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Population Status and Threats of Lake Sturgeon in Designatable Unit 8 (Great Lakes / St. Lawrence River Watersheds)

État de la population d'esturgeons jaunes et menaces pesant sur celle-ci dans l'unité désignable 8 (bassin hydrographique des Grands Lacs et du Saint-Laurent)

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TABLE OF CONTENTS / TABLE DES MATIÈRES

ABSTRACT

A recovery potential analysis, addressing the aspects outlined in Fisheries and Ocean Canada's framework, was undertaken for lake sturgeon in the Great Lakes - St. Lawrence River watershed. Lake sturgeon remain widespread throughout the basin, but serious declines in the number and size of populations have occurred. Lake sturgeon require spatially extensive habitat, and their life history traits, including large size, delayed maturation and slow growth, make them susceptible to over-exploitation and in turn are disadvantageous in the face of human-induced mortality and habitat change. Two main anthropogenic activities, the presence of dams and exploitation, were the most important lake sturgeon threats in basin. Dams result in habitat fragmentation, flow manipulation, and limit access to spawning habitat, which can result in habitat loss, the loss of genetic diversity and direct mortality on egg and age-0 life stages. Exploitation, including First Nation harvest, poaching, and commercial harvest, remove the sub-adult and adult life stages that are most crucial for lake sturgeon recovery. While adult habitat is not believed to be limiting, there is much uncertainty around whether spawning habitat is limiting in some of the Sturgeon Management Units.

RÉSUMÉ

Une analyse du potentiel de rétablissement portant sur les aspects décrits dans le cadre de travail du MPO a été entreprise pour l'esturgeon jaune du bassin hydrographique des Grands Lacs et du Saint-Laurent. L'esturgeon jaune demeure présent dans tout le bassin, mais d'importants déclins du nombre de populations et de l'effectif se sont produits. L'esturgeon jaune a besoin d'un habitat étendu sur le plan spatial, mais les caractéristiques de son cycle biologique, notamment sa grande taille, sa maturité tardive et sa croissance lente le rendent vulnérable à la surexploitation et le désavantagent vis-à-vis de la mortalité d'origine anthropique et des changements que subit l'habitat. Les deux principaux facteurs anthropiques, à savoir la présence des barrages et leur exploitation, ont été les plus importantes menaces pesant sur l'esturgeon jaune dans le bassin hydrographique. Les barrages causent la fragmentation de l'habitat, la modification du débit et la limitation de l'accès à l'habitat de frai, ce qui entraîne des pertes d'habitat et de diversité génétique de même qu'une mortalité directe des œufs et des individus d'âge 0. L'exploitation, notamment les prélèvements, le braconnage et l'exploitation commerciale par les Premières nations, élimine les individus aux stades sous-adulte et adulte, qui sont les plus essentiels pour le rétablissement de l'esturgeon jaune. On ne croit pas que l'habitat des adultes soit un facteur limitatif, mais l'incertitude est beaucoup plus grande à savoir si l'habitat de frai est un facteur limitatif dans certaines des unités de gestion de l'esturgeon.

SPECIES INFORMATION

Scientific Name – *Acipenser fulvescens* (Rafinesque 1817)
Common Name – lake sturgeon
Current COSEWIC Status & Year of Designation – Threatened, 2007
Status Criteria – A2a-e
SARA Schedule – N/A
Range in Canada – Alberta, Saskatchewan, Manitoba, Ontario, Quebec

INTRODUCTION

The *Species at Risk Act* (SARA) is intended to protect species at risk of extinction in Canada and to promote their recovery. SARA includes prohibitions on killing, harming, harassing, capturing, or taking individuals of species listed as threatened or endangered on Schedule 1. SARA also specifies that a recovery strategy that addresses all potential sources of harm, including harvesting activities, in a way that does not jeopardize the survival and recovery of the populations concerned be prepared for species that are listed as threatened or endangered. In order to address potential harm in a recovery strategy, scientific evaluation of the likelihood that recovery goals or targets will be achieved in biologically reasonable time frames should be included. The basis for the designation of recovery targets and times-to-recovery for species listed under SARA is informed by sound peer reviewed scientific advice. SARA provides for exemptions to the prohibition to harm under certain circumstances, including specific activities permitted in the recovery strategy. Therefore, it is important that, if activities are to continue after designation, the recovery strategy includes levels of harvest, recovery assessment, recovery rate, level of confidence, etc.

A meeting of the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) in November 2006 recommended that the western populations of the lake sturgeon, *Acipenser fulvescens*, (Western DUs 1 - 5), be designated as Endangered, DUs 6 and 7 (Lake of the Woods - Rainy River and Southern Hudson Bay) as Special Concern, and DU 8, populations in the Great Lakes - Upper St. Lawrence River, as Threatened. Lake sturgeon, one of 27 sturgeon species world-wide, is a potamodromous fish from an ancient ancestral lineage found in many large rivers and lakes of North America. Its Canadian range extends from the St. Lawrence River in the east, to Hudson Bay in the north, and west to the North Saskatchewan River in Alberta (Scott and Crossman 1998).

Initial steps required under the legislation to inform the listing decision include conducting a Recovery Potential Assessment (RPA), a subsequent socio-economic analysis and listing consultations with affected stakeholders. A RPA process was developed by Fisheries and Oceans Canada (DFO) Science to provide the information and scientific advice required to meet the various requirements of the SARA, such as the authorization to carry out activities that would otherwise violate the SARA as well as the development of recovery strategies (DFO 2007). The scientific information also serves as advice to the Minister of Fisheries and Oceans Canada regarding the listing of the species under SARA. Consequently, the information is used when analyzing the socio-

economic impacts of adding the species to the list as well as during subsequent consultations, where applicable.

This document provides background information necessary for the development the RPA for lake sturgeon populations in the Great Lakes - Upper St. Lawrence River. Together with two companion research documents, focusing on lake sturgeon habitat requirements (Randall 2008) and recovery and harm modeling (Vélez-Espino and Koops 2008), these documents provide the information necessary to address the 17 questions outlined in DFO's RPA framework (DFO 2007).

Phase 1: Assess Current Species Status

Population Status and Trajectory

Lake sturgeon were a dominant fish in the Great Lakes watershed nearshore fish community into the nineteenth century. European settlement of the region resulted in a rapid decline as habitat loss, degraded water quality and intensive fishing took their toll. Today, relatively large populations (>1000 spawning individuals/yr) remain only in a few areas; the Lake Winnebago system (Lake Michigan), Lake Nipissing, Lake St. Claire, and in the St. Lawrence River. Numerous smaller populations have persisted in several Great Lakes tributaries, but in most areas and rivers where they were found historically, lake sturgeon are reduced to very low abundance or have been extirpated.

Lake Superior

It is believed that at least 15 Canadian tributaries were home to lake sturgeon populations prior to European settlement (Auer 2003), along with a physically isolated population within the watershed in Lake Nipigon. Remnant lake sturgeon populations exist in six of those tributaries (Kaministiquia, Black Sturgeon, Nipigon, Pic, Batchawana, and Goulais rivers) and Lake Nipigon, while populations are thought to be extirpated from an additional four streams (Table 1; Figure 1). It is uncertain whether lake sturgeon populations remain in the remaining five tributaries. Population estimates exist only for the Kaministiquia and Black Sturgeon rivers, with low numbers of individuals estimated in both populations (Table 1). The conservation status of all populations was considered to be critical or cautious, with only the population trajectory of the Kaministiquia River and Lake Nipigon identified as stable; all other population trajectories were unknown (Table 1). Successful reproduction, including evidence for spawning, hatch and larval drift, was documented in both the Kaministiquia and Goulais rivers.

An additional seven lake sturgeon populations were found on the United States side of Lake Superior, including three extant populations with abundance estimates and evidence for successful natural reproduction (Sturgeon, Bad and White rivers) (Table 1). Lake sturgeon were stocked into the St. Louis River and juveniles from this stocking are regularly captured in fisheries assessments in the area. The remaining three populations are considered extirpated.

Lake Huron

There are 23 Canadian tributaries and three lakes that drain into Lake Huron with historical records of lake sturgeon populations (Table 2, Figure 2). Lake sturgeon populations are known to inhabit 15 of those tributaries (St. Marys, Garden, Thessalon,

Table 1. The population status and size, conservation status, population trajectory and importance to recovery, as determined by experts familiar with each population, of lake sturgeon populations in the Lake Superior basin. The conservation status for each population was determined to be critical, cautious or healthy, and the certainty of that assessment was listed as 1 = best guess, 2 = catch per effort data, or 3 = quantitative population data. The population trajectory was assessed as unknown, stable, increasing or decreasing for each population using Committee on the Status of Endangered Wildlife in Canada criteria, with the certainty of that assessment (1, 2, or 3) as defined above. The importance of each population to the recovery of lake sturgeon in each sturgeon management unit (defined in the Recovery Target section below) was qualitatively determined to be low, medium, or high, with the certainty of that assessment (1, 2, or 3) as defined above. Populations in italics are entirely found in United States waters.

Map	Drainage	Population Status	Population Size	Conservation Status	Certainty	Trajectory	Certainty	Importance	Certainty	Source
1	Pigeon River ON/MN	Extant	Unknown	Critical	2	Unknown		Low	1	Mohr *et al.* 2007
2	Kaministiquia River	Extant	~200	Cautious	3	Stable	1	High	2,3	M. Friday, *pers. comm.*
3	Wolf River	Extirpated								Mohr *et al.* 2007
4	Black Sturgeon River	Extant	<100	Critical	3	Unknown		High	2,3	M. Friday, *pers. comm.*
5	Nipigon River	Extant	Unknown	Critical	1	Unknown		Medium	1	Mohr *et al.* 2007
6	Lake Nipigon	Extant	Unknown	Cautious	1,2	Stable	1,2	Medium	1	R. Salmon, *pers. comm.*
7	Gravel River	Extant / Extirpated	Unknown	Critical	1	Unknown		Low	1	Mohr *et al.* 2007
8	Prairie River	Extirpated								Mohr *et al.* 2007
9	Pic River	Extant	Unknown	Cautious	1,2	Unknown		High	1,2	T. Pratt, *pers. comm.*
10	White River, ON	Extant / Extirpated	Unknown	Critical	1,2	Unknown		Low	1	T. Pratt, *pers. comm.*
11	Michipicoten River	Extant / Extirpated	Unknown	Critical	1,2	Unknown		Low	1	T. Pratt, *pers. comm.*
12	Batchawana River	Extant	<20	Critical	2	Unknown		Low	1	T. Pratt, *pers. comm.*
13	Chippewa River	Extant / Extirpated	Unknown	Critical	2	Unknown		Low	1	T. Pratt, *pers. comm.*

Map	Drainage	Population Status	Population Size	Conservation Status	Certainty	Trajectory	Certainty	Importance	Certainty	Source
14	Harmony River	Extirpated								Mohr *et al.* 2007
15	Stokely Creek	Extirpated								Mohr *et al.* 2007
16	Goulais River	Extant	<50	Cautious	1,2,3	Unknown		High	1	S. Greenwood, *pers. comm.*
17	*Tahquamenon River*	Extirpated								Zollweg *et al.* 2003
18	*Sturgeon River*	Extant	~500	Cautious						Zollweg *et al.* 2003
19	*Ontonagon River*	Extirpated ?								Zollweg *et al.* 2003
20	*Montreal River, WI/MI*	Extirpated ?								Zollweg *et al.* 2003
21	*Bad River*	Extant	~250	Cautious						Zollweg *et al.* 2003
22	*White River, WI*	Extant	~50	Cautious						Zollweg *et al.* 2003
23	*St. Louis River (lower)*	Introduced	Unknown							Zollweg *et al.* 2003
24	*St. Louis River (upper)*	Introduced	Unknown							Zollweg *et al.* 2003

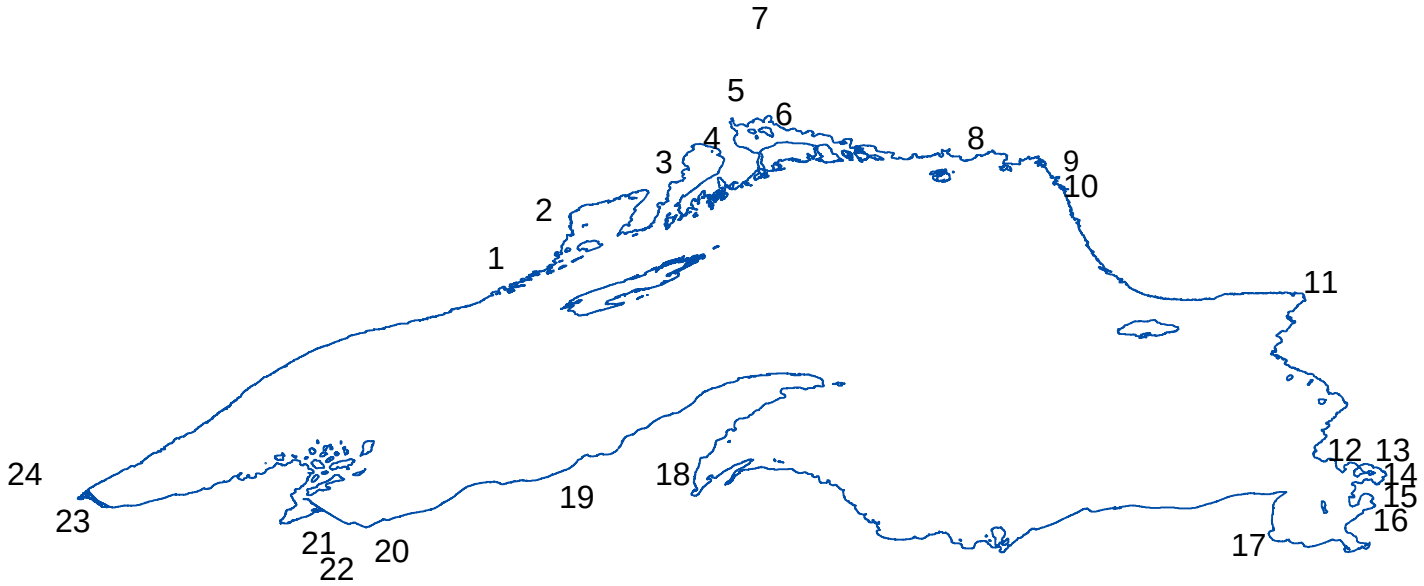

Figure 1. Map displaying the distribution of current and former lake sturgeon populations in the Lake Superior basin. Current population status, size and trajectory and stream name are located in Table 1.

Table 2. The population status and size, conservation status, population trajectory and importance to recovery, as determined by experts familiar with each population, of lake sturgeon populations in the Lake Huron basin. Definitions for the table columns are provided in Table 1. Populations in italics are entirely found in United States waters.

Map	Drainage	Population Status	Population Size	Conservation Status	Certainty	Trajectory	Certainty	Importance	Certainty	Source
1	St. Marys River	Extant	~500	Cautious	1,2	Unknown		High	2	Mohr *et al.* 2007
2	Root River	Extirpated								
3	Garden River	Extant	Unknown	Unknown	1,2	Unknown		Medium	1	Mohr *et al.* 2007
4	Echo River	Extirpated								
5	Thessalon River	Extant	<100	Critical	1,2	Unknown		Medium	1	Mohr *et al.* 2007
6	Mississagi River	Extant	~500	Cautious	2	Stable	2,3	High	2,3	Mohr *et al.* 2007
7	Mississagi R (landlocked)	Extant	Unknown	Unknown		Unknown		Low	1	Mohr *et al.* 2007
8	Blind River	Extirpated								Mohr *et al.* 2007
9	Serpent River	Extirpated		Critical	2			Medium	1	Mohr *et al.* 2007
10	Spanish River	Extant	<100	Cautious	2	Stable	1	High	2	Mohr *et al.* 2007
11	French River	Extant	Unknown	Unknown		Unknown		High	1	Mohr *et al.* 2007
12	Lake Nipissing	Extant	~300	Cautious	3	Increasing	3	High	3	S. Kaufman, *pers. comm.*
13	Key River	Extant	Unknown	Unknown		Unknown		Low	1	Mohr *et al.* 2007
14	Magnetawan River	Extant	Unknown	Unknown		Unknown		Low	1	Mohr *et al.* 2007
15	Naiscoot River	Extant	Unknown	Unknown		Unknown		Low	1	Mohr *et al.* 2007
16	Seguin River	Extirpated								Mohr *et al.* 2007
17	Moon River	Extant	Unknown	Critical	1	Unknown		Low	1	Mohr *et al.* 2007
18	Go Home River	Extant / Extirpated	Unknown	Unknown		Unknown		Low	1	Mohr *et al.* 2007
19	Severn River	Extant	Unknown	Unknown		Unknown		Low	1	Mohr *et al.* 2007
20	Lake Simcoe	Extirpated								J. Borwick, *pers. comm.*
21	Sturgeon River	Extant	Unknown	Unknown		Unknown		Low	1	Mohr *et al.* 2007
22	Nottawasaga River	Extant	<100	Cautious	1,2	Unknown		High	1	Mohr *et al.* 2007

Map	Drainage	Population Status	Population Size	Conservation Status	Certainty	Trajectory	Certainty	Importance	Certainty	Source
23	Manitou River	Extirpated								Mohr *et al.* 2007
24	Sauble River	Extant	Unknown	Unknown		Unknown		Medium	1	Mohr *et al.* 2007
25	Saugeen River	Extirpated								Mohr *et al.* 2007
26	AuSable River	Extirpated								Mohr *et al.* 2007
27	*Saginaw River*	Extant	<50	Critical	1	Unknown		High	1	Zollweg *et al.* 2003
28	*Tittabawassee River*	Extant	<50	Critical	1	Unknown		High	1	Zollweg *et al.* 2003
29	*Kawkawlin River*	Extirpated								Zollweg *et al.* 2003
30	*Rifle River*	Extant	<50	Critical	1	Unknown		Medium	1	Zollweg *et al.* 2003
31	*Au Gres River*	Extirpated								Zollweg *et al.* 2003
32	*Au Sable River, MI*	Extant	~100	Critical	1	Unknown		High	1	Zollweg *et al.* 2003
33	*Thunder Bay River*	Extant	<50	Critical	1	Unknown		Medium	1	Zollweg *et al.* 2003
34	*Ocqueoc River*	Extirpated								Zollweg *et al.* 2003
35	*Black River / Lake*	Extant	550	Cautious	3	Stable	3	High	3	Zollweg *et al.* 2003
36	*Cheboygan River*	Extant	~100	Critical	1	Unknown		High	1	Zollweg *et al.* 2003
37	*Carp River*	Extant	~100	Critical	1	Unknown		High	1	Zollweg *et al.* 2003
38	*Munuscong River*	Extirpated								Zollweg *et al.* 2003

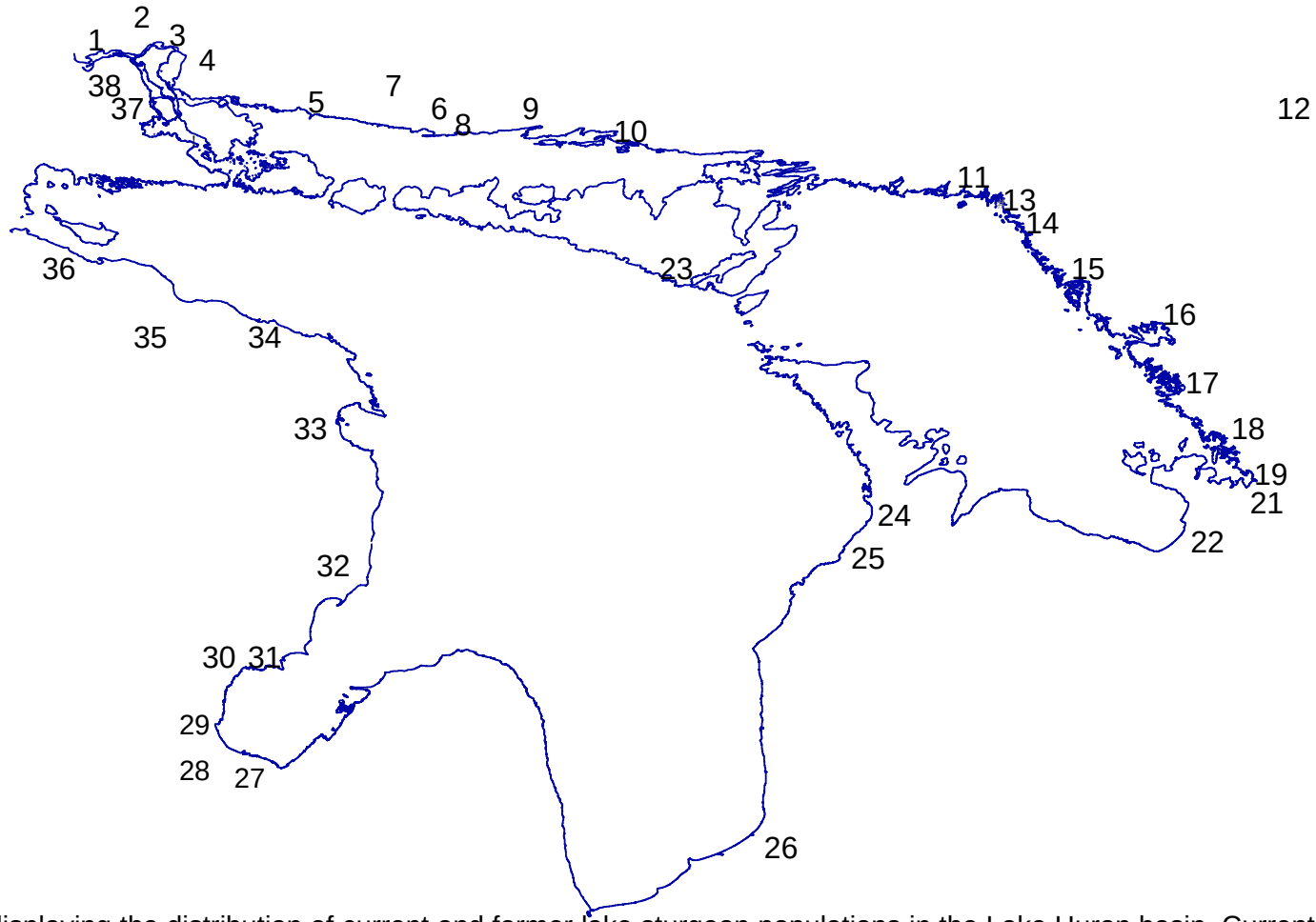

Figure 2. Map displaying the distribution of current and former lake sturgeon populations in the Lake Huron basin. Current population status, size and trajectory and stream name are located in Table 2.

Mississagi, Spanish, French, Key, Magnetawan, Maiscoot, Moon, Go Home, Severn, Sturgeon, Nottawasaga and Sauble rivers) and two lake (Nipissing, Mississagi) systems. Lake sturgeon are believed to be extirpated from the remaining eight tributaries and Lake Simcoe. Population estimates exist for the St. Marys, Mississagi, and Spanish rivers, along with Lake Nipissing (Table 2). In addition, mark-recapture population estimates were made on mixed stocks in the North Channel (4,000-8,000), Georgian Bay (10,000) and the southern main basin (13,000-20,000) (Mohr *et al.* 2007). Tagging research has shown that lake sturgeon from the Mississaugi, Spanish, and St. Marys rivers contribute to the North Channel mixed stock, the St. Clair River contributes to the southern main basin mixed stock and the Nottawasaga River contributes to the southern Georgian Bay mixed stock (Mohr *et al.* 2007). Successful reproduction has been observed in six populations (Mohr *et al.* 2007). The conservation status of all extant populations in the Lake Huron basin is either cautious or unknown (Table 2). The population trajectory of the Lake Nipissing population is increasing, while the Mississagi and Spanish river populations are stable, and the remaining populations have no trajectory data available.

Lake sturgeon populations were found on an additional 12 United States tributaries to Lake Huron. Lake sturgeon populations remain in seven of these tributaries, while the remaining five populations are believed to be extirpated.

Lake Erie

There are no known historic Canadian lake sturgeon tributaries in Lake Erie, but sturgeon are found in the connecting waterways shared with the United States (St. Clair River, Lake St. Clair, Detroit River; Figure 3). These lake sturgeon populations are quite significant, with 20,000-40,000 individuals estimated in both the St. Clair River and Lake St. Clair (Table 3). The Lake St. Clair population currently supports a small commercial fishery (Mohr *et al.* 2007). Juvenile and adult lake sturgeon are observed in the eastern basin of Lake Erie and the Upper Niagara River, but it is possible that these fish are part of the St. Clair and Detroit rivers spawning populations. The conservation status of both the Lake St. Clair and St. Clair River populations is healthy, and their population trajectories are stable (Table 3). Parameters for the Detroit River population are not known (Table 3).

Five additional historic lake sturgeon populations are recognized from United States waters of Lake Erie, but all the populations are considered extirpated.

Lake Ontario

There were three Canadian tributaries, a shoal and a river shared with the United States (Lower Niagara River) that are believed to have historically supported Canadian lake sturgeon populations in the Lake Ontario basin (Table 4, Figure 4). Extant lake sturgeon populations are found only in the Trent and Lower Niagara rivers. The conservation status on both populations is thought to be critical, with both having unknown population sizes and trajectories (Table 4).

Four additional lake sturgeon populations were found in United States waters of Lake Ontario, with only an extant population remaining in the Black River and an introduced population inhabiting Oneida Lake (Table 4).

Table 3. The population status and size, conservation status, population trajectory and importance to recovery, as determined by experts familiar with each population, of lake sturgeon populations in the Lake Erie / Lake St. Clair basin. Definitions for the table columns are provided in Table 1. Populations in italics are entirely found in United States waters.

Map	Drainage	Population Status	Population Size	Conservation Status	Certainty	Trajectory	Certainty	Importance	Certainty	Source
1	Detroit River	Extant	~500	Cautious	1,2	Increasing	1,2	High	1	Mohr *et al.* 2007
2	Lake St. Clair	Extant	30,000	Healthy	3	Stable	2,3	High	3	Mohr *et al.* 2007
3	St. Clair River	Extant	30,000	Healthy	3	Stable	2,3	High	3	Mohr *et al.* 2007
4	*Upper Niagara River*	Extant	Unknown	Critical	1	Unknown		Low	1	Zollweg *et al.* 2003
5	*Eastern basin (NYS)*	Extant	Unknown	Critical	1	Unknown		Low	1	Zollweg *et al.* 2003
6	*Cattaraugus Creek*	Extirpated								Zollweg *et al.* 2003
7	*Sandusky River*	Extirpated								Zollweg *et al.* 2003
8	*Maumee River*	Extirpated								Zollweg *et al.* 2003
9	*Raisin River*	Extirpated								Zollweg *et al.* 2003
10	*Huron River*	Extirpated								Zollweg *et al.* 2003

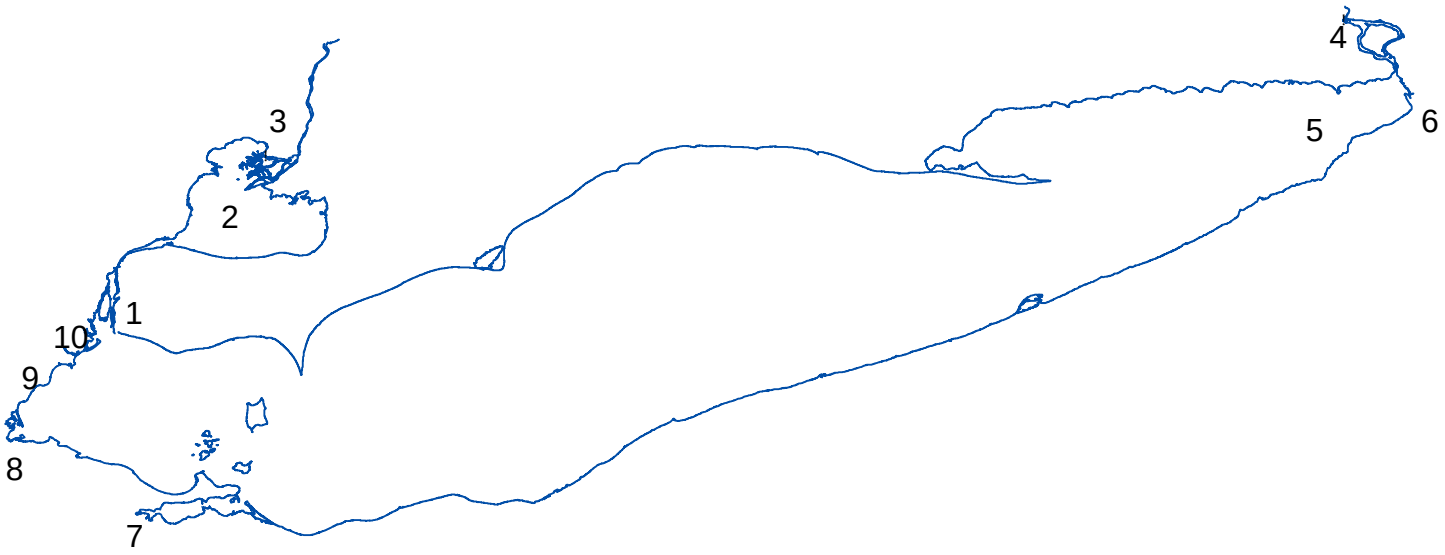

Figure 3. Map displaying the distribution of current and former lake sturgeon populations in the Lake Erie basin. Current population status, size and trajectory and stream name are located in Table 3.

Table 4. The population status and size, conservation status, population trajectory and importance to recovery, as determined by experts familiar with each population, of lake sturgeon populations in the Lake Ontario basin. Definitions for the table columns are provided in Table 1. Populations in italics are entirely found in United States waters.

Map	Drainage	Population Status	Population Size	Conservation Status	Certainty	Trajectory	Certainty	Importance	Certainty	Source
1	Trent River (ON)	Extant	Unknown	Critical	1	Unknown		High	1	Mohr *et al.* 2007
2	Salmon River (ON)	Extirpated								Mohr *et al.* 2007
3	Napanee River (ON)	Extirpated								Mohr *et al.* 2007
4	Amherst Island Shoal (ON)	Extirpated								Mohr *et al.* 2007
5	Lower Niagara River (ON & NY)	Extant	Unknown	Critical	1	Unknown		High	1	Mohr *et al.* 2007
6	*Genesee River (NY)*	Extirpated								Zollweg *et al.* 2003
7	*Oneida/Cayuga lakes (NY)*	Introduced	Unknown							Zollweg *et al.* 2003
8	*Oswego River mouth (NY)*	Extirpated								Zollweg *et al.* 2003
9	*Black River (NY)*	Extant	Unknown	Critical	1	Unknown		High	1	Zollweg *et al.* 2003

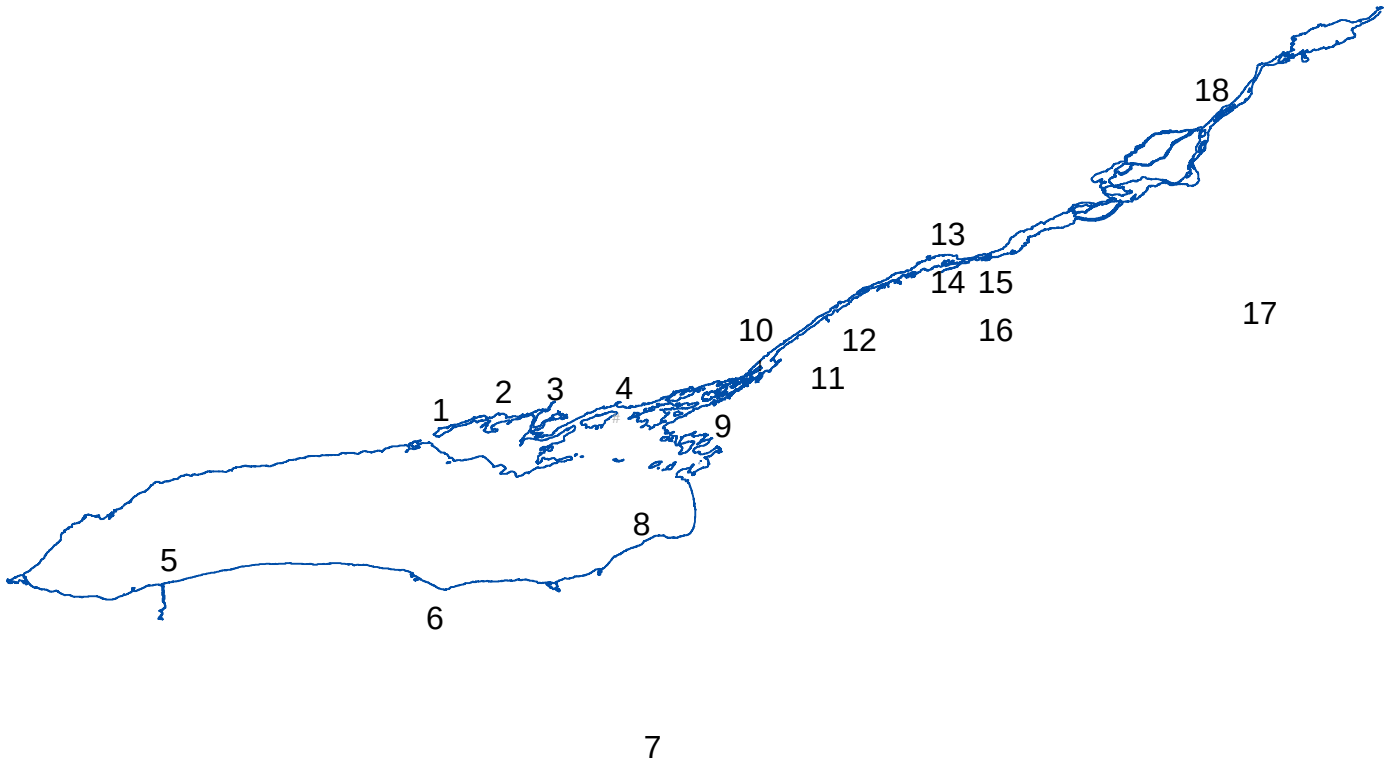

Figure 4. Map displaying the distribution of current and former lake sturgeon populations in Lake Ontario and the St. Lawrence River basin. Current population status and stream names are located in Tables 4 and 5.

St. Lawrence River

Lake sturgeon populations in the St. Lawrence River are fragmented due to impassable hydroelectric facilities. There are only small, remnant populations in the upper part of the river above the Moses-Saunders generating station, the top dam in the system, and in Lake St. Francis between the Moses-Saunders and Beauharnois generating stations (Figure 4, Table 5). There is a large extant population below the Beauharnois generating station, residing in the Des Prairie and St. Maurice rivers, and in Lac St. Pierre. The conservation status for both the upper St. Lawrence and Lake St. Francis populations is critical, while the lower St. Lawrence River population is cautious. The population trajectory is not known for the upper St. Lawrence population and decreasing for the Lake St. Francis and lower St. Lawrence River populations.

Historic lake sturgeon populations that spawned on the United States side of the St. Lawrence River are either extirpated, remnant or have undergone rehabilitation stocking programs (Table 5).

Ottawa River

The Ottawa River has been highly fragmented by dams since European colonization, and what was likely a single or few lake sturgeon populations that could freely migrate long distances are now disparate populations separated by impassable barriers. Ten isolated, remnant stocks are all that remain in these disconnected populations (Figure 5, Table 6). The conservation status of the mid-Ottawa River fragment is considered healthy, while the remaining segments are cautious (seven segments) or critical (two segments) (Table 6). The population trajectory is increasing in two segments, stable in two segments, decreasing in five segments and unknown in the remaining segment (Table 6).

Life History Characteristics

Lake sturgeon life history traits, including large size, delayed maturation, low natural adult mortality and high fecundity, are successful when facing extremes in environmental conditions and consequently have contributed to the long-term success of the species (Hay-Chmielewski and Whelan 1997). Unfortunately, these traits are disadvantageous when facing human-induced mortality and habitat changes, as large, slow growing and late maturing lake sturgeon become economically valuable and susceptible to over-exploitation. Specific life history parameters for Canadian populations appear reasonably stable, though there is a range in some parameters. A thorough review of life history parameters was undertaken by Vélez-Espino and Koops (2008).

Recovery Target

While the selection of recovery targets is ultimately the responsibility of the Recovery Team when drafting a recovery strategy, it is necessary for this exercise to provide some preliminary recovery targets to allow an assessment of potential recovery scenarios. The mitigation component of any recovery potential assessment requires the identification of recovery targets, timeframes for recovery, and the specification of the uncertainty of outcomes associated with management actions. Separate recovery goals for abundance, distribution and range are needed as part of a recovery potential assessment. As this recovery potential assessment focuses on only DU8, no range recovery goals were considered.

Table 5. The population status and size, conservation status, population trajectory and importance to recovery, as determined by experts familiar with each population, of lake sturgeon populations in the St. Lawrence River. Definitions for the table columns are provided in Table 1. Populations in italics are entirely found in United States waters.

Map	Drainage	Population Status	Population Size	Conservation Status	Certainty	Trajectory	Certainty	Importance	Certainty	Source
10	St. Lawrence River, above Moses-Saunders dam	Extant	Unknown	Critical	1	Unknown	1	Medium	1	Mohr *et al.* 2007
13	Lake St. Francis	Extant	Unknown	Critical	1,2	Decreasing	1,2	Medium	1,2	Mohr *et al.* 2007
18	From Lake St. Louis to upper estuary	Extant	>100,000	Cautious	1,2	Decreasing	2,3	High	2,3	Mohr *et al.* 2007, P. Dumont, *pers. comm.*
11	*Black Lake*	Introduced								Zollweg *et al.* 2003
12	*Oswegatchie River*	Introduced								Zollweg *et al.* 2003
14	*Grasse River*	Extant	<50							Zollweg *et al.* 2003
15	*Raquette River*	Extant	Unknown							Zollweg *et al.* 2003
16	*St.Regis River*	Introduced								Zollweg *et al.* 2003
17	*Lake Champlain, VT*	Extant	Unknown							Zollweg *et al.* 2003

Table 6. The population status and size, conservation status, population trajectory and importance to recovery, as determined by experts familiar with each population, of lake sturgeon populations in the Ottawa River watershed. Definitions for the table columns are provided in Table 1.

Map	Drainage	Population Status	Population Size	Conservation Status	Certainty	Trajectory	Certainty	Importance	Certainty	Source
1	R. Outaouais between dams in Gatineau-Ottawa and Carillon	Extant	Unknown	Cautious	1,2	Increasing	1,2	High	1	H. Fournier, *pers. comm.*, Haxton 2002, 2007
2	Lac Deschênes, between dams in Quyon - Fitzroy and Gatineau	Extant	>500	Cautious	1,2	Decreasing	1,2	Medium	1	H. Fournier, *pers. comm.*, Haxton 2002, 2007
3	Lac des Chats	Extant	Unknown	Cautious	1,2	Decreasing	1,2	Medium	1	Haxton 2002, 2006, 2007
4	Lac des Rocher Fendu	Extant	Unknown	Cautious	1,2	Unknown	1,2	Medium	1	Haxton 2002, 2007
5	Mid Ottawa River (Lac Colounge, Lower and Upper Allumette Lake)	Extant	>5000	Healthy	1,2	Increasing	1,2	High	1	Haxton 2002, 2007
6	Holden Lake/Lac la Cave	Extant	Unknown	Critical	1,2	Decreasing	1,2	Low	1	Haxton 2002, 2007
7	Lake Timiscaming	Extant	Unknown	Cautious	1,2	Decreasing	1	High	1	D. Nadeau, pers. comm
8	Mid upper Ottawa River (lakes des Quinze, Simard, Preissac, Malartic, De Celles)	Extant	Unknown	Critical	1,2	Stable	1	Medium	1	D. Nadeau, *pers. comm.*
9	Upper Ottawa River (Réserve de La Vérendrye, etc.)	Extant	Unknown	Cautious	1,2	Decreasing	1	Medium	1	D. Nadeau, *pers. comm.*
10	Gatineau River (plus tribs)	Extant	Unknown	Cautious	1	Stable	1	Medium	1	H. Fournier, *pers. comm.*

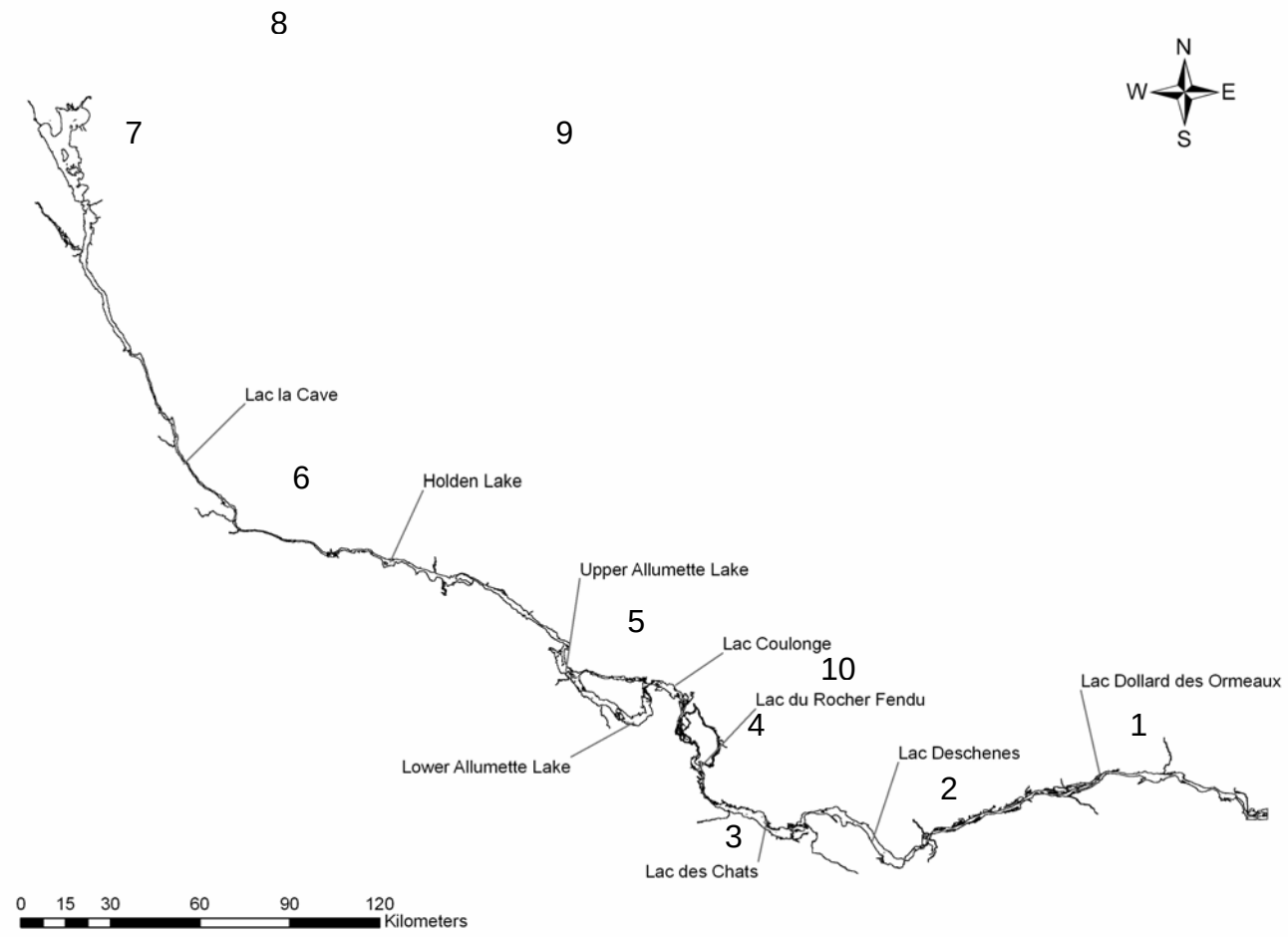

Figure 5. Map displaying the distribution of lake sturgeon populations in the Ottawa River watershed. Current population status and population segment names are located in Table 6.

Recovery Target for Abundance

Vélez-Espino and Koops (2008) modeled an average recovery target for each lake sturgeon management unit of 1188 spawning females per year, with 95% confidence limits of 1160-1216. Details on this analysis are available in Vélez-Espino and Koops (2008).

Recovery Target for Distribution

Lake sturgeon populations in the Great Lakes basin are widely distributed, separated by natural and man-made barriers, and in many instances genetically distinct (Welsh 2006). The recovery target of 1188 spawning females per year is an ambitious target for a single spawning population, but we used observed lake sturgeon genetic structuring and known barriers to migration to guide the development of twelve lake sturgeon management units (SMUs) which, in most cases, consist of a more than one known extant populations (Figure 6).

Since each SMU is either genetically distinct or geographically isolated, all twelve SMUs were identified as being important to recover to the levels identified above for abundance. Within each SMU, it is important to maintain all remaining small populations, even at remnant levels, and even if the majority of lake sturgeon contributing to the recovery of the overall SMU comes from a single spawning population.

Phase 2: Scope for Management to Facilitate Recovery

Identification and Assessment of Mortality Risks

Background

Major threats to the lake sturgeon recovery in Canada include overexploitation, dams, flow management practices, habitat degradation, contaminants, and introduced species (COSEWIC 2007). Life history traits that were adaptive over the last 100 million years became disadvantageous during the last century in the face of severe overexploitation and habitat degradation (Beamesderfer and Farr 1997). Most lake sturgeon populations that were commercially exploited have decreased in abundance, and few if any have recovered to pre-exploitation levels (COSEWIC 2007). Only small, highly regulated commercial fisheries on the St. Lawrence River and in Lakes Huron and St. Clair remain sustainable (Dumont *et al.* 1987; COSEWIC 2007). An unreported but potentially significant number of lake sturgeon are captured by First Nations members from some populations. High world-wide demand for sturgeon flesh and caviar has increased poaching worldwide (Vescei 2005). The reality of small, remnant stocks means that overexploitation is likely an even bigger threat today than it was historically for most populations.

Lake sturgeon spawn primarily in large river systems, so the effects of dams can be significant. Dams can interfere with spawning and feeding migrations, reducing population numbers and their genetic resiliency (Ferguson and Duckworth 1997). Dam construction can extirpate local lake sturgeon populations (Dumont *et al.* 1987) by preventing fish from accessing spawning areas and stranding fish between impassable

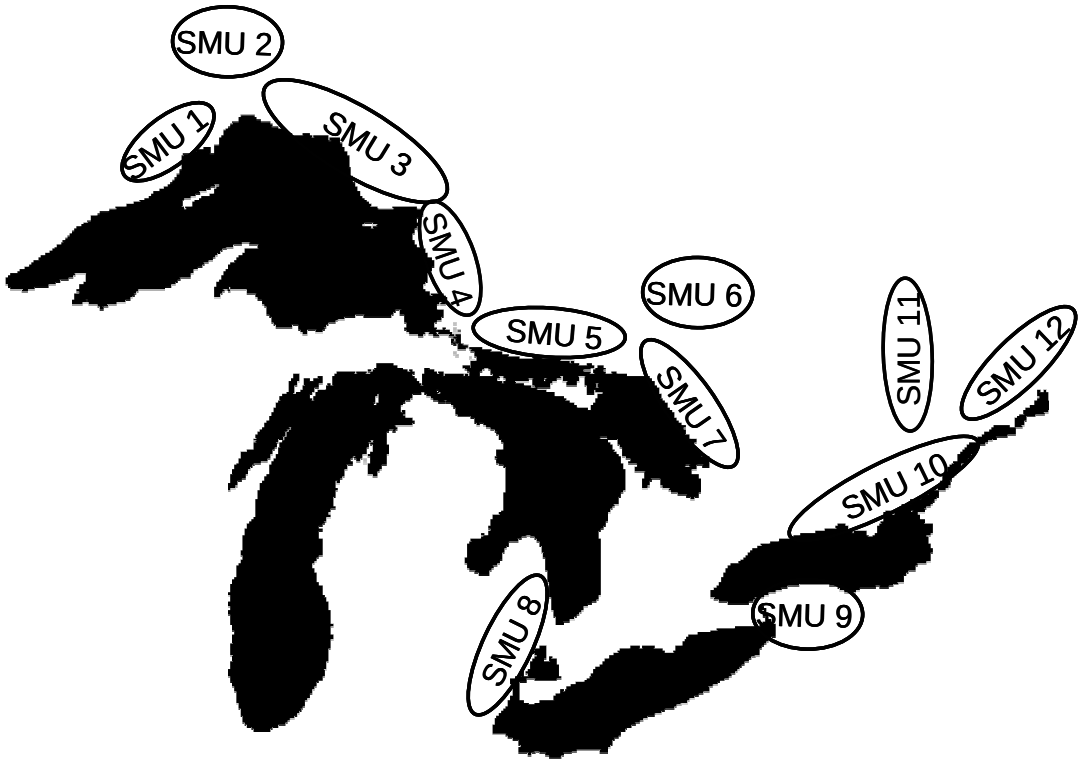

Figure 6. The composition and distribution of Sturgeon Management Units (SMUs) within the Great Lakes basin. The SMUs are made up of the following extant populations: SMU 1 = western Lake Superior (Pigeon and Kaministiquia rivers), SMU 2 = Lake Nipigon, SMU 3 = northern Lake Superior (Black Sturgeon, Nipigon, Gravel, Pic, White and Michipicoten rivers), SMU 4 = eastern Lake Superior (Batchawana, Chippewa and Goulais rivers), SMU 5 = Lake Huron north channel (St. Marys, Garden, Thessalon, Mississagi and Spanish rivers), SMU 6 = Lake Nipissing, SMU 7 = Georgian Bay Lake Huron (French, Key, Magnetawan, Naiscoot, Moon, Go Home, Severn, Sturgeon and Nottawasaga rivers), SMU 8 = Lake Huron / Erie Corridor (Main basin Lake Huron, St. Clair River, Lake St. Clair, Detroit River and Lake Erie), SMU 9 = Lower Niagara River, SMU 10 = eastern Lake Ontario / upper St. Lawrence River (Trent and upper St. Lawrence rivers and Lake St. Francis), SMU 11 = Ottawa River watershed population, SMU 12 = lower St. Lawrence River.

barriers. Direct mortality from turbine entrainment can also occur at hydroelectric facilities (McKinley *et al.* 1998).

Flow management practices at dams whose purpose is hydroelectric generation are also an important threat to lake sturgeon populations. These dams cause periodic and seasonal water level fluctuations, resulting in decreased production (Khoroshko 1972; Payne 1987). Low or variable water conditions after spawning can affect survival of the earliest life stages via changes in water temperatures, oxygen concentrations, and stranding (Ferguson and Duckworth 1997). Successful recruitment in sturgeons generally is correlated with spring and summer discharge (Stevens and Miller 1970; Khoroshko 1972). Flowing water provides oxygen, disperses eggs, and excludes egg predators, processes that can be disrupted by unnatural flow regimes. Returning to more natural flows can greatly benefit lake sturgeon spawning success (Auer 1996).

Lake sturgeon habitat is also threatened by dams and other anthropogenic activities. Dams can restrict access to spawning sites, and flow management regimes can dampen the hydrologic cycle resulting in the degradation of downstream spawning and feeding habitats (Beamesderfer and Farr 1997; COSEWIC 2007; Peterson *et al.* 2007). Wood fibre from pulp and paper operations also degrade lake sturgeon spawning and rearing habitat (Mosindy 1987). Habitat quality in many rivers is reduced due to increases in suspended sediment and sewage effluent from agricultural practices and urbanization (COSEWIC 2007).

Contaminants are another possible threat to lake sturgeon recovery. Their benthic trophic position and long lifespan increase the vulnerability of lake sturgeon to the bioaccumulation of toxins (Ruelle and Keenlyne 1993). Lake sturgeon contaminant loads, including mercury and PCB's, have historically been high (Baldwin *et al.* 1978). Pollution, in particular organic contaminants, has affected the development of lake sturgeon larvae in Quebec waters (Doyon *et al.* 1999), and effluent from pulp and paper mills are suspected as important factor in the decline of some populations (COSEWIC 2007).

Aquatic invasive species can pose a variety of threats to lake sturgeon. Juvenile lake sturgeon are susceptible to sea lamprey predation in the Great Lakes basin (Sutton *et al.* 2007), and the lampricides used to control larval sea lampreys are lethal to small (< 100 mm) lake sturgeon (Boogaard *et al.* 2003). In addition, non-native egg predators such as rainbow smelt and round gobies could prey on lake sturgeon eggs (COSEWIC 2007).

The rehabilitation stocking of lake sturgeon has occurred in United States jurisdictions within the Great Lake basin, and genetic strains from outside of local areas have been used as brood stock for the stocking programs. The emerging genetic evidence that lake sturgeon populations are fairly reproductively isolated means that genetic contamination could be an issue if brood stocks are poorly screened.

Key Threats for Individual Populations

A number of threats were identified by biologists and managers familiar with individual lake sturgeon populations. The major threats identified above, particularly exploitation (including commercial harvest, First Nation harvest, and poaching) and the

varied effects of dams (including habitat fragmentation, habitat loss and flow management) were identified as the most important threats for the majority of populations (Table 7). Where possible, threats were ranked for each population based on expert opinion. As a second step, individual threats identified at the population level were examined to determine which life stage was affected by the threat (Table 8). This was important as it provided the potential for alternate recovery scenarios to be assessed in the life-stage based modeling exercise. While many threats were felt across all life stages, there were threats that differentially affected specific life stages (e.g. exploitation, lampricide treatments, flow management, sea lamprey predation; Table 8).

It was not possible to quantify the magnitude of any of the major potential sources of lake sturgeon mortality. Instead, identified threats were ranked to provide at least a relative measure of their importance by determining the most important threats from the individual population data (Table 9). The threat data was summarized by identifying anthropogenic activities that resulted in the specific threats that were assessed, and identifying which lake sturgeon life stages those activities and outcomes were likely to differentially affect. Two main anthropogenic activities, the presence of dams and exploitation, were the most important threats across all the sturgeon management units (Table 9). Dams result in habitat fragmentation, flow manipulation, and limit access to spawning habitat, which can result in habitat loss, the loss of genetic diversity and direct mortality on egg and age-0 life stages. Exploitation, including First Nation harvest, poaching, and commercial harvest, remove the sub-adult and adult life stages that are most crucial for lake sturgeon recovery (Vélez-Espino and Koops 2008). Activities including agricultural activities, urbanization and invasive species were considered to result in outcomes that provided moderate threats, though these threats were considered to be the most important for a few individual populations. All remaining activities were considered to be a low threat on the whole, but again these activities have the potential to negatively affect particular populations.

Assessment of Habitat Threats

While it is not possible to completely assess the magnitude by which current habitat threats are limiting lake sturgeon recovery, it is possible to assess the ranked threats for each population and summarize by sturgeon management unit to determine if the main threats for each unit are related to habitat quantity or quality. Ranked threats from Table 8 were averaged across populations, with threats to habitat quantity or quality ranked as high (threat average = < 2), moderate (threat average - 2-3) or low (threat average > 3). The highest ranked threat was used when more than one threat was listed as affecting either habitat quantity or quality. Threats to habitat quantity included in this analysis were limited riverine habitat, habitat loss due to dams, habitat fragmentation due to dams, limited spawning habitat, and limited staging habitat, while threats to habitat quality included in the analysis were changes in flow regimes, water quality, urbanization, agricultural activities, industrial activities, and low discharge.

Threats to habitat quantity were identified as being high or moderate in all sturgeon management units with the exception of Georgian Bay / Lake Huron (Table 10). Habitat loss and fragmentation due to dams was prevalent throughout the sturgeon management units. Habitat quantity was generally considered to be a higher threat than habitat quality, which was only considered to be a high threat for Lake Nipissing and

Table 7. Population-specific threats identified for Designatable Unit 8 lake sturgeon populations. Where possible, threats were ranked from the most to least important by biologists most familiar with that population.

Sturgeon Management Unit	Population	Threats	Source
SMU 1	Pigeon River ON/MN	1. Limited riverine habitat	Mohr *et al.* 2007
SMU 1	Kaministiquia River	1. Changes in flow regimes; 2. Habitat fragmentation due to dams; 3. Illegal exploitation; 4. Lampricide treatments; Urbanization; Agricultural activities; Industrial activities; Habitat loss due to dams; Genetic contamination due to stocking	M. Friday, *pers. comm.*
SMU 3	Wolf River	1. Limited staging habitat	Mohr *et al.* 2007
SMU 3	Black Sturgeon River	1. Habitat fragmentation due to dams; 2. Illegal exploitation; 3. Habitat loss due to dams; 4. Lampricide treatments	M. Friday, *pers. comm.*
SMU 2	Lake Nipigon	1. Habitat loss due to dams; 2. Changes in flow regimes; 3. Habitat fragmentation due to dams; 4. First Nation exploitation; Effects of forestry/log drives on habitat	R. Salmon, *pers. comm.*
SMU 3	Nipigon River	1. Changes in flow regimes; 2. Lampricide treatments; 3. Illegal exploitation; Genetic contamination due to stocking	M. Friday, *pers. comm.*
SMU 3	Gravel River	No information	Mohr *et al.* 2007
SMU 3	Prairie River	No information	Mohr *et al.* 2007
SMU 3	Pic River	First Nation exploitation; Lampricide treatments	Mohr *et al.* 2007
SMU 3	White River, ON	No information	Mohr *et al.* 2007
SMU 3	Michipicoten River	1. Changes in flow regimes; 2. Habitat loss due to dams; Illegal exploitation; Lampricide treatments	Mohr *et al.* 2007
SMU 4	Batchawana River	1. Limited staging habitat; 2. First Nation exploitation	T. Pratt, *pers. comm.*
SMU 4	Chippewa River	No information	Mohr *et al.* 2007
SMU 4	Harmony River	No information	Mohr *et al.* 2007
SMU 4	Stokely Creek	No information	Mohr *et al.* 2007
SMU 4	Goulais River	1. First Nation exploitation; 2. Changes in flow regimes due to climate change	S. Greenwood, *pers. comm.*
SMU 5	St. Marys River	1. Habitat loss due to dams; 2. Changes in flow regimes; 3. First Nation exploitation; 4. Water quality; Habitat fragmentation due to dams	Mohr *et al.* 2007

Sturgeon Management Unit	Population	Threats	Source
SMU 5	Root River	No information	Mohr *et al.* 2007
SMU 5	Garden River	First Nation exploitation	Mohr *et al.* 2007
SMU 5	Echo River	Habitat loss due to dams;	Mohr *et al.* 2007
SMU 5	Thessalon River	Habitat loss due to dams; Exploitation	Mohr *et al.* 2007
SMU 5	Mississagi River	1. Changes in flow regimes; 2. Exploitation; 3. Sea lamprey predation	Mohr *et al.* 2007
SMU 5	Mississagi River (landlocked)	No information	Mohr *et al.* 2007
SMU 5	Blind River	1. Habitat loss due to dams; 2. Limited staging habitat; Habitat fragmentation due to dams; Water quality	Mohr *et al.* 2007
SMU 5	Serpent River	1. Water quality; 2. Limited spawning habitat	Mohr *et al.* 2007
SMU 5	Spanish River (landlocked)	1. Changes in flow regimes; 2. Limited spawning habitat; 3. Exploitation	B. McGregor *pers. comm.*
SMU 5	Spanish River	1. Changes in flow regimes 2. Water quality; 3. Exploitation; 4. Limited spawning habitat	Mohr *et al.* 2007
SMU 7	French River	1. Changes in flow regimes; 2. Exploitation	Mohr *et al.* 2007
SMU 6	Lake Nipissing	1. Changes in flow regimes; 2. Limited spawning habitat; 3. Agricultural activities; Urbanization	S. Kaufman, *pers. comm.*
SMU 7	Key River	No information	Mohr *et al.* 2007
SMU 7	Magnetawan River	Exploitation; Habitat loss due to dams; Habitat fragmentation due to dams; Changes in flow regimes; Limited spawning habitat	Mohr *et al.* 2007
SMU 7	Naiscoot River	No information	Mohr *et al.* 2007
SMU 7	Seguin River	Habitat loss due to dams; Habitat fragmentation due to dams	Mohr *et al.* 2007
SMU 7	Moon River	1. Changes in flow regimes; 2. Limited spawning habitat; 3. Habitat loss due to dams; Habitat fragmentation due to dams; Low discharge	Mohr *et al.* 2007
SMU 7	Go Home River	No information	Mohr *et al.* 2007
SMU 7	Severn River	1. Habitat loss due to dams; 2. Limited spawning habitat; Habitat fragmentation due to dams; Changes in flow regimes	Mohr *et al.* 2007
SMU 7	Lake Simcoe	Exploitation; Urbanization; Agricultural activities; Industrial activities	J. Borwick, *pers. comm.*
SMU 7	Sturgeon River	1. Water quality; 2. Low discharge; 3. Agricultural activities; Habitat loss due to dams; Habitat fragmentation due to dams	Mohr *et al.* 2007

Sturgeon Management Unit	Population	Threats	Source
SMU 7	Nottawasaga River	1. Water quality; 2. Urbanization; 3. Agricultural activities; Habitat loss due to dams; Habitat fragmentation due to dams; Low discharge	Mohr *et al.* 2007
SMU 8	Manitou River	1. Habitat loss due to dams; 2. Low discharge; Habitat fragmentation due to dams; Limited staging habitat	Mohr *et al.* 2007
SMU 8	Sauble River	1. Limited spawning habitat; 2. Changes in flow regimes; Habitat loss due to dams; Habitat fragmentation due to dams	Mohr *et al.* 2007
SMU 8	Saugeen River	1. Habitat loss due to dams; 2. Changes in flow regimes; Habitat fragmentation due to dams; Limited staging habitat	Mohr *et al.* 2007
SMU 8	AuSable River, ON	1. Water quality; 2. Low discharge; 3. Agricultural activities; Habitat loss due to dams; Habitat fragmentation due to dams; Limited staging habitat	Mohr *et al.* 2007
SMU 8	Detroit River	1. Water quality; 2. Limited spawning habitat; 3. Urbanization; 4. Exploitation	Mohr *et al.* 2007
SMU 8	Lake St. Clair	1. Limited spawning habitat; 2. Exploitation 3. Water quality	Mohr *et al.* 2007
SMU 8	St. Clair River	1. Limited spawning habitat; 2. Exploitation; 3. Water quality; 4. Urbanization	Mohr *et al.* 2007
SMU 10	Trent River	Illegal and First Nation exploitation; Habitat fragmentation due to dams; Changes in flow regimes; Introduction of exotics (food web disruption); Introduction of other diseases	A. Mathers, *pers. comm.*
SMU 10	Salmon River	First Nation exploitation Habitat fragmentation due to dams; Introduction of exotics (food web disruption); Introduction of other diseases	A. Mathers, *pers. comm.*
SMU 10	Napanee River	First Nation exploitation; Introduction of exotics (food web disruption); Introduction of other diseases	A. Mathers, *pers. comm.*
SMU 10	Amherst Island Shoal	No information	Mohr *et al.* 2007
SMU 9	Lower Niagara River	Changes in flow regime; Introduction of exotics (food web disruption); Introduction of other diseases	A. Mathers, *pers. comm.*
SMU 10	St. Lawrence River above Moses-Saunders	Habitat loss due to dams; Limited spawning habitat; Introduction of exotics (food web disruption); Introduction of other diseases	A. Mathers, *pers. comm.*

Sturgeon Management Unit	Population	Threats	Source
SMU 10	Lake St. Francis	1. Habitat loss due to dams; 2. Habitat fragmentation due to dams; 3. Illegal and First Nation exploitation; 3. Introduction of other diseases (VHS); Urbanization; Agricultural activities; Industrial activities; Introduction of exotics; Genetic contamination due to stocking	P. Dumont and Y. Mailhot *pers. comm.*
SMU 12	From Lake St. Louis to upper estuary	1. Exploitation (commercial, First Nation, illegal); 2. Habitat fragmentation due to dams; 3. Changes in flow regimes; 4. Water quality; 5. Introduction of other diseases (VHS); Urbanization; Agricultural activities; Industrial activities; Introduction of exotics	P. Dumont and Y. Mailhot *pers. comm.*
SMU 11	Lac Des Deux Montagnes	1. Water quality; 2. Habitat loss due to dams; Habitat fragmentation due to dams	T. Haxton and H. Fournier, *pers. comm.*
SMU 11	R. Outaouais between dams in Gatineau-Ottawa and Carillon	1. Habitat loss due to dams; 2. Habitat fragmentation due to dams; 3. Water quality; Urbanization; Agricultural activities; Industrial activities; Changes in flow regimes; Introduction of exotics; Introduction of other diseases (VHS)	T. Haxton and H. Fournier, *pers. comm.*
SMU 11	Lac Deschênes, between dams in Quyon - Fitzroy and Gatineau	1. Habitat loss due to dams; 2. Habitat fragmentation due to dams; 3. Changes in flow regimes; 4. Urbanization; 5. Exploitation; Agricultural activities; Industrial activities; Introduction of exotics	T. Haxton and H. Fournier, *pers. comm.*
SMU 11	Lac des Chats	1. Habitat loss due to dams; 2. Habitat fragmentation due to dams; 3. Changes in flow regimes; 4. Exploitation	T. Haxton and H. Fournier, *pers. comm.*
SMU 11	Lac des Rocher Fendu	No information	T. Haxton and H. Fournier, *pers. comm.*
SMU 11	Mid Ottawa River (Lac Colounge, Lower Allumette Lake, Upper Allumette Lake)	1. Exploitation	T. Haxton and H. Fournier, *pers. comm.*
SMU 11	Holden Lake/Lac la Cave	1. Habitat loss due to dams; 2. Habitat fragmentation due to dams; 3. Changes in flow regimes	T. Haxton and H. Fournier, *pers. comm.*
SMU 11	Lake Timiscaming	1. Habitat loss due to dams; 2. Habitat fragmentation due to dams; 3. Exploitation; 4. Agricultural activities; Changes in flow regimes; Introduction of exotics	D. Nadeau, *pers. comm.*

Sturgeon Management Unit	Population	Threats	Source
SMU 11	Mid upper Ottawa River (lakes des Quinze, Simard, Preissac Malartic, De Celles etc.)	1. Habitat loss due to dams; 2. Habitat fragmentation due to dams; 3. Agricultural activities; Exploitation; Changes in flow regimes	D. Nadeau, *pers. comm.*
SMU 11	Upper Ottawa River (Réserve de La Vérendrye, etc.)	1. Habitat loss due to dams; 2. Habitat fragmentation due to dams; 3. Illegal exploitation; Changes in flow regimes	D. Nadeau, *pers. comm.*
SMU 11	Gatineau River (plus tribs)	1. Habitat loss due to dams; 2. Habitat fragmentation due to dams; Changes in flow regimes	H. Fournier, *pers. comm*

Table 8. A summary of lake sturgeon life stages affected by threats identified to lake sturgeon populations in Designatable Unit 8.

Threat	Age-0	Early juvenile	Late juvenile	Early adult	Late adult
Exploitation			Yes	Yes	Yes
Shoreline hardening	Yes	Yes			
Lampricide treatments	Yes				
Habitat loss due to dams	Yes	Yes	Yes	Yes	Yes
Habitat fragmentation due to dams	Yes	Yes	Yes	Yes	Yes
Flow manipulation	Yes			Yes	Yes
Limited staging habitat	Yes	Yes	Yes	Yes	Yes
limited spawning habitat	Yes			Yes	Yes
Genetic contamination due to stocking	Yes	Yes	Yes	Yes	Yes
Climate change impacts	Yes	Yes	Yes	Yes	Yes
Water level fluctuation (reservoirs)	Yes	Yes	Yes	Yes	Yes
Sedimentation	Yes			Yes	Yes
Nutrient loading	Yes	Yes	Yes	Yes	Yes
Sea lamprey predation		Yes	Yes		
Contaminants	Yes	Yes	Yes	Yes	Yes
Dissolved oxygen	Yes	Yes	Yes	Yes	Yes
Introduction of exotics	Yes	Yes	Yes	Yes	Yes
Low discharge	Yes			Yes	Yes
Temperature	Yes	Yes	Yes	Yes	Yes
Introduction of other diseases	Yes	Yes	Yes	Yes	Yes

Table 9. A summary of anthropogenic activities, the resulting outcomes of those activities on lake sturgeon, and the lake sturgeon life stages those outcomes affect. Activities were assessed as to their importance as main, moderate or low threats to lake sturgeon recovery.

Importance of threat	Threats	Activity	Life stage affected
Main	Presence of dams	habitat fragmentation	all
		flow manipulation	age-0, eggs
		habitat loss	all
		limited access to spawning habitat	age-0, eggs
	Exploitation	First Nation harvest	late juvenile, early and late adult
		poaching	late juvenile, early and late adult
		commercial exploitation	late juvenile, early and late adult
Moderate	Agriculture	nutrient loading	all
		sedimentation (also affected by agriculture)	age-0, eggs
	Urbanization	low discharge	age-0, eggs
	Invasive species	food web disruption	all
		introduction of other diseases	late juvenile, early and late adult
	Presence of dams	reservoir management	age-0, eggs
		turbine mortality	early and late juvenile, early adult
	Invasive species	lampricide control	age-0
		sea lamprey predation	late juvenile, early and late adult
Low	Rehabilitation stocking	genetic loss	all
		diseases and fellow travellers	all
	Climate change	fluctuating water levels	all
		increased temperatures	all
	Exploitation	recreational exploitation	all
	Dredging	habitat loss	all

Table 10. Ranking of habitat threats by sturgeon management unit. Ranked threats from Table 8 were averaged across populations, with threats to habitat quantity or quality ranked as high (threat average = < 2), moderate (threat average - 2-3) or low (threat average > 3).

Sturgeon Management Unit	Habitat Quantity	Habitat Quality
Western Lake Superior (SMU 1)	High	Moderate
Lake Nipigon (SMU 2)	High	Moderate
Northern Lake Superior (SMU 3)	Moderate	Moderate
Eastern Lake Superior (SMU 4)	Moderate	Low
North Channel Lake Huron (SMU 5)	Moderate	Moderate
Lake Nipissing (SMU 6)	Moderate	High
Georgian Bay Lake Huron (SMU 7)	Low	High
Lake Huron / Erie Corridor (SMU 8)	High	Moderate
Lower Niagara River (SMU 9)	Moderate	High
Eastern Lake Ontario / Upper St. Lawrence River (SMU 10)	High	Low
Ottawa River (SMU 11)	High	Low
Lower St Lawrence River (SMU 12)	Moderate	Low

Georgian Bay Lake Huron (Table 10). It is obvious that within a sturgeon management unit the relative importance of habitat quantity and quality threats depend on individual lake sturgeon populations, and any generalizations for a given unit do not necessarily reflect individual populations. In general, habitat threats were considered to be important for most populations and sturgeon management units.

Phase 3: Scenarios for Mitigation and Alternatives to Activities

Inventory of Feasible Mitigation Measures and Alternative Activities

Participants were solicited for input on potential mitigation measures or alternatives to the activities for the threats to individual lake sturgeon populations that were identified in Table 7 prior to the assessment, and the suggested mitigation and activities were reviewed at the assessment. Mitigations and alternative activities were identified for most threats (Table 11).

CONCLUSIONS

Lake sturgeon remain widespread throughout the Great Lakes and St. Lawrence River basin (Designatable Unit 8), but serious declines in the number and size of populations have occurred. Lake sturgeon require spatially extensive habitat, and their life history traits, including large size, delayed maturation and slow growth, make then susceptible to over-exploitation and in turn are disadvantageous in the face of human-induced mortality and habitat change. Two main anthropogenic activities, the presence of dams and exploitation, were the most important lake sturgeon threats in Designatable Unit 8. Dams result in habitat fragmentation, flow manipulation, and limit access to spawning habitat, which can result in habitat loss, the loss of genetic diversity and direct mortality on egg and age-0 life stages. Exploitation, including First Nation harvest, poaching, and commercial harvest, remove the sub-adult and adult life stages that are most crucial for lake sturgeon recovery. While adult habitat is not believed to be limiting, there is much uncertainty around whether spawning habitat is limiting in some of the Sturgeon Management Units.

A recovery target of 1188 spawning females per year was developed for 12 Sturgeon Management Units around the basin that were either genetically distinct or geographically isolated. Model projections suggest that recovery without intervention is possible over 170 - 300 years under the currently estimated suite of mortality rates and life history parameters. Lake sturgeon populations are most sensitive to harm on adult survival.

However, maximum proportional increases in population growth rates can be achieved by focusing recovery efforts on age-0 and juvenile survival. Based on the recovery target and assuming that current abundances are 10% of this target, the time to 95% probability of recovery range from 20 years to over 100 years (1-3 generations), depending on the recovery actions implemented.

Table 11. Suggested mitigations and alternatives to activities for population-level threats identified for lake sturgeon in Table 7.

Threat	Suggested Mitigation / Alternative	Life stage enhanced
Exploitation	enact zero harvest regulation	late juvenile, early and late adult
	enhance law enforcement	late juvenile, early and late adult
	improve public and First Nation education	late juvenile, early and late adult
Urbanization	increase protection during work permit reviews	all
	enforce discharge limits	all
	improve effluent from water treatment plants	all
Agricultural activities	advocate proper drainage	all
	reduce contaminant loads in run-off	all
	control erosion	all
Industrial activities	minimize point source pollution	age-0, eggs
Habitat loss due to dams	enact minimum flow requirements	age-0, eggs
	provision fish passage	all
	habitat improvement work	age-0, eggs
	prevent any additional fragmentation	all
Changes in flow regimes	amend water management plan	all
	follow natural flow regimes	age-0, eggs
Parasite infestations	monitor aquatic invasives	all
Predation by fishes	routinely examine for sea lamprey wounds	late juvenile, early and late adult
Introduction of exotics	monitor invasive species	all
	ban use of live bait	all
	strengthen ballast water regulations	all
Genetic contamination due to stocking	develop a stocking policy	all
Diseases from aquaculture	monitor for bacteria and viruses	all
Lampricide treatments	schedule treatments according to spawning times and age-0 growth	age-0

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