasons previously discussed, the DU2 threat assessment was conducted by zone. Zones were comprised of the following:

- Zone 1: Saskatchewan River Drainage includes four MUs (Table 17):
  - MU1 – North Saskatchewan River, South Saskatchewan River Downstream of Coteau Creek HS, Saskatchewan River from The Forks to the Nipawin HS
  - MU2 – South Saskatchewan River upstream of Coteau Creek HS
  - MU3 – Saskatchewan River Nipawin HS to E.B. Campbell HS
  - MU4 – E.B. Campbell HS to the Grand Rapids GS
- Zone 2: Assiniboine and Red rivers upstream of Lockport includes two MUs (Table 18):
  - MU1 – Assiniboine River upstream of the Portage la Prairie Diversion Control Structure
  - MU2 – Red River and tributaries upstream of Lockport, including the Assiniboine River to Portage la Prairie Diversion Control Structure

- Zone 3: Red River downstream of Lockport, Winnipeg River downstream of Pine Falls GS, Lake Winnipeg and all inflowing eastside tributaries both upstream and downstream of impassable barriers includes two MUs (Table 19):
    - MU1 – Lake Winnipeg and Tributaries Downstream of Impassable Barriers
    - MU2 – Lake Winnipeg East Side Tributaries Upstream of Impassable Barriers
- Zone 4: Rainy River–Lake of the Woods, and English/Winnipeg River Drainages includes 14 MUs (Table 20):

    Rainy River–Lake of the Woods

    - MU1 – Sturgeon Lake–Lac la Croix System
    - MU2 – Namakan River
    - MU3 – Namakan Reservoir
    - MU4 – Rainy Lake and Tributaries
    - MU5 – Rainy River from Fort Frances GS to the outlet of Lake of the Woods

    Winnipeg/English River drainages

    - MU1 – Wabigoon River
    - MU2 – English River: Manitou Falls GS–Caribou Falls GS
    - MU3 – Winnipeg River: Norman GS–Whitedog Falls GS
    - MU4 - Winnipeg/English River: Caribou Falls GS and Whitedog Falls GS–Pointe du Bois GS
    - MU5 – Winnipeg River: Pointe du Bois GS–Slave Falls GS
    - MU6 – Winnipeg River: Slave Falls GS–Seven Sisters GS
    - MU7 – Seven Sisters Falls GS–MacArthur Falls GS
    - MU8 – MacArthur GS–Great Falls GS
    - MU9 – Great Falls GS–Pine Falls GS
- Zone 5: Nelson River drainage comprised of six MUs (Table 21):
    - MU1 – Playgreen Lake–Whitemud Falls
    - MU2 – Whitemud Falls–Kelsey GS
    - MU3 – Kelsey GS–Kettle GS; lower Burntwood River between First Rapids and Split Lake
    - MU4 – Kettle GS–Long Spruce GS
    - MU5 – Long Spruce GS–Limestone GS
    - MU6 – Limestone GS–Hudson Bay

Table 17. Threat assessment for Lake Sturgeon populations in Zone 1 of DU2. Zone 1 includes four MUs in the Saskatchewan River Drainage (MU1 – North Saskatchewan River; South Saskatchewan River Downstream of Coteau Creek HS, Saskatchewan River from The Forks to the Nipawin HS; MU2 – South Saskatchewan River upstream of Coteau Creek HS; MU3 – Saskatchewan River Nipawin HS to E.B. Campbell HS; and MU4 – E.B. HS Campbell to Cedar Lake).

Threat	Likelihood of Occurrence	Level of Impact	Causal Certainty	Threat Risk	Threat Occurrence	Threat Frequency	Threat Extent
Residential & Commercial Development							
Tourism & recreation areas	Known	Unknown	Very Low	**Unknown**	HIS/CUR/ANT	REC	RES
Transportation & Service Corridors							
Roads & railroads	Known	Unknown	Very Low	**Unknown**	HIS/CUR/ANT	REC	RES
Utility & service lines	Known	Unknown	Very Low	**Unknown**	HIS/CUR/ANT	REC	RES
Biological Resource Use							
Fishing & harvesting aquatic resources	Known	High	High	**High**	HIS/CUR/ANT	REC	RES
Human Intrusions and Disturbances							
Work & other activities	Known	Low	Very Low	**Low**	HIS/CUR/ANT	REC	RES
Natural System Modifications							
Dams and water management/use	Known	High	High	**High**	HIS/CUR	CONT	EXT
Invasive and Other Problem Species & Genes							
Invasive non-native/alien species	Known	Unknown	Low	**Unknown**	CUR/ANT	CONT	EXT
Pollution							
Household sewage & urban waste water	Known	Low	Very Low	**Low**	HIS/CUR/ANT	REC	RES
Industrial & military effluents	Known	Low	Very Low	**Low**	HIS/CUR/ANT	REC	RES
Agricultural & forestry effluents	Known	Low	Low	**Low**	HIS/CUR/ANT	REC	RES
Climate Change and Severe Weather							
Habitat shifting & alteration	Known	Unknown	Very Low	**Unknown**	CUR/ANT	CONT	EXT
Droughts	Known	Unknown	Very Low	**Unknown**	CUR/ANT	CONT	EXT
Temperature extremes	Known	Unknown	Very Low	**Unknown**	CUR/ANT	CONT	EXT
Storms & flooding	Known	Unknown	Very Low	**Unknown**	CUR/ANT	CONT	EXT

Table 18. Threat Assessment for Zone 2 of DU2. Zone 2 includes two MUs (MU1 – Assiniboine River upstream of the Portage la Prairie Diversion Control Structure; and MU2 – Red River and tributaries upstream of Lockport, including the Assiniboine River to Portage la Prairie Diversion Control Structure).

Threat	Likelihood of Occurrence	Level of Impact	Causal Certainty	Threat Risk	Threat Occurrence	Threat Frequency	Threat Extent
Residential & Commercial Development							
Tourism & recreation areas	Known	Unknown	Very Low	**Unknown**	HIS/CUR/ANT	REC	RES
Transportation & Service Corridors							
Roads & railroads	Known	Unknown	Very Low	**Unknown**	HIS/CUR/ANT	REC	RES
Utility & service lines	Known	Unknown	Very Low	**Unknown**	HIS/CUR/ANT	REC	RES
Shipping lanes	Known	Unknown	Very Low	**Unknown**	HIS/CUR/ANT	REC	RES
Biological Resource Use							
Fishing & harvesting aquatic resources	Known	High	High	**High**	HIS/CUR/ANT	REC	RES
Human Intrusions and Disturbances							
Work & other activities	Known	Low	Very Low	**Low**	HIS/CUR/ANT	REC	RES
Natural System Modifications							
Dams and water management/use	Known	High	High	**High**	HIS/CUR	CONT	EXT
Invasive and Other Problem Species & Genes							
Invasive non-native/alien species	Known	Unknown	Low	**Unknown**	CUR/ANT	CONT	EXT
Pollution							
Household sewage & urban waste water	Known	Low	Very Low	**Low**	HIS/CUR/ANT	REC	RES
Industrial & military effluents	Known	Low	Very Low	**Low**	HIS/CUR/ANT	REC	RES
Agricultural & forestry effluents	Known	Low	Low	**Low**	HIS/CUR/ANT	REC	RES
Climate Change and Severe Weather							
Habitat shifting & alteration	Known	Unknown	Very Low	**Unknown**	CUR/ANT	CONT	EXT
Droughts	Known	Unknown	Very Low	**Unknown**	CUR/ANT	CONT	EXT
Temperature extremes	Known	Unknown	Very Low	**Unknown**	CUR/ANT	CONT	EXT
Storms & flooding	Known	Unknown	Very Low	**Unknown**	CUR/ANT	CONT	EXT

Table 19. Threat assessment for Zone 3 of DU2. Zone 3 includes two MUs (MU1 – Lake Winnipeg and Tributaries Downstream of Impassable Barriers; and MU2 – Lake Winnipeg East Side Tributaries Upstream of Impassable Barriers).

Threat	Likelihood of Occurrence	Level of Impact	Causal Certainty	Threat Risk	Threat Occurrence	Threat Frequency	Threat Extent
Residential & Commercial Development							
Tourism & recreation areas	Known	Unknown	Very Low	**Unknown**	HIS/CUR/ANT	REC	RES
Transportation & Service Corridors							
Roads & railroads	Known	Unknown	Very Low	**Unknown**	HIS/CUR/ANT	REC	RES
Utility & service lines	Known	Unknown	Very Low	**Unknown**	HIS/CUR/ANT	REC	RES
Biological Resource Use							
Fishing & harvesting aquatic resources	Known	High	High	**High**	HIS/CUR/ANT	REC	RES
Human Intrusions and Disturbances							
Work & other activities	Known	Low	Very Low	**Low**	HIS/CUR/ANT	REC	RES
Natural System Modifications							
Dams and water management/use	Known	Low	Low	**Low**	HIS/CUR	CONT	EXT
Invasive and Other Problem Species & Genes							
Invasive non-native/alien species	Known	Unknown	Low	**Unknown**	CUR/ANT	CONT	EXT
Pollution							
Household sewage & urban waste water	Known	Low	Very Low	**Low**	HIS/CUR/ANT	REC	RES
Industrial & military effluents	Known	Low	Very Low	**Low**	HIS/CUR/ANT	REC	RES
Agricultural & forestry effluents	Known	Low	Low	**Low**	HIS/CUR/ANT	REC	RES
Climate Change and Severe Weather							
Habitat shifting & alteration	Known	Unknown	Very Low	**Unknown**	CUR/ANT	CONT	EXT
Droughts	Known	Unknown	Very Low	**Unknown**	CUR/ANT	CONT	EXT
Temperature extremes	Known	Unknown	Very Low	**Unknown**	CUR/ANT	CONT	EXT
Storms & flooding	Known	Unknown	Very Low	**Unknown**	CUR/ANT	CONT	EXT

Table 20. Threat Assessment for Zone 4 of DU2. Zone 4 includes the Rainy River, Lake of the Woods, and English/Winnipeg River watersheds comprised of 14 MUs (Rainy River–Lake of the Woods – MU1 – Sturgeon Lake–Lac la Croix System; MU2 – Namakan River; MU3 – Namakan Reservoir; MU4 – Rainy Lake and Tributaries; MU5 – Rainy River from Fort Frances GS to the outlet of Lake of the Woods; Winnipeg/English River drainages – MU1 – Wabigoon River; MU2 – English River: Manitou Falls GS–Caribou Falls GS; MU3 – Winnipeg River: Norman GS–Whitedog Falls GS; MU4 – Winnipeg/English River: Caribou Falls GS and Whitedog Falls GS–Pointe du Bois GS; MU5 – Winnipeg River: Pointe du Bois GS–Slave Falls GS; MU6 – Winnipeg River: Slave Falls GS–Seven Sisters GS; MU7 – Seven Sisters Falls GS–MacArthur Falls GS; MU8 – MacArthur GS–Great Falls GS; MU9 – Great Falls GS–Pine Falls GS).

Threat	Likelihood of Occurrence	Level of Impact	Causal Certainty	Threat Risk	Threat Occurrence	Threat Frequency	Threat Extent
Residential & Commercial Development							
Tourism & recreation areas	Known	Unknown	Very Low	**Unknown**	HIS/CUR/ANT	REC	RES
Transportation & Service Corridors							
Roads & railroads	Known	Unknown	Very Low	**Unknown**	HIS/CUR/ANT	REC	RES
Utility & service lines	Known	Unknown	Very Low	**Unknown**	HIS/CUR/ANT	REC	RES
Biological Resource Use							
Fishing & harvesting aquatic resources	Known	High	High	**High**	HIS/CUR/ANT	REC	RES
Human Intrusions and Disturbances							
Work & other activities	Known	Low	Very Low	**Low**	HIS/CUR/ANT	REC	RES
Natural System Modifications							
Dams and water management/use	Known	High	High	**High**	HIS/CUR	CONT	EXT
Invasive and Other Problem Species & Genes							
Invasive non-native/alien species	Known	Unknown	Low	**Unknown**	CUR/ANT	CONT	EXT
Pollution							
Household sewage & urban waste water	Known	Low	Very Low	**Low**	HIS/CUR/ANT	REC	RES
Industrial & military effluents	Known	Low	Very Low	**Low**	HIS/CUR/ANT	REC	RES
Agricultural & forestry effluents	Known	Low	Low	**Low**	HIS/CUR/ANT	REC	RES
Climate Change and Severe Weather							
Habitat shifting & alteration	Known	Unknown	Very Low	**Unknown**	CUR/ANT	CONT	EXT
Droughts	Known	Unknown	Very Low	**Unknown**	CUR/ANT	CONT	EXT
Temperature extremes	Known	Unknown	Very Low	**Unknown**	CUR/ANT	CONT	EXT
Storms & flooding	Known	Unknown	Very Low	**Unknown**	CUR/ANT	CONT	EXT

Table 21. Threat Assessment for Zone 5 of DU2. Zone 5 includes the Nelson River watershed comprised of six MUs (MU1 – Playgreen Lake–Whitemud Falls; MU2 – Whitemud Falls–Kelsey GS; MU3 – Kelsey GS–Kettle GS; lower Burntwood River between First Rapids and Split Lake; MU4 – Kettle GS–Long Spruce GS; MU5 – Long Spruce GS–Limestone GS; MU6 – Limestone GS–Hudson Bay).

Threat	Likelihood of Occurrence	Level of Impact	Causal Certainty	Threat Risk	Threat Occurrence	Threat Frequency	Threat Extent
Residential & Commercial Development	Known	Unknown	Very Low	**Unknown**	HIS/CUR/ANT	REC	RES
Tourism & recreation areas	Known	Unknown	Very Low	**Unknown**	HIS/CUR/ANT	REC	RES
Transportation & Service Corridors							
Roads & railroads	Known	Unknown	Very Low	**Unknown**	HIS/CUR/ANT	REC	RES
Utility & service lines	Known	Unknown	Very Low	**Unknown**	HIS/CUR/ANT	REC	RES
Biological Resource Use							
Fishing & harvesting aquatic resources	Known	High	High	**High**	HIS/CUR/ANT	REC	RES
Human Intrusions and Disturbances							
Work & other activities	Known	Low	Very Low	**Low**	HIS/CUR/ANT	REC	RES
Natural System Modifications							
Dams and water management/use	Known	High	High	**High**	HIS/CUR	CONT	EXT
Invasive and Other Problem Species & Genes							
Invasive non-native/alien species	Known	Unknown	Very Low	**Unknown**	CUR/ANT	CONT	EXT
Pollution							
Household sewage & urban waste water	Known	Low	Very Low	**Low**	HIS/CUR/ANT	REC	RES
Industrial & military effluents	Remote	Unknown	Very Low	**Unknown**	HIS/CUR/ANT	REC	RES
Agricultural & forestry effluents	Remote	Unknown	Very Low	**Unknown**	HIS/CUR/ANT	REC	RES
Climate Change and Severe Weather							
Habitat shifting & alteration	Known	Unknown	Very Low	**Unknown**	CUR/ANT	CONT	EXT
Droughts	Known	Unknown	Very Low	**Unknown**	CUR/ANT	CONT	EXT
Temperature extremes	Known	Unknown	Very Low	**Unknown**	CUR/ANT	CONT	EXT
Storms & flooding	Known	Unknown	Very Low	**Unknown**	CUR/ANT	CONT	EXT

Threats and Limiting Factors to the Survival and Recovery of Lake Sturgeon – DU4

Residential and Commercial Development

The threat of residential and commercial development in DU4 is cumulative, has occurred historically and will continue into the future. Impacts of this threat would likely affect a very small proportion of the population given the regulatory controls in place. The Threat Risk assessed for residential and commercial development in DU4 is Unknown for all zones with the exception of the Lower St. Lawrence River (Zone 5) where the Threat Risk was assessed as Low (Tables 22–26).

Transportation and Service Corridors

Roads and Railroads, Utility and Service Corridors, Shipping Lanes

The St. Lawrence River, Detroit River, St. Clair River, Lake St. Clair and the St. Marys River have all been channelized to create shipping channels (COSEWIC 2017). Channelization creates pathways that may be attractive to Lake Sturgeon migrating through waterways (Hondorp et al. 2017). If Lake Sturgeon use these habitats, they become vulnerable to collision with ships, and may be injured or killed (Hondorp et al. 2017). In addition, dredging has unknown impacts on Lake Sturgeon populations (COSEWIC 2017). The Threat Risk posed to Lake Sturgeon in DU4 from shipping lanes is Unknown for Lake Superior and the Ottawa River (MUs 1–4, 12–19) and Low for all other zones in DU4 (Tables 22–26; MUs 5–11 and 20).

Biological Resource Use

Fishing and Harvesting Aquatic Resources

Historically, Lake Sturgeon were heavily harvested throughout DU4, leading to dramatic population declines in some waterbodies. Harvest has the potential to remove large adult spawners from populations, as well as fish that were large enough to be harvested but not yet old enough to reproduce (COSEWIC 2017). The Great Lakes and their tributaries, as well as the St. Lawrence River and its tributaries both supported large Lake Sturgeon populations and large commercial fisheries (COSEWIC 2017). These historical fisheries ended early in the 20th century as populations collapsed. Lake Sturgeon in the Great Lakes are now listed as Threatened in Ontario under the provincial *Endangered Species Act*, and as such are protected from harvest with the exception of First Nation subsistence fisheries.

In Canada, one strictly managed commercial Lake Sturgeon fishery remains in the St. Lawrence River. Large adults are not exploited due to a slot size limit of 800–1,305 mm. The annual quota for the commercial fishery is 80 tons and individual codebar plastic tag and weight declaration coupons are used to control harvest quantities. In addition, targeted sport fishing is permitted in Quebec, although both commercial fishing and angling are closed during winter. The slot size limit applies to both the angler and commercial harvest.

Subsistence harvest still occurs in some regions of DU4 and may pose a threat to certain Lake Sturgeon populations. Beside commercial and recreational fishing activities, illegal harvest through poaching is a serious threat to Lake Sturgeon populations.

Some populations in the Great Lakes are co-managed with the United States. Some of these transboundary populations are subject to a limited legal harvest by anglers in the United States even though they are protected in Canada. Additionally, illegal harvest of sturgeon for the black market or the capture and harassment of staging female Lake Sturgeon by naïve anglers could affect local populations.

Consistent with the threat risk of harvest in DU1 and DU2, the Threat Risk of harvest in all five zones of DU4 was assessed as High (Tables 22–26).

Human Intrusions and Disturbance

Work and Other Activities

Scientific research has been conducted throughout DU4 and similar to DU1 and DU2, was assessed as a Low threat risk in all zones (Tables 22–26).

Natural System Modifications

Dams and Water Management/Use

Dams are prevalent throughout DU4 and have impacted the habitat of Lake Sturgeon to varying degrees throughout the DU. Similar to DU2, dams in DU4 have negatively impacted spawning habitat, altered flow dynamics, may increase mortality through impingement and entrainment, and have prevented upstream movement to historical spawning sites. Any future dam construction has a high potential for negative population level impacts in DU4, especially if impacts are not mitigated. In the Ottawa River, winter draw down has been linked with lower populations in some reaches. In the St. Lawrence River, it has been hypothesized that the Lake Sturgeon population in Lake St. Francis above the Beauharnois GS continues to be negatively impacted by dams. As such, the Threat Risk of dams and water management in all five zones of DU4 was assessed as High.

Invasive and Other Problematic Species and Genes

Invasive non-native/alien species

Sea Lamprey (*Petromyzon marinus*) is an invasive species that is present in the Great Lakes, as well as many of its tributaries that are inhabited by Lake Sturgeon (O'Connor et al. 2017). Adult Sea Lamprey are known to attack Lake Sturgeon and may cause mortality or reduced fitness (Dobiesz et al. 2018). In the tributaries of the Great Lakes, age-0 Lake Sturgeon and larval Sea Lamprey share the same habitat, meaning age-0 sturgeon may be susceptible to lampricide application used in assessment and control programs (COSEWIC 2017). This is particularly true in high alkalinity tributaries, where the mortality risk of age-0 Lake Sturgeon increases (O'Connor et al. 2017). Most Canadian tributaries treated with lampricide have low alkalinity, so this risk was assessed as low.

Another invasive species that has potentially impacted Lake Sturgeon in the Great Lakes is the Round Goby (*Neogobius melanostomus*). Round Goby are known to eat Lake Sturgeon eggs (COSEWIC 2017); however, Round Goby may comprise a high proportion of the diet of larger Lake Sturgeon (Jacobs et al. 2017). If Lake Sturgeon use Round Goby as a significant food source, it could lead to an increased growth rate (Jacobs et al. 2017). Although providing a significant food source for larger fish, Round Goby may compete for food resources with juvenile Lake Sturgeon, which have similar diet and habitat requirements (Bruestle et al. 2018). The net impact of Round Goby on Lake Sturgeon is therefore unknown.

Four other invasive species that have been flagged as potentially impacting Lake Sturgeon populations in DU4 are Zebra Mussel, Quagga Mussel (*Dreissena bugensis*), Asian carp (if introduced and established), and Rusty Crayfish. The net impact of these species on Lake Sturgeon populations in DU4 is unknown, but mussels and Asian carp have caused ecosystem modification in areas where they have become established (COSEWIC 2017).

The Threat Risk posed by invasive species in DU4 is Unknown in the Ottawa River (Zone 4), and the Threat Risk is considered Low in the other zones (Table 22-26).

Pollution

Household Sewage and Urban Waste Water, Industrial and Military Effluents, and Agricultural and Forestry Effluents

The threat of pollution to Lake Sturgeon populations is likely declining due to stricter environmental regulations (COSEWIC 2017). Some Lake Sturgeon populations in DU4 were impacted by degraded water quality caused by pulp-and-paper industry effluents (COSEWIC 2017). Historically, log drives in many rivers scoured the bottom and deposited woody debris over Lake Sturgeon habitat (COSEWIC 2017). In DU4, the threat risk of several pollutants is still unknown (e.g., pharmaceuticals downstream of major metropolitan areas that could affect sex ratio, maturation, and gonad development) and these are released into lake and rivers through municipal wastewater discharge. As such, the Threat Risk posed by pollution to Lake Sturgeon populations in DU4 was assessed as Low (Tables 22–26).

Climate Change and Severe Weather

Habitat shifting and alteration, Droughts, Temperature extremes, Storms and flooding

Climate change was assessed as applicable to DU4 populations in COSEWIC (2017). The water level in the St. Lawrence River will likely be affected by climate change over the next 100 years. Overall, the Threat Risk of climate change on Lake Sturgeon for each subcategory in all five zones of DU2 (listed in Tables 22–26) was assessed as Unknown as the Level of Impact is Unknown.

DU4 Threat Assessment

Five distinct zones were included in the DU4 threat assessment (Tables 22–26). Zones were comprised of the following:

- Zone 1: Western, Northern and Eastern Lake Superior as well as Lake Nipigon includes four MUs (Table 22):
  - MU1 – Western Lake Superior
  - MU2 – Lake Nipigon
  - MU3 – Northern Lake Superior
  - MU4 – Eastern Lake Superior
- Zone 2: Lake Huron and Lake Nipissing threat assessment includes four MUs (Table 23):
  - MU5 – Lake Huron North Channel
  - MU6 – Lake Nipissing
  - MU7 – Georgian Bay – Lake Huron
  - MU8 – Lake Huron/Erie Corridor
- Zone 3: Lower Niagara River and Eastern Ontario/Upper St. Lawrence threat assessment includes three MUs (Table 24):
  - MU9 – Lower Niagara River
  - MU10 – Eastern Lake Ontario-Upper St. Lawrence River
  - MU11 – Lake St. Francis
- Zone 4: Ottawa River watershed threat assessment includes eight MUs (Table 25):
  - MU12 – Lake Temiscaming
  - MU13 – Lac la Cave
  - MU14 – Holden Lake
  - MU15 – Allumette Lake/Lac Coulonge

- MU16 – Lac du Rocher Fendu
- MU17 – Lac des Chats
- MU18 – Lac Deschênes
- MU19 – Lac Dollard des Ormeaux

- Zone 5: Lower St. Lawrence River threat assessment includes only MU20 (Table 26):
  - MU20 - Lower St. Lawrence River

Table 22. Threat Assessment for Zone 1 of DU4. Zone 1 includes four MUs, Western (MU1), Northern (MU3) and Eastern Lake Superior (MU4), as well as Lake Nipigon (MU2).

Threat	Likelihood of Occurrence	Level of Impact	Causal Certainty	Threat Risk	Threat Occurrence	Threat Frequency	Threat Extent
Residential & Commercial Development							
Tourism & recreation areas	Known	Unknown	Very Low	**Unknown**	HIS/CUR/ANT	REC	RES
Transportation & Service Corridors							
Roads & railroads	Known	Unknown	Very Low	**Unknown**	HIS/CUR/ANT	REC	RES
Utility & service lines	Known	Unknown	Very Low	**Unknown**	HIS/CUR/ANT	REC	RES
Shipping lanes	Known	Unknown	Very Low	**Unknown**	HIS/CUR/ANT	REC	RES
Biological Resource Use							
Fishing & harvesting aquatic resources	Known	High	High	**High**	HIS/CUR/ANT	REC	RES
Human Intrusions and Disturbances							
Work & other activities	Known	Low	Very Low	**Low**	HIS/CUR/ANT	REC	RES
Natural System Modifications							
Dams and water management/use	Known	High	High	**High**	HIS/CUR/ANT	CONT	EXT
Invasive and Other Problem Species & Genes							
Invasive non-native/alien species	Known	Low	Low	**Low**	CUR/ANT	CONT	EXT
Pollution							
Household sewage & urban waste water	Known	Low	Very Low	**Low**	HIS/CUR/ANT	REC	RES
Industrial & military effluents	Known	Low	Unknown	**Low**	HIS/CUR/ANT	REC	RES
Agricultural & forestry effluents	Known	Low	Low	**Low**	HIS/CUR/ANT	REC	RES
Climate Change and Severe Weather							

Threat	Likelihood of Occurrence	Level of Impact	Causal Certainty	Threat Risk	Threat Occurrence	Threat Frequency	Threat Extent
Habitat shifting & alteration	Known	Unknown	Very Low	**Unknown**	CUR/ANT	CONT	EXT
Droughts	Known	Unknown	Very Low	**Unknown**	CUR/ANT	CONT	EXT
Temperature extremes	Known	Unknown	Very Low	**Unknown**	CUR/ANT	CONT	EXT
Storms & flooding	Known	Unknown	Very Low	**Unknown**	CUR/ANT	CONT	EXT

Table 23. Threat Assessment for Zone 2 of DU4. Zone 2 includes Lake Huron and Lake Nipissing and is comprised of four MUs (MU5 – Lake Huron North Channel; MU6 – Lake Nipissing; MU7 – Georgian Bay–Lake Huron; and MU8 – Lake Huron/Erie Corridor).

Threat	Likelihood of Occurrence	Level of Impact	Causal Certainty	Threat Risk	Threat Occurrence	Threat Frequency	Threat Extent
Residential & Commercial Development							
Tourism & recreation areas	Known	Unknown	Very Low	**Unknown**	HIS/CUR/ANT	REC	RES
Transportation & Service Corridors							
Roads & railroads	Known	Medium	Very Low	**Medium**	HIS/CUR/ANT	CONT	NAR
Utility & service lines	Known	Unknown	Very Low	**Unknown**	HIS/CUR/ANT	REC	RES
Shipping lanes	Known	Low	Very Low	**Low**	HIS/CUR/ANT	CONT	NAR
Biological Resource Use							
Fishing & harvesting aquatic resources	Known	High	High	**High**	HIS/CUR/ANT	REC	RES
Human Intrusions and Disturbances							
Work & other activities	Known	Low	Very Low	**Low**	HIS/CUR/ANT	REC	RES
Natural System Modifications							
Dams and water management/use	Known	High	High	**High**	HIS/CUR/ANT	CONT	EXT
Invasive and Other Problem Species & Genes							

Threat	Likelihood of Occurrence	Level of Impact	Causal Certainty	Threat Risk	Threat Occurrence	Threat Frequency	Threat Extent
Invasive non-native/alien species	Known	Low	Low	**Low**	CUR/ANT	CONT	EXT
Pollution							
Household sewage & urban waste water	Known	Low	Low	**Low**	HIS/CUR/ANT	REC	RES
Industrial & military effluents	Known	Low	Low	**Low**	HIS/CUR/ANT	REC	RES
Agricultural & forestry effluents	Known	Low	Very Low	**Low**	HIS/CUR/ANT	REC	RES
Climate Change and Severe Weather							
Habitat shifting & alteration	Known	Unknown	Very Low	**Unknown**	CUR/ANT	CONT	EXT
Droughts	Known	Unknown	Very Low	**Unknown**	CUR/ANT	CONT	EXT
Temperature extremes	Known	Unknown	Very Low	**Unknown**	CUR/ANT	CONT	EXT
Storms & flooding	Known	Unknown	Very Low	**Unknown**	CUR/ANT	CONT	EXT

Table 24. Threat Assessment for Zone 3 of DU4. Zone 3 includes the Lower Niagara River and Eastern Ontario/Upper St. Lawrence comprised of three MUs (MU9 – Lower Niagara River; MU10 – Eastern Lake Ontario–Upper St. Lawrence River; MU11 – Lake St. Francis).

Threat	Likelihood of Occurrence	Level of Impact	Causal Certainty	Threat Risk	Threat Occurrence	Threat Frequency	Threat Extent
Residential & Commercial Development							
Tourism & recreation areas	Known	Unknown	Very Low	**Unknown**	HIS/CUR/ANT	REC	RES
Transportation & Service Corridors							
Roads & railroads	Known	Medium	Low	**Medium**	HIS/CUR/ANT	REC	RES
Utility & service lines	Known	Unknown	Very Low	**Unknown**	HIS/CUR/ANT	REC	RES
Shipping lanes	Known	Low	Very Low	**Low**	HIS/CUR/ANT	REC	RES
Biological Resource Use							

Threat	Likelihood of Occurrence	Level of Impact	Causal Certainty	Threat Risk	Threat Occurrence	Threat Frequency	Threat Extent
Fishing & harvesting aquatic resources	Known	High	High	**High**	HIS/CUR/ANT	REC	RES
Human Intrusions and Disturbances							
Work & other activities	Known	Low	Very Low	**Low**	HIS/CUR/ANT	REC	RES
Natural System Modifications							
Dams and water management/use	Known	High	High	**High**	HIS/CUR/ANT	CONT	EXT
Invasive and Other Problem Species & Genes							
Invasive non-native/alien species	Known	Low	Low	**Low**	CUR/ANT	CONT	EXT
Pollution							
Household sewage & urban waste water	Known	Low	Low	**Low**	HIS/CUR/ANT	REC	RES
Industrial & military effluents	Known	Low	Low	**Low**	HIS/CUR/ANT	REC	RES
Agricultural & forestry effluents	Known	Low	Very Low	**Low**	HIS/CUR/ANT	REC	RES
Climate Change and Severe Weather							
Habitat shifting & alteration	Known	Unknown	Very Low	**Unknown**	CUR/ANT	CONT	EXT
Droughts	Known	Unknown	Very Low	**Unknown**	CUR/ANT	CONT	EXT
Temperature extremes	Known	Unknown	Very Low	**Unknown**	CUR/ANT	CONT	EXT
Storms & flooding	Known	Unknown	Very Low	**Unknown**	CUR/ANT	CONT	EXT

Table 25. Threat Assessment for Zone 4 of DU4. Zone 4 includes 8 MUs in the Ottawa River watershed (MU12 – Lake Temiscaming; MU13 – Lac la Cave; MU14 – Holden Lake; MU15 – Allumette Lake/Lac Coulonge; MU16 – Lac du Rocher Fendu; MU17 – Lac des Chats; MU18 – Lac Deschênes; MU19 – Lac Dollard des Ormeaux).

Threat	Likelihood of Occurrence	Level of Impact	Causal Certainty	Threat Risk	Threat Occurrence	Threat Frequency	Threat Extent
Residential & Commercial Development							
Tourism & recreation areas	Known	Unknown	Very Low	**Unknown**	HIS/CUR/ANT	REC	RES
Transportation & Service Corridors							
Roads & railroads	Known	Unknown	Very Low	**Unknown**	HIS/CUR/ANT	REC	RES
Utility & service lines	Known	Unknown	Very Low	**Unknown**	HIS/CUR/ANT	REC	RES
Biological Resource Use							
Fishing & harvesting aquatic resources	Known	High	High	**High**	HIS/CUR/ANT	REC	RES
Human Intrusions and Disturbances							
Work & other activities	Known	Low	Very Low	**Low**	HIS/CUR/ANT	REC	RES
Natural System Modifications							
Dams and water management/use	Known	High	High	**High**	HIS/CUR/ANT	CONT	EXT
Invasive and Other Problem Species & Genes							
Invasive non-native/alien species	Known	Unknown	Low	**Unknown**	CUR/ANT	CONT	EXT
Pollution							
Household sewage & urban waste water	Known	Low	Low	**Low**	HIS/CUR/ANT	REC	RES
Industrial & military effluents	Known	Low	Very Low	**Low**	HIS/CUR/ANT	REC	RES
Agricultural & forestry effluents	Known	Low	Very Low	**Low**	HIS/CUR/ANT	REC	RES
Climate Change and Severe Weather							
Habitat shifting & alteration	Known	Unknown	Very Low	**Unknown**	CUR/ANT	CONT	EXT
Droughts	Known	Unknown	Very Low	**Unknown**	CUR/ANT	CONT	EXT
Temperature extremes	Known	Unknown	Very Low	**Unknown**	CUR/ANT	CONT	EXT
Storms & flooding	Known	Unknown	Very Low	**Unknown**	CUR/ANT	CONT	EXT

Table 26. Threat Assessment for Zone 5 of DU4. Zone 5 includes one MU, MU20, the Lower St. Lawrence River.

Threat	Likelihood of Occurrence	Level of Impact	Causal Certainty	Threat Risk	Threat Occurrence	Threat Frequency	Threat Extent
Residential & Commercial Development							
Tourism & recreation areas	Known	Low	Low	**Low**	HIS/CUR	REC	RES
Transportation & Service Corridors							
Roads & railroads	Known	Low	Very Low	**Low**	HIS/CUR/ANT	REC	RES
Utility & service lines	Known	Unknown	Very Low	**Unknown**	HIS/CUR/ANT	REC	RES
Shipping lanes	Known	Low	Low	**Low**	HIS/CUR	REC	Broad
Biological Resource Use							
Fishing & harvesting aquatic resources	Known	High	High	**High**	HIS/CUR/ANT	REC	RES
Human Intrusions and Disturbances							
Work & other activities	Known	Low	Very Low	**Low**	HIS/CUR/ANT	REC	RES
Natural System Modifications							
Dams and water management/use	Known	High	High	**High**	HIS/CUR	CONT	EXT
Invasive and Other Problem Species & Genes							
Invasive non-native/alien species	Known	Low	Unknown	**Low**	HIS/CUR	CONT	RES
Pollution							
Household sewage & urban waste water	Known	Low	Low	**Low**	HIS/CUR	CONT	Broad
Industrial & military effluents	Known	Low	High	**Low**	HIS/CUR	CONT	NAR
Agricultural & forestry effluents	Known	Low	Low	**Low**	HIS/CUR	REC	RES
Climate Change and Severe Weather							
Habitat shifting & alteration	Known	Unknown	Unknown	**Unknown**	CUR/ANT	REC	RES
Droughts	Known	Unknown	Unknown	**Unknown**	CUR/ANT	REC	RES
Temperature extremes	Known	Unknown	Unknown	**Unknown**	CUR/ANT	REC	RES
Storms & flooding	Known	Unknown	Unknown	**Unknown**	CUR/ANT	REC	RES

MITIGATIONS AND ALTERNATIVES

Threats to survival can be minimized by implementing mitigation measures to reduce or eliminate potential harmful effects that could result from works or undertakings associated with projects or activities in Lake Sturgeon habitat. Lake Sturgeon in DUs 1, 2, and 4 are currently not protected under the SARA. Research has been completed summarizing the types of works, activities, or projects that have been undertaken in habitat known to be occupied by Lake Sturgeon in DUs 1, 2, and 4 (Table 27). The DFO Program Activity Tracking for Habitat (PATH) database was reviewed to estimate the number of projects that have occurred between 2013 and 2018. A total of 118 projects were found – one in DU1, 37 in DU2, and 80 in DU4 (Table 17). This may not represent a comprehensive list of all projects and activities because some may not have been reported to DFO. The works, undertakings, and activities that may have directly or indirectly affected Lake Sturgeon habitat include: watercourse crossings, shoreline/streambank work, instream works, water management, and structures in water. The single activity in DU1 was dredging in Waterhen Lake. The majority of activities in DU2 involved structures in water (n = 16) and shoreline stabilization (n = 12). In DU4 most activities involved shoreline/streambank work (primarily shoreline stabilization) (n = 40), and structures in water (n = 20). The category 'invasive species introductions (authorized and unauthorized)' was added to the list although this is not tracked in PATH.

Habitat-related threats to Lake Sturgeon have been linked to the Pathways of Effects developed by DFO (Table 27). DFO has developed guidance on mitigation measures for 19 Pathways of Effects for the protection of aquatic species at risk in the Central and Arctic Region (Coker et al. 2010). This guidance should be referred to when considering mitigation and alternative strategies for habitat-related threats.

Table 27. Summary of works, projects and activities that have occurred during the period of January 2014 to December 2018 in areas known to be occupied by Lake Sturgeon (DU 1, 2, and 4). Threats known to be associated with these types of works, projects, and activities have been indicated by a checkmark. The number of works, projects, and activities associated with each Lake Sturgeon DU 1, 2 and 4 watershed, as determined from the project assessment analysis, has been provided. Applicable Pathways of Effects as described in Coker et al. (2010) have been indicated for each threat associated with a work, project or activity (1 – Vegetation clearing; 2 – Grading; 3 – Excavation; 4 – Use of explosives; 5 – Use of industrial equipment; 6 – Cleaning or maintenance of bridges or other structures; 7 – Riparian planting; 8 – Streamside livestock grazing; 9 – Marine seismic surveys; 10 – Placement of material or structures in water; 11 – Dredging; 12 – Water extraction; 13 – Organic debris management; 14 – Wastewater management; 15 – Addition or removal of aquatic vegetation; 16 – Change in timing, duration and frequency of flow; 17 – Fish passage issues; 18 – Structure removal; 19 – Placement of marine finfish aquaculture site).

Work/Project/Activity	**Threats (associated with work/project/activity)**						**DU (number of works/projects/ activities between 2013-2018)**		
	Residential and Commercial Development	**Transportation and Service Corridors**	**Natural System Modifications – Dams and Water Management**	**Natural System Modifications– Other Ecosystem Modifications**	**Invasive and Other Problematic Species and Genes**	**Pollution**	**DU1**	**DU2**	**DU4**
Applicable pathways of effects for threat mitigation and project alternatives	1, 2, 3, 4, 5	1, 2, 3, 4, 5, 6, 10, 11, 12, 13, 15, 17	1, 2, 3, 4, 5, 6, 10, 11, 12, 13, 16, 17	1, 5, 7, 13,15, 18	14, 17	1, 4, 5, 6, 7, 8, 10, 11, 13, 14, 15, 16, 18	-	-	-
Watercourse crossings (e.g., bridges, culverts, open cut crossings)	-	✓	-	-	-	✓	0	4	4
Shoreline, streambank work (e.g., stabilization, infilling, retaining walls, riparian vegetation management)	✓	✓	✓	✓	-	✓	0	12	40
Mineral Aggregate, Oil & Gas Exploration, Extraction, Production	-	-	-	-	-	✓	0	0	0
Instream works (e.g., channel maintenance, restoration, modifications, realignments, dredging, aquatic vegetation removal)	-	✓	-	✓	-	✓	1	4	12

Work/Project/Activity	Threats (associated with work/project/activity)						DU (number of works/projects/ activities between 2013-2018)		
	Residential and Commercial Development	Transportation and Service Corridors	Natural System Modifications – Dams and Water Management	Natural System Modifications– Other Ecosystem Modifications	Invasive and Other Problematic Species and Genes	Pollution	DU1	DU2	DU4
Applicable pathways of effects for threat mitigation and project alternatives	1, 2, 3, 4, 5	1, 2, 3, 4, 5, 6, 10, 11, 12, 13, 15, 17	1, 2, 3, 4, 5, 6, 10, 11, 12, 13, 16, 17	1, 5, 7, 13,15, 18	14, 17	1, 4, 5, 6, 7, 8, 10, 11, 13, 14, 15, 16, 18	-	-	-
Water management (e.g., storm-water management, water withdrawal)	✓	-	✓	-	-	✓	0	1	4
Structures in water (e.g., boat launches, docks, effluent outfalls, water intakes)	✓	-	✓	-	-	✓	0	16	20
Control of Nuisance Species	-	-	-	-	-	✓	0	0	0
Contaminated Site Remediation	-	-	-	✓	-		0	0	0
Other (e.g., conduit installation on bridge, bridge washing)	✓	✓	-	-	-	✓	0	0	0
Invasive species introductions (authorized and unauthorized)	-	-	-	-	✓	-	n/a	n/a	n/a
TOTAL	-	-	-	-	-	-	1	37	80

Additional mitigation and alternative measures are listed below.

INVASIVE AND OTHER PROBLEMATIC SPECIES, GENES AND DISEASES

Mitigation

- Physically remove non-native species from areas inhabited by Lake Sturgeon.
- Monitor range of Lake Sturgeon in DUs 1, 2, and 4 for introduced species that may negatively impact Lake Sturgeon populations or preferred habitat.
- Develop a plan to address potential risks, impacts and proposed actions if monitoring detects the arrival or establishment of introduced species.
- Introduce a public awareness campaign and encourage the use of existing invasive species reporting systems.

Alternatives

- Unauthorized
    - None
- Authorized
    - Use only native species.
    - Follow the National Code on Introductions and Transfers of Aquatic Organisms for all aquatic organism introductions (DFO 2017).

BIOLOGICAL RESOURCE USE (HARVEST)

Mitigation

- Maintain and monitor harvest quotas and angling restrictions and adjust where needed using sound fisheries management guidelines.
- Formation of Sturgeon Management Boards (e.g., Nelson River Sturgeon Management Board, Saskatchewan River Sturgeon Management Board) to increase awareness of how harvest may affect local populations.

NATURAL SYSTEM MODIFICATIONS (DAMS AND WATER MANAGEMENT/USE; OTHER ECOSYSTEM MODIFICATIONS

Mitigation

- Develop new and monitor existing artificial spawning shoals (e.g., Winnipeg River, Nelson River, St. Lawrence River)

EXISTING PROTECTIONS

Lake Sturgeon are currently protected under the *Fisheries Act*. Despite being recommended as “threatened” or “endangered” by COSEWIC in 2006 and 2017 a decision to list the species under Schedule 1 of the *Species at Risk Act* (SARA) has not been made and the species is therefore not currently protected under the SARA.

Individual provinces also provide additional protection for Lake Sturgeon through legislation. In Alberta, Lake Sturgeon are listed as Threatened under the *Wildlife Act*. Populations in northwestern Ontario (DU2) and the Great Lakes and upper St. Lawrence River (DU4) are listed as Endangered and are therefore protected under Ontario's Endangered Species Act (ESA). The Lake Sturgeon population in Southern Hudson Bay/James Bay is listed as Special Concern, and is therefore not afforded protection under the ESA. Lake Sturgeon receive further protection under Ontario's Fish and Wildlife Conservation Act. Currently, anglers are not permitted to target Lake Sturgeon in northwestern Ontario and the Great Lakes basin, whereas there is a possession limit of zero for Lake Sturgeon in the southern Hudson Bay/James Bay basin. In both Saskatchewan and Manitoba, angler harvest of Lake Sturgeon is prohibited. In Manitoba, conservation closures are in place for sections of the upper Nelson River and Winnipeg River. In Québec, Lake Sturgeon are included on the list of species likely to be designated threatened or vulnerable. Although commercial and sport fishing still occur in Quebec, they are strictly managed with slot size limits and quotas are in place (COSEWIC 2017).

SOURCES OF UNCERTAINTY

- Age estimates for Lake Sturgeon made using a longstanding technique (i.e., counting growth increments on pectoral fin spine cross sections) were found to underestimate the true age of fish older than 14 years and error increased with age. The average difference was -4.96 ± 4.57 years, and ranged from +2 to -17 years (Bruch et al. 2009). A correction factor has been developed for the Winnebago system to correct existing age estimates obtained using this method; validation studies are needed to determine whether there are differences among populations (Cleator et al. 2010a-e).
- Assessing population size for Lake Sturgeon is difficult given the behaviour and ecology of the species (Haxton and Friday 2019). In addition, it is difficult to obtain accurate population estimates in multiple interconnected populations that can freely move between and within waterbodies.
- There is a lack of pre-anthropogenic historical data for most Lake Sturgeon populations and limited data on population sizes prior to harvest or prior to dam construction.
- For areas where stocking Lake Sturgeon may be the only option for population recovery, further study is necessary to determine the optimal number of fish to stock (Pollock et al. 2015).
- Impacts of invasive species on Lake Sturgeon are not fully understood. Invasive species such as Rusty Crayfish and Round Goby may prey on Lake Sturgeon eggs, but may be a significant food source for larger sturgeon (COSEWIC 2017). Although these species have been identified as possible threats to Lake Sturgeon, the overall impact is unknown.
- Effects of high densities on Lake Sturgeon populations are a source of uncertainty (Pollock et al. 2015). In the Winnipeg River below the Pointe du Bois GS, for example, it is believed that the Lake Sturgeon population has reached carrying capacity (COSEWIC 2017).
- How will climate change, including warming temperatures and flow changes, affect recruitment?

REFERENCES CITED

Adams Jr., W.E., Kallemeyn, L.W., and Willis, D.W. 2006. Lake Sturgeon population characteristics in Rainy Lake, Minnesota and Ontario. J. Appl. Ichthyol. 22: 97–102.

Aiken, J.K., and Cooley, P.M. 2017. Lake Sturgeon monitoring in the Seine River near Sturgeon Falls, District of Rainy River, Ontario: juvenile gillnetting, fall 2016. A report prepared for H2O Power LP by North/South Consultants Inc., Winnipeg, MB. 36 p.

Aiken, J.K., Alperyn, M.D., and McDougall, C.A. 2013. Results of Assiniboine River Lake Sturgeon investigations, 2013. A report prepared for Manitoba Hydro by North/South Consultants Inc., Winnipeg, MB. 62 p.

ALSRT (Alberta Lake Sturgeon Recovery Team). 2011. Alberta Lake Sturgeon Recovery Plan, 2011–2016. Alberta Environment and Sustainable Resource Development, Alberta Species at Risk Recovery Plan No. 22. Edmonton, AB. 98 p.

Altenritter, M.E.L., Wieten, A.C., Ruetz, C.R., and Smith, K.M. 2013. Seasonal spatial distribution of juvenile Lake Sturgeon in Muskegon Lake, Michigan, USA. Ecol. Freshw. Fish. 22: 467–478.

Ambrose, K.M., and McDougall, C.A. 2018. Results of Lake Sturgeon population studies conducted in the lower Churchill River, fall 2017. A report prepared for Manitoba Hydro by North/South Consultants Inc., Winnipeg, MB. 17 p.

Ambrose, K.M., Pisiak, D.J., Nelson, P.A., and MacDonell, D.S. 2010. Results of the 2008 fish community investigations focusing on Lake Sturgeon in the Conawapa study area. A report prepared for Manitoba Hydro by North/South Consultants Inc., Winnipeg, MB. 297 p.

Ambrose, K.M., McDougall, C.A., Blanchard, M., and Nelson, P.A. 2017. Results of Lake Sturgeon population studies conducted in the lower Churchill River between the Little Churchill River confluence and Swallow Rapids, summer 2016 – Year 3. A report prepared for Manitoba Hydro by North/South Consultants Inc., Winnipeg, MB. 46 p.

A/OFRC (Anishinabek/Ontario Fisheries Resource Centre). 2014a. Michipicoten and Magpie rivers Lake Sturgeon assessment, 2012–2016 Year 2: 2013. Anishinabek/Ontario Fisheries Resource Centre (A/OFRC), North Bay, ON. 8 p.

A/OFRC. 2014b. Garden River fisheries update January 2014. Anishinabek/Ontario Fisheries Resource Centre (A/OFRC), North Bay, ON. 1 p.

A/OFRC. 2015a. A/OFRC project summary: Magnetawan River Lake Sturgeon Assessment. Anishinabek/Ontario Fisheries Resource Centre (A/OFRC), North Bay, ON. 1 p.

A/OFRC. 2015b. A/OFRC project summary: Ojibways of Garden River Sturgeon Spawning Assessment. Anishinabek/Ontario Fisheries Resource Centre (A/OFRC), North Bay, ON. 1 p.

A/OFRC. 2015c. A/OFRC project summary: Pays Plat First Nation Lake Superior juvenile Lake Sturgeon study. Anishinabek/Ontario Fisheries Resource Centre (A/OFRC), North Bay, ON. 1 p.

Auer, N.A. 1996a. Importance of habitat and migration to sturgeons with emphasis on Lake Sturgeon. Can. J. Fish. Aquat. Sci. 53: 152–160.

Auer, N.A. 1996b. Response of spawning Lake Sturgeons to change in hydroelectric facility operation. Trans. Am. Fish. Soc. 125(1): 66–77.

Auer, N.A. 1999. Population characteristics and movements of Lake Sturgeon in the Sturgeon River and Lake Superior. J. Great Lakes Res. 25: 282–293.

Auer, N.A., and Baker, E.A. 2002. Duration and drift of larval Lake Sturgeon in the Sturgeon River, Michigan. J. Appl. Ichthyol. 18: 557–564.

Avery, C. 2015. Red Rock Indian Band: Nipigon River Lake Sturgeon spawning assessment and fall netting survey. Anishinabek/Ontario Fisheries Resource Centre (A/OFRC), North Bay, ON. 46 p.

Bajkov, A. 1930. Fishing industry and fisheries investigations in the Prairie provinces. Trans. Am. Fish. Soc. 60(1): 215–237.

Baldwin, N.A., Saalfeld, R.W., Dochoda, M.R., Buettner, H.J., and Eshenroder, R.L. 2009. Commercial fish production in the Great Lakes 1867-2006. Great Lakes Fishery Commission. Ann Arbor, MI. (accessed 7 July 2017).

Barth, C.C., and Henderson, L.M. 2017. Summary of Lake Sturgeon focused studies conducted in the Nipigon River from 2007 to 2015 and recommendations for Lake Sturgeon mitigation at the Alexander Generating Station, Nipigon River, Ontario. A report prepared for Ontario Power Generation by North/South Consultants Inc., Winnipeg, MB. 58 p.

Barth, C.C., Anderson, W.G., Henderson, L.M., and Peake, S.J. 2011. Home range size and season movement of juvenile Lake Sturgeon in a large river in the Hudson Bay drainage basin. Trans. Am. Fish. Soc. 140: 1629–1641.

Barth, C.C., Burnett, D., McDougall, C.A., and Nelson, P.A. 2018. Information in support of the 2017 COSEWIC assessment and status report on the Lake Sturgeon (*Acipenser fulvescens*) in Canada. Can. Manuscr. Rep. Fish. Aquat. Sci. 3166: vi + 115 p.

Bauman, J.M., Moerke, A., Greil, R., Gerig, B., Baker, E., and Chiotti, J. 2011. Population status and demographics of Lake Sturgeon (*Acipenser fulvescens*) in the St. Marys River, from 2000 to 2007. J. Great Lakes Res. 37: 47–53.

Bell, J., Henderson, L.M., and McDougall, C.A. 2016. Results of Lake Sturgeon investigations below the Jenpeg Generating Station, spring and fall 2015. A report prepared for Manitoba Hydro by North/South Consultants Inc., Winnipeg, MB. 71 p.

Bennet, W.R., Edmondson, G., Williamson, K., and Gelley, J. 2007. An investigation of the substrate preference of White Sturgeon (*Acipenser transmontanus*) eleutheroembryos. J. Appl. Ichthyol. 23: 539–542.

Benson, A.C., Sutton, T.M., Elliot, R.F., and Meronek, T.G. 2005. Seasonal movement patterns and habitat preferences of age-0 Lake Sturgeon in the lower Peshtigo River, Wisconsin. Trans. Am. Fish. Soc. 134: 1400–1409.

Blanchard, M., Parker, A., and McDougall, C.A. 2014. Results of Lake Sturgeon investigations conducted in the Churchill River between Swallow Rapids and the confluence with the Little Beaver River, June 2013. A report prepared for Manitoba Hydro by North/South Consultants Inc., Winnipeg, MB. 36 p.

Block, D. 2001. Growth estimates, habitat use, and ecology of the Lake Sturgeon, *Acipenser fulvescens* Rafinesque, from Round Lake and mature reservoirs in the Winnipeg River. Thesis (M.Sc.) University of Manitoba, Winnipeg, MB. 171 p.

Bobrowicz, S.M. 2012. Black Bay and Black Sturgeon River native fisheries rehabilitation – decommissioning of the camp 43 dam and construction of a multi-purpose sea lamprey barrier at Eskwanonwatin Lake. Ontario Ministry of Natural Resources, Thunder Bay, ON. 26 p.

Brandt, C., Burnett, D.C., Arcinas, L., Palace, V., and Anderson, W.G. 2015. Effects of chlorpyrifos on *in vitro* sex steroid production and thyroid follicular development in adult and larval Lake Sturgeon, *Acipenser fulvescens*. Chemosphere. 132: 179–187.

Braun, D.P., Phillips, I.D., Nanayakkara, L., and Wissel, B. 2018. Diet characterization and a preliminary investigation into trophic niche placement for an endangered Lake Sturgeon (*Acipenser fulvescens*) population in the Saskatchewan River, SK, Canada. PLoS ONE. 13 (11): e0206313.

Brooks, J.L., Boston, C., Doka, S., Gorsky, D., Gustavson, K., Hondorp, D., Isermann, D., Midwood, J.D., Pratt, T.C., Rous, A.M., Withers, J.L., Krueger, C.C., and Cooke, S.J. 2017. Use of fish telemetry in rehabilitation planning, management, and monitoring in areas of concern in the Laurentian Great Lakes. J. Environ. Manage. 60: 1139–1154.

Bruch, R.M. 1999. Management of Lake Sturgeon on the Winnebago System – long term impacts of harvest and regulations on population structure. J. Appl. Ichthyol. 15: 142–152.

Bruch, R.M., and Binkowski, F.P. 2002. Spawning behavior of Lake Sturgeon (*Acipenser fulvescens*). J. Appl. Ichthyol. 18: 570–579.

Bruch, R.M., Campana, S.E., Davis-Foust, S.L., Hansen, M.J., and Janssen, J. 2009. Lake Sturgeon age validation using bomb radiocarbon and known-age fish. Trans. Am. Fish. Soc. 138: 361–372.

Bruestle, E. 2017. Lake Sturgeon (*Acipenser fulvescens*) trophic position and movement patterns in the lower Niagara River, NY. Thesis (M.A.) State University of New York, Albany, NY. 66 p.

Bruestle, E.L., Karboski, C., Hussey, A., Fisk, A.T., Mehler, K., Pennuto, C., and Gorsky, D. 2018. Novel trophic interaction between Lake Sturgeon (*Acipenser fulvescens*) and non-native species in an altered food web. Can. J. Fish. Aquat. Sci. 76(1): 6–14.

Bureau environnement et terre d'Odanak. 2019. Évaluation du succès de reproduction de l'esturgeon jaune à la frayère de Drummondville et influence des débits, printemps 2018. Dufour-Pelletier, S. & Beaupré, J. for Conseil des Abénakis d'Odanak. 33 p.

Burnett, D., and McDougall, C.A. 2015. Upper Nelson River juvenile Lake Sturgeon inventories, 2014: Little Playgreen Lake. A report prepared for Manitoba Hydro by North/South Consultants Inc., Winnipeg, MB. 75 p.

Burnett, D., Nelson, P.A., and Mazur, J. 2017. Saskatchewan River Sturgeon Management Board: juvenile Lake Sturgeon surveys 2017. A report prepared for SaskPower and Manitoba Hydro by North/South Consultants Inc., Winnipeg, MB. 62 p.

Burnett, D.C, Hrenchuk, C.L., and Barth, C.C. 2018. Juvenile Lake Sturgeon population monitoring, fall 2017: Year 4 Construction. Keeyask Generation Project Aquatic Effects Monitoring Report #AEMP-2018-02. A report prepared for Manitoba Hydro by North/South Consultants Inc., Winnipeg, MB. 135 p.

Burnett, D.C., and Hrenchuk, C.L. 2019. Juvenile Lake Sturgeon population monitoring, fall 2018: Year 5 Construction. Keeyask Generation Project Aquatic Effects Monitoring Plan Report #AEMP-2019-06. A report prepared for Manitoba Hydro by North/South Consultants Inc., Winnipeg, MB. 117 p.

CARA and MRNF (Corporation de l'Aménagement de la Rivière l'Assomption and Ministry of Natural Resources and Forestry). 2007. Restauration des frayères d'esturgeon jaune de la rivière Ouareau : Sommaire du suivi 2007. Corporation de l'Aménagement de la Rivière l'Assomption & Ministère des Ressources naturelles et de la Faune. 14 p.

CARA and MRNF. 2008. Restauration des frayères d'esturgeon jaune de la rivière Ouareau : Sommaire du suivi 2008. Corporation de l'Aménagement de la Rivière l'Assomption & Ministère des Ressources naturelles et de la Faune. 5 p.

CARA and MRNF. 2010. Suivi post-aménagement des frayères d'esturgeon jaune de la rivière Ouareau. Corporation de l'Aménagement de la Rivière l'Assomption & Ministère des Ressources naturelles et de la Faune. 7 p. + annexes.

CARA and MRNF. 2011. Bilan du suivi post-aménagement des frayères d'esturgeon jaune de la rivière Ouareau 2007-2011. Corporation de l'Aménagement de la Rivière l'Assomption & Ministère des Ressources naturelles et de la Faune. 23 p. + annexes.

Carlander, K.D. 1942. An investigation of Lake of the Woods, Minnesota, with particular reference to the commercial fisheries. Minnesota Department of Natural Resources, Division of Game and Fish, Section of Fisheries, St. Paul, MN. 54 p.

Caroffino, D.C., Sutton, T.M., and Daugherty, D.J. 2009. Assessment of the vertical distribution of larval Lake Sturgeon drift in the Peshtigo River, Wisconsin, U.S.A. J. Appl. Ichthyol. 25: 14–17.

Caswell, N.M, Peterson, D.L., Manny, B.A., and Kennedy, G.W. 2004. Spawning by Lake Sturgeon (*Acipenser fulvescens*) in the Detroit River. J. Appl. Ichthyol. 20: 1–6.

Chiotti, J.A., Holtgren, J.M., Auer, N.A., and Ogren, S.A. 2008. Lake Sturgeon spawning habitat in the Big Manistee River, Michigan. N. Am. J. Fish. Manag. 28: 1009–1019.

Chiasson, W.B., Noakes, D.L., and Beamish, F.W.H. 1997. Habitat, benthic prey, and distribution of juvenile Lake Sturgeon (*Acipenser fulvescens*) in northern Ontario rivers. Can. J. Fish. Aquat. Sci. 54: 2866–2871.

Choudhury, A., and Dick, T.A. 1993. Parasites of Lake Sturgeon, *Acipenser fulvescens* (Chondrostei: Acipenseridae), from central Canada. J. Fish. Biol. 42: 571–584.

Clarke, K.D., Pratt, T.C., Randall, R.G., Scuten, D.A., and Smokorowski, K.E. 2008. Validation of the flow management pathway: effects of altered flow on fish habitat and fishes downstream of a hydropower dam. Can. Tech. Rep. Fish. Aquat. Sci. 2784: vi + 111 p.

Cleator, H., Martin, K.A., Pratt, T.C., and MacDonald, D. 2010a. Information relevant to a recovery potential assessment of Lake Sturgeon: western Hudson Bay populations (DU1). DFO Can. Sci. Advis. Sec. Res. Doc. 2010/080. vi + 26 p.

Cleator, H., Martin, K.A., Pratt, T.C., Campbell, R., Pollock, M., and Watters, D. 2010b. Information relevant to a recovery potential assessment of Lake Sturgeon: Saskatchewan River populations (DU2). DFO Can. Sci. Advis. Sec. Res. Doc. 2010/081. vi + 36 p.

Cleator, H., Martin, K.A., Pratt, T.C., and MacDonald, D. 2010c. Information relevant to a recovery potential assessment of Lake Sturgeon: Nelson River populations (DU3). DFO Can. Sci. Advis. Sec. Res. Doc. 2010/082. vi + 33 p.

Cleator, H., Martin, K.A., Pratt, T.C., Bruederlin, B., Erickson, M., Hunt, J., Kroeker, D., Leroux, D., Skitt, L., and Watkinson, D. 2010d. Information relevant to a recovery potential assessment of Lake Sturgeon: Red-Assiniboine rivers – Lake Winnipeg populations (DU4). DFO Can. Sci. Advis. Sec. Res. Doc. 2010/083. vi + 38 p.

Cleator, H., Martin, K.A., Pratt, T.C., Barth, C., Corbett, B., Duda, M., and Leroux, D. 2010e. Information relevant to a recovery potential assessment of Lake Sturgeon: Winnipeg River-English River populations (DU5). DFO Can. Sci. Advis. Sec. Res. Doc. 2010/084. vi + 34 p.

Clouthier, S.C., Van Welleghem, E., Copeland, S., Klassen, C., Hobbs, G., Nielsen, O., and Anderson, E.D. 2013. A new species of nucleo-cytoplasmic large DNA virus (NCLDV) associated with mortalities in Manitoba Lake Sturgeon *Acipenser fulvescens*. Dis. Aquat. Org. 102: 195–209.

Coker, G.A., Ming, D.L., and Mandrak, N.E. 2010. Mitigation guide for the protection of fishes and fish habitat to accompany the species at risk recovery potential assessments conducted by Fisheries and Oceans Canada (DFO) in Central and Arctic Region. Version 1.0. Can. Manuscr. Rep. Fish. Aquat. Sci. 2904: vi + 40 p.

Commanda, N. 2011. Lake Sturgeon *Acipenser fulvescens* Population and Habitat Status for Lake Nipissing. Nipissing First Nation. 27 p.

Commanda, N. 2018. Lake Sturgeon (*Acipenser fulvescens*) management and status update for the Lake Nipissing watershed – part of the Great Lakes Upper St. Lawrence population, Ontario, Canada. Thesis (M.Env.Sci.) Nipissing University, North Bay, ON. 114 p.

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2006. COSEWIC assessment and update status report on the Lake Sturgeon (*Acipenser fulvescens*) in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa, ON. xi + 107 p.

COSEWIC. 2017. COSEWIC assessment and status report on the Lake Sturgeon *Acipenser fulvescens*, Western Hudson Bay populations, Saskatchewan-Nelson River populations, Southern Hudson Bay-James Bay populations and Great Lakes-Upper St. Lawrence populations in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa, ON. xxx + 153 p.

CAMP (Coordinated Aquatic Monitoring Program). 2014. Three year summary report (2008-2010). Report prepared for the Manitoba/Manitoba Hydro MOU Working Group by North/South Consultants Inc., Winnipeg, MB. Vol. 2: 265 p.

CAMP 2017. Six year summary report (2008–2013). Report prepared for Manitoba/Manitoba Hydro MOU Working Group by North/South Consultants Inc., Winnipeg, MB. Technical Document 7: 178 p.

Crossman, J.A., and Hildebrand, L.R. 2012. Evaluation of spawning substrate enhancement for White Sturgeon in a regulated river: effects on larval retention and dispersal. River Res. Appl. 30: 1–10.

D'Amours, J., Thibodeau, S., and Fortin, R. 2001. Comparison of Lake Sturgeon (*Acipenser fulvescens*), *Stizostedion* spp., *Catostomus* spp., *Moxostoma* spp., Quillback (*Carpiodes cyprinus*), and Mooneye (*Hiodon tergisus*) larval drift in Des Prairies River, Quebec. Can. J. Zool. 79: 1472–1489.

DFO. 2014. Guidance on assessing threats, ecological risk and ecological impacts for species at risk. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2014/013. (*Erratum*: June 2016)

DFO. 2015. Directive on the Application of Species at Risk act Section 33 (Residence) to Aquatic Species at Risk. Fisheries and Oceans Canada. Ottawa, ON. 7 p.

DFO. 2016. Proceedings of the zonal peer review of the pre-COSEWIC assessment for Lake Sturgeon, *Acipenser fulvescens*, designatable units 7-8, in Canada; November 3-4, 2015. DFO Can. Sci. Advis. Sec. Proceed. Ser. 2016/010.

DFO. 2017. National code on introductions and transfers of aquatic organisms. Fisheries and Oceans Canada, Ottawa, ON. 41 p.

DFO. 2019. Assessment of the instream flow needs for fish and fish habitat in the Saskatchewan River downstream of the E.B. Campbell Hydroelectric Station. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2018/048.

DFO. 2021a. Proceedings of the Zonal Peer Review on the Recovery Potential Assessment – Lake Sturgeon, *Acipenser fulvescens*, Designatable Unit 4 (Great Lakes-Upper St. Lawrence populations); March 19–20, 2019. DFO Can. Sci. Advis. Sec. Proceed. Ser. 2021/032.

DFO. 2021b. Proceedings of the Regional Peer Review on the Recovery Potential Assessment – Lake Sturgeon, *Acipenser fulvescens*, Designatable Units 1 (Western Hudson Bay populations) and 2 (Saskatchewan-Nelson River populations); March 12–14, 2019. DFO Can. Sci. Advis. Sec. Proceed. Ser. 2021/030.

Dobiesz, N.E., Bence, J.R., Sutton, T., Ebener, M., Pratt, T.C., O'Connor, L.M., and Steeves, T.B. 2018. Evaluation of sea lamprey-associated mortality sources on a generalize Lake Sturgeon population in the Great Lakes. J. Great Lakes Res. 44: 319–329.

Dumont, P., and Mailhot, Y. 2013. The St. Lawrence River Lake Sturgeon management in Québec: 1940s-2000s. *In* The Great Lake Sturgeon. *Edited by* N. Auer and D. Dempsey. Michigan State University Press, East Lansing, MI. pp. 101–132.

Dumont, P., D'Amours, J., Thibodeau, S., Dubuc, N., Verdon, R., Garceau, S., Bilodeau, P., Mailhot, Y., and Fortin, R. 2011. Effects of the development of a newly created spawning ground in the Des Prairies River (Québec, Canada) on the reproductive success of Lake Sturgeon (*Acipenser fulvescens*). J. Appl. Ichthyol. 27: 394–404.

Dymond, J.R. 1939. Fishes of the Ottawa Region. Contribution of the Royal Ontario Museum of Zoology. 15: 1–43.

EGBSC (Eastern Georgian Bay Stewardship Council). 2016. 2016 Spring spawning summary Deadman's Rapids, Magnetawan River. 2 p. (accessed 11 February 2019).

Ecclestone, A. 2012a. Movement patterns, habitat utilization, and spawning habitat of Lake Sturgeon (*Acipenser fulvescens*) in the Pic River, northeastern Lake Superior tributary in Ontario, Canada. Thesis (M.Sc.) Trent University, Peterborough, ON. 174 p.

Ecclestone, A. 2012b. Population characteristics, habitat utilization, and movement patterns of Lake Sturgeon in the White River, Ontario. Anishinabek/Ontario Fisheries Resource Centre (A/OFRC), North Bay, ON. 79 p.

Ecclestone, A. 2012c. Lake Sturgeon spawning assessment in the Michipicoten River, 2012. Anishinabek/Ontario Fisheries Resource Centre (A/OFRC), North Bay, ON. 56 p.

Eckes, O.T., Aloisi, D.B., and Sandheinrich, M.B. 2015. Egg and larval development index for Lake Sturgeon. N. Am. J. Aquacult. 77: 211–216.

Environnement Illimité Inc. 2004. Aménagement hydroélectrique de l'Eastmain-1 – caractérisation de la population d'esturgeons jaune. Rapport Sectoriel 2002-2003. Report prepared by F. Burton, M. Gendron, G. Guay, and J. Gingras for Société d'énergie de la Baie James. 137 p.

Environnement Illimité Inc. 2012. Pehonan Hydroelectric Project Lake Sturgeon study: spring and summer 2011 and summer 2012 baseline field report. A report presented to SNC-Lavalin/Kewit/Brookfield. 29 p.

Forsythe, P.S., Scribner, K.T., Crossman, J.A., Ragavendran, A., Baker, E.A., Davis, C., and Smith, K.K. 2012. Environmental and lunar cues are predictive of the timing of river entry and spawning-site arrival in Lake Sturgeon *Acipenser fulvescens*. J. Fish Biol. 81: 35–53.

Fortin, R., Guenette, S., and P. Dumont. 1992. Biologie, exploitation, modelisation et gestion des populations d'esturgeon jaune (*Acipenser fulvescens*) dans 14 reseaux de lacs et de rivieres du Québec. Québec Ministere du Loisir, de la Chasse et de la Peche, Service de l'amenagement et de l'exploitation de la faune and Service de la faune aquatique, Montreal and Québec, QC. 213 p.

Fortin, R., Dumont, P., and Guénette, S. 1996. Determinants of growth and body condition of Lake Sturgeon (*Acipenser fulvescens*). Can. J. Fish. Aquat. Sci. 53: 1150–1156.

Friday, M.J. 2005. Black Sturgeon River Lake Sturgeon (*Acipenser fulvescens*) index netting program 2002-2004. Ontario Ministry of Natural Resources Draft Report. 35 p.

Friday, M.J. 2006. An assessment of growth of young-of-the-year Lake Sturgeon in the Kaministiquia River, ON, 2006. Ontario Ministry of Natural Resources Upper Great Lakes Management Unit. Lake Superior Technical Report No. 06.06. 12 p.

Friday, M.J. 2013. The migratory and reproductive response of spawning Lake Sturgeon to controlled flows over Kakabeka Falls on the Kaministiquia River, 2011. Ontario Ministry of Natural Resources, Northwest Science and Information, NWSI Technical Report TR-148. 15 p.

Gauthier, J., 2014. Revue sur le projet de restauration de frayères à esturgeon jaune (*Acipenser fulvescens*) sur la rivière Ouareau. Ministère du Développement durable, de l'Environnement, de la Faune et des Parcs, Repentigny, 68 p. + annexes.

Gessner, J., Kamerichs, C.M., Kloas, W., and Wuertz, S. 2009. Behavioural and physiological responses in early life phases of Atlantic Sturgeon (*Acipenser oxyrinchus* Mitchell 1815) towards different substrates. J. Appl. Ichthyol. 25: 83–90.

Gill, G.J., Sutton, T., and Barth, C.C. 2018. Lake Sturgeon habitat assessment in the Winnipeg River downstream of Kenora and Norman generating stations, fall 2017. A report prepared for H2O Power Limited Partnership by North/South Consultants Inc., Winnipeg, MB. 93 p.

Gillespie, M.A., and MacDonell, D.S. 2018. Operation Phase I: Year 3 Results of Lake Sturgeon egg deposition and larval drift monitoring below Pointe du Bois Generating Station, 2017. A report prepared for Manitoba Hydro by North/South Consultants Inc., Winnipeg, MB. 74 p.

Gillespie, M.A., McDougall, C.A., and Nelson, P.A. 2015. Lake Sturgeon spawning studies in the Saskatchewan River in the vicinity of the Nipawin and E.B. Campbell Hydroelectric Generating Stations, spring 2014. A report prepared for Manitoba Hydro by North/South Consultants Inc., Winnipeg, MB. 47 p.

Gillies, M. 2010. Spanish River Lake Sturgeon, *Acipenser fulvescens*, spawning assessment 2003, 2005, 2006, 2008, 2009. Anishinabek/Ontario Fisheries Resource Centre (A/OFRC), North Bay, ON. 14 p.

Golder Associates Ltd. 2011. Recovery strategy for Lake Sturgeon (*Acipenser fulvescens*) – Northwestern Ontario, Great Lakes-Upper St. Lawrence River and Southern Hudson Bay-James Bay populations in Ontario. Ontario Recovery Strategy Series. Prepared for the Ontario Ministry of Natural Resources, Peterborough, ON. vii + 77 p.

Gosselin, T., Nelson, P.A., McDougall, C.A., and Bernatchez, L. 2015. Population genomics of Lake Sturgeon (*Acipenser fulvescens*) in the Churchill, Hayes, and Nelson rivers. A report prepared for Manitoba Hydro by Université Laval, Québec City, Québec and North South Consultants Inc., Winnipeg, MB. 68 p.

Goulet, G. 2014. Lake Sturgeon (*Acipenser fulvescens*) Aboriginal Traditional Knowledge assessment report 2014. Aboriginal Traditional Knowledge Assessment Report prepared for the ATK subcommittee of COSEWIC. 83 p.

Gross, M.R., Repka, J., Robertson, C.T., and Secor, D.H. 2002. Sturgeon conservation: insights from elasticity analysis. Am. Fish. Soc. Symp. 28: 183–200.

Harkness, W.J.K. 1980. Report on the sturgeon situation in Manitoba. Manitoba Department of Natural Resources, Winnipeg, MB. Report No. 80-3: 18 p.

Harkness, W.J.K., and Dymond, J.R. 1961. The Lake Sturgeon: the history of its fishery and problems of conservation. Ontario Department of Lands and Forests, Fish and Wildlife Branch, Toronto, ON. 121 p.

Harris, A., Colby, P., Hall-Armstrong, J., and Ratcliff, B. 2000. Status of Lake Sturgeon in the Winnipeg River: recovery considerations and implications. A report prepared for the Ontario Ministry of Natural Resources by Northern Bioscience Ecological Consulting, Kenora, ON. 42 p.

Hastings, R.P., Bauman, J.M., Baker, E.A., and Scribner, K.T. 2013. Post-hatch dispersal of Lake Sturgeon (*Acipenser fulvescens*, Rafinesque, 1817) yolk-sac larvae in relation to substrate in an artificial stream. J. Appl. Ichthyol. 29: 1208–1213.

Haugen, G.H. 1969. Life history, habitat and distribution of the Lake Sturgeon (*Acipenser fulvescens*) in the South Saskatchewan River, Alberta. Alberta Fish and Wildlife Division Research Report 4. 27 p.

Haxton, T.J. 2002. An assessment of Lake Sturgeon (*Acipenser fulvescens*) in various reaches of the Ottawa River. Can. Field-Nat. 117: 541–545.

Haxton, T.J. 2006. Characteristics of a Lake Sturgeon spawning population sampled a half century apart. J. Great Lakes Res. 32: 124–130.

Haxton, T.J. 2008. A synoptic review of the history and our knowledge of lake sturgeon in the Ottawa River. Southern Science and Information Technical Report SSI #126. 31 p.

Haxton, T.J. 2011. Depth selectivity and spatial distribution of juvenile Lake Sturgeon in a large, fragmented river. J. Appl. Ichthyol. 27(Suppl. 2): 45–52.

Haxton, T.J., and Cano, T. 2016. A global perspective of fragmentation on a declining taxon – the sturgeon (Acipenseriformes). Endanger. Species Res. 31: 203–210.

Haxton, T.J., and Findlay, C.S. 2008. Variation in Lake Sturgeon (*Acipenser fulvescens*) abundance and growth among river reaches in a large regulated river. Can. J. Fish. Aquat. Sci. 65: 645–657.

Haxton, T.J., and Friday, M.J. 2019. Are we overestimating recovery of sturgeon populations using mark/recapture surveys? J. Appl. Ichthyol. 35: 336–343.

Haxton, T.J., Friday, M., Cano, T., and Hendry, C. 2014a. Historical biomass and sustainable harvest of Great Lakes Lake Sturgeon (*Acipenser fulvescens* Rafinesque, 1817). J. Appl. Ichthyol. 30: 1371–1378.

Haxton, T.J., Friday, M., Cano, T., and Hendry, C. 2014b. Variation in Lake Sturgeon (*Acipenser fulvescens* Rafinesque, 1817) abundance in rivers across Ontario, Canada. J. Appl. Ichthyol. 30: 1335–1341.

Haxton, T.J., Friday, M., Cano, T., and Hendry, C. 2015. Assessing the magnitude of effect of hydroelectric production on Lake Sturgeon abundance in Ontario. N. Am. J. Fish. Manag. 35: 930–941.

Hay-Chmielewski, E.M. 1987. Habitat preferences and movement patterns of the Lake Sturgeon (*Acipenser fulvescens*) in Black Lake, Michigan. Michigan Department of Natural Resources Fisheries Division, Ann Arbor, MI. 39 p.

Hay-Chmielewski, E.M., and Whelan, G.E. 1997. Lake Sturgeon rehabilitation strategy. Michigan Department of Natural Resources Fisheries Division. Fisheries Special Report 18. 51 p.

Hegerat, E., and Paul, A.J. 2013. Abundance, survival, and trends for Lake Sturgeon in the North Saskatchewan River. Fish and Wildlife, Alberta Environment and Sustainable Resource Development, Edmonton, AB. 11 p.

Heinrich, T., and Friday, M. 2014. A population assessment of the Lake of the Woods – Rainy River Lake Sturgeon population, 2014. Ontario Ministry of Natural Resources and Minnesota Department of Natural Resources. 38 p.

Henderson, L.M., and McDougall, C.A. 2012. Lake Sturgeon spawning investigations in the Great Falls and Pine Falls Reservoirs – spring, 2011. A report prepared for Manitoba Hydro by North/South Consultants Inc., Winnipeg. MB. 34 p.

Henderson, L.M., and McDougall, C.A. 2015. Results of Lake Sturgeon investigations in the Winnipeg River between the Ontario border and Point du Bois Generating Station, 2014. A report prepared for Manitoba Hydro by North/South Consultants Inc., Winnipeg, MB. 60 p.

Henderson, L.M., and McDougall, C.A. 2016. Results of Lake Sturgeon investigations in the Winnipeg River from the McArthur Generating Station to Lake Winnipeg – spring 2016. A report prepared for Manitoba Hydro by North/South Consultants Inc., Winnipeg, MB. 45 p.

Henderson, L.M., and McDougall, C.A. 2017. Operation Phase 1: Year 1 results of juvenile Lake Sturgeon monitoring in the Slave Falls Reservoir, 2016. A report prepared for Manitoba Hydro by North/South Consultants Inc., Winnipeg, MB. 108 p.

Henderson, L.M., and McDougall, C.A. 2018. Operation Phase 1: Year 2 results of juvenile Lake Sturgeon monitoring in the Slave Falls Reservoir, 2017. A report prepared for Manitoba Hydro by North/South Consultants Inc., Winnipeg, MB. 104 p.

Henderson, L.M., Nelson, P.A., and MacDonell, D.S. 2014. Results of the 2013 fish community investigations focusing on Lake Sturgeon in the Conawapa Study Area, 2013. A report prepared for Manitoba Hydro by North/South Consultants Inc., Winnipeg, MB. 57 p.

Henderson, L.M., Barth, C.C., Blanchard, M., and Dolce-Blanchard, L. 2015a. Results of Lake Sturgeon larval drift assessments conducted in the Nipigon River downstream of the Alexander Generating Station, summer, 2015. A report prepared for Ontario Power Generation by North/South Consultants Inc., Winnipeg, MB. 17 p.

Henderson, L.M., McDougall, C.A., and Barth, C.C. 2015b. Results of Lake Sturgeon spawning assessments conducted in the vicinity of Caribou Falls and Whitedog Falls generating stations, spring 2015. A report prepared for Ontario Power Generation by North/South Consultants Inc., Winnipeg, MB. 56 p.

Henderson, L.M., McDougall, C.A., and Nelson, P.A. 2015c. Lake Sturgeon population studies in the Saskatchewan River: The Forks to the Nipawin HS, 2014. A report prepared for Saskatchewan Power Corporation by North/South Consultants Inc., Winnipeg, MB. 67 p.

Henderson, L.M., Sutton, T.J., and McDougall, C.A. 2015d. Lake Sturgeon spawning and habitat investigations below the Jenpeg Generating Station, spring 2014. A report prepared for Manitoba Hydro by North/South Consultants Inc., Winnipeg, MB. 51 p.

Henderson, L.M., Lacho, C.D., Alperyn, M.D., McDougall, C.A., and Nelson, P.A. 2016. Lake Sturgeon population studies in the Saskatchewan River: The Forks to the Nipawin HS, 2015. A report prepared for Saskatchewan Power Corporation by North/South Consultants Inc., Winnipeg, MB. 108 p.

Henderson, L.M., McDougall, C.A., and Barth, C.C. 2018. Results of a juvenile Lake Sturgeon inventory conducted in the Caribou Falls/Whitedog Falls to Manitoba border reach of the English and Winnipeg rivers, fall 2017. A report Prepared for Ontario Power Generation by North/South Consultants Inc., Winnipeg, MB. 58 p.

Holm, J., and Bernhardt, W.J. 2011. Results of the 2006 fish community investigations in the Nelson River Estuary. Conawapa Generation Project Environmental Studies. A report prepared for Manitoba Hydro by North/South Consultants Inc., Winnipeg, MB. 25 p.

Holm, J., and Hrenchuk, C.L. 2019. Adult Lake Sturgeon population monitoring in the future Keeyask reservoir and Stephens Lake, 2018. Keeyask Generation Project Aquatic Effects Monitoring Plan Report #AEMP-2019-05. A report prepared for Manitoba Hydro by North/South Consultants Inc., Winnipeg, MB. 100 p.

Holtgren, J.M., and Auer, N.A. 2004. Movement and habitat of juvenile Lake Sturgeon (*Acipenser fulvescens*) in the Sturgeon River/Portage Lake system, Michigan. J. Freshw. Ecol. 19: 419–432.

Hondorp, D.W., Bennion, D.H., Roseman, E.F., Holbrook, C.M., Boase, J.C., Chiotti, J.A., Thomas, M.V., Wills, T.C., Drouin, R.G., Kessel, S.T., and Krueger, C.C. 2017. Use of navigation channels by Lake Sturgeon: Does channelization increase vulnerability of fish to ship strikes? PLoS ONE. 12: e0179791.

Houston, J.J. 1987. Status of Lake Sturgeon, *Acipenser fulvescens*, in Canada. Can. Field-Nat. 10: 171–185.

Hrenchuk, C.L. 2011. Influences of water velocity and hydropower operations on spawning site choice and recruitment success of Lake Sturgeon, *Acipenser fulvescens*, in the Winnipeg River. Thesis (M.Sc.) University of New Brunswick, Fredericton, NB. 153 p.

Hughes, T.C. 2002. Population characteristics, habitats, and movement of Lake Sturgeon (*Acipenser fulvescens*) in the lower Niagara River. Thesis (M.Sc.) State University of New York at Brockport, Brockport, NY. 175 p.

Hughes, T.C., Lowie, C.E., and Haynes, J.M. 2005. Age, growth, relative abundance, and scuba capture of a new or recovering spawning population of Lake Sturgeon in the Lower Niagara River, New York. N. Am. J. Fish. Manag. 25: 1263–1272.

IUCN (International Union for Conservation of Nature). 2001. IUCN Red List categories and criteria: Version 3.1. Prepared by IUCN Species Survival Commission. World Conservation Union, Gland, Switzerland and Cambridge, United Kingdom. ii + 30 p.

IUCN 2012. Threats Classification Scheme (Version 3.2). (accessed 21 February 2019).

Jackson, B., and Braithwaite, T. 2017. Fisheries assessment of Little Turtle and Big Turtle rivers with emphasis on juvenile Lake Sturgeon: 2016 update. 23 p.

Jacobs, G.R., Bruestle, E.L., Hussey, A., Gorsky, D., and Fisk, A.T. 2017. Invasive species alter ontogenetic shifts in the trophic ecology of Lake Sturgeon (*Acipenser fulvescens*) in the Niagara River and Lake Ontario. Biol. Invasions. 19(5): 1533–1546.

Jansen, W.A., and Dawson, K. 2007. Biological data from fish sampling on Cedar Lake, Manitoba, 2006. A report prepared for Manitoba Hydro by North/South Consultants Inc., Winnipeg, MB. 135 p.

Jansen, W.A., and Maclean, B. 2006. A fish tagging program on Cedar Lake, Manitoba, 2005 with reference to recapture and fish movement data from 1999-2005. A report prepared for Manitoba Hydro by North/South Consultants Inc., Winnipeg, MB. 90 p.

Johnson, J.H., LaPan, S.R., Klindt, R.M., and Schiavone, A. 2006. Lake Sturgeon spawning on artificial habitat in the St. Lawrence River. J. Appl. Ichthyol. 22: 465–470.

Johnson, M.W., and Nelson, P.A. 2011. Lake Sturgeon population assessment in the Churchill River near Island Falls hydroelectric station, spring 2011. A report prepared for SaskPower by North/South Consultants Inc., Winnipeg, MB. 72 p.

Johnson, M.W., Brandt, C., and Cooley, P.M. 2014. Lake Sturgeon studies in the Winnipeg River near Norman and Kenora Damn, District of Kenora, Ontario: adult and juvenile gillnetting, 2014. A report prepared for H2O Power LP by North/South Consultants Inc., Winnipeg, MB. 26 p.

Keeyask Hydropower Limited Partnership. 2012. Keeyask Generation Project environmental impact statement supporting volume: aquatic environment. 1745 p.

Kempinger, J.J. 1988. Spawning and early life history of Lake Sturgeon in the Lake Winnebago system, Wisconsin. Am. Fish. Soc. Symp. 5: 110–122.

Kempinger, J.J. 1996. Habitat, growth, and food of young Lake Sturgeons in the Lake Winnebago system, Wisconsin. N. Am. J. Fish. Manag. 16: 102–114.

Kessel, S.T., Hondorp, D.W., Holbrook, C.M., Boase, J.C., Chiotti, J.A., Thomas, M.V., Wills, T.C., Roseman, E.F., Drouin, R., and Krueger, C.C. 2018. Divergent migration within lake sturgeon (*Acipenser fulvescens*) populations: Multiple distinct patterns exist across an unrestricted migration corridor. J. Anim. Ecol. 87: 259–273.

Kitigan Zibi Anishinabeg First Nation. 2015. Kitigan Zibi Anishinabeg Lake Sturgeon summary of research report 2006-2015. Kitigan Zibi Anishinabeg First Nation, QC. 5 p.

Knights, B.C., Vallazza, J.M., Zigler, S.J., and Dewey, M.R. 2002. Habitat and movement of Lake Sturgeon in the upper Mississippi River System, U.S.A. Trans. Am. Fish. Soc. 131: 507–522.

Kough, A.S., Jacobs, G.R., Gorsky, D., and Willink, P.W. 2018. Diel timing of Lake Sturgeon (*Acipenser fulvescens*) activity revealed by satellite tags in the Laurentian Great Lake basin. J. Great Lakes Res. 44(1): 157–165.

Krieger, J.R. 2017. Habitat utilization and early life history characteristics of larva, young-of-the year, and juvenile Lake Sturgeon (*Acipenser fulvescens*) in the Great Lakes connecting channels. Thesis (PhD) University of Michigan, Ann Arbor, MI. 112 p.

Labadie, H. 2011. Growth patterns and movements of adult Lake Sturgeon (*Acipenser fulvescens*) in a deep impounded river. Thesis (M.Sc.) University of New Brunswick, Fredericton, NB. 115 p.

Lacho, C.D. 2013. Movement and habitat use of Lake Sturgeon (*Acipenser fulvescens*) in the South Saskatchewan River system. Thesis (M.Sc.) University of Lethbridge, Lethbridge, AB. 79 p.

Lacho, C.D., Hudd, D., and MacDonell, D.S. 2015. Results of the 2014 fall studies focusing on Lake Sturgeon in the lower Nelson River. A report prepared for Manitoba Hydro by North/South Consultants Inc., Winnipeg, MB. 50 p.

Lacho, C.D., Hrenchuk, C.L., Nelson, P.A., and Barth, C.C. 2018. Adult Lake Sturgeon population monitoring in the upper Split Lake area, 2017. Keeyask Generation Project Aquatic Effects Monitoring Report #AEMP-2018-01. A report prepared for Manitoba Hydro by North/South Consultants Inc., Winnipeg, MB. 110 p.

LaHaye, M., Branchaud, A., Gendron, M., Verdon, R., and Fortin, R. 1992. Reproduction, early life history, and characteristics of the spawning grounds of the Lake Sturgeon (*Acipenser fulvescens*) in Des Prairies and L'Assomption rivers, near Montreal, Quebec. Can. J. Zool. 70: 1681–1689.

Lake Erie Lake Sturgeon Working Group. 2018. Lake Erie Lake Sturgeon Working Group Annual Report 2018. 15 p.

Lake Huron Lake Sturgeon Working Group. 2015. 2015 Lake Huron Lake Sturgeon Working Group Report. Ontario Ministry of Natural Resources and the U.S. Fish and Wildlife Service Report. Bailey's Crossroads, VA. 11 p.

LeBaron, A., T. Haxton. 2015. Sturgeon Assessment Project Trent River: September – October 2015. Ontario Ministry of Natural Resources, Aquatic Research and Monitoring Section, 2 p. unpublished report.

LeBreton, G.T.O., and Beamish, F.W.H. 1998. The influence of salinity on ionic concentrations and osmolarity of blood serum in Lake Sturgeon, *Acipenser fulvescens*. Env. Biol. Fishes. 52: 477–482.

Legge, M.M., Hrenchuk, C.L., Nelson, P.A., Burnett, D.C., and Barth, C.C. 2017. Adult Lake Sturgeon population monitoring in the future Keeyask reservoir and Stephens Lake, 2016. Keeyask Generation Project Aquatic Effects Monitoring Plan Report #AEMP-2017-05. A report prepared for Manitoba Hydro by North/South Consultants Inc., Winnipeg, MB. 79 p.

Legget, R. 1975. Ottawa waterway: gateway to a continent. University of Toronto Press, Toronto, ON. 375 p.

Limno-Service inc., 2002. Suivi de la montaison et recherche de frayères d'esturgeon jaune des rivières Ouareau et L'Assomption, printemps 2002. Report prepared for Corporation de l'Aménagement de la Rivière l'Assomption (CARA), Sainte-Julienne, 15 p. + annexes.

Limno-Service inc., 2003. Suivi de la montaison et recherche de frayères d'esturgeon jaune des rivières Ouareau et L'Assomption, printemps 2003. Report prepared for Corporation de l'Aménagement de la Rivière l'Assomption (CARA), Sainte-Julienne, 20 p. + annexes.

Lord, K. 2007. Movements and habitat use of juvenile Lake Sturgeon in the North Channel of the St. Clair River. Thesis (M.Sc.) University of Michigan, Ann Arbor, MI. 39 p.

Lyons, J., and Stewart, J.S. 2014. Predicted effects of future climate warming on thermal habitat suitability for Lake Sturgeon (*Acipenser fulvescens*, Rafinesque, 1817) in rivers in Wisconsin, USA. J. Appl. Ichthyol. 30: 1508–1513.

Lowdon, M., and Queen, L. 2013. Pine Falls Generating Station: environmental assessment fisheries technical report. A report prepared for Manitoba Hydro by AAE Tech Services Inc., Winnipeg, MB. 197 p.

MacDonell, D.S. 1997. The Nelson River Lake Sturgeon fishery from the perspective of the Bayline communities of Pikwitonei, Thicket Portage, and Waboden. Thesis (M.Sc,) University of Manitoba, Winnipeg, MB. 173 p.

MacLean, B.D., and Nelson, P.A. 2005. Population and spawning studies of Lake Sturgeon (*Acipenser fulvescens*) at the confluence of the Churchill and Little Churchill rivers, Manitoba, spring 2003. A report prepared for Manitoba Hydro by North/South Consultants Inc., Winnipeg, MB. 56 p.

Manitoba Hydro. 2010. A history of electric power in Manitoba. Manitoba Hydro, Winnipeg, MB. 79 p.

Manitoba Hydro and the Province of Manitoba. 2015. Regional cumulative effects assessment for hydroelectric developments on the Churchill, Burntwood and Nelson river systems: Phase II Report. Manitoba Hydro, Winnipeg, MB. xxx + 459 p.

Manny, B.A., and Kennedy, G.W. 2002. Known Lake Sturgeon (*Acipenser fulvescens*) spawning habitat in the channel between lakes Huron and Erie in the Laurentian Great Lakes. J. Appl. Ichthyol. 18: 486–490.

Mailhot, Y., Dumont, P., and Vachon, N. 2011. Management of the Lake Sturgeon *Acipenser fulvescens* population in the lower St. Lawrence River (Québec, Canada) from the 1910s to the present. J. Appl. Ichthyol. 27: 405–410.

McAdam, S.O., and Jonsson, B. 2011. Effects of substrate condition on habitat use and survival by White Sturgeon (*Acipenser transmontanus*) larvae and potential implications for recruitment. Can. J. Fish. Aquat. Sci. 68: 812–822.

McDougall, C.A. 2011. Results of Lake Sturgeon inventories in the Great Falls and Pine Falls reservoirs – fall, 2011. A report prepared for Manitoba Hydro by North/South Consultants Inc., Winnipeg, MB. 46 p.

McDougall, C.A., and Barth, C.C. 2015. Caribou Falls and Whitedog Falls Generating Stations mitigation program: results of a juvenile inventory conducted in the Caribou Falls/Whitedog Falls to Manitoba border reach of the Winnipeg River, fall 2014. A report prepared for Ontario Power Generation by North/South Consultants Inc., Winnipeg, MB. 29 p.

McDougall, C.A., and Cooley, P.M. 2013. Lake Sturgeon studies in the Seine River near Sturgeon Falls, District of Rainy River, Ontario: acoustic tagging of adults and juvenile gillnetting, 2013. A report prepared for H2O Power LP by North/South Consultants Inc., Winnipeg, MB 19 p.

McDougall, C.A., and Gillespie, M.A. 2012. Habitat documentation at potential Winnipeg River spawning locations – fall, 2011. A report prepared for Manitoba Hydro by North/South Consultants Inc., Winnipeg, MB. 254 p.

McDougall, C.A., and Nelson, P.A. 2015. Upper Nelson River juvenile Lake Sturgeon inventories, 2014: Sea Falls – Sugar Falls. A report prepared for Manitoba Hydro by North/South Consultants Inc., Winnipeg, MB. 56 p.

McDougall, C.A., and Nelson, P.A. 2016. Upper Nelson River juvenile Lake Sturgeon inventories, 2015: Sea Falls to Sugar Falls. A report prepared for Manitoba Hydro by North/South Consultants Inc., Winnipeg, MB. 71 p.

McDougall, C.A., and Nelson, P.A. 2017. Upper Nelson River juvenile Lake Sturgeon inventories, 2016: Sea Falls to Sugar Falls. A report prepared for Manitoba Hydro by North/South Consultants Inc., Winnipeg, MB. 68 p.

McDougall, C.A., and Pisiak, D.J. 2012. Results of a Lake Sturgeon inventory conducted in the Sea Falls to Sugar Falls reach of the Nelson River – fall 2012. A report prepared for Manitoba Hydro by North/South Consultants Inc., Winnipeg, MB. 46 p.

McDougall, C.A., and Pisiak, D.J. 2014. Upper Nelson River juvenile Lake Sturgeon inventories, 2013: Sea Falls-Sugar Falls and the Pipestone Lake area. A report prepared for Manitoba Hydro by North/South Consultants Inc., Winnipeg, MB. 91 p.

McDougall, C.A., Blanchfield, P.J., Peake, S.J., and Anderson, W.G. 2013. Movement patterns and size-class influence entrainment susceptibility of Lake Sturgeon in a small hydroelectric reservoir. Trans. Am. Fish. Soc. 142: 1508–1521.

McDougall, C.A., Anderson, W.G., and Peake, S.J. 2014a. Downstream passage of Lake Sturgeon through a hydroelectric generating station: route determination, survival, and fine-scale movements. N. Am. J. Fish. Manag. 34: 546–558.

McDougall, C.A., Barth, C.C., Aiken, J.K., Henderson, L.M., Blanchard, M.A., Ambrose, K.M., Hrenchuk, C.L., Gillespie, M.A., and Nelson, P.A. 2014b. How to sample juvenile Lake Sturgeon, (*Acipenser fulvescens* Rafinesque, 1817), in Boreal Shield rivers using gill nets, with an emphasis on assessing recruitment patterns. J. Appl. Ichthyol. 30: 1402–1415.

McDougall, C.A., Blanchfield, P.J., and Anderson, W.G. 2014c. Linking movements of Lake Sturgeon (*Acipenser fulvescens* Rafinesque, 1817) in a small hydroelectric reservoir to abiotic variables. J. Appl. Ichthyol. 30: 1149–1159.

McDougall, C.A., Pisiak, D.J., Barth, C.C., Blanchard, M.A., MacDonell, D.S., and Macdonald, D. 2014d. Relative recruitment success of stocked age-1 vs age-0 Lake Sturgeon (*Acipenser fulvescens* Rafinesque, 1817) in the Nelson River, northern Canada. J. Appl. Ichthyol. 30: 1451–1460.

McDougall, C.A., Nelson, P.A., Macdonald, D., Kroeker, D., Kansas, K., Barth, C.C., and MacDonell, D.S. 2017. Habitat quantity required to support self-sustaining Lake Sturgeon populations: an alternative hypothesis. Trans. Am. Fish. Soc. 146: 1137–1155.

McDougall, C.A., Nelson, P.A., and Barth, C.C. 2018. Extrinsic factors influencing somatic growth of Lake Sturgeon. Trans. Am. Fish. Soc. 147: 459–479.

McIntyre. E. 2010. 2010 Lake Sturgeon spawning monitoring project at the Moon River of Eastern Georgian Bay. Eastern Georgian Bay Stewardship Council, Burk's Falls, ON. 2 p.

McKenzie, R.A. 1930. The reported decrease in fish life and the pollution of the Winnipeg River, Kenora, Ontario. Trans. Am. Fish. Soc. 60: 311–323.

McLeod. J.A. 1943. Preliminary biological investigations of eight lakes in the Whiteshell Forest Reserve. Manitoba Department of Mines and Natural Resources. 106 p.

McLeod, D.T. 2008a. A population estimate of Lake Sturgeon in the Namakan River, Ontario 2006-2008. Ontario Ministry of Natural Resources, Fort Francis District Report Series No. 81, Fort Francis, ON. 39 p.

McLeod, D.T. 2008b. A population estimate of Lake Sturgeon in Little Eva Lake, Ontario 2007. Ontario Ministry of Natural Resources – Fort Frances District Report Series No. 79, Fort Francis, ON. 27 p.

McLeod, D., and Martin, C. 2015. Movement and seasonal distribution of Lake Sturgeon in the Namakan River, Ontario 2007-2013. Ontario Ministry of Natural Resources. Fort Frances District Report Series No. 94, Fort Francis, ON. 126 p.

MCWS (Manitoba Conservation and Water Stewardship). 2012. Manitoba Lake Sturgeon Management Strategy. Manitoba Conservation and Water Stewardship Division, Winnipeg, MB. 52 p.

Mergler, D., Anderson, H.A., Chan, L., Mahaffey, K.R., Murray, M., Sakamoto, M., and Stern, A.H. 2007. Methylmercury exposure and health effects in humans: a worldwide concern. AMBIO. 36: 3–11.

Morin, G. 2002. Translation of elder interviews on sturgeon – Sandy Bay and Pelican Narrows May–July 2001. “Missinippi Namew Recovery Project” submitted to Department of Fisheries and Oceans, Prince Albert, SK. November 14, 2002.

Mosindy, T. 1987. The Lake Sturgeon (*Acipenser fulvescens*) fishery of Lake of the Woods, Ontario. *In* Proceedings of a workshop on the Lake Sturgeon (*Acipenser fulvescens*). *Edited by* C.H. Olver. Ontario Fisheries Technical Report Series 23. Ontario Ministry of Natural Resources, Toronto, ON. pp. 48–56.

Mosindy, T., and Rusak, J. 1991. An assessment of Lake Sturgeon populations in Lake of the Woods and Rainy River: 1987-1990. Ontario Ministry of Natural Resources – Lake of the Woods Fisheries Assessment Unit. No. 1991-01. Ontario Ministry of Natural Resources. Kenora, ON. 66 p.

Murray, L., and Gillespie, M.A. 2011. Lake Sturgeon inventory and habitat assessment – Winnipeg River from McArthur to Pine Falls, 2010. A report prepared for Manitoba Hydro by North/South Consultants Inc., Winnipeg, MB. 52 p.

Murray, L., Gillespie, M., and MacDonell, D.S. 2017. Operation Phase I: Year 2 Results of Lake Sturgeon egg deposit and larval drift monitoring below Pointe du Bois Generating Station, 2016. A report prepared for Manitoba Hydro by North/South Consultants Inc., Winnipeg, MB. 73 p.

Nahwegahbow, K. 2015. Garden River First Nation Lake Sturgeon assessment. Anishinabek/Ontario Fisheries Resource Centre (A/OFRC), North Bay, ON. 29 p.

Nelson, J.S., and Paetz, M.J. 1992. The fishes of Alberta. University of Alberta Press, Edmonton, AB. 437 p.

Nelson, P.A. 2015. Saskatchewan River sturgeon management board index netting: data review, preliminary analysis, and recommendations. A report prepared for SaskPower and Manitoba Hydro by North/South Consultants Inc., Winnipeg, MB. 18 p.

Nelson, P.A., and Barth, C.C. 2011. Results of a Lake Sturgeon population assessment conducted in the Churchill River near the Island Falls hydroelectric station. A report prepared for SaskPower by North/South Consultants Inc., Winnipeg, MB. 43 p.

Nelson, P.A., and Johnson, M. 2016. Saskatchewan River sturgeon management board: juvenile Lake Sturgeon surveys 2015. A report prepared for SaskPower and Manitoba Hydro by North/South Consultants Inc., Winnipeg, MB. 50 p.

Neuenhoff, R.D., Withers, J.L., Davis, L.A., Markley, N.D., Dowell, S., Bartron, M.L., Gorsky, D., and Sweka, J.A. 2018. Discovery of an undocumented Lake Sturgeon spawning site in the headwaters of the Niagara River. J. Fish Wildl. Manage. 9: 266–273.

NYSDEC (New York State Department of Environmental Conservation). 2018. Lake Sturgeon recovery plan 2018–2024. New York Department of Environmental Conservation, Albany, NY. 40 p.

Nilo, P., Dumont, P., and Fortin, R. 1997. Climatic and hydrological determinants of year-class strength of St. Lawrence River Lake Sturgeon (*Acipenser fulvescens*). Can. J. Fish. Aquat. Sci. 54: 774–780.

NSC (North/South Consultants Inc.). 2011. Manitoba Hydro Lake Sturgeon Stewardship Program: Churchill River Lake Sturgeon inventory, 2010. A report prepared for Manitoba Hydro by North/South Consultants Inc., Winnipeg, MB. 18 p.

NSC. 2012. Lower Churchill River confluence study: Larval drift trap component (June–July, 2011). A draft report prepared for Tataskweyak Cree Nation and Manitoba Hydro by North/South Consultants Inc., Winnipeg, MB. 25 p.

NSC. 2014. All seasons road: Provincial Road 304 to Berens River First Nation: Pigeon River juvenile Lake Sturgeon utilization. A report prepared for Manitoba Floodway and East Side Road Authority by North/South Consultants Inc., Winnipeg, MB. 15 p.

O'Connor, L.M., Pratt, T.C., Steeves, T.B., Stephens, B., Boogaard, M., and Kaye, C. 2017. *In situ* assessment of lampricide toxicity to age-0 Lake Sturgeon. J. Great Lakes Res. 43: 189–198.

OMNRF (Ontario Ministry of Natural Resources and Forestry). 2009. The Lake Sturgeon in Ontario. Fish and Wildlife Branch. Peterborough, ON. 48 p.

OMNRF. 2017. Lake Ontario Fish Communities and Fisheries: 2016 Annual Report of the Lake Ontario Management Unit. Ontario Ministry of Natural Resources and Forestry, Picton, ON. 221 p.

OMNRF. 2018. Lake Ontario Fish Communities and Fisheries: 2017 Annual Report of the Lake Ontario Management Unit. Ontario Ministry of Natural Resources and Forestry, Picton, ON. 200 p.

OPG and SENES Consultants (Ontario Power Generation and SENES Consultants Ltd). 2011. Little Jackfish Hydroelectric Development: project description pursuant to the Canadian Environmental Assessment Act. 118 p.

Paul, A.J. 2013. Population size, survival, and trends for Lake Sturgeon in the South Saskatchewan River. Fish and Wildlife, Alberta Environment and Sustainable Development, Edmonton, AB. 8 p.

Paul, A.J. 2019. Alberta Lake Sturgeon Population Estimates from the Volunteer Angling Program. Unpublished Report. Fish and Wildlife Policy, Alberta Environment and Parks, Cochrane, AB. 24 p.

Peacock, J. 2014. Winnipeg River Lake Sturgeon (*Acipenser fulvescens*) assessment program, 2010-2012 progress report. Kenora District Office, Ontario Ministry of Natural Resources, Kenora, ON. 31 p.

Peake, S. 1999. Substrate preferences of juvenile hatchery-reared Lake Sturgeon, *Acipenser fulvescens*. Env. Biol. Fishes. 56: 367–374.

Peterson, D., Vecsei, P., and Noakes, D. 2003. Threatened Fishes of the World: *Acipenser fulvescens* Rafinesque, 1817 (Acipenseridae). Environ. Biol. Fish. 68: 174.

Pollock, M. 2012. Saskatchewan River sturgeon report, 2011. Saskatchewan Watershed Authority, Saskatoon, SK. 185 p.

Pollock, M.S., Carr, M., Kreitals, N.M., and Phillips, I.D. 2015. Review of a species in peril: what we do not know about Lake Sturgeon may kill them. Environ. Rev. 23(1): 30–43.

Power, M., and McKinley, R.S. 1997. Latitudinal variation in Lake Sturgeon size as related to the thermal opportunity for growth. Trans. Am. Fish. Soc. 126: 549–558.

Pratt, T.C. 2008. Population status and threats of Lake Sturgeon in designatable unit 8 (Great Lakes/St. Lawrence River watersheds). DFO Can. Sci. Advis. Sec. Res. Doc. 2008/043. 33 p.

Pratt, T.C., Gardner, W.M., Pearce, J., Greenwood, S., and Chong, S.C. 2014. Identification of a robust Lake Sturgeon (*Acipenser fulvescens*, Rafinesque, 1817) population in Goulais Bay, Lake Superior. J. Appl. Ichthyol. 30: 1328–1334.

Priegel, G.R., and Wirth, T.L. 1974. The Lake Sturgeon: its life history, ecology, and management. Wisconsin Department of Natural Resources, Madison, WI. 20 p.

Remnant, R.A., and Bernhardt, W.J. 1994. An assessment of fish utilization of Goose Creek, near Churchill, Manitoba, 1993. A report prepared for Manitoba Hydro by North/South Consultants Inc., Winnipeg, MB. 248 p.

Robitaille, J.A., Vigneault, Y., Shooner, G., Pomerleau, C., and Mailhot, Y. 1988. Modifications physiques de l'habitat du poisson dans le Saing-Laurent de 1945-1984 et effets sur les peches commerciales. Donnees complementaires sur les peches commercialese en eau douce au Québec. Rapp. Stat. Can. Sci. Halieut, Aquatic. 697: 31 p.

Rochard, E., Castelnaud, G., and Lepage, M. 1990. Sturgeons (Pisces Acipenseridae); threats and prospects. J. Fish Biol. 37: 123–132.

Roseman, E.F., Manny, B., Boase, J., Child, M., Kennedy, G., Craig, J., Soper, K., and Drouin, R. 2011. Lake Sturgeon response to a spawning reef constructed in the Detroit River. J. Appl. Ichthyol. 27: 66–76.

Roussow, G. 1955. Les esturgeons du fleuve Saint-Laurent en comparaison avec les autres espèces d'Acipenséridés. Office de Biologie, Ministère de la Chasse et des Pêcheries, province de Québec, Montréal, QC. 123 p.

Roy, S., Cholette, S. & Houle, R. 2016. Inventaire de l'esturgeon jaune (*Acipenser fulvescens*) : rivière Saint-François, région de l'Estrie en 2014-2015. Ministère des Forêts, de la Faune et des Parcs, Québec, QC. 30 p.

Rusak, J.A., and Mosindy, T. 1997. Seasonal movements of Lake Sturgeon in Lake of the Woods and the Rainy River, Ontario. Can. J. Zool. 75: 383–395.

Salafsky, N., Salzer, D., Stattersfield, A.J., Hilton-Taylor, C., Neugarten, R., Butchart, S.H.M., Collen, B., Cox, N., Master, L.L., O'Connor, S., and Wilkie, D. 2008. A standard lexicon for biodiversity conservation: unified classifications of threats and actions. Conservation Biology 22: 897–911.

Saunders, E.J. 2006. Lake Sturgeon in Alberta: A summary of current knowledge. Unpublished report for Fish and Wildlife Division, Alberta Sustainable Resource Development, Lethbridge, AB. 22 p.

Sawchyn, W.W. 1975. Impact on Reindeer River and four Churchill River lakes. Churchill River Study Final Report 9, Churchill River Study Board, Saskatoon, SK. 260 p.

Schloesser, J.T., Quinlan, H.R., Pratt, T.C., Baker, E.A., Adams, J.V., Mattes, W.P., Greenwood, S., Chong, S., Berglund, E., Gardner, W.M., Lindgren, J.P., Palvere, C., Stevens, P., Borkholder, B.D., Edwards, A.J., Mensch, G., Isaac, E.J., Moore, S., Abel, C., Wilson, T., Ripple, P. and Ecclestone, A. 2014. Lake Superior Lake Sturgeon index survey: 2011 status report. Lake Superior Lake Sturgeon Work Group of the Lake Superior Technical Committee, Ann Arbor, MI. 67 p.

Scott, W.B., and Crossman, E.J. 1973. Freshwater fishes of Canada. Fisheries Research Board of Canada, Bulletin 184. 966 p.

Seyler, J. 1997. Biology of selected riverine fish species in the Moose River Basin. Ontario Ministry of Natural Resources, Timmins, ON. 100 p.

Shaw, S.L., Chipps, S.R., Windels, S.K., Webb, M.A.H., McLeod, D.T., and Willis, D.W. 2012. Lake Sturgeon population attributes and reproductive structure in the Namakan Reservoir, Minnesota and Ontario. J. Appl. Ichthyol. 28: 168–175.

Shaw, S.L., Chipps, S.R., Windels, S.K, Webb, M.A.H., and McLeod, D.T. 2013. Influence on sex and reproductive status on seasonal movement of Lake Sturgeon in the Namakan Reservoir, Minnesota-Ontario. Trans. Am. Fish. Soc. 142: 10–20.

Skaptason, J.B. 1926. The fish resources of Manitoba. The Industrial Development Board of Manitoba, Winnipeg, MB. 43 p.

Smith, C.G. 2003. Historical and present locations of Lake Sturgeon (*Acipenser fulvescens*) in Saskatchewan. Saskatchewan Environment Fish and Wildlife Branch, Saskatoon, SK. Fish and Wildlife Technical Report 2003-2: 32 p.

Smith, K.M., and Baker, E.A. 2005. Characteristics of spawning Lake Sturgeon in the Upper Black River, Michigan. N. Am. J. Fish. Manag. 25: 301–307.

Smith, K.M., and King, D.K. 2005. Dynamics and extent of larval Lake Sturgeon *Acipenser fulvescens* drift in the Upper Black River, Michigan. J. Appl. Ichthyol. 21: 161–168.

Smith, J.A., Handley, J.C., and Dietl, G.P. 2017. Effects of dams on downstream molluscan predator-prey interactions in the Colorado River estuary. Proc. R. Soc. Biol. Sci. Ser. B. 285(1879): 20180724

Solomon, L., and Baljko, C. 2011. A population assessment of Lake Sturgeon in Sturgeon Lake, Quetico Provincial Park: 2008-2010. Ontario Parks Completion Report. 38 p.

Split Lake Cree-Manitoba Hydro Joint Studies Group. 1996. Analysis of change, Split Lake Cree post project. Environ. Rev. Volume 1. 96 p.

Stewart, D.B. 2009. Historical harvests of Lake Sturgeon (*Acipenser fulvescens*) from western Canada. Can. Tech. Rep. Fish. Aquat. Sci. 43 p.

Stewig, J.D. 2005. A population assessment of the Lake Sturgeon in Lake of the Woods and the Rainy River, 2004. Minnesota Department of Natural Resources Division of Fisheries, St. Paul, MN. 38 p.

Struthers, D.P., Gutowsky, L.F., Enders, E.C., Smokorowski, K.W., Watkinson, D.A., Silva, A.T., Cvetkovic, M., Bibeau, E., and Cooke, S.J. 2017. Factors influencing the spatial ecology of Lake Sturgeon and Walleye within an impounded reach of the Winnipeg River. Env. Biol. Fishes 100: 1085–1103.

Suchy, M.D. 2009. Effects of salinity on growth and survival of larval and juvenile Alligator Gar, *Atractosteus spatula*, and on plasma osmolality of non-teleost Actinopergiian fishes. Thesis (M.Sc.), Nicholls State University, Thibodeaux, LA. 95 p.

Sumner, L. 2017. Ojibways of Garden River First Nation Lake Sturgeon spawning migration and larval drift dynamics in the Garden River. Anishinabek/Ontario Fisheries Resource Centre (A/OFRC), North Bay, ON. Report IS17_GR1. 28 p.

Sumner, L. 2018. Ojibways of Garden River First Nation Lake Sturgeon spawning migration and larval drift dynamics in the Garden River. Anishinabek/Ontario Fisheries Resource Centre (A/OFRC), North Bay, ON. Report IS18_GR1. 32 p.

Sunde, L.A. 1961. Growth and reproduction of the Lake Sturgeon (*Acipenser fulvescens* Rafinesque) of the Nelson River in Manitoba. Thesis (M.Sc.) University of British Columbia, Vancouver, BC. 93 p.

Swainson, R. 2001. Fish and fisheries of the Lake Nipigon basin, Nipigon River and Black Sturgeon River system from 1840 to 2001. Report of the Lake Nipigon Signature Site, Ontario's Living Legacy. Ontario Ministry of Natural Resources, Nipigon, ON. 85 p.

Sweka, J.A., Neuenhoff, R., Withers, J., and Davis, L. 2018. Application of a depletion-based stock reduction analysis (DB-SRA) to Lake Sturgeon in Lake Erie. J. Great Lakes Res. 44: 311–318.

Thayer, D. 2016. Identifying seasonal Lake Sturgeon (*Acipenser fulvescens*) movement patterns and habitat selection in the South Saskatchewan River Basin. Thesis (M.Sc.) University of Alberta, Edmonton, AB. 112 p.

Thayer, D., Ruppert, J.L.W., Watkinson, D., Clayton, T., and Poesch, M.S. 2017. Identifying temporal bottlenecks for the conservation of large-bodied fishes: Lake Sturgeon (*Acipenser fulvescens*) show highly restricted movement and habitat use over-winter. Glob. Ecol. Conserv. 10: 194–205.

Thiem, J.D., Binder, T.R., Dawson, J.W., Dumont, P., Hatlin, D., Katopodis, C., Zhu, D.Z., and Cooke, S.J. 2011. Behaviour and passage success of upriver-migrating Lake Sturgeon *Acipenser fulvescens* in a vertical slot fishway on the Richelieu River, Québec, Canada. Endanger. Species Res. 15: 1–11.

Thiem, J.D., Hatin, D., Dumont, P., Van Der Kraak, G., and Cook, S.J. 2013. Biology of Lake Sturgeon (*Acipenser fulvescens*) spawning below a dam on the Richelieu River, Québec: behaviour, egg deposition, and endocrinology. Can. J. Zool. 91(3): 175–186.

Thomas, M.V., and Haas, R.C. 2002. Abundance, age structure, and spatial distribution of Lake Sturgeon, *Acipenser fulvescens*, in the St. Claire system. J. Appl. Ichthyol. 18: 495–501.

Threader, R.W., Pope, R.J., and Schaap, P.R.H. 1998. Development of a habitat suitability index for lake sturgeon. Ontario Hydro, Report H-07015.01-0012, Toronto.

Threader, R.W., and Brousseau, C.S. 1986. Biology and management of the Lake Sturgeon in the Moose River, Ontario. N. Am. J. Fish. Manag. 6: 383–390.

Trembath, C.A. 2013. An assessment of juvenile Lake Sturgeon movement and habitat use in the Namakan River of northwestern Ontario. Thesis (M.Sc.) Lakehead University, Thunder Bay, ON. 32 p.

Tremblay, K. 2013. Mississauga #8 First Nation Mississagi River Lake Sturgeon spawning assessment 2011 and 2012. Anishinabek/Ontario Fisheries Resource Centre (A/OFRC), North Bay, ON. 19 p.

van der Lee, A.S. and Koops M.A. 2021. Recovery Potential Modelling of Lake Sturgeon (*Acipenser fulvescens*) in Canada. DFO Can. Sci. Advis. Sec. Res. Doc. 2021/025. iv + 48 p.

Vélez-Espino, L.A., and Koops, M.A. 2009. Recovery potential assessment for Lake Sturgeon in Canadian designatable units. N. Am. J. Fish. Manag. 29(4): 1065–1090.

Vélez-Espino, L.A., Fox, M.G., and McLaughlin, R.L. 2006. Characterization of elasticity patterns of North American freshwater fishes. Can. J. Fish. Aquat. Sci. 63: 2050–2066.

Verdon, R., Guay, J.C., La Haye, M., Simoneau, M., Côté-Bherer, A., Ouellet, N., and Gendron, M. 2012. Assessment of spatio-temporal variation in larval abundance of Lake Sturgeon (*Acipenser fulvescens*) in the Rupert River (Québec, Canada), using drift nets. J. Appl. Ichthyol. 29: 435–436.

Wallace, R.G. 1999. Lake Sturgeon in the lower Saskatchewan River: spawning sites, general habitat, and tagging, 1994–1997. Saskatchewan Environment and Resource Management, Fish and Wildlife Branch Technical Report 99-03, Regina, SK. 91 p.

Wang, L.Y., Binkowski F.P., and S.I. Doroshov, S.I. 1985. Effect of temperature on early development of white and lake sturgeon, *Acipenser transmontanus* and *A. fulvescens*. Environ. Biol. Fish. 14: 43–50.

Watkins, O.B. 2016. Sustaining the recovery of Lake Sturgeon (*Acipenser fulvescens*) in the North Saskatchewan River of Alberta. Thesis (M.Sc.) University of Alberta, Edmonton, AB. 71 p.

Wishingrad, V., Carr, M.K., Pollock, M.S., Ferrari, M.C.O., and Chivers, D.P. 2014. Lake Sturgeon geographic range, distribution, and migration patterns in the Saskatchewan River. Trans. Am. Fish. Soc. 143: 1555–1561.

Welsh, A. and McLeod, D. 2010. Detection of natural barriers to movement of Lake Sturgeon (*Acipenser fulvescens*) within the Namakan River, Ontario. Can. J. Zool. 397: 390–397.

Welsh, A., Hill, T., Quinlan, H., Robinson, C., and May, B. 2008. Genetic assessment of Lake Sturgeon population structure in the Laurentian Great Lakes. N. Am. J. Fish. Manag. 28: 572–591.

Wright, J., and Imhof, J. 2001. Technical background report for the Grand River fisheries management plan. Ontario Ministry of Natural Resources and Grand River Conservation Authority. A report prepared for the Department of Fisheries and Oceans (Canada), Burlington, ON. 190 p.