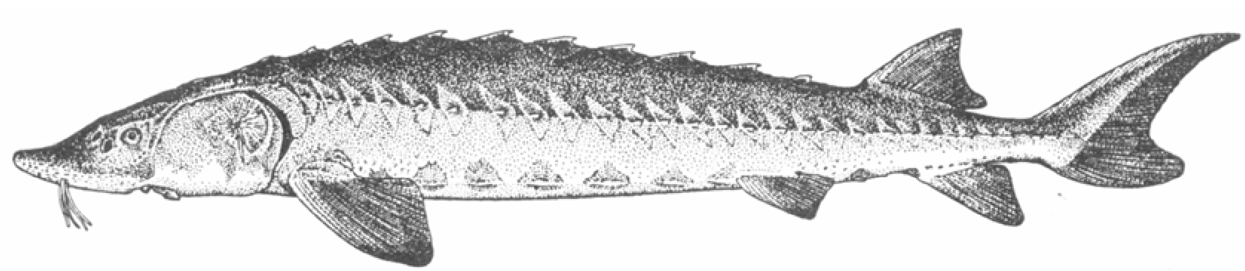
COSEWIC
Assessment and Status Report

on the

Lake Sturgeon
Acipenser fulvescens

Western Hudson Bay populations
Saskatchewan-Nelson River populations
Southern Hudson Bay-James Bay populations
Great Lakes-Upper St. Lawrence populations

in Canada



Western Hudson Bay populations - ENDANGERED
Saskatchewan-Nelson River populations - ENDANGERED
Southern Hudson Bay-James Bay populations - SPECIAL CONCERN
Great Lakes-Upper St. Lawrence populations - THREATENED
2017

COSEWIC
Committee on the Status
of Endangered Wildlife
in Canada

COSEPAC
Comité sur la situation
des espèces en péril
au Canada

COSEWIC status reports are working documents used in assigning the status of wildlife species suspected of being at risk. This report may be cited as follows:

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. xxx + 153 pp. (http://www.registrelep-sararegistry.gc.ca/default.asp?lang=en&n=24F7211B-1).

Previous report(s):

COSEWIC 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. xi + 107 pp. (www.sararegistry.gc.ca/status/status_e.cfm).

Houston, J.J.P. 1986. COSEWIC status report on the lake sturgeon *Acipenser fulvescens* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. 1-32 pp.

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Lake Sturgeon — Provided by authors.

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COSEWIC
Assessment Summary

Assessment Summary – April 2017

Common name
Lake Sturgeon - Western Hudson Bay populations

Scientific name
Acipenser fulvescens

Status
Endangered

Reason for designation
This is one of the largest, longest-lived, freshwater fish species in Canada and has special significance to Indigenous Peoples. Over three generations, the distribution and abundance of mature individuals has declined dramatically, largely as the result of harvesting and dams, which have not ceased.

Occurrence
Saskatchewan, Manitoba

Status history
The species was considered a single unit and designated Not at Risk in April 1986. When the species was split into separate units in May 2005, the "Western populations" unit was designated Endangered. In November 2006, when the Western populations unit was split into five separate populations, the "Western Hudson Bay populations" unit was designated Endangered. Status re-examined and confirmed in April 2017.

Assessment Summary – April 2017

Common name
Lake Sturgeon - Saskatchewan-Nelson River populations

Scientific name
Acipenser fulvescens

Status
Endangered

Reason for designation
This is one of the largest, longest-lived, freshwater fish species in Canada and has special significance to Indigenous Peoples. Formerly assessed as five separate designatable units, recent genetic evidence indicates that those populations should be treated as a single unit. Harvesting and dams were the main reasons for historical declines. Although some populations appear to be recovering, this species is not yet clearly secure.

Occurrence
Alberta, Saskatchewan, Manitoba, Ontario

Status history
The species was considered a single unit and designated Not at Risk in April 1986. When the species was split into separate units in May 2005, the "Western populations" unit was designated Endangered. In November 2006, the Western populations unit was split into five separate populations. In April 2017, the Winnipeg - English River, Red-Assiniboine Rivers - Lake Winnipeg, Saskatchewan River, Nelson River, and Lake of the Woods - Rainy River populations were considered a single unit and this 'Saskatchewan - Nelson River populations' unit was designated Endangered.

Assessment Summary – April 2017

Common name
Lake Sturgeon - Southern Hudson Bay – James Bay populations

Scientific name
Acipenser fulvescens

Status
Special Concern

Reason for designation
This is one of the largest, longest-lived, freshwater fish species in Canada and has special significance to Indigenous Peoples. Some populations are impacted by harvesting and dams, some populations exist in pristine environments, and there are likely many populations yet to be discovered in this remote area. If not mitigated, future development may negatively impact the species.

Occurrence
Manitoba, Ontario, Quebec

Status history
The species was considered a single unit and designated Not at Risk in April 1986. When the species was split into separate units in May 2005, the "Southern Hudson Bay - James Bay populations" unit was designated Special Concern. Status re-examined and confirmed in November 2006. Status re-examined and confirmed in April 2017.

Assessment Summary – April 2017

Common name
Lake Sturgeon - Great Lakes – Upper St. Lawrence populations

Scientific name
Acipenser fulvescens

Status
Threatened

Reason for designation
This is one of the largest, longest-lived, freshwater fish species in Canada and has special significance to Indigenous Peoples. The main reasons for historical declines in most populations, harvesting and dams, are clearly reversible and understood, but have not ceased in all populations. Some populations appear not to have been severely impacted and some populations appear to be recovering but are not yet secure.

Occurrence
Ontario, Quebec

Status history
The species was considered a single unit and designated Not at Risk in April 1986. When the species was split into separate units in May 2005, the "Great Lakes - Upper St. Lawrence populations" unit was designated Special Concern. Status re-examined and designated Threatened in November 2006. Status re-examined and confirmed in April 2017.

COSEWIC
Executive Summary

Lake Sturgeon
Acipenser fulvescens

Western Hudson Bay populations
Saskatchewan-Nelson River populations
Southern Hudson Bay-James Bay populations
Great Lakes-Upper St. Lawrence populations

Wildlife Species Description

The Lake Sturgeon is one of five sturgeon species found in Canada. It is one of Canada's largest freshwater fishes. Lake Sturgeon has a pointed snout, ventral protrusible mouth, four barbels in front of the mouth, five rows of bony scutes, and a heterocercal tail.

Special Significance

The Lake Sturgeon has a rich historical significance to First Nations peoples and was also commercially harvested across much of the species' range between the late-1800s and mid-1900s. The St. Lawrence River in Quebec supports the only remaining commercial fishery. Aboriginal fisheries are ongoing. Caviar, made from Lake Sturgeon eggs, is still highly prized. Lake Sturgeon is also sought by trophy anglers (where permitted; predominantly catch-and-release) in many locations.

Distribution

The Canadian range stretches from the North and South Saskatchewan rivers in Alberta in the west, to the St. Lawrence River estuary in the east, and from various rivers that empty into Hudson Bay in the north to several boundary waters (e.g., Rainy River, Great Lakes) in the south.

Designatable Units

Based on the national freshwater biogeographic zones used by COSEWIC and supplemental genetic information, four designatable units were identified:
DU1 - Western Hudson Bay; DU2 - Saskatchewan-Nelson River; DU3 - Southern Hudson Bay-James Bay; DU4 - Great Lakes-Upper St. Lawrence.

Habitat

The range of the Lake Sturgeon spans four freshwater biogeographic zones and six terrestrial ecozones. The species occupies a wide variety of aquatic ecosystem types (e.g., stepped-gradient Boreal Shield rivers, low-gradient meandering Prairie rivers, low gradient Hudson lowland rivers, Great Lakes and associated tributaries).

Habitat Requirements

Lake Sturgeon requires a variety of habitats to complete its lifecycle, and the species has evolved to exploit typical upstream to downstream hydraulic and substrate gradients. Spawning habitat is typically characterized by fast-moving water found at the base of falls, rapids, or dams. Hatch is contingent on aeration by flowing water, after which larvae apparently require gravel substrate in which to bury and remain while development continues. Once the yolk sac is absorbed, larvae drift downstream via water currents. Habitat requirements at the age-0 stage are not well understood, but may not be as strict as previously assumed. Aside from the requirement of adequate benthic prey items, the habitat requirements for middle to later life stages (juveniles and adults) are not particularly narrow.

Habitat Trends

Habitat trends vary across the species' range. In some areas, the construction of dams has ceased but, in other areas, it is expected to continue into the foreseeable future. Sediment and water quality has improved in many areas formerly impacted by pollution from the pulp-and-paper industry.

Biology

General

The Lake Sturgeon is a benthic generalist, whose forage base diversifies as body size increases.

Reproduction

Spawning occurs during spring and has been observed at water temperatures ranging from 8-21.5°C. Females are attended to by multiple males, and males may spawn with multiple females during a given year. Eggs are broadcast into the water column, and those fertilized develop a sticky exterior and adhere to the substrate. Age at maturity for males is generally in the range of 12-20 years, and 15-30 years for females. Males generally spawn every 1-3 years, and females every 2-7 years.

Recruitment

Inter-annual recruitment across the species' range is often variable or erratic, apparently influenced by biological, environmental, and anthropogenic factors.

Survival

There is low survival to age-1. Once age-1 has been reached, annual survival may be very high, barring anthropogenic influences.

Physiology

Maximum thermal tolerance of Lake Sturgeon is believed to be in the range of 28-30°C.In terms of cold tolerance, the species can survive temperatures of 0°C for up to 6 months. Lake Sturgeon occupies rivers characterized by a wide range of turbidity, clarity, and oxygen levels. Lake Sturgeon is known to move into estuarine environments, but the species has a low salinity tolerance.

Movements/Dispersal

Movement patterns of Lake Sturgeon are driven by the physical separation of habitats needed to complete life-history processes. In low-gradient systems, the species may need to migrate hundreds of kilometres between spawning, foraging, and overwintering habitats. In stepped-gradient systems, habitat diversity can occur over small spatial scales and recruiting populations are known to occur in hydroelectric reservoirs as small as 10 km in length. Furthermore, genetic results indicate populations historically occurred in small, naturally fragmented sections of several large stepped-gradient riverine systems for thousands of years. Dispersal is limited to connected wetted habitats, with volitional movement (primarily by adults) and passive downstream redistribution of larvae being the primary natural processes that influence inter-population dynamics.

Population Sizes and Trends

The majority of Lake Sturgeon populations in Canada declined precipitously over a period of ~150 years beginning in the 18th century. Some of the well-studied populations appear to be rebounding, with several populations consisting of tens of thousands of individuals and others likely approaching carrying capacity. Still, a sizable proportion of populations have yet to exhibit meaningful signs of population recovery, and the species has disappeared from some formerly inhabited areas.

Limiting Factors and Threats

Threats to sustainability and/or impediments to recovery of Lake Sturgeon populations include harvest, habitat alterations (primarily due to dams), barriers to migration (dams), entrainment losses (dams), invasive species, and pollution.

Protection, Status and Ranks

Federal Protection

Lake Sturgeon is not listed under the *Species at Risk Act*. The *Fisheries Act* provides protection to Lake Sturgeon and its habitat.

TECHNICAL SUMMARY (DU1)

Acipenser fulvescens

Lake Sturgeon
Western Hudson Bay populations

Esturgeon jaune
Populations de l'ouest de la baie d'Hudson

Range of occurrence in Canada (province/territory/ocean): Saskatchewan, Manitoba

Demographic Information

Generation time Age at maturity for females has generally been reported at 15 - 30 years, based on imperfect data, varying by population. Females > 80 years of age thought to be historically common in unexploited populations.	~45 – 50 years
Is there an [observed, inferred, or projected] continuing decline in number of mature individuals? Based on the only known recruiting population (population exists between Missi Falls CS and the Churchill River Weir) within the DU.	Yes
Estimated percent of continuing decline in total number of mature individuals within [5 years or 2 generations] Based on ~ 20% decline over last 10 years (2%/y).	100% over 2 generations
[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over the last [10 years, or 3 generations]	>98% over last three generations
Projected or suspected] percent [reduction or increase] in total number of mature individuals over the next [10 years, or 3 generations]. Based on ~ 20% decline over last 10 years (2%/y). Assumes status quo harvest practices, no changes to flow regulation in lower Churchill River.	Projected decline of 100% over 3 generations
Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over any [10 years, or 3 generations] period, over a time period including both the past and the future. Based on now remnant populations in upper portion of the DU.	>98% over last 3 generations.

Are the causes of the decline a. clearly reversible and b. understood and c. ceased? Historical declines primarily due to historical exploitation, pollution, and/or hydroelectric development. Contemporary habitat seems suitable to support self-sustaining populations.	a. Yes, assuming commercial fishery/pollution were primary drivers b. Not completely. c. Probably, commercial harvest has ceased throughout much of the DU, but subsistence harvest continues in lone recruiting population.
Are there extreme fluctuations in number of mature individuals?	No

Extent and Occupancy Information

Estimated extent of occurrence (EOO)	Pre-2005: 43,936 km² 2005-Present: 911 km²
Index of area of occupancy (IAO)	Pre-2005: Discrete 80 km²; Continuous 892 km² 2005 - Present: Discrete 64 km²; Continuous 372 km²
Is the population "severely fragmented" i.e. is >50% of its total area of occupancy in habitat patches that are (a) smaller than would be required to support a viable population, and (b) separated from other habitat patches by a distance larger than the species can be expected to disperse?	a. No b. Yes – natural and/or artificial barriers (dams) preclude upstream dispersal from extant downstream populations
Number of "locations"* Based on management unit structure presented in Cleator *et al.* 2010a, which is based on contemporary delineation of habitat by dams, the greatest threat in this DU. Only 1 of the 3 MUs identified supports a recruiting population.	1
Is there an [observed, inferred, or projected] decline in extent of occurrence? No records of Lake Sturgeon throughout most of upper portion of the DU since 2005, despite considerable search effort.	98% decline in EOO
Is there an [observed, inferred, or projected] decline in extent of occurrence? No records of Lake Sturgeon throughout most of upper portion of the DU since 2005, despite directed effort.	20% decline IAO-discrete, 58% decline IAO-continuous
Is there an [observed, inferred, or projected] decline in number of subpopulations? No records of Lake Sturgeon throughout most of upper portion of the DU since 2005, despite directed effort.	Yes

* See Definitions and Abbreviations on COSEWIC website and IUCN (Feb 2014) for more information on this term

Is there an [observed, inferred, or projected] decline in number of "locations"*? No records of Lake Sturgeon throughout most of upper portion of the DU since 2005, despite directed effort. Two locations (c. 2005) no longer considered to support populations.	Yes
Is there an [observed, inferred, or projected] decline in [area, extent and/or quality] of habitat? In the lower Churchill River downstream of Missi Falls habitat quantity/quality has been severely reduced by the Churchill River Diversion project; however, in this area, the lone recruiting population persists. Further upstream, where no recruiting populations remain, habitat to support all life stages exists in large quantities.	Yes
Are there extreme fluctuations in number of subpopulations?	No
Are there extreme fluctuations in number of "locations"∗?	No
Are there extreme fluctuations in extent of occurrence?	No
Are there extreme fluctuations in index of area of occupancy?	No

Number of Mature Individuals (in each subpopulation)

Subpopulations (give plausible ranges)	**N Mature Individuals**
*this subpopulation no longer considered a location	Kettle Falls to Island Falls – Remnant
***this subpopulation no longer considered a location	Island Falls to Missi Falls – Remnant
	Missi Falls to Churchill Weir - 1,573 (1,401-1,745)
Total	<2,500

Quantitative Analysis

Probability of extinction in the wild is at least 10% within 100 years. Based on a population-viability model (Nelson *et al.* in prep), assuming 10% of recovery target (543 adult spawning females) probability of extinction ranges from 0 without harvest to 42.9% at 10% annual harvest of adults.	Yes

[∗] See Definitions and Abbreviations on COSEWIC website and IUCN (Feb 2014) for more information on this term

Threats (actual or imminent, to populations or habitats, from highest impact to least)

i. Fishing & harvesting aquatic resources - actual
ii. Dams & water management/use - actual

Was a threats calculator completed for this species and if so, by whom? Yes

Overall Threat Impact: High

Threats calculator done July 7, 2016 with the following attendees: Nick Mandrak (co-chair), Dwayne Lepitzki (Facilitator and Molluscs SSC co-chair), Cam Barth, Patrick Nelson, Craig McDougall (authors), Margaret Docker, Doug Watkinson (SSC members), Dan Benoit (ATK SC co-chair), Mike Friday, Josh Peacock (OMNR), Yves Paradis (MFFP - QC), Isabelle Gauthier (MFFP and COSEWIC member for Quebec), Mike Pollock (SK), Josée Brunelle (HFTCC), Shane Petry, Robin Gutsell (AB), Angèle Cyr (COSEWIC Secretariat), Chantal Sawatzky (DFO), Alan Penn (Cree Nation). See Appendix 1.

Rescue Effect (immigration from outside DUs or populations)

Status of outside population(s) most likely to provide immigrants. There are no adjacent populations outside of Canada.	n/a
26. Is immigration known or possible?	No
27. Would immigrants be adapted to survive in DU1?	Yes
28. Is there sufficient habitat for immigrants in DU1?	Yes
29. Are conditions deteriorating in DU1?[+]	No
30. Are conditions for the source population deteriorating?[+]	n/a
31. Is the DU1 population considered to be a sink?[+]	No
32. Is rescue from outside populations likely?	No

Data Sensitive Species

Is this a data sensitive species? No

Status History

COSEWIC: The species was considered a single unit and designated Not at Risk in April 1986. When the species was split into separate units in May 2005, the "Western populations" unit was designated Endangered. In November 2006, when the Western populations unit was split into five separate populations, the "Western Hudson Bay populations" unit was designated Endangered. Status re-examined and confirmed in April 2017.

Status and Reasons for Designation:

Status: Endangered	**Alpha-numeric codes:** A2bcd; B1ab(i,ii,iii,iv,v)+2ab(i,ii,iii,iv,v); C2a(ii)

[+] See Table 3 (Guidelines for modifying status assessment based on rescue effect)

Reasons for designation:
This is one of the largest, longest-lived, freshwater fish species in Canada and has special significance to Indigenous peoples. Over three generations, the distribution and abundance of mature individuals has declined dramatically, largely as the result of harvesting and dams, which have not ceased.

Applicability of Criteria

Criterion A (Decline in Total Number of Mature Individuals): Meets Endangered, A2bcd, because the decline in total number of mature individuals is estimated at 99% and is clearly reversible and understood, but not ceased.
Criterion B (Small Distribution Range and Decline or Fluctuation): Meets Endangered, B1ab(i,ii,iii,iv,v)+2ab(i,ii,iii,iv,v), because the EOO is less than 5000 km² (911 km²), the IAO is less than 500 km² (64 km²), the number of locations is less than 5 (1), and there is a projected continuing decline in the IAO, EOO, number of subpopulations and number of mature individuals.
Criterion C (Small and Declining Number of Mature Individuals): Meets Endangered, C2a(ii), because the total number of mature individuals is less than 2500 and the one subpopulation has 100% of all mature individuals.
Criterion D (Very Small or Restricted Population): Not applicable. Meets Threatened, D2, because there are fewer than 5 locations (1) and is capable of becoming extinct, extirpated or critically endangered in a very short period of time since the percent population reduction is estimated at greater than 90% (99%).
Criterion E (Quantitative Analysis): Probability of extinction based on an unpublished population viability analysis ranges 0-43% over an unspecified period of time depending on harvest scenarios; therefore, a single status cannot be assigned based on this criterion.

TECHNICAL SUMMARY (DU2)

Acipenser fulvescens

Lake Sturgeon Saskatchewan-Nelson River populations	Esturgeon jaune Populations de la rivière Saskatchewan et du fleuve Nelson

Range of occurrence in Canada (province/territory/ocean): Alberta, Saskatchewan, Manitoba, Ontario

Demographic Information

Generation time Age at maturity for females has generally been reported at 15 - 30 years, based on imperfect data, varying by population. Females > 80 years of age thought to be historically common in unexploited populations.	~45-50 years
Is there an [observed, inferred, or projected] continuing decline in number of mature individuals?	No
Estimated percent of continuing decline in total number of mature individuals within [5 years or 2 generations]	0
[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over the last [10 years, or 3 generations].	>90% over last 3 generations
[Projected or suspected] percent [reduction or increase] in total number of mature individuals over the next [10 years, or 3 generations].	Unknown
[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over any [10 years, or 3 generations] period, over a time period including both the past and the future.	> 90% or past 3 generations
Are the causes of the decline a. clearly reversible and b. understood and c. ceased? Historical declines primarily due to historical exploitation, pollution, and/or hydroelectric development. Contemporary habitat seems suitable to support self-sustaining populations.	a. Yes b. Not completely c. Not completely; harvest is ongoing in several locations, flow regulation and fragmentation by dams thought to be problematic on the Saskatchewan River
Are there extreme fluctuations in number of mature individuals?	No

Extent and Occupancy Information

Estimated extent of occurrence (EOO)	Pre-2005: 1,083,517 km² 2005-Present: 1,011,515 km²
Index of area of occupancy (IAO)	Pre-2005: Discrete 916 km², Continuous 17,172 km² 2005 - Present: Discrete 1,224 km², Continuous 7,884 km²

Is the population "severely fragmented" i.e. is >50% of its total area of occupancy in habitat patches that are (a) smaller than would be required to support a viable population, and (b) separated from other habitat patches by a distance larger than the species can be expected to disperse?	a. No b. No – however, several artificial barriers preclude upstream dispersal from extant downstream populations.
Number of "locations"* Based on MU structure presented in Cleator *et al.* 2010b,c,d,e, which is based on contemporary delineation of habitat by dams.*	31
Is there an [observed, inferred, or projected] decline in extent of occurrence. The <7% reduction in EOO likely does not reflect a range contraction, just lack of records since 2005 in certain reaches due to lack of effort.	No
Is there an [observed, inferred, or projected] decline in index of area of occupancy? The 54% decrease in IAO-continuous likely does not reflect a range contraction, just lack of records since 2005 in certain reaches due to lack of effort.	No
Is there an [observed, inferred, or projected] decline in number of subpopulations?	No
Is there an [observed, inferred, or projected] decline in number of "locations"*?	No
Is there an [observed, inferred, or projected] decline in [area, extent and/or quality] of habitat? However, flow regulation is ongoing and major navigational or flood control structures remain active throughout the DU.	No
Are there extreme fluctuations in number of subpopulations?	No
Are there extreme fluctuations in number of "locations"∗?	No
Are there extreme fluctuations in extent of occurrence?	No
Are there extreme fluctuations in index of area of occupancy?	No

Number of Mature Individuals (in each subpopulation)

Subpopulations	**N Mature Individuals**
North Saskatchewan R., AB	~6,350
South Saskatchewan R., AB	~6,450
Saskatchewan R., upstream SK	~2,580
Saskatchewan R., downstream SK	~3,100

* See Definitions and Abbreviations on COSEWIC website and IUCN (Feb 2014) for more information on this term

English and Wabigoon R.	>500
Seine River, ON	>50
Rainy Lake, South Arm	>500
Rainy Lake, Redgut Bay	>50
Namakan Reservoir	>500
Namakan River	~2,730
Sturgeon Lake	~2,050
Lac la Croix	>500
Big and Little Turtle Rivers	>50
Lake of the Woods – Rainy River	~92,000
Winnipeg R., Lake of the Woods to Whitedog	Remnant
Winnipeg R., Whitedog/Caribou to Pointe du Bois	>50
Winnipeg R., Pointe du Bois to Slave Falls	~2,320
Winnipeg R., Slave Falls to Seven Sisters	~5,000
Winnipeg R., Seven Sisters to MacArthur Falls	>500
Winnipeg R., MacArthur to Great Falls	Very Low
Winnipeg R., Great Falls to Pine Falls	>50
Winnipeg R., Pine Falls/Traverse Bay	>50
Red/Assiniboine	>50
Lake Winnipeg East-Side Tributaries	>500
Nelson R., Warren Landing to Kelsey	~3,260
Nelson R., Kelsey/Burntwood to Kettle	~1,590
Nelson R., Kettle to Long Spruce	Very low
Nelson R., Long Spruce to Limestone	Very low
Nelson R., Limestone to Hudson Bay	~8,410
Total	>139,150

Quantitative Analysis

Probability of extinction in the wild is at least 10% within 100 years.	No analysis available.

Threats (actual or imminent, to populations or habitats, from highest impact to least)

i. Dams & water management/use – actual ii. Fishing & harvesting aquatic resources – actual Was a threats calculator completed for this species and if so, by whom? Yes Overall Threat Impact: Low Threats calculator done July 7, 2016 with the following attendees: Nick Mandrak (co-chair), Dwayne Lepitzki (Facilitator and Molluscs SSC co-chair), Cam Barth, Patrick Nelson, Craig McDougall (authors), Margaret Docker, Doug Watkinson (SSC members), Dan Benoit (ATK SC co-chair), Mike Friday, Josh Peacock (OMNR), Yves Paradis (MFFP - QC), Isabelle Gauthier (MFFP and COSEWIC member for Quebec), Mike Pollock (SK), Josée Brunelle (HFTCC), Shane Petry, Robin Gutsell (AB), Angèle Cyr (COSEWIC Secretariat), Chantal Sawatzky (DFO), Alan Penn (Cree Nation). See Appendix 2.

Rescue Effect (immigration from outside DU)

Status of outside population(s) most likely to provide immigrants to DU.	Increasing
Is immigration known or possible?	Yes
Would immigrants be adapted to survive in DU?	Yes
Is there sufficient habitat for immigrants in DU?	Yes
Are conditions deteriorating in DU?[+]	No
Are conditions for the source population deteriorating?[+]	No
Is the DU population considered to be a sink?[+]	No
Is rescue from outside populations likely? Documented recaptures of fish tagged in Minnesota (progeny of Rainy River broodstock stocked in headwaters of the Red River) have been recorded and there have been increased encounters of juvenile Lake Sturgeon (likely individuals stocked in the headwaters) in the Manitoba portion of the Red River over the past decade.	Yes

Data Sensitive Species

Is this a data sensitive species?	No

Status History

COSEWIC: The species was considered a single unit and designated Not at Risk in April 1986. When the species was split into separate designatable units in May 2005, the “Western populations” unit was designated Endangered. In November 2006, the Western populations unit was split into five separate designatable units. In April 2017, the Winnipeg-English River, Red-Assiniboine Rivers-Lake Winnipeg, Saskatchewan River, Nelson River, and Lake of the Woods-Rainy River populations were considered a single designatable unit and this “Saskatchewan-Nelson River populations” unit was designated Endangered.

[+] See Table 3 (Guidelines for modifying status assessment based on rescue effect)

Status and Reasons for Designation:

Status: Endangered	**Alpha-numeric codes:** A2bc
Reasons for designation: This is one of the largest, longest-lived, freshwater fish species in Canada and has special significance to Indigenous peoples. Formerly assessed as five separate designatable units, recent genetic evidence indicates that those populations should be treated as a single unit. Harvesting and dams were the main reasons for historical declines. Although some populations appear to be recovering, this species is not yet clearly secure.	

Applicability of Criteria

Criterion A (Decline in Total Number of Mature Individuals): Meets Endangered, A2bc, because there is a suspected 90% reduction in total number of mature individuals over the last three generations.
Criterion B (Small Distribution Range and Decline or Fluctuation): Not applicable. EOO, IAO, and number of locations exceed thresholds.
Criterion C (Small and Declining Number of Mature Individuals): Not applicable. Increasing number of mature individuals.
Criterion D (Very Small or Restricted Population): Not applicable.
Criterion E (Quantitative Analysis): Relevant quantitative analyses have not been completed.

TECHNICAL SUMMARY (DU3)

Acipenser fulvescens

Lake Sturgeon Southern Hudson Bay-James Bay populations	Esturgeon jaune Populations du sud de la baie d'Hudson et de la baie James

Range of occurrence in Canada (province/territory/ocean): Manitoba, Ontario, Quebec

Demographic Information

Generation time Age at maturity for females has generally been reported at 15 - 30 years, based on imperfect data, varying by population. Females > 80 years of age thought to be historically common in unexploited populations.	~45 – 50 years
Is there an [observed, inferred, or projected] continuing decline in number of mature individuals?	Unknown
Estimated percent of continuing decline in total number of mature individuals within [5 years or 2 generations]	Unknown
[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over the last [10 years, or 3 generations].	Unknown
[Projected or suspected] percent [reduction or increase] in total number of mature individuals over the next [10 years, or 3 generations].	Unknown
[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over any [10 years, or 3 generations] period, over a time period including both the past and the future.	Unknown
Are the causes of the decline a. clearly reversible and b. understood and c. ceased? For some developed systems (i.e., the Moose/ Mattagami, Rupert, Eastmain, La Grande), some information is known regarding population trajectory and the mechinisms for declines. Values entered reflect these populations, not necessarily the majority within the DU.	a. Yes b. Yes c. No – subsistence harvest is ongoing in several locations, flow regulation and fragmentation persist.
Are there extreme fluctuations in number of mature individuals?	No

Extent and Occupancy Information

Estimated extent of occurrence (EOO)	Pre-2005: 918,956 km² 2005-Present: 482,724 km²

Index of area of occupancy (IAO)	Pre-2005: Discrete 1,280 km², Continuous 49,876 km^2 2005 - Present: Discrete 636 km², Continuous 3,928 km^2
Is the population "severely fragmented" i.e. is >50% of its total area of occupancy in habitat patches that are (a) smaller than would be required to support a viable population, and (b) separated from other habitat patches by a distance larger than the species can be expected to disperse?	a. No b. No – however, numerous artificial barriers preclude upstream dispersal from extant downstream populations.
Number of "locations"* Number of locations is based on data availability. If no data exist for a given river, the river is treated as a single location. If data exist (as is the case for hydroelectrically developed systems), locations are generally based on delineation by dams.	15
Is there an [observed, inferred, or projected] decline in extent of occurrence? Likely not a range contraction, just lack of records since 2005 in certain reaches due to lack of effort.	48% reduction in EOO
Is there an [observed, inferred, or projected] decline in index of area of occupancy? Likely not a range contraction, just lack of records since 2005 in certain areas due to lack of effort.	50% decrease in IAO-discrete; 92% decrease in IAO-continuous
Is there an [observed, inferred, or projected] decline in number of subpopulations? All previously identified populations are extant with stable numbers.	No
Is there an [observed, inferred, or projected] decline in number of "locations"*?	No
Is there an [observed, inferred, or projected] decline in [area, extent and/or quality] of habitat?	No
Are there extreme fluctuations in number of subpopulations?	No
Are there extreme fluctuations in number of "locations"∗?	No
Are there extreme fluctuations in extent of occurrence?	No
Are there extreme fluctuations in index of area of occupancy?	No

* See Definitions and Abbreviations on COSEWIC website and IUCN (Feb 2014) for more information on this term

Number of Mature Individuals (in each subpopulation)

Subpopulations (give plausible ranges)	**N Mature Individuals**
Fox R.	>500
Gods R.	>500
Hayes R.	>500
Severn R.	Unknown
Winisk R.	Unknown
Attawapiskat R.	>50
Albany/Kenogami R.	>50
Mattagami R., Little Long Reservoir	~9,890
Frederick House R.	~190
Abitibi R.	~990
Moose R.	~7,090
Harracana R.	Unknown
Nottaway R.	Unknown
Rupert R.	Unknown
Eastmain R.	>500
La Grande R.	Unknown
Total	>20,260

Quantitative Analysis

Probability of extinction in the wild is at least 10% within 100 years.	No analysis available.

Threats (actual or imminent, to populations or habitats, from highest impact to least)

i. Dams & water management/use - actual

Was a threats calculator completed for this species and if so, by whom? Yes

Overall Threat Impact: Low

Threats calculator done July 7, 2016 with the following attendees: Nick Mandrak (co-chair), Dwayne Lepitzki (Facilitator and Molluscs SSC co-chair), Cam Barth, Patrick Nelson, Craig McDougall (authors), Margaret Docker, Doug Watkinson (SSC members), Dan Benoit (ATK SC co-chair), Mike Friday, Josh Peacock (OMNR), Yves Paradis (MFFP - QC), Isabelle Gauthier (MFFP and COSEWIC member for Quebec), Mike Pollock (SK), Josée Brunelle (HFTCC), Shane Petry, Robin Gutsell (AB), Angèle Cyr (COSEWIC Secretariat), Chantal Sawatzky (DFO), Alan Penn (Cree Nation), René Dion (Hydro-Québec). See Appendix 3.

Rescue Effect (immigration from outside DU)

Status of outside population(s) most likely to provide immigrants to DU.There are no adjacent populations outside of Canada.	n/a
Is immigration known or possible?	Yes

Would immigrants be adapted to survive in DU?	Yes
Is there sufficient habitat for immigrants in DU?	Yes
Are conditions deteriorating in DU?+	No
Are conditions for the source population deteriorating?+	n/a
Is the DU population considered to be a sink?+	No
Is rescue from outside populations likely?	No

Data Sensitive Species

Is this a data sensitive species? No

Status History

COSEWIC: The species was considered a single unit and designated Not at Risk in April 1986. When the species was split into separate units in May 2005, the "Southern Hudson Bay-James Bay populations" unit was designated Special Concern. Status re-examined and confirmed in November 2006. Status re-examined and confirmed in April 2017.

Status and Reasons for Designation:

Status: Special Concern	**Alpha-numeric codes:** Not applicable
Reasons for designation: This is one of the largest, longest-lived, freshwater fish species in Canada and has special significance to Indigenous peoples. Some populations are impacted by harvesting and dams, some populations exist in pristine environments, and there are likely many populations yet to be discovered in this remote area. If not mitigated, future development may negatively impact the species.	

Applicability of Criteria

Criterion A (Decline in Total Number of Mature Individuals): Not applicable. Population trends stable.
Criterion B (Small Distribution Range and Decline or Fluctuation): Not applicable. EOO, IAO, and number of locations exceed thresholds.
Criterion C (Small and Declining Number of Mature Individuals): Not applicable. Stable number of mature individuals.
Criterion D (Very Small or Restricted Population): Not applicable.
Criterion E (Quantitative Analysis): Relevant quantitative analyses have not been completed.

+ See Table 3 (Guidelines for modifying status assessment based on rescue effect)

TECHNICAL SUMMARY (DU4)

Acipenser fulvescens

Lake Sturgeon
Great Lakes-Upper St. Lawrence populations

Esturgeon jaune
Populations des Grands Lacs et du haut Saint-Laurent

Range of occurrence in Canada (province/territory/ocean): Ontario, Quebec

Demographic Information

Generation time Age at maturity for females has generally been reported at 15 - 30 years, based on imperfect data, varying by population. Females > 80 years of age thought to be historically common in unexploited populations.	~45 – 50 years
Is there an [observed, inferred, or projected] continuing decline in number of mature individuals?	No
Estimated percent of continuing decline in total number of mature individuals within [5 years or 2 generations]	0
[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over the last [10 years, or 3 generations].	>99% over the last 3 generations
[Projected or suspected] percent [reduction or increase] in total number of mature individuals over the next [10 years, or 3 generations].	Suspected increase over next 3 generations, % unknown.
[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over any [10 years, or 3 generations] period, over a time period including both the past and the future.	>99% reduction in past over 3 generations
Are the causes of the decline a. clearly reversible and b. understood and c. ceased?	a. Yes b. Yes c. Partially, harvest has been reduced in the Great Lakes, but incidental commercial by-catch continues. Harvest is regulated in the St. Lawrence River, downstream of Beauharnois dam. The population is increasing in the St. Lawrence River, downstream of the Beauharnois dam since 2002. Dams persist, meaning flow regulation and migratory barriers are still influential.
Are there extreme fluctuations in number of mature individuals?	No

Extent and Occupancy Information

Estimated extent of occurrence	Pre-2005: 827,530 km² 2005-Present: 852,243 km²
Index of area of occupancy (IAO)	Pre-2005: Discrete 5,044 km², Continuous 124,204 km^2 2005 - Present: Discrete 3,728 km², Continuous 126,012 km^2
Is the population "severely fragmented" i.e. is >50% of its total area of occupancy in habitat patches that are (a) smaller than would be required to support a viable population, and (b) separated from other habitat patches by a distance larger than the species can be expected to disperse?	a. No b. No – however, artificial barriers preclude upstream dispersal from extant downstream populations.
Number of "locations"* Based on MU structure presented in Pratt (2008), which is based on contemporary delineation of habitat by dams, but with the recent separation of the Ottawa River into 9 segments delineated by dams (T. Haxton pers. comm.).	20
Is there an [observed, inferred, or projected] decline in extent of occurrence? The 3% increase in EOO likely does not reflect a range expansion, just new records since 2005 in certain areas due to increased sampling effort.	No
Is there an [observed, inferred, or projected] decline in index of area of occupancy? The 26% decrease in IAO-discrete and 1.5% increase in IAO-continuous likely do not reflect a range change, just new records since 2005 in certain areas due to increased sampling effort.	No
Is there an [observed, inferred, or projected] decline in number of subpopulations?	No
Is there an [observed, inferred, or projected] decline in number of "locations"*?	No
Is there an [observed, inferred, or projected] decline in [area, extent and/or quality] of habitat? However, flow regulation is ongoing throughout much of the Great Lakes and Ottawa and St. Lawrence river tributaries in ON and QC.	No
Are there extreme fluctuations in number of subpopulations?	No

* See Definitions and Abbreviations on COSEWIC website and IUCN (Feb 2014) for more information on this term

Are there extreme fluctuations in number of "locations"*?	No
Are there extreme fluctuations in extent of occurrence?	No
Are there extreme fluctuations in index of area of occupancy?	No

Number of Mature Individuals (in each subpopulation)

Subpopulations (does not reflect the number of MUs because MUs contain multiple locations)	**N Mature Individuals**
Omabika Bay	Unknown
Namewaminikan River	Unknown
Pigeon River	Unknown
Kaministiquia River	≤200
Black Sturgeon River	≤200
Nipigon River	Remnant
Gravel River	Unknown
Prairie River	Remnant
Pic River	< 500
White River	< 500
Michipicoten R.	Remnant
Batchawana R.	>50
Chippewa R.	Unknown
Goulais R.	>50
St. Marys R.	>200
Mississagi R., Tunnel Lake	>10
Mississagi R., Red Rock and up	>10
Spanish R.	>10
Magnetawan R.	>50
Nottawasaga R.	>~350
Moon R.	Unknown
Moon R., Nairn Centre to High Falls	>10
Lake Nipissing	Unknown
Upper St. Clair R., Southern Lake Huron	~35,480
North Channel St. Clair R.	~11,720
St. Claire R., Lake St. Clair	~45,510
Detroit R.	~4,070
Lower Niagara R.	>50
Trent R.	>10

* See Definitions and Abbreviations on COSEWIC website and IUCN (Feb 2014) for more information on this term

Ottawa R., Lac Dollard des Ormeaux	>50
Ottawa R., Lac Deschenes	~202
Ottawa R., Lac Des Chats	>50
Ottawa R., Lac du Rocher Fendu	>50
Ottawa R., Lac Coulonge – Upper Allumette	>1,000
Ottawa R., Holden Lake/Lac la Cave	>50
Ottawa, R., Lake Temiscaming	>50
St. Lawrence R., St. François R. upstream of Drummondville dam	>50
Ottawa R. upstream of Carillon Dam	>50
St. Lawrence R. upstream of Moses Saunders Dam	>50
De l'Aigle R.	>50
Gatineau R., upstream Paugan dam and downstream Mercier dam	>50
Des Rapides R.	>50
St. Lawrence R, downstream of Beauharnois Dam	>100,000
St. Lawrence R., Lake St. Francis, upstream of Beauharnois Dam	>50
St. Lawrence R., Lac des Deux-Montagnes	>200
Total	>200,000

Quantitative Analysis

Probability of extinction in the wild is at least 10% within 100 years.	No analysis available.

Threats (actual or imminent, to populations or habitats, from highest impact to least)

i. Industrial & military effluents - actual
ii. Agricultural & forestry effluents - actual
iii. Dams & water management/use - actual
iv. Fishing & harvesting aquatic resources - actual
v. Shipping lanes - actual

Was a threats calculator completed for this species and if so, by whom? Yes

Overall Threat Impact: Medium - Low

Threats calculator done July 7, 2016 with the following attendees: Nick Mandrak (co-chair), Dwayne Lepitzki (Facilitator and Molluscs SSC co-chair), Cam Barth, Patrick Nelson, Craig McDougall (authors), Margaret Docker, Doug Watkinson (SSC members), Dan Benoit (ATK SC co-chair), Mike Friday, Josh Peacock (OMNR), Yves Paradis (MFFP - QC), Isabelle Gauthier (MFFP and COSEWIC member for Quebec), Mike Pollock (SK), Josée Brunelle (HFTCC), Shane Petry, Robin Gutsell (AB), Angèle Cyr (COSEWIC Secretariat), Chantal Sawatzky (DFO), Alan Penn (Cree Nation). See Appendix 4.

Rescue Effect (immigration from outside DU)

Status of outside population(s) most likely to provide immigrants to DU. US populations most likely to provide immigrants.	Increasing
Is immigration known or possible?	Yes
Would immigrants be adapted to survive in DU?	Yes
Is there sufficient habitat for immigrants in DU?	Yes
Are conditions deteriorating in DU?[+]	No
Are conditions for the source population deteriorating?[+]	No
Is the DU population considered to be a sink?[+]	No
Is rescue from outside populations likely? Within the Great Lakes, straying of adults from tributary populations is known to occur, so a rescue effect via contributions from US tributary populations is feasible in the long term.	Yes

Data Sensitive Species

Is this a data sensitive species?	No

Status History

COSEWIC: The species was considered a single unit and designated Not at Risk in April 1986. When the species was split into separate designatable units in May 2005, the "Great Lakes-Upper St. Lawrence populations" unit was designated Special Concern. Status re-examined and designated Threatened in November 2006. Status re-examined and confirmed in April 2017.

Status and Reasons for Designation:

Status: Threatened	**Alpha-numeric codes:** Meets Endangered, A2b, but designated Threatened, A2b, because a portion of the unit is showing signs of improvement.

Reasons for designation:
This is one of the largest, longest-lived, freshwater fish species in Canada and has special significance to Indigenous peoples. The main reasons for historical declines in most populations, harvesting and dams, are clearly reversible and understood, but have not ceased in all populations. Some populations appear not to have been severely impacted and some populations appear to be recovering but are not yet secure.

[+] See Table 3 (Guidelines for modifying status assessment based on rescue effect)

Applicability of Criteria

Criterion A (Decline in Total Number of Mature Individuals): Meets Endangered, A2bc, because there is a suspected >75% reduction in total number of mature individuals over the last three generations.
Criterion B (Small Distribution Range and Decline or Fluctuation): Not applicable. EOO, IAO, and number of locations exceed thresholds.
Criterion C (Small and Declining Number of Mature Individuals): Not applicable. Increasing number of mature individuals.
Criterion D (Very Small or Restricted Population): Not applicable.
Criterion E (Quantitative Analysis): Relevant quantitative analyses have not been completed.

PREFACE

In 2006, COSEWIC assessed the status of Lake Sturgeon in Canada, dividing numerous populations into eight designatable units (DUs). The statuses proposed by COSEWIC in 2006 resulted in widespread research and management effort and, as a result, the understanding of Lake Sturgeon biology, population sizes, and population trends has improved considerably since the species was last assessed. Because populations exploit a variety of different habitat types across the species' range, it is problematic to make broad generalizations regarding many aspects of life history, since diet, growth, movement, and behaviour vary among populations. Commercial harvest records provide some context regarding historical population sizes, but trajectory and status assessments of many populations are still hampered by a lack of robust historical datasets.

A more thorough analysis of population genetics across much of the Canadian range has been conducted and, based on a lack of deep-rooted structure (i.e. genetic divergence of populations) and significance, the number of designatable units has been reduced from eight to four, based on the national freshwater biogeographic zones.

As part of the COSEWIC assessment process, an Aboriginal Traditional Knowledge (ATK) assessment report was prepared by Goulet (2014).

COSEWIC HISTORY

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) was created in 1977 as a result of a recommendation at the Federal-Provincial Wildlife Conference held in 1976. It arose from the need for a single, official, scientifically sound, national listing of wildlife species at risk. In 1978, COSEWIC designated its first species and produced its first list of Canadian species at risk. Species designated at meetings of the full committee are added to the list. On June 5, 2003, the *Species at Risk Act* (SARA) was proclaimed. SARA establishes COSEWIC as an advisory body ensuring that species will continue to be assessed under a rigorous and independent scientific process.

COSEWIC MANDATE

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assesses the national status of wild species, subspecies, varieties, or other designatable units that are considered to be at risk in Canada. Designations are made on native species for the following taxonomic groups: mammals, birds, reptiles, amphibians, fishes, arthropods, molluscs, vascular plants, mosses, and lichens.

COSEWIC MEMBERSHIP

COSEWIC comprises members from each provincial and territorial government wildlife agency, four federal entities (Canadian Wildlife Service, Parks Canada Agency, Department of Fisheries and Oceans, and the Federal Biodiversity Information Partnership, chaired by the Canadian Museum of Nature), three non-government science members and the co-chairs of the species specialist subcommittees and the Aboriginal Traditional Knowledge subcommittee. The Committee meets to consider status reports on candidate species.

DEFINITIONS
(2017)

Wildlife Species	A species, subspecies, variety, or geographically or genetically distinct population of animal, plant or other organism, other than a bacterium or virus, that is wild by nature and is either native to Canada or has extended its range into Canada without human intervention and has been present in Canada for at least 50 years.
Extinct (X)	A wildlife species that no longer exists.
Extirpated (XT)	A wildlife species no longer existing in the wild in Canada, but occurring elsewhere.
Endangered (E)	A wildlife species facing imminent extirpation or extinction.
Threatened (T)	A wildlife species likely to become endangered if limiting factors are not reversed.
Special Concern (SC)*	A wildlife species that may become a threatened or an endangered species because of a combination of biological characteristics and identified threats.
Not at Risk (NAR)**	A wildlife species that has been evaluated and found to be not at risk of extinction given the current circumstances.
Data Deficient (DD)***	A category that applies when the available information is insufficient (a) to resolve a species' eligibility for assessment or (b) to permit an assessment of the species' risk of extinction.

* Formerly described as "Vulnerable" from 1990 to 1999, or "Rare" prior to 1990.

** Formerly described as "Not In Any Category", or "No Designation Required."

*** Formerly described as "Indeterminate" from 1994 to 1999 or "ISIBD" (insufficient scientific information on which to base a designation) prior to 1994. Definition of the (DD) category revised in 2006.

Environment and Climate Change Canada
Canadian Wildlife Service

Environnement et Changement climatique Canada
Service canadien de la faune

Canada

The Canadian Wildlife Service, Environment and Climate Change Canada, provides full administrative and financial support to the COSEWIC Secretariat.

COSEWIC Status Report

on the

Lake Sturgeon
Acipenser fulvescens

Western Hudson Bay populations
Saskatchewan-Nelson River populations
Southern Hudson Bay – James Bay populations
Great Lakes – Upper St. Lawrence populations

in Canada

2017

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WILDLIFE SPECIES DESCRIPTION AND SIGNIFICANCE

Name and Classification

Class:	Actinopterygii
Order:	Acipenseriformes
Family:	Acipenseridae
Genus:	*Acipenser*
Scientific name:	*Acipenser fulvescens* Rafinesque 1817 (Page *et al.* 2013)
Common name:	English: Lake Sturgeon (Page *et al.* 2013) French: esturgeon jaune (Page *et al.* 2013)
First Nation names:	numáw (Cree) sigahigun namao (Fox Lake Cree Nation) numao (Chippewyan) (sturgeon <30 lbs.; Norway House Cree) mistanamao (sturgeon >100 lbs.; Norway House Cree) nuhmay (Pikangikum Ojibwe) namay namaew (Cree) Kabasa (Abénaki Nation) name (Ojibwe), namewag (Ojibwe plural) namegoshe (river and rock sturgeon; Sagkeeng Ojibwe) kitchiname (sturgeon >100 lbs.; Sagkeeng Ojibwe) namee (Anishininaabemowin) (from Goulet 2014)

Morphological Description

The Lake Sturgeon has a large, torpedo-shaped body covered with five rows of bony scutes, a heterocercal tail, a large swim bladder, and a single dorsal fin. The species possesses cartilaginous vertebrae that lack a centrum, and the notochord extends into the tail (Scott and Crossman 1973). The snout is pointed with a ventral protrusible mouth and four barbels located anterior to the mouth. Young Lake Sturgeon have characteristic large, dark olive, brown, grey, or black blotches while juveniles and adults are uniform light to dark shades of grey or brown in colour with white ventral surfaces. First Nations fishers report external and internal colour variations from different waterbodies (MacDonell 1997a). Colour variations were most often attributed to water quality. The bony scutes of juvenile Lake Sturgeon are sharp while those of adults are smooth (Scott and Crossman 1973).

Population Spatial Structure

Lake Sturgeon populations (or within watershed meta-populations) across the species range are demographically independent from one another and, presumably, no natural gene flow has occurred between watersheds since they were formed following the last glacial recession.

Within-watershed population spatial structure in Lake Sturgeon is strongly tied to in-stream habitat, which varies both within and among watersheds. For example, in shallow prairie rivers, such as the Saskatchewan River, meandering is the main habitat driver controlled by discharge and its effects on erosion, transport, and substrates; genetic analyses based on microsatellite markers indicates a panmictic population historically occurred along the flow axis (Kjartanson 2009; McDermid *et al.* 2011; Wozney and Wilson 2014). Fragmentation by dams now precludes upstream gene flow at several points, but there is evidence of contemporary upstream to downstream contributions via entrainment of juveniles and adults (Henderson *et al.* 2015d).

In large, stepped-gradient rivers, such as the Winnipeg River, which flow through the Boreal Shield, habitat was highly heterogeneous along the flow axis historically (Johnston 1915; Denis and Challies 1916). Hydroelectric dams on these systems are barriers to upstream movement and gene flow, but contemporary patterns may not be far removed from what existed historically; results of a microsatellite analysis of Lake Sturgeon found upstream and downstream of the Slave Falls Generating Station (GS) (built downstream of historical falls) are consistent with population structure that pre-dates development, stemming from one-way gene flow (McDougall 2011a; McDougall *et al.* accepted).

Several large rivers that empty into Hudson Bay transition from fragmented stepped-gradient Boreal Shield habitats to moderate to low-gradient homogenous habitats as they enter the Hudson Plain. The degree of historical within-watershed genetic structuring has been linked to in-stream habitat type; populations in stepped-gradient upstream reaches tend to be structured due to natural fragmentation, while Hudson plain habitats harbour panmictic populations (Gosselin *et al.* 2015).

On the undeveloped Namakan River, which is a small stepped-gradient Boreal Shield river, evidence of extensive movement by adults was observed that, in combination with a lack of genetic differentiation along the flow axis, was consistent with a panmictic population (Welsh and McLeod 2010).

On the Ottawa River, no evidence for a historically structured population was found based on microsatellite analysis (Wozney *et al.* 2011). On the Rupert River in northern Quebec, there was evidence of isolation by distance (Bernatchez and Saint-Laurent 2004).

In the Great Lakes, many (but not all) tributary populations have been found to be genetically distinct from each other (DeHaan *et al.* 2006; Welsh *et al.* 2008). Welsh *et al.* (2010) identified six management units (MU), based on observed genetic structuring.

The species occurs all along the Quebec portion of the St. Lawrence River, but has been artificially subdivided due to habitat fragmentation. An upstream population, located in Lake St. Francis, was isolated from the downstream population group by the construction of the Beauharnois–Les Cèdres (1912–1961) and Moses-Saunders (1958) hydropower complexes. The downstream population exists in the 350-km long section stretching from the Beauharnois dam to the brackish waters downstream of the city of Québec. Recent tagging studies confirm that Lake Sturgeon resident in the downstream population move throughout the entire mainstem reach and also utilize many major tributaries (Fortin *et al.* 1993; Thiem *et al.* 2013; Valiquette *et al.* 2016), consistent with previous observations of a panmictic stock (Guénette *et al.*, 1993).

Designatable Units

Lake Sturgeon has no recognized subspecies. In the previous COSEWIC report, eight designatable units (DU) were identified based on several genetic studies (Table 1; COSEWIC 2006). Since then, these and additional genetic studies (Welsh *et al.* 2008; Kjartanson 2009; Wozney *et al.* 2011; Côté *et al.* 2011; McDougall 2011a; McDermid *et al.* 2011) were synthesized in an examination of DU structure. A total of 2,781 samples spread across 42 Lake Sturgeon populations in Canada and 3 from Wisconsin were analysed at 14 microsatellite loci (C. Wilson unpubl. data). This analysis has filled several spatial gaps via the inclusion of populations not sampled in previous studies (i.e., Welsh *et al.* 2008; Kjartanson 2009; McDermid *et al.* 2011), but the results are congruent with these studies. Within Canada, there is evidence for two discrete phylogeographic lineages. Lake Sturgeon populations in former DUs 1 to 7 originated primarily from the Missourian glacial refugium and are distinct from Great Lakes (former DU8) populations, which originated from the Mississippian glacial refugium (Figure 1). Specifically, Lake Sturgeon populations in former DUs 5 and 6 exhibit little evidence of Mississippian ancestry despite their proximity to the Great Lakes basin. Populations in former DU5 exhibit Missourian ancestry comparable to the other western DUs, consistent with colonization via glacial Lake Agassiz, whereas populations in the upper watersheds of former DU6 exhibit evidence of admixture, reflecting mixed or multiple colonization history (secondary refugium or colonization). The genetic signature of former DU7 is similar to the former western DUs, assumed to be attributable to a shared Missourian origin (Figure 1). Compared to other fish species, the Lake Sturgeon exhibits low levels of genetic differentiation between populations that have lacked gene flow for several thousand years (i.e., since glacial recession), which reflects both their evolutionary history and long generation time (De Haan *et al.* 2006; Welsh *et al.* 2008; Kjartanson 2009; McDermid *et al.* 2011). The lack of substantial genetic differentiation (distinctiveness) and lack of evidence of significance (e.g. local adaptation) fails to support the eight DU structure used in the previous report (COSEWIC 2006).

Table 1. Designatable units identified for Lake Sturgeon in this report and the previous COSEWIC report (COSEWIC 2006).

Current Report	COSEWIC (2006)
DU1 - Western Hudson Bay	DU1 - Western Hudson Bay
DU2 - Saskatchewan-Nelson River	DU2 - Saskatchewan River
	DU3 - Nelson River
	DU4 - Red-Assiniboine Rivers-Lake Winnipeg
	DU5 - Winnipeg River-English River
	DU6 - Lake of the Woods-Rainy River
DU3 - Southern Hudson Bay-James Bay	DU7 - Southern Hudson Bay-James Bay
DU4 - Great Lakes-Upper St. Lawrence	DU8 - Great Lakes-Upper St. Lawrence

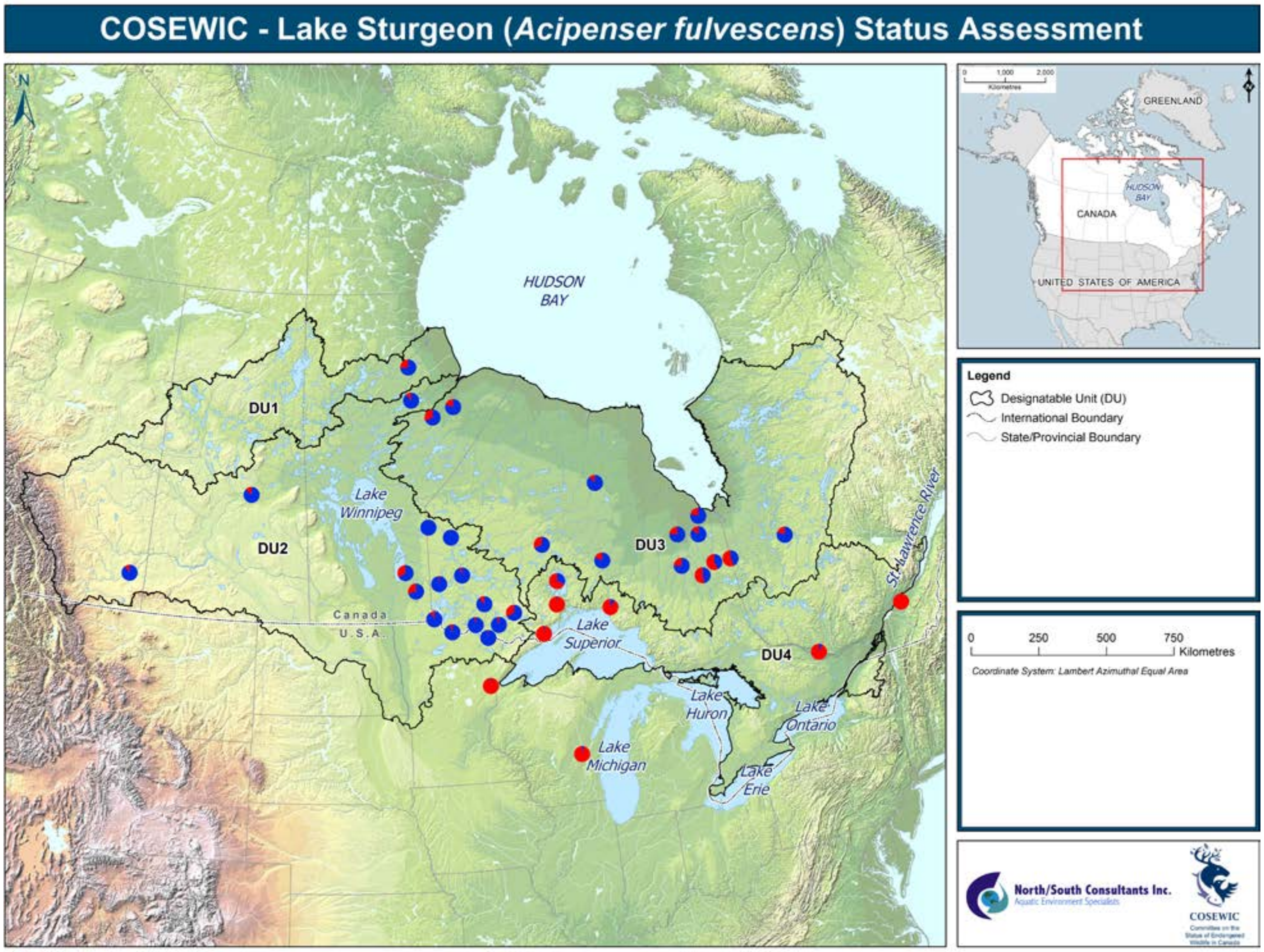

Figure 1. Designatable units delineation based on freshwater biogeographic zones and haplotypes. Pie charts show the population average ancestry for 14 standardized microsatellites K=2 from STRUCTURE (C. Wilson *et al.* unpubl. data)

Lake Sturgeon occupy four national freshwater fish biogeographic zones (NFBZ) and the populations in each of these four NFBZ are considered separate designatable units (COSEWIC 2015) based on the discrete and significance criteria.These DUs are: DU1 - Western Hudson Bay; DU2 - Saskatchewan-Nelson River (former DUs 2-6); DU3 - Southern Hudson Bay-James Bay; and, DU4 - Great Lakes-Upper St. Lawrence (Table 1; Figure 1).

DU1 – Western Hudson Bay

Microsatellite analysis (haplotypes and Bayesian clustering) indicates a Missourian refugial origin (Figure 1); no distinctive traits or significant range disjunctions have been identified. The DU occurs within the Western Hudson Bay NFBZ (COSEWIC 2015) (Figure 2).

DU2 – Saskatchewan-Nelson River

Microsatellite analysis (haplotypes and Bayesian clustering) indicates a Missourian refugial origin (Figure 1); no distinctive traits or significant range disjunctions have been identified. The DU occurs within the Saskatchewan-Nelson River NFBZ (Figure 3).

DU3 – Southern Hudson Bay-James Bay

Microsatellite analysis (haplotypes and Bayesian clustering) indicates a Missourian refugial origin (Figure 1); no distinctive traits or significant range disjunctions have been identified. The DU occurs within the Southern Hudson Bay-James Bay NFBZ (Figure 4).

DU4 – Great Lakes-Upper St. Lawrence

Microsatellite analysis (haplotypes and Bayesian clustering) indicates a Mississippian refugial origin (Figure 1); no distinctive traits or significant range disjunctions have been identified. This DU occurs within the Great Lakes-Upper St. Lawrence NFBZ (Figure 5).

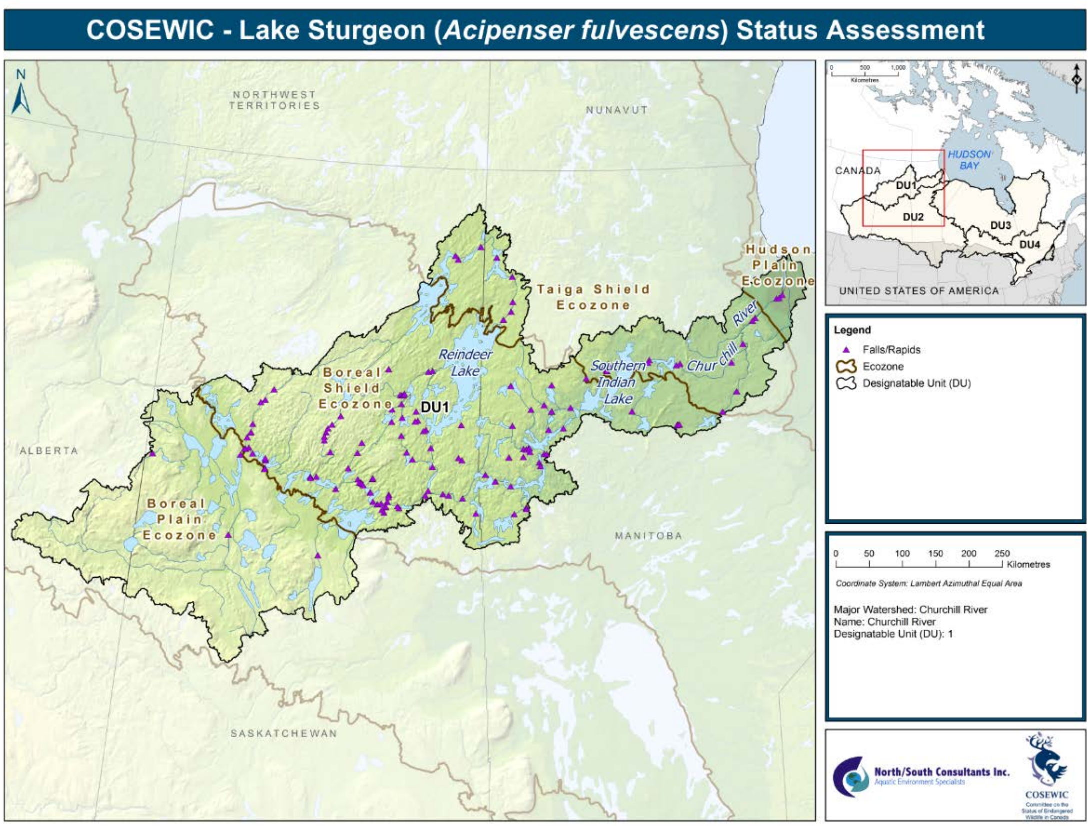

Figure 2.Western Hudson Bay DU showing the terrestrial ecozones and locations of officially named rapids and falls.

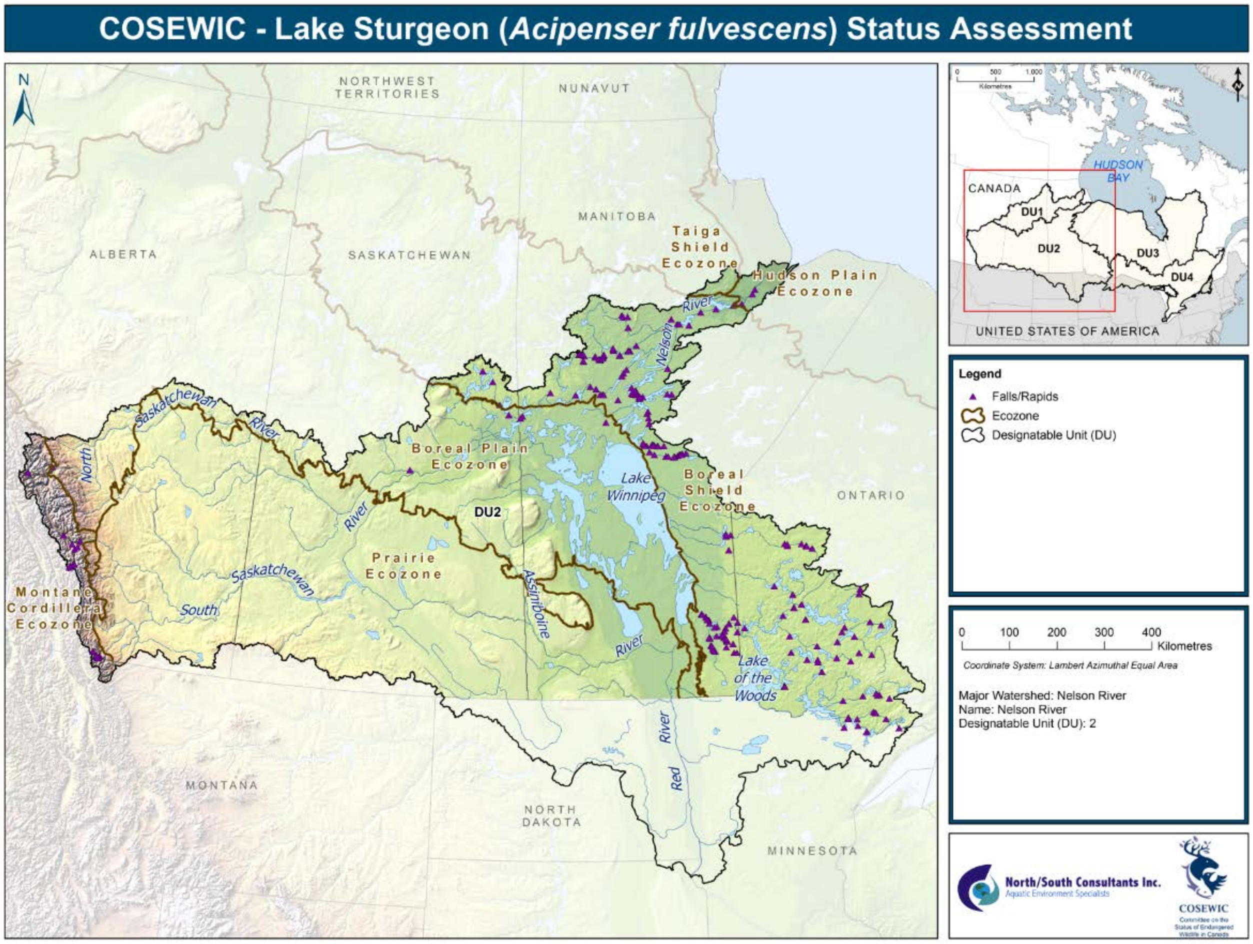

Figure 3. Saskatchewan-Nelson River DU showing the terrestrial ecozones and locations of officially named rapids and falls.

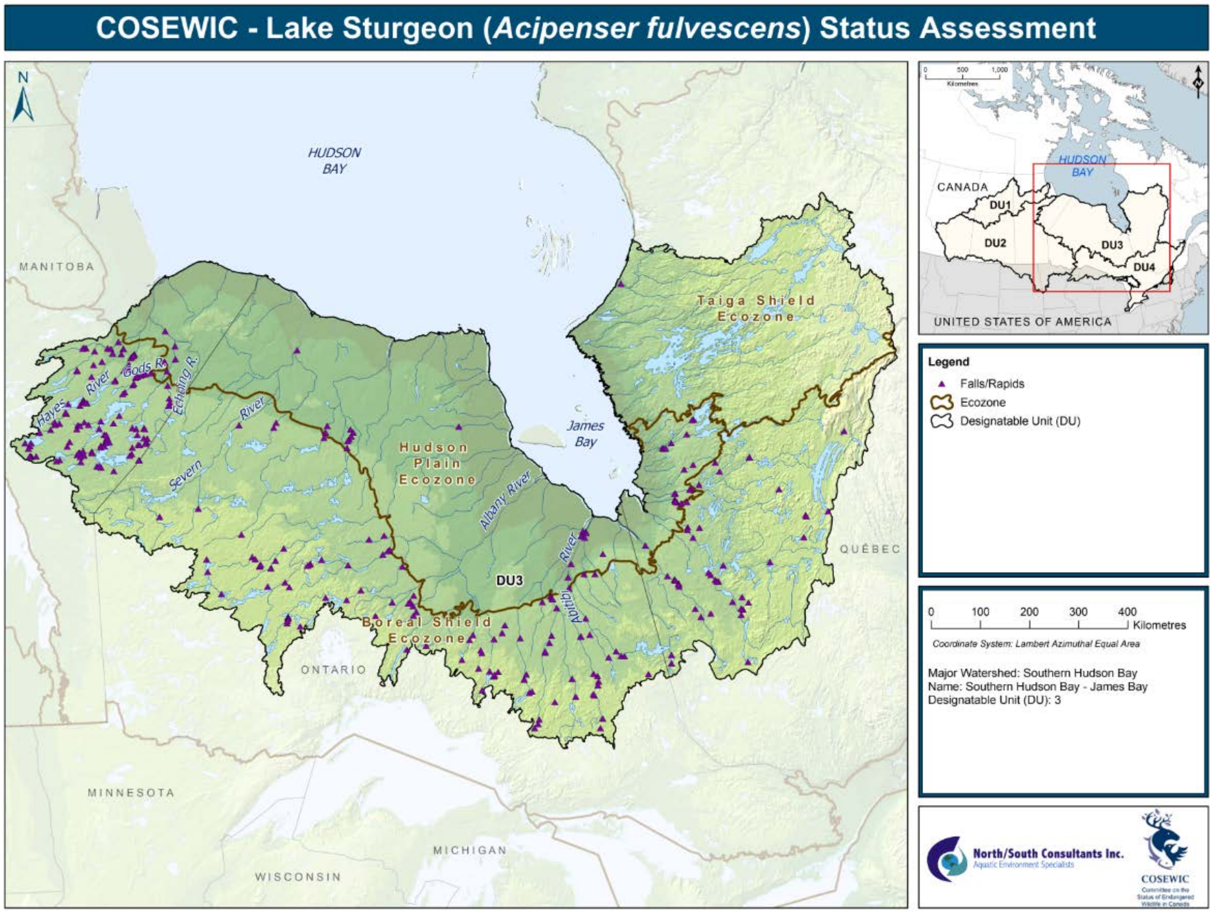

Figure 4. Southern Hudson Bay-James Bay DU showing the terrestrial ecozones and locations of officially named rapids and falls.

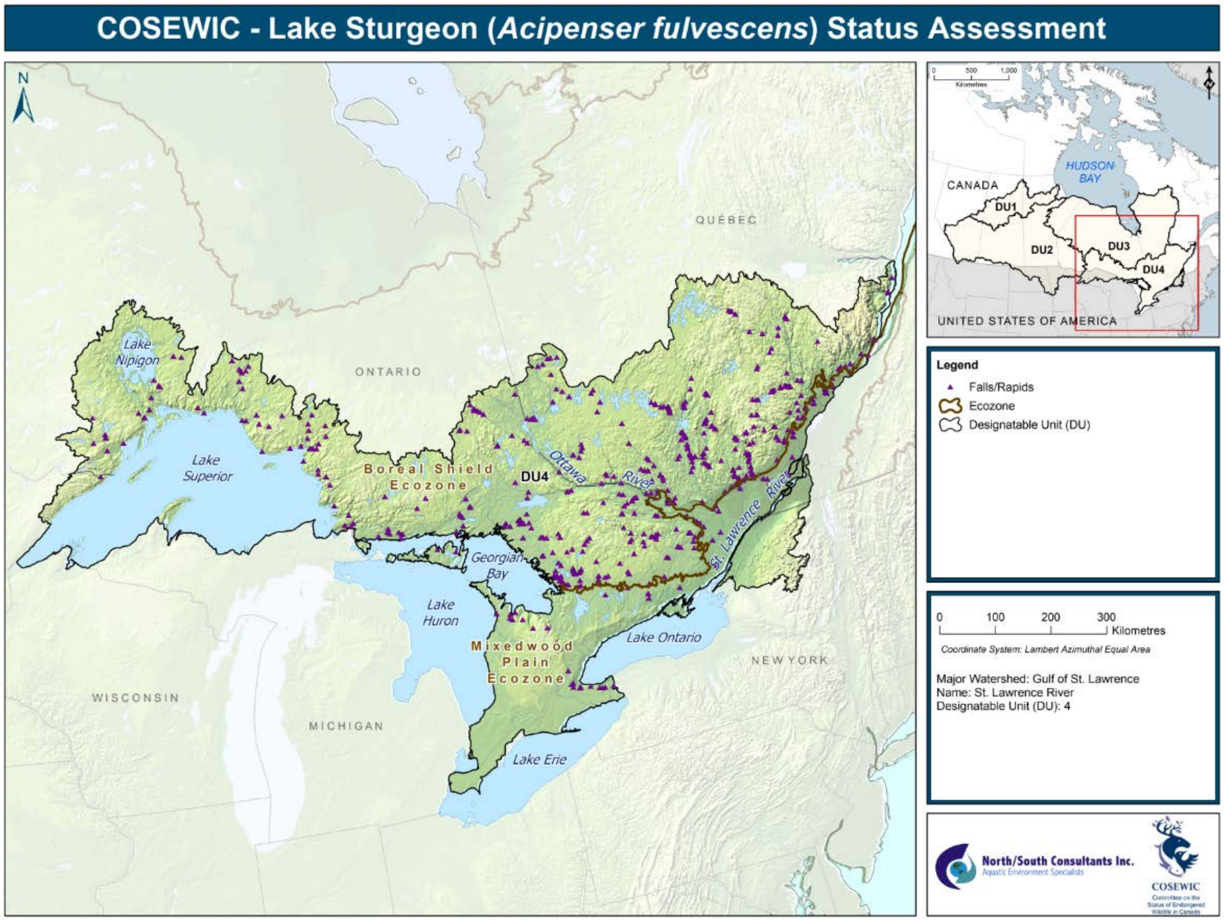

Figure 5. Great Lakes-Upper St. Lawrence DU showing the terrestrial ecozones and locations of officially named rapids and falls.

SPECIAL SIGNIFICANCE

The Lake Sturgeon is one of Canada's largest and most recognizable freshwater fish species (Scott and Crossman 1973). Of the sturgeon species found in Canada, the Lake Sturgeon is the only one that is considered to strictly inhabit fresh waters. It belongs to an ancient group of fishes that have existed in the Holarctic region for over 200 million years (Bemis and Kynard 1997). Sturgeons are referred to as living fossils because they form an extant link between primitive fishes (e.g., sharks) and bony fishes (teleosts) (Krieger *et al.* 2000).

Lake Sturgeon is of special significance to Aboriginal people across its range. Lake Sturgeon was an important food source and closely connected to spirituality (Holzkamm and Wilson 1988; Northern Lights Heritage 1994; Tough 1996). Goulet (2014) reported a long-term, sustained and profound relationship between Aboriginal peoples and Lake Sturgeon conveyed through ancient pictographs and archaeological artifacts, toponyms (place names) and the ancient roots of knowledge evident in creation stories (Cook 2000 cited in Goulet 2014). Lake Sturgeon is sacred to Cree (Federation of Saskatchewan Indians 2012 cited in Goulet 2014) and, for the Anishanabek, Lake Sturgeon is a totemic symbol signifying depth and strength (Luby 2012 cited in Goulet 2014). Algonquin, Cree, Abenaki, Mohawk, and Metis in Alberta, Saskatchewan, Manitoba, Ontario and Quebec have a long and important relationship with Lake Sturgeon (Clermont *et al.* 2003; Dumont and Mailhot 2013; Goulet 2014; Bureau environnement et terre d'Odanak 2015). Several cultural practices evolved specific to treatment of Lake Sturgeon such as disposing of sturgeon remains on shore while fishing to prevent disturbing other sturgeon in the area (MacDonell 1997a; Goulet 2014).

Lake Sturgeon was of considerable economic importance during the 1800s for early settlers and Aboriginal communities. For example, sturgeon fishing for isinglass (a derivative of the swim bladder used in the clarification of beer and in early adhesives) became an important part of regional trade economy of Aboriginal communities circa 1832 (Holzkamm and McCarthy 1988; Northern Lights Heritage 1994). As early as the 1860s, intensive commercial fisheries had been established, driven by an increasing demand for smoked meat and caviar (Harkness and Dymond 1961; Houston 1987). Lake Sturgeon remains of high economic importance to fishers along the St. Lawrence River in Quebec where an 80 tonne annual commercial quota is maintained with restrictive capture size (800-1305 mm) to protect spawners (Mailhot *et al.* 2011; Dumont *et al.* 2013).

DISTRIBUTION

Global Range

The Lake Sturgeon is restricted to North America, ranging from Alberta east to Quebec, and from Hudson Bay south to Alabama (Page and Burr 2011; Figure 6).

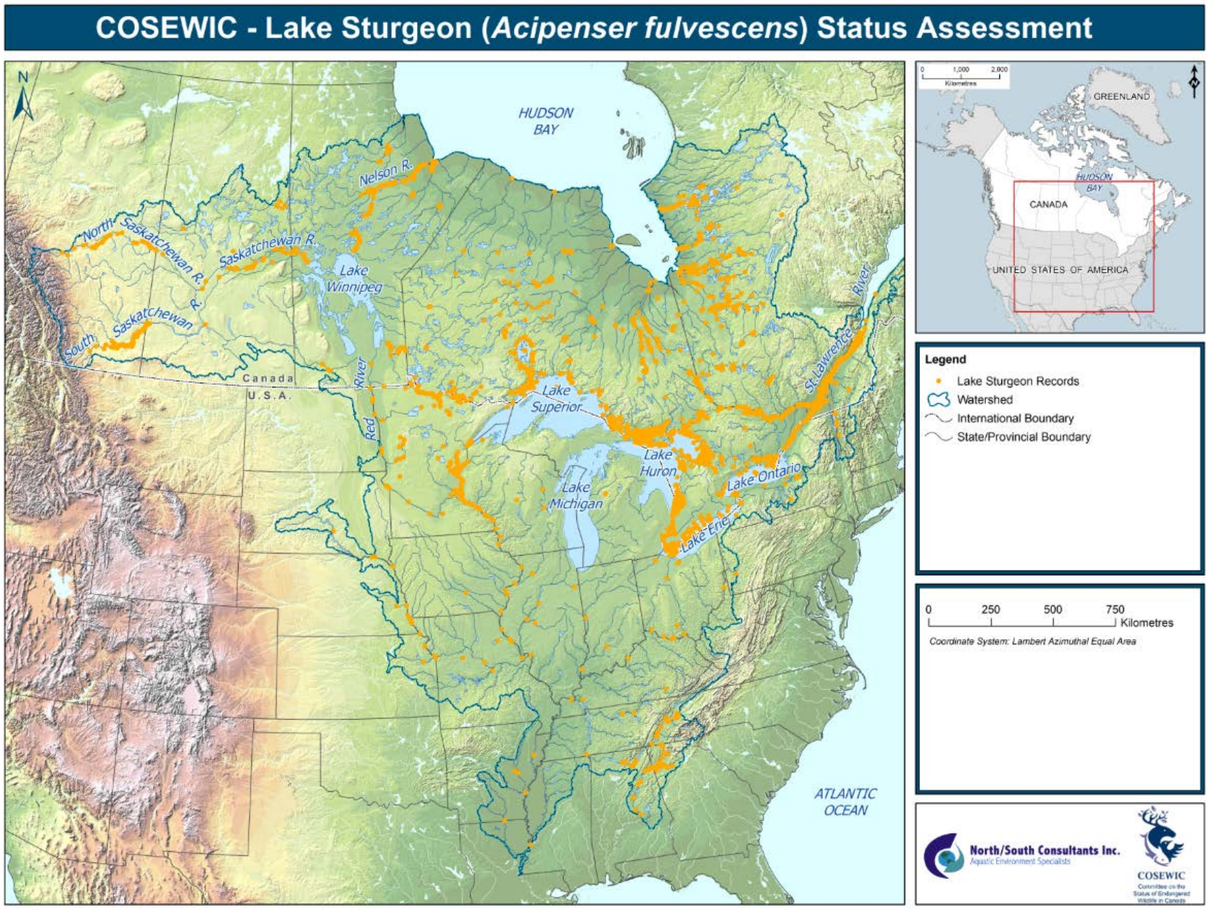

Figure 6. Lake Sturgeon distribution in North America based on historical and contemporary data.

Canadian Range

The distribution of Lake Sturgeon in Canada is confined to the rivers and lakes of Alberta, Saskatchewan, Manitoba, Ontario, and Quebec, specifically those that fall within the Hudson Bay and Great Lakes drainages (Figure 6). In the north, the Lake Sturgeon occurs in the Western Hudson Bay Freshwater Biogeographic Zone in the Churchill River from Kettle Falls in Saskatchewan to Hudson Bay (Scott and Crossman 1973). In the northeast, Lake Sturgeon is present in the La Grande, Rupert, Harricana, Nottaway, Broadback, Eastmain and Opinaca rivers and associated tributaries on the east side of James Bay (Harkness and Dymond 1961; Scott and Crossman 1973). In the western part of its Canadian distribution, the species ranges from the North and South Saskatchewan rivers in southwestern Alberta (Nelson and Paetz 1992) as far east as the St. Lawrence River at Saint Roch des Aulnaies where salinity becomes too high (Harkness and Dymond 1961). The Lake Sturgeon is also present in the lower sections of the larger rivers draining into the St. Lawrence River, such as the Châteauguay, des Prairies, des Mille-Îles, l'Assomption, Ouareau, Richelieu, Saint-François, Saint-Maurice, Batiscan, Chaudière and Montmorency (Stone 1900, 1901).

Extent of Occurrence and Area of Occupancy

Extent of occurrence (EOO) was measured using a minimum convex polygon. Index of area of occupancy (IAO) was calculated as both discrete (D), based on grid over each observation (IAO-D), and continuous (C) based on a continuous stretch of river and lake between observations (IAO-C). Pre-2005 and 2005-present data were considered separately, as this report updates information presented in the 2006 Lake Sturgeon status report (COSEWIC 2006).

<u>DU1 - Western Hudson Bay</u>

The pre-2005 EOO was 43,936 km^2 the 2005-present EOO is 911 km^2, reflecting a substantial observed decrease in EOO.

The pre-2005 IAO-D was 80 km^2, while the 2005-present IAO-D is 64 km^2. The pre-2005 IAO-C was 892 km^2, while the 2005-present IAO-C is 372 km^2. Both IAO measures indicated a significant decrease from pre-2005 values. Given the significant targeted effort to find spawning Lake Sturgeon on the upper Churchill River in Saskatchewan during 2010 and 2011 (see DU1 section), the decreased values currently observed likely reflect a true decrease in EOO and IAO indices for DU1.

<u>DU2 - Saskatchewan-Nelson River</u>

The pre-2005 EOO was 1,083,517 km^2 and the 2005-present EOO is 1,011,515 km^2, reflecting no substantial observed change in EOO.

The pre-2005 IAO-D was 916 km^2, while the 2005-present IAO-D is 1,224 km^2. The pre-2005 IAO-C was 17,172 km^2, while the 2005-present IAO-C is 7,884 km^2. The IAO-D measure indicated an increase from pre-2005 values, while the IAO-C indicated a decrease from historical values. Given the significant targeted effort to study Lake Sturgeon throughout this DU since 2005 (see DU2 section), the changes in IAO-D likely reflect previously unsurveyed locations; conversely, the decrease in IAO-C is probably an artifact of the spatial bias in sampling effort since 2005 (i.e., areas were known to have Lake Sturgeon pre-2005, but no sampling occurred 2005-2015). The spatial extent of Lake Sturgeon in this DU likely remains unchanged.

<u>DU3 - Southern Hudson-James Bay</u>

The pre-2005 EOO was 918,956 km^2 and the 2005-present EOO is 482,724 km^2, reflecting a substantial decrease in EOO.

The pre-2005 IAO-D was 1,280 km², while the 2005-present IAO-D is 636 km². The pre-2005 IAO-C was 49,876 km^2, while the 2005-present IAO-C is 3,928 km^2. Both AO indices indicate a decrease from historical (pre-2005) values. Given the significant targeted effort to study Lake Sturgeon throughout this DU since 2005, changes in IAO are likely an artifact of sampling effort. The spatial extent of Lake Sturgeon in this DU likely remains unchanged

DU4 - Great Lakes-Upper St. Lawrence

The pre-2005 EOO was 827,530 km^2 and the 2005-present EOO is 852,243 km^2, reflecting no substantial change in EOO.

The pre-2005 IAO-D was 5,044 km², while the 2005-present IAO-D is 3,728 km². The pre-2005 IAO-C was 124,204 km^2, while the 2005-present IAO-C is 126,012 km^2. Only IAO-D indicates a decrease from pre-2005 values. Given the significant targeted effort to study Lake Sturgeon throughout this DU since 2005, the changes in IAO-D are likely an artifact of spatial bias in sampling effort since 2005. The spatial extent of Lake Sturgeon occurrence in this DU likely remains unchanged.

Search Effort

Search effort for Lake Sturgeon (see acknowledgements for a complete list) has likely been sufficient to accurately describe the present-day occurrence (above remnant status) in the designatable units, with some exceptions. Juveniles are easily captured via research and fisheries monitoring gillnets deployed in appropriate habitats, while the large size of adults makes them a noteworthy angler and subsistence fisher by-catch worthy of local media attention and reports to fisheries managers. However, search effort has not been sufficient in all inhabited areas to quantify population size or trajectory, although many data gaps have been filled since the 2006 COSEWIC assessment.

HABITAT

The Lake Sturgeon occupies a large range across Canada, spanning four freshwater biogeographic zones and six terrestrial ecozones. Within freshwater biogeographic zones, many rivers that harbour Lake Sturgeon transect multiple terrestrial ecozones and in-stream habitat differs dramatically among ecozones. This is important because a synthesis of recent research indicates that Lake Sturgeon population structure and biology are driven by habitat type. At the watershed scale, habitat is directly related to geomorphology and the resulting hydraulic gradients, which vary by terrestrial ecozones.

Taiga Shield and Boreal Shield habitat consists of large (and often deep) lacustrine reaches separated by short, high-gradient riverine sections. These systems are defined by stepped gradients, as hydraulic drops are concentrated at sites of falls/rapids. Water velocity often decreases immediately downstream of falls/rapids. Boreal Shield systems provide a diversity of habitats over small spatial scales.

Habitat in the Hudson Plains and Mixed Wood Plains ecozones consists of shallow and straight single channels. Hydraulic gradient is moderate and consistent over lengthy stretches of river; mainstem rapids may occur, but are generally infrequent with major rapids/falls located at transition zone between Boreal/Taiga Shield and Hudson Plains. Deep pool and backwater areas are limited.

Habitat in the Boreal Plains and Prairie ecozones consists of shallow, braided and/or meandering channels. Hydraulic gradient tends to be moderate to low and relatively consistent over lengthy stretches of river. As such, habitat characteristics (water velocity, substrate) tend to be similar over large spatial extents, with rapids concentrated in areas of larger glacial deposits.

The Great Lakes proper are characterized by vast expanses of open water; some sections of individual lakes possess significant littoral zones. Numerous tributaries of various size empty into the Great Lakes. Tributaries resemble those found in small to medium Boreal Shield rivers, and/or Prairie and Mixed Wood Plain riverine habitats.

St. Lawrence River habitat is characterized by a deep main channel with moderately deep side channels and extensive shallow/marginal habitats similar to the littoral zone of lakes. The size and discharge of the St. Lawrence River makes it somewhat unique, having significant variation laterally across the channel as well as longitudinally. From Lake Ontario to the Gulf of St. Lawrence, the St. Lawrence River transitions from relatively narrow and fast flowing to wide and more moderate velocities in the fluvial lakes.

Habitat Requirements

Lake Sturgeon populations occur in larger rivers and lakes and require several specific habitats to fulfill their life history (Harkness and Dymond 1961; Scott and Crossman 1973; Auer 1996a). Particularly during its first year of life, there is a spatial procession of habitats utilized; the species tends to exploit the typical upstream to downstream hydraulic (fast- to slow-moving water) and substrate (coarse aggregates to fine sediments) gradients (Gosselin *et al.* 2015; McDougall *et al.* in prep), which are related to fluvial erosion and transport processes (Hjulstrom 1935). Lake Sturgeon spawning often occurs at the upstream extent of a given habitat unit, where high velocities, coarse aggregates, and gravels predominate. Hatched larvae drift downstream to areas where finer sediments, such as sand, tend to settle out. If this area provides sufficient characteristics for overwintering and a suitable forage base, an individual may not need to move significant distance until it is ready to spawn many years later (Barth 2011; Barth *et al.* 2011; McDougall *et al.* 2013b). If proximal habitats are insufficient to support year-round residence, migration (cyclical pattern) may be required (Auer 1996a).

Spawning

Spawning occurs in both tributaries and large-river mainstems that support populations year round. In most systems, females and males congregate downstream of hydraulic features such as falls, rapids, river constrictions, and hydroelectric generating stations (Bajkov 1930; Harkness and Dymond 1961; Scott and Crossman 1973; Priegel and Wirth 1974; Auer 1996a). In the Fox and Wolf rivers, which are tributaries to Lake Winnebago, WI, and harbour a very high density of Lake Sturgeon during the spawning season, egg deposition also occurs along rather nondescript shorelines (Bruch and Binkowski 2002). Spawning has been reported at velocities of 0.1 – 2.1 m/s, over a variety of coarse substrates (cobble, boulder, gravel, bedrock, cinders) and at depths ranging from <0.3 – 23 m (LaHaye *et al.* 1992; Manny and Kennedy 2002; Johnson *et al.* 2006; Chiotti *et al.* 2008; Dumont *et al.* 2011; Thiem *et al.* 2013). On the St. Lawrence and Des Prairies rivers, utilization of artificial "spawning shoals" suggests spawning-site selection is driven by substrate (Johnson *et al.* 2006; Dumont *et al.* 2011; Bouckaert 2013).

Below the Pointe du Bois Generating Station (GS) on the Winnipeg River, MB, egg deposition seems to occur in relation to high-velocity turbine discharges and spillway rapids (physical and energetic barriers), with substrate and depth being largely non-predictive (Gillespie *et al.* in prep.). Spawning shoals have also been constructed in the Pointe du Bois GS tailrace and, while there is some evidence that pre-spawn individuals exploit the off-current refuge downstream of boulders, no spawning has been observed over a 6-year monitoring period despite the presence of an adult population measuring ~2,000 individuals and extensive annual egg deposition <25 m upstream at the base of the powerhouse (Murray *et al.* in prep).

Lake Sturgeon will shift spawning locations. In the Winnebago system, the addition of coarse substrate (including cinders) has yielded spawning in areas where it was historically unknown (R. Koenigs pers. comm.). On one section of the Nelson River, MB, the Landing River tributary supported spawning runs of hundreds of fish prior to decimation by commercial and then subsistence harvest (D. Macdonald pers. comm.). Currently, the tributary is largely ignored (despite habitat still being suitable), and spawning occurs in the Nelson River mainstem. Specifically, the fish utilize a nearshore, recently eroded area; 20 years ago, this area was not wetted habitat (D. Macdonald, pers. comm.). In the Detroit River, ON/MI, spawning Lake Sturgeon show no repeatable preference for any of the sites recently enhanced with limestone aggregates (Roseman *et al.* 2011).

Egg incubation and hatch

Successful larval-hatch is contingent on sufficient aeration via oxygenated water, which flow provides (Harkness and Dymond 1961, Scott and Crossman 1973, Beamesderfer and Farr 1997). Dewatering and subsequent desiccation of eggs during the incubation period (see Biology section) is assumed to result in complete mortality (Ferguson and Duckworth 1997, Caroffino *et al.* 2010). Based on one field-laboratory study examining velocities of ~0.1, 0.3, and 0.5 m/s, both the 0.3 and 0.5 m/s treatments were determined suitable for successful hatch, while lower velocities were deemed inferior due to sedimentation, predation, and fungal infection (Hrenchuk 2011). There has been little effort to assess the combined influence of habitat configuration, flow, and predator assemblages on larval hatch in field settings, which can be highly dynamic due to environmental variation as well as anthropogenic influence.

Larval drift and age-0

The understanding of habitat requirements of sturgeon species from hatch to age-1 has improved in recent years. Gravel substrates allow large numbers of yolk-sac larvae to burrow and thereby avoid predation during development; other substrates do not allow for this (Auer and Baker 2002; Bennett *et al.* 2007; Gessner *et al.* 2009; McAdam and Jonsson 2011; Crossman and Hildebrand 2012; Hastings *et al.* 2013). Following yolk-sac absorption and emergence from the gravel, flow facilitates downstream dispersal (La Haye *et al.* 1992; D'Amours *et al.* 2001; Auer and Baker 2002; Smith and King 2005a; Caroffino *et al.* 2009; Verdon *et al.* 2012). The characteristics of habitat that cue exogenous-feeding larvae to settle out is a focus of current research but, at present, the understanding is incomplete. In shallow Great Lakes tributaries, larvae and age-0 fish are generally observed on sand substrate (Kempinger 1996; Holtgren and Auer 2004; Benson *et al.* 2005), which tends to co-occur with low water velocities in these shallow, low-gradient systems. Laboratory studies have suggested that sand is preferred by age-0 Lake Sturgeon of Wisconsin pedigree (Peake 1999), but to conclude that this substrate is a requirement for this life stage across the species' range may not be accurate, as recruitment seems to be occurring in at least one area (the Great Falls Reservoir on the Winnipeg River, MB) that is devoid of large, sand-dominated patches (McDougall 2011b; Murray and Gillespie 2011; McDougall *et al.* 2014b).

Little is known regarding overwintering requirements for age-0 fish but, based on inferences from larger conspecifics, individuals likely require off-current refuge from flow; lakes downstream of spawning tributaries in the Great Lakes area, and pools, deeper holes, natural lacustrine widenings, and some artificial reservoirs in large rivers all likely provide the appropriate characteristics (Kempinger 1996; Knights *et al.* 2002; Benson *et al.* 2005; Labadie 2011; Barth *et al.* 2011; McDougall *et al.* 2013b; Wishingrad 2014; Pollock *et al.* 2015).

Juvenile and adult

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 flowages) inhabited by the species (Sunde 1961; Fortin *et al.* 1996; Power and McKinley 1997; Bruch 1999; Adams *et al.* 2006; Vélez-Espino *et al.* 2006; Shaw *et al.* 2012; McDougall *et al.* in prep.). Combined with the latitudinal range of the species, this suggests that habitat requirements to support these life-history stages are not particularly strict.

Juvenile and adult Lake Sturgeon, largely not susceptible to predation after age-1, require overwintering habitat that offers refuge from flow (see inferred requirements for age-0), and foraging habitat that provides a sufficient food supply to allow them to attain the large sizes typically associated with sexual maturity (Harkness and Dymond 1961; Sunde 1961; Scott and Crossman 1973; Bruch 1999; Peterson *et al.* 2003; Smith and Baker 2005). Movement corridors between these habitats are also required. Foraging habitat for small juveniles is likely limited to lotic or lotic-to-lentic transition areas that offer drifting invertebrates and/or in situ benthic production; however, the reliance on flow to deliver drifting prey items is expected to ease as an individual ages/grows and its food-base diversifies. By the time Lake Sturgeon reach adult size, they are able to exploit a plethora of food resources (Harkness and Dymond 1961; Scott and Crossman 1973; MacDonell 1997a; Stelzer *et al.* 2008; Goulet 2014; Smith *et al.* 2016).

Given the variety of systems that Lake Sturgeon inhabit, it is important to note that, unless genetic adaptation has occurred, apparent differences in utilization and movement patterns of middle to later life stages probably reflect habitat preferences rather than requirements specific to a given population.

Population-level habitat units

The hypothesis of self-sustaining Lake Sturgeon populations requiring a minimum of 250-300 km of barrier-free lake and river habitat (Auer 1996a) has often been cited as a rule of thumb (Snellen 2008; Wozney *et al.* 2011; Thiem *et al.* 2011; Lacho 2013; Pollock *et al.* 2015). However, in recent years, it has become clear that recruiting populations exist in sections of river as small as 10 km (McDougall *et al.* in prep.). Furthermore, genetic evidence suggests that populations have thrived in naturally fragmented rivers, within sections much smaller than 250 km in length, for thousands of years (Côté *et al.* 2011; McDougall 2011a; Gosselin *et al.* 2015). Self-sustaining populations require uninterrupted spawn-drift-settle-establish habitat sequences, but there is variation in the distance over which these occur, driven by system geomorphology and resulting hydraulic/substrate gradients (Gosselin *et al.* 2015; McDougall *et al.* in prep.).

Habitat Trends

Historically, construction of dams, diversion and alteration of flows and introductions of deleterious substances (e.g., wood fibres, sediment) profoundly altered Lake Sturgeon habitats across North America. Such changes were observed and noted by several First Nations as presented in Goulet (2014). Opaskwayak Cree Nation in Manitoba noted alterations to water flows and levels in the Saskatchewan River Delta region from hydroelectric projects in the 1960s. The diversion of the Churchill River into the Nelson River from the mid-1970s to 1990s was observed to have reversed seasonal flows and water levels on the Nelson River (Split Lake Cree FN 1996). Fluctuations in water depth and flow were observed by Norway House community members following construction of the Jenpeg GS (Hannibal-Paci 2000). Following construction of the Limestone Dam, York Landing members observed changes to many streams and rivers (Hannibal-Paci 2000). Habitat alterations in the traditional resource-use area of Fox Lake First Nation included the diversion of the Butnau River and altered habitat in the Nelson River from Gull Rapids to the Limestone Rapids (Agger 2012). Chemawawin First Nation Elders reported that construction of the Grand Rapids Dam (built 1960-1968), which flooded Cedar Lake, MB, resulted in changes to water quality and increased debris in the waterways (Schueler 2012). Members of the Roseau River Anishinabe First Nation in Southern Manitoba suggested that the St. Andrews Lock and Dam have constrained the ability of Lake

Sturgeon to travel upstream to spawn in the Roseau River since the early 1900s (Roseau River International Watershed 2007). Sagkeeng fishers reported that the Pine Falls Dam, constructed in 1952, and the McArthur Falls powerhouse, constructed in 1955, altered Lake Sturgeon spawning localities in the Winnipeg River area (Hannibal-Paci 2000). In the St. Lawrence River, the Lake St. Francis population was fragmented by the construction of the Beauharnois-Les Cèdres (1912–1961) and Moses-Saunders (1958) hydropower complexes. Ottawa River populations were fragmented by dams beginning in the 1850s, with the last dam being built in 1964 (Carillon dam).

Habitat trends vary across the species' range. In DU4, the construction of dams on historical spawning tributaries has largely ceased although dams are still being built at natural barriers upstream of the species extent. In the United States, some dam removals on systems inhabited by Lake Sturgeon have already occurred (Borkholder *et al.* 2002; Aadland *et al.* 2005) and others are being considered. Conversely, large dams have been and/or likely will continue to be constructed in the coming decades in DUs 1-3.

Well dispersed among the four DUs, water and sediment quality appear to be improving in some systems historically impacted by the pulp-and-paper industry since mills were shut down and/or tighter environmental standards have been implemented (Beak Consultants 1990 in Rusak and Mosindy 1997; D. Gibson pers. comm.).

BIOLOGY

Life Cycle and Reproduction

Spawning

Much of the knowledge regarding Lake Sturgeon spawning behaviour comes from the Great Lakes region, where fish can be visually observed in shallow, relatively clear waters. Males arrive on the spawning grounds first and wait for females (Priegel and Wirth 1974; Bruch and Binkowski 2002; Forsythe *et al.* 2012a). Spawning occurs at water temperatures ranging from 8-21.5°C (Harkness and Dymond 1961; Scott and Crossman 1973; Priegel and Wirth 1974; La Haye *et al.* 1992; Bruch and Binkowski 2002; Johnson *et al.* 2006; Dumont *et al.* 2011; Forsythe *et al.* 2012a), although the peak windows for some populations tend to be considerably narrower (Thiem *et al.* 2013; Gillespie *et al.* in prep.). These temperatures correspond to environmental cues, such as when rose buds or poplar leaves emerge, used by First Nations to identify local Lake Sturgeon spawning periods (Hannibal-Paci 2000; MacDonell 1997). Individual females are predisposed to depositing eggs during the early, middle, or late portions of the spawning window and there is evidence to suggest inter-annual repeatability in terms of spawning location by individual females (Forsythe *et al.* 2012a). Males often remain on, or near, the spawning grounds for the entire period, and spawn with multiple females during a given year (Bruch and Binkowski 2002; Forsythe *et al.* 2012a). The temporal distribution of spawning behaviour varies by location; for example, on the Wolf River, WI, the number of females spawning across the broad window follows a normal distribution, with the spread influenced by the rate of water warming; inclement weather can disrupt and/or delay spawning behaviour (Bruch and Binkowski 2002). Below the Pointe du Bois GS on the much larger Winnipeg River, MB, egg mat data indicate that the primary spawning peak is skewed towards the onset of spawning behaviour, tapering off thereafter (Gillespie *et al.* in prep.). In Black River, MI, lagged effects of water temperature and flow, as well as moon phase have been identified as spawning cues (Forsythe *et al.* 2012b). A smaller secondary spawning peak, often 7-14 days after the primary, is known in at least a few populations (Bruch and Binkowski 2002; Friday 2014; Gillespie *et al.* in prep.).

The act of spawning was chronicled by Bruch and Binkowski (2002). A single female releases her eggs while attended to by one or more males. Eggs are broadcast into the water column where a proportion are fertilized during a series of individual spawning bouts that last only a few seconds, spread over a period of <1 hour. The end result is that the Lake Sturgeon mating system is both polyandrous and polygynous. No parental care is provided by adults, whose attention shifts quickly to foraging after spawning (Bruch and Binkowski 2002). Reproductive senescence has never been reported in Lake Sturgeon.

<u>Eggs and larvae</u>

Fertilized Lake Sturgeon eggs quickly develop a sticky exterior, which allows them to adhere to the substrate. Incubation times are driven by water temperature and are conditional on sufficient aeration with oxygenated water. A small proportion will hatch 5 - >20 days after deposition (Harkness and Dymond 1961; Kempinger 1988; La Haye *et al.* 1992; Auer and Baker 2002; Hastings *et al.* 2013; Eckes *et al.* 2015). Upon hatch, yolk-sac larvae are generally reputed to burrow within gravel, hiding in the interstitial spaces (particularly gravels) from would-be predators while the yolk-sac is absorbed (Kempinger 1988; La Haye *et al.* 1992; Auer and Baker 2002). Following plug-shedding 10 to 14 days post-hatch, the need to exogenously feed forces the larvae to emerge from the substrate and drift downstream (Kempinger 1988; La Haye *et al.* 1992; Auer and Baker 2002; Caroffino *et al.* 2009).

The time it takes for eggs to hatch is well predicted using a cumulative thermal unit (CTU) approach (Kempinger 1988; Smith and King 2005a; Friday 2014; Eckes *et al.* 2015). In Black Lake, MI, Smith and King (2005a) found that incubation was complete after 54.7 to 71.4 CTUs, while peak drift of exogenous feeding larvae occurred after 136.2 to 181.2 CTUs. Conversely, on the Kaministiquia River, ON, in 2013, peak larval drift occurred at 267 CTUs (Friday 2014). Slight variation in development trajectories among populations seems conceivable based on the aforementioned results; however, Eckes *et al.* (2015) derived development indices using eggs and larvae from the Wolf River, WI and found that development of St. Lawrence River eggs and larvae to all stages occurred within 24 h of the predicted relationship. At temperatures ranging 10-19.9 °C, the development from fertilization to exogenous feeding occurred at rates of 2-8.3% per day (Eckes *et al.* 2015). Friday (2014) found CTUs ranging from 299-571 prior to the end of the larval drift period over a 10-year monitoring interval on the Kaministiquia River, ON, which suggests inter-annual variation within populations, perhaps as a function of the temporal distribution of spawning behaviour. As such, variation in drift relative to CTU accumulation patterns seems likely to vary between populations as well.

While burrowing in the vicinity of where eggs were deposited seems to be the norm in the Great Lakes tributaries, some free-embryos (yolk-sac larvae) drifting immediately following hatch have been observed (Friday 2014) or assumed likely (Hastings *et al.* 2013). Recent laboratory studies have shown that free-embryos, hatched at the upstream end of flumes on solid material, periodically probe the substrate as they drift downstream (Hastings *et al.* 2013). During these trials, free-embryos settled out exclusively in gravel substrates, bypassing those (sand included) apparently unsuitable. This may explain why, on the large Winnipeg River system, the majority of the larvae captured in drift nets set immediately downstream of egg deposition locations at the Pointe du Bois GS between 2006 and 2014 were newly hatched yolk-sac individuals (McDougall *et al.* 2008a,b; McDougall and MacDonell 2009; Koga and MacDonell 2011, 2012; Mandzy *et al.* 2015). Given the amount of recruitment occurring in this system (it is suspected that carrying capacity is being approached; McDougall *et al.* in prep.), free-embryos drifting after hatch may not always be cause for concern. Rather, the pattern could relate to the spatial configuration of available habitat; following hatch, individuals may be blown out of interstitial spaces, along with sediments in which they were buried, when flows increase following spawning. Alternatively, there may be insufficient gravel in the spaces among larger aggregates (boulder/cobbles) immediately downstream of the spawning location to facilitate burrowing, necessitating downstream drift until the hydraulic gradient dictates the presence of larger gravel patches. Dispersal distance of free-embryos prior to settling out also varied in the laboratory study as a function of family (i.e., offspring body size and endogenous yolk-reserve differences) and egg-incubation temperatures (Hastings *et al.* 2013).

True larval drift (i.e., after exogenous feeding has commenced) is partially passive, but behaviour and habitat selection also seem to play a role. In small Great Lakes tributaries and other shallow rivers, both the longitudinal and vertical distribution of drift appears to be non-random (Caroffino *et al.* 2009; Verdon *et al.* 2012). Larvae are negatively phototactic (Ćeskleba *et al.* 1985; Peterson *et al.* 2007; Hastings *et al.* 2013), and exhibit circadian rhythms (Svendsen *et al.* 2014). Day/night variation in behaviour has been observed in shallow Great Lakes and St. Lawrence River tributaries; drift seems to occur more often at night, and the larvae tend to be oriented higher in the water column under the cover of darkness (Kempinger 1988; D'Amours *et al.* 2001; Auer and Baker 2002; Dumont *et al.* 2011). The relative abundance of larvae in bottom-set drift traps relative to traps 1 m above the river bottom in the Winnipeg River, MB, suggests that, in large, deep rivers, larvae are predominantly bottom-oriented (Henderson 2013).

Where, when, and why larval Lake Sturgeon settle out is not well understood, but it seems likely that distance itself is meaningless and that water velocity gradients, substrate gradients, and/or energetic demands associated with exogenous feeding drive the general pattern. This is the most plausible explanation as to why, for example, a high proportion of larvae in the Sturgeon River, MI, might drift >61 km prior to settling out (Auer and Baker 2002), yet enough clearly establish within the 10-km long Slave Falls Reservoir on the Winnipeg River, MB to allow a population measuring in the 1000s of fish to develop (McDougall *et al.* in prep.).

Age-0

The transition of larval stage to age-0 is rather cryptic and, therefore, difficult to characterize. The assumption is that once larvae settle-out, they move little on a daily basis (Benson *et al.* 2005), perhaps relying on drifting invertebrates to be delivered via flow. Foraging on small drifting organisms probably continues into fall, with diet incorporating increasingly larger organisms as the sturgeon grows. In Great Lakes tributaries, age-0 fish are typically observed in shallow (<5 m) habitats characterized by low-velocities and sand or pea-sized gravel substrates (Kempinger 1996; Holtgren and Auer 2004; Benson *et al.* 2005), which generally co-occur in these systems. In both the middle and lower sections of the Nelson River, which is a moderate- to high-flow environment, age-0 fish have been captured in deeper sections characterized by lower velocities and sand substrate (Ambrose *et al.* 2009; 2010; MacDonald 2009); however, it should be noted that high-velocity/coarse-substrate habitats cannot be effectively sampled in this system, and there has been minimal investigation of potential utilization in backwatered main-channel habitats. This may be relevant, because, in the Winnipeg River, a large stepped-gradient river system, age-0 fish have been captured in gill nets at depths ranging from 5-35 m, over sand, clay, gravel, cobble, boulder, bedrock, and silt substrates (McDougall *et al.* 2008a; 2008b; McDougall and MacDonell 2009; Barth 2011; McDougall 2011b; Henderson 2013; Lacho *et al.* 2015b). Synthesizing data from multiple Winnipeg River reservoirs, no clear pattern of habitat selection has emerged (Manitoba Hydro 2014). Reported gut contents include Diptera, Ephemeroptera, Trichoptera and Nematoda, results corroborated by stable isotope analysis (Henderson 2013).

In the Great Lakes area, age-0 fish that spend summer at the lower end of shallow tributaries often move downstream into deeper lacustrine habitats to overwinter (Kempinger 1996; Benson *et al.* 2005). In the Winnipeg River, MB, results of various gillnetting studies (McDougall *et al.* 2008a,b; McDougall and MacDonell 2009; Barth *et al.* 2009; Barth 2011; Henderson 2013; Klassen 2014) provide no evidence for a marked seasonal shift in spatial distribution of age-0 fish, presumably because there is spatial overlap of foraging habitat and overwintering habitat for young Lake Sturgeon within these systems.

Juvenile and adult

At the time of the 2006 COSEWIC assessment, the juvenile life stage represented a major gap in the understanding of the species' biology (COSEWIC 2006, Peterson *et al.* 2007). Much has been learned over the past decade, although research has focused on certain river types (e.g., large stepped-gradient rivers in the Boreal Shield, large lake/tributary systems in the Great Lakes basin and St. Lawrence River). This is important because there appears to be marked variation in terms of movement and habitat utilization trends of juvenile Lake Sturgeon across the species' range, with habitat variation presumably being a primary driver. As such, caution must be taken to avoid generalizing too broadly for system types for which the knowledge of the juvenile life stage is lacking. Significant gains have also been made regarding the biology of adults in recent years, but most of the information summarized herein needs to be considered in the context of the habitat from which the observations were derived.

The confounding issue of variable size/age at maturity on the designation “juvenile” also needs to be considered when attempting to compare and consolidate results of the various Lake Sturgeon studies; the juvenile stage is protracted and, on most systems, “adult” status is not attained until a fish measures >1000 mm FL (Bruch 1999; Smith and Baker 2005). However, much of the recent juvenile literature focuses on fish <800 mm FL (Barth *et al.* 2009; 2011; McDougall *et al.* 2013b; 2014b; Boase *et al.* 2014; Hrenchuk *et al.* in prep.). Herein, an attempt was made to differentiate between juvenile and adult stages based on the designations provided by original authors, but it should be noted that, in terms of diet and habitat utilization patterns, variation likely reflects a gradual transition process, as opposed to a sudden shift associated with the onset of maturity.

Diet

Lake Sturgeon is a benthic generalist during middle to later life stages, whose diet often diversifies with age/size as increasing larger food items can be consumed (Kempinger 1996; Chiasson *et al.* 1997; MacDonell 1997a; Beamish *et al.* 1998; Jackson *et al.* 2002; Werner and Hayes 2004; Smith and King 2005b; Nilo *et al.* 2006; Guilbard *et al.* 2007; Barth *et al.* 2013; Goulet 2014). Amphipods, ephemeropteran larvae, trichopteran larvae, molluscs (including Zebra Mussel, *Dreissena polymorpha*), dipteran larvae, chironomids, crayfishes, snails, and leeches have all been reported as accounting for high proportions of juvenile stomach contents (Kempinger 1996; Chiasson *et al.* 1997; Beamish *et al.* 1998; Jackson *et al.* 2002; Smith and King 2005b; Nilo *et al.* 2006; Guilbard *et al.* 2007; Barth *et al.* 2013). Large adults are known to feed at higher trophic levels (i.e., consume fishes) (Harkness and Dymond 1961; Cuerrier 1966; Thomas and Haas 1999; Stelzer *et al.* 2008; Smith *et al.* 2016).

Foraging behaviour

Lake Sturgeon exhibit pronounced diel swings in activity rate, as the catch rate of day sets tends to be much lower than for those set overnight (Chiasson *et al.* 1997). However, there is contradictory evidence for spatial shifts in habitat utilization as a function of diel variation during the open-water (foraging) period. Holtgren and Auer (2004) observed vertical shifts, with juveniles tending to be located several metres shallower during night hours in Portage Lake, MI. On the upper section of the South Saskatchewan River, AB/SK, characterized by depths <5 m, low velocities, fluctuating water clarity, and substrate homogeneity over large spatial scales, both juveniles and adults tended to be more frequently detected and also moved between acoustic monitoring stations at night (Lacho 2013). In the Stephens Lake section of the Nelson River, MB, characterized by a river/reservoir transition zone, very low water clarity, and depths in the old river channel varying from 5 – 35 m, average day versus night vertical shifts for juveniles was only ~13 cm, and no evidence for a population-level pattern was found (Hrenchuk *et al.* in prep.). On the Winnipeg River, MB, characterized by moderate water clarity, and depth/substrate/velocity heterogeneity, movements into the vicinity of Slave Falls GS spillway infrastructure only occurred at depths of 6 - 9 m during night, whereas approaches via deeper water (9 – 13 m) occurred during both day and night. Also, on the Winnipeg River, diel period improved the fit of an adult activity model in Lac du Bonnet (Struthers

2016). In Muskegon Lake, MI, acoustic telemetry revealed no significant diel influence on movement patterns or depth utilization (Altenritter *et al.* 2013). In the Namakan River, ON/MN, no indication of a diel movement pattern was observed (Trembath 2013). In summary, it seems likely deep-rooted circadian rhythms drive diel activity patterns (Svendsen *et al.* 2014), but how these manifest in terms of movement and utilization tendencies seems to vary by location. Again, assuming that genetic adaptation has not occurred, habitat variation would seem the logical driver.

Based on the presence of annuli at the outer edge of pectoral-fin spines for juveniles sampled during fall (McDougall *et al.* 2014b, d), seasonal growth often has ceased by the time water temperature declines to 10°C. Temperature manipulation trials conducted in the Grand Rapids Hatchery, MB, also suggest a fast-to-slow growth transition point at ~10°C, at least for juveniles of Nelson River pedigree (C. Klassen pers. comm.).

<u>Movement and habitat utilization</u>

The following sections summarize what is known about Lake Sturgeon movement and habitat utilization patterns in various systems, in relation to foraging and overwintering. In general, there is more discrepancy than consistency, likely due to habitat variation among the systems where studies were conducted. The following commonalities seem to transcend system types:

1) Habitat preferred by juvenile Lake Sturgeon (and perhaps larger conspecifics) tends to be devoid of aquatic vegetation (Kempinger 1996; Holtgren and Auer 2004; Smith and King 2005b; Barth *et al.* 2009, 2011; Trembath 2013; McDougall *et al.* 2013b). 2) Lake Sturgeon often occur in multi-cohort aggregations and are not uniformly distributed among suitable/accessible habitats (Chiasson *et al.* 1997; Knights *et al.* 2002; Barth *et al.* 2009, 2011; Altenritter *et al.* 2013; McDougall *et al.* 2014b; Hrenchuk *et al.* in prep.). While probably not a complete explanation, one laboratory study revealed the lack of size-based hierarchal behaviour structure and that the presence of conspecifics shortened individuals' responses to acute stress, suggesting that there may be social benefits associated with these aggregations (Allen *et al.* 2009). 3) Likely related to point #2, individuals often exhibit affinity to core areas (i.e., activity centres) and/or habitual movement patterns during mid- to later life stages (Rusak and Mosindy 1997; Borkholder *et al.* 2002; Knights *et al.* 2002; Haxton 2003; Barth *et al.* 2011; Déry 2012; Trembath 2013; McDougall *et al.* 2013b; Wishingrad *et al.* 2014; Valiquette *et al.* 2016). 4) Lake Sturgeon seems to move little during winter (i.e., remain within the same basin or move < 5 km) (Rusak and Mosindy 1997; Borkholder *et al.* 2002; Knights *et al.* 2002; Welsh and McLeod 2010; Labadie 2011; Barth *et al.* 2011; Lacho 2013; Shaw *et al.* 2013; McDougall *et al.* 2013b, 2014c). 5) Lake Sturgeon are capable of moving (migrating) vast distances (e.g., > 100 km) to fulfill life history requirements when spawning, overwintering, and foraging habitat are not located in close proximity to each other (Auer 1996a; Knights *et al.* 2002; Lacho 2013).

Physiology and Adaptability

Maximum thermal tolerance of Lake Sturgeon is uncertain, but water temperatures above 28 – 30 °C have been reasoned to be less suitable (Lyons and Stewart 2014). At the other extreme, it is clear that Lake Sturgeon resident in northern rivers are able to survive temperatures of 0 °C for up to 6 months at a time (McDougall *et al.* 2014c; 2014d). Populations occur in turbid, low-clarity rivers, such as the lower Nelson River, high-clarity oligotrophic systems, such as Lake Superior, and a broad range in between. Oxygen tolerance of Lake Sturgeon is not known.

Small Lake Sturgeon (~110 mm FL) have been reported to be able to survive salinities of 16 ppt, but only for short duration (Suchy 2009). These results agree with the conclusions of Lebreton and Beamish (1998) that it is unlikely that juvenile Lake Sturgeon reside in salinities much above 15 ppt, nor survive even brief exposure to 25 ppt. Larger individuals were determined to be more tolerant and may exploit brackish waters in Hudson Bay and the St. Lawrence River, as long as concentrations do not greatly exceed 15 ppt (LeBreton and Beamish 1998).

The Lake Sturgeon is regarded as a poor swimmer relative to salmonids, owing to excessive drag (scutes) during juvenile stages, a heterocercal tail, and a generally lower metabolism (Webb 1986; Singer *et al.* 1990). Peake *et al.* (1997) examined the swimming performance of Lake Sturgeon. Endurance was reported to increase with body size over a range of speeds and temperatures. Water temperature was found to be positively correlated with maximum sustained speeds and endurance; a ~390 mm FL can achieve 12 cm/s at 7°C and 26.0 cm/s at 21°C. Similarly, a ~390 mm FL individual swimming at 90 cm/s tires after 7.8 s at 7°C and 9.7 s at 21°C. Bottom-holding facilitated by large pectoral fins aside, an 1170 mm FL Lake Sturgeon can maintain position indefinitely in flows up to 96.8 cm/s, and can attain speeds of 180 cm/s for short durations (Peake *et al.* 1997).

Lake Sturgeon occurs in a diversity of habitats across the species' range, despite a low rate of genetic differentiation among populations (DeHaan *et al.* 2006; Welsh *et al.* 2008; Cote *et al.* 2011; Wozney *et al.* 2011; McDermid *et al.* 2011; Homola *et al.* 2012). Greater than 90% of the genetic variation observed based on microsatellites was attributable to individuals, as opposed to being partitioned among populations and/or clusters (Welsh *et al.* 2008; Kjartanson 2009; Côté et al 2011); this may speak to an inherent phenotypic plasticity. However, the adaptability of the species, in terms of genetic selection in response to external forces (stressors) can be reasoned to be quite low. Generation times for Lake Sturgeon are considered to be in the range of 26-50 years (Vélez-Espino *et al.* 2006) and one of the manifestations of the reduction in census population sizes during the past 150 years may be reductions in effective population size (N_e), in other words, the adaptive resources of populations (Wilson *et al.* 2014).

Dispersal and Migration

Migration

It is difficult to make generalizations regarding migration, because of the variety of system types that Lake Sturgeon inhabits. The Lake Sturgeon is commonly reputed to undertake migrations of 100s to 1000s of km between foraging, overwintering, and spawning habitat, and must do so contemporarily in a few Great Lakes tributaries, in the St. Lawrence River downstream of the Beauharnois dam, low-gradient prairie and, presumably, some lowland rivers to fulfill life history requirements (Harkness and Dymond 1961; Scott and Crossman 1973; MacDonell 1993; Auer 1996a; Lacho 2013; Dumont *et al.* 2013; Wishingrad *et al.* 2014; Valiquette *et al.* 2016). However, at the other extreme, in stepped-gradient rivers that offer a diversity of habitats over short spatial scales (e.g., the 10 km long Slave Falls Reservoir on the Winnipeg River), Lake Sturgeon do not move nearly as far (Déry 2012; McDougall *et al.* 2013b). The Lake Sturgeon is a poor burst swimmer (Webb 1986; Peake *et al.* 1997) and lack of upstream movement past historical hydraulic features and resulting asymmetric gene flow have been attributed to why populations on the stepped-gradient Nelson and Winnipeg rivers show evidence of historical population structure (Côté et al 2011; McDougall 2011a; Gosselin *et al.* 2015; McDougall *et al.* accepted). If Lake Sturgeon historically migrated up and down the flow axis of these rivers, the signature of within-watershed panmixia would be expected today, because too few generations have passed for observed levels of differentiation to be attributable to recent anthropogenic influences such as hydroelectric dams (Côté et al 2011; McDougall 2011a; Nelson and McAdam 2012; Drauch Schreier *et al.* 2013; Gosselin *et al.* 2015; McDougall *et al.* accepted). Based on these observations, it becomes problematic to even classify Lake Sturgeon as ubiquitously migratory; they certainly have the capacity to move distances of 10s or 100s of km, but the need to do so is linked to the spatial configuration of habitat and, therefore will vary among populations (Gosselin *et al.* 2015; McDougall *et al.* in prep.) and within a population (Déry 2012; Valiquette *et al.* 2016).

In systems where Lake Sturgeon must move long distances between non-spawning and spawning habitats, one-step migrations (direct movement to spawning areas during spring) have been reported (Auer 1996a; Rusak and Mosindy 1997; Peterson *et al.* 2007), although patterns consistent with two-step migrations (movement closer to spawning area during winter, followed by movement to spawning area during spring) have also been observed (Shaw *et al.* 2013). Even within a single population, both one- and two- step migrations have been reported (Bruch and Binkowski 2002). In general, Lake Sturgeon spawning migrations are characterized by upstream movements, but downstream movements to spawning locations followed by upstream movement to foraging and overwintering locations have also been observed (Hondorp *et al.* 2014).

Dispersal

Natural dispersal is likely limited to connected (barrier-free) wetted aquatic habitat. Dispersal via aquatic birds is unlikely given that Lake Sturgeon eggs are negatively buoyant, tend to be deposited in high-velocity areas, and those fertilized adhere to the substrate. Volitional movement of later life stages and semi-passive downstream drift of larvae might both theoretically result in inter-population dispersal and/or (re)colonization; however, once again, considerable process variation between system types is expected, influenced by the spatial configuration of both habitat and neighbouring populations.

Interspecific Interactions

Kempinger (1988) observed egg predation by crayfishes, redhorses (*Moxostoma* spp.), Common Carp (*Cyprinus carpio*), post-spawning Lake Sturgeon, and Mudpuppy (*Necturus maculosus*) in the Wolf River, WI. On artificial spawning habitat created in the St. Lawrence River, egg predation by redhorses and Logperch (*Percina caprodes*) was observed (Johnson *et al.* 2006). In Black River/Black Lake, Michigan, native and Rusty crayfishes are believed to be among of the biggest predators of eggs, larvae, and age-0 Lake Sturgeon (E. Baker pers. comm.). In the Winnipeg River, Lake Sturgeon eggs have been observed in the stomach contents of adult sturgeon (C. Barth, unpubl. data). Predation on Lake Sturgeon after age-1 has not been documented. An Elder participating in the Kitcisakik First Nation Symposium (2011 cited in Goulet 2014) reported that catfish eat Lake Sturgeon eggs.

Common parasites include various lamprey species. Little is known about the lethal and sub-lethal effects of native species although, in the St. Lawrence River, Vladykov (1985) reported seeing 61 Silver Lamprey (*Ichthyomyzon unicuspis*) attached to a single Lake Sturgeon. Thomas and Haas (2002) reported that almost half of the Lake Sturgeon examined in 1999 and 2000 in Lake St. Clair and the St. Clair River bore lamprey scars; however, most attachments were superficial. Juvenile Lake Sturgeon from the Winnipeg, Nelson, and Saskatchewan rivers rarely (if ever) bear lamprey scars (L. Henderson pers. comm.).

Attacks by invasive Sea Lamprey (*Petromyzon marinus*) may have dire ramifications, such as acute anemia, and smaller Lake Sturgeon may experience lethal and serious sub-lethal effects (Patrick *et al.* 2009; Sepúlveda *et al.* 2012). Pratt *et al.* (unpubl. data) examined the contemporary incidence of lamprey attacks in Lake Superior. Only 0.09 % of juveniles (<850 mm FL) bore signs of previous attachments, compared to 1.4% of adults, with some evidence of variation between sampling locations. Furthermore, the vast majority of those captured bore scars or marks, as opposed to open wounds (T. Pratt, DFO, unpubl. data). However, it is worth noting that these findings are likely in part attributable to ongoing suppression of Sea Lamprey in the Great Lakes area; for example in Lake Champlain, Sea Lamprey-induced mortality may have been as important a factor as overharvest and habitat loss in the decline of the Lake Sturgeon population in the late 1900s (MacKenzie 2016).

Quantitative Biology

Fecundity

Female Lake Sturgeon are highly fecund. Fortin *et al.* (1992) calculated the following equation for Lake Sturgeon populations in Quebec:

$\text{Log}_{10}(F) = 3.70214(\text{Log}_{10})TL - 2.62905$ (r^2=0.90)

Bruch *et al.* (2006) derived the following linear relationship based on pre-spawn fish from the Winnebago, Wisconsin system:

Fecundity = 16,640 * weight (kg) – 150,683, $r^2 = 0.66$

Nelson *et al.* (in prep.) synthesized the aforementioned data with those summarized by Harkness and Dymond (1961) to yield a similar relationship, as depicted in Figure 7. Regardless of which equation is used, a 30 kg female would be expected to produce ~350,000 eggs.

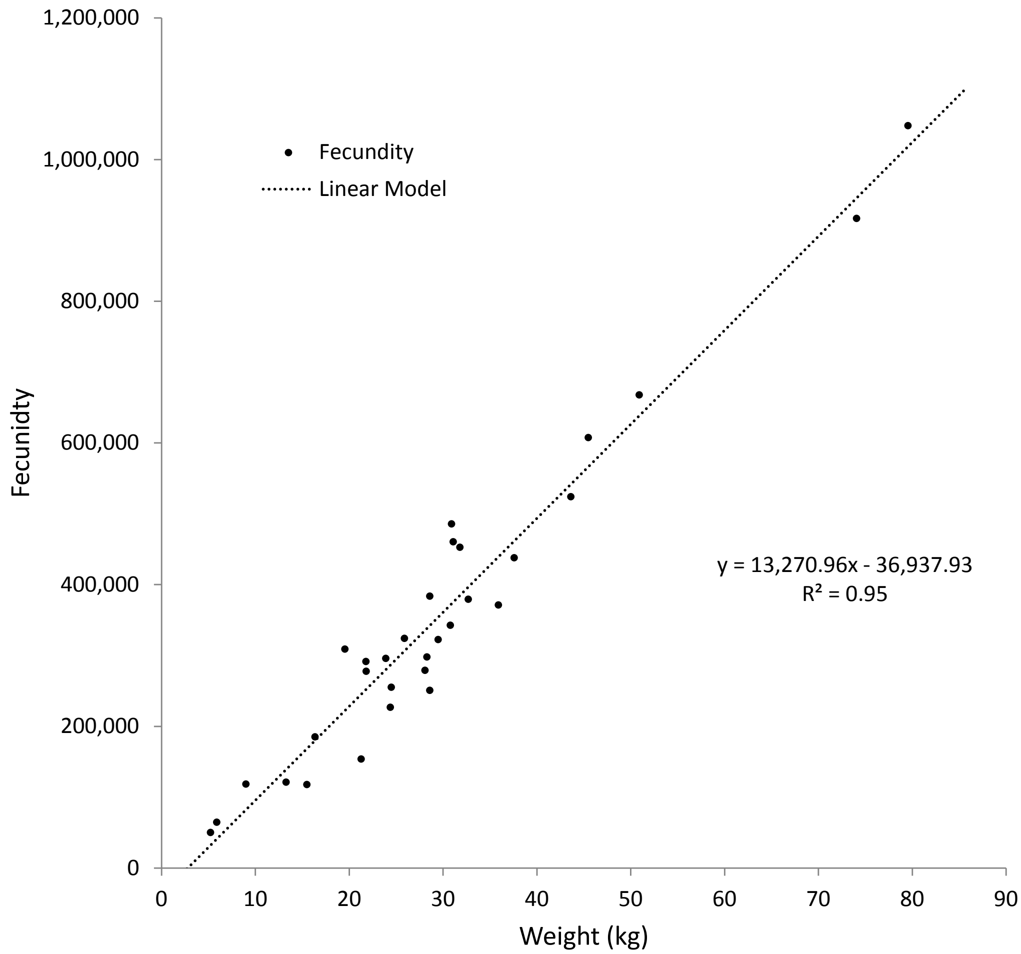

Figure 7. Fecundity of Lake Sturgeon based on Harkness and Dymond (1961) and citations therein, Bruch *et al.* (2009), and using Bruch *et al.* (2009) to estimate the fecundity for early reports where only weight of female and total weight of eggs were reported.

Survival

As is the case for most fish species, Lake Sturgeon life history is characterized by low survival to age-1. On the Richelieu River, Quebec, ~88% of the Lake Sturgeon eggs collected on egg mats deployed at a spawning location during 2011 were determined to be viable (Thiem *et al.* 2013). In the Des Prairie River, Quebec, egg viability ranged from 85.6-94.2% between 1996 and 1999 (Dumont *et al.* 2011). On the Winnipeg River, downstream of the Pointe du Bois GS, viability of eggs captured on egg mats has been examined in four years; viability of eggs deposited at the base of the powerhouse has ranged from 75.4 to 79.4%, compared to 70.5 – 86% at the base of the spillway (Gillespie *et al.* in prep.).

Relatively little is known about survival rates of fertilized eggs to free-embryo, free-embryo to exogenous feeding larval, or larval to “age-0” stages. Dumont *et al.* (2011) estimated annual survival of eggs to drifting larvae at 0.009 to 0.06. Cumulatively, survival from fertilized eggs to age-0 is generally assumed to be very low (Gross *et al.* 2002; Vélez-Espino and Koops 2009; Schueller and Hayes 2010a). Caroffino *et al.* (2010) examined early-life stage survival. From larval to age-0, rates varied from 0.017 to 0.095 in the two years examined. When considering the entire egg to age-0 interval, survival ranged from 0.002 to 0.007 (Carroffino *et al.* 2010). While specific estimates based on empirical data are lacking, cumulative survival to age-0 probably also varies in relation to habitat differences, inter-annual environmental fluctuations, and inter-specific interactions.

The limited amount of information that exists regarding early life-stage survival has been generated and/or applied in the context of stocked fish. In Black Lake, Michigan, the overwinter survival rate for age-0 Lake Sturgeon, which measured 252 - 297 mm FL when stocked in fall, was at least 0.4 (Crossman *et al.* 2009). Klassen (2014) found no evidence that size differences of age-0s at the time of stocking influenced recapture probability in the Winnipeg River, MB. In addition, slower growth rates and smaller sizes did not result in elevated mortality or depleted energy stores during exposure to a pseudo-winter laboratory study (Klassen 2014). However, there is evidence from extensive stocking programs in Minnesota that larger age-0s have survived better than smaller ones (Schram *et al.* 1999). Similarly, minimal recruitment of stocked age-0s in the upper Nelson River has been attributed to size inferiorities relative to wild conspecifics from the source river (McDougall *et al.* 2014d; McDougall and Nelson 2015).

Once age-1 is attained, annual survival of Lake Sturgeon can be very high. On the Winnipeg and Nelson rivers, where Lake Sturgeon (especially juveniles) tend to rarely move from discrete basins (Barth *et al.* 2011; McDougall *et al.* 2013b), extensive mark-recapture programs targeting juvenile segments of populations (both wild and introduced) have recently facilitated calculation of survival estimates. For example, in the Slave Falls Reservoir, based on juveniles <800 mm FL (age-0 to ~age-12) survival/retention was estimated to be 0.99 (McDougall *et al.* in prep.). In the Sea Falls – Sugar Falls reach of the upper Nelson River, mean estimates of annual survival/retention based on Cormack-Jolly-Seber routines for stocked 2007 and 2010 cohorts were 1.0 and 0.79, respectively (McDougall and Nelson 2015).

Barring anthropogenic influence, such as harvest or entrainment, annual survival for adult Lake Sturgeon is generally also assumed to be high (Vélez-Espino *et al.* 2006; Vélez-Espino and Koops 2009; Schueller and Hayes 2010a,b). Studies conducted on Rainy Lake, ON/MN (Adams *et al.* 2006) and the Namakan Reservoir, ON/MN (Shaw *et al.* 2012) used catch-curve analysis to estimate annual survival rates of 0.952 and 0.953, respectively. Mark-recapture analysis can theoretically provide the most robust annual survival estimates, but the methods require intensive sampling effort spread over long periods; in the artificially confined Black Lake/Black River, MI, breeding return times were incorporated into a Jolly-Seber framework, revealing mean annual survival estimates of ~0.98 for both mature males and females (Pledger *et al.* 2013).

Annual survival estimates have been generated for adults from several reaches of the Nelson and Winnipeg rivers based on mark-recapture (Nelson and Barth 2012; Henderson *et al.* 2014b; McDougall *et al.* in prep.), but these data sets are complicated to varying degrees by unreported subsistence harvest, poaching, entrainment, unknown spawning periodicity, and changes in sampling over time. In general, the survival rates described below are probably biased low. In Gull and Split lakes on the middle Nelson River, MB, contemporary annual adult survival was recently estimated to be 0.85 and 0.94, respectively (Nelson and Barth 2012). On the lower Nelson River, mean estimated annual survival of adults was ~0.94 (Henderson *et al.* 2014b). In the vicinity of the Landing River confluence on the upper Nelson River, annual survival was estimated to be 0.90 (McDougall *et al.* in prep.). On the Winnipeg River, annual adult survival in the Nutimik/Numao and Slave Falls Reservoir sections were estimated to be 0.82 and 0.79, respectively (McDougall *et al.* in prep.).

Bruch (1999) reported that males in the Lake Winnebago population rarely reached 40 years of age, while the lifespan of females has been found to exceed 80 years. This observation suggested that there is variation in annual survival rates by sex, at least once maturity is reached.

<u>Growth</u>

Eggs measure ~2.74 mm (range: 2.6 – 3.5) in diameter and are negatively buoyant (Bruch *et al.* 2006). Much of the variation in size seems to be explained by maternal influence (C. Klassen pers. comm.). Upon hatch, Lake Sturgeon measure 6.5-14 mm long (Auer 1982, Kempinger 1988, Smith and King 2005a, Friday 2014), and variation seems to be explained partially by family influences on egg size (C. Klassen pers. comm.). While individual-level genetics would seem likely to influence growth trajectories following the onset of exogenous feeding, Klassen (2014) found that extrinsic factors (grouped vs isolated during feeding) were more important based on a series of laboratory studies.

As is the case for most fishes, growth rate of Lake Sturgeon older than age-1 is generally assessed based on hard-structure interpretation in combination with measurements of body size (e.g., length-at-age), for which accuracy is contingent on the assumption of fish laying down "annuli", which correspond to alternating periods of fast and slow/non-growth (Cuerrier 1966; Lebreton *et al.* 1999; LeBreton and Beamish 2000). A few studies that corroborate assignments with known-age individuals have suggested that juvenile Lake Sturgeon can generally be aged accurately (i.e., a population sample is assigned ages without directional bias) and also relatively precisely using thin sections of pectoral-fin spines (Bruch *et al.* 2009; McDougall *et al.* 2014d).

Based on bomb-radiocarbon signatures, Bruch *et al.* (2009) reported that annuli-count methods tended to underestimate the ages of Lake Winnebago adults and noted that the correction factor derived (for the purposes of calculating fishing mortality) may not have inter-population relevance. There was minimal bias associated with ages assigned based on examination of otoliths; however, imprecision relative to true age was still evident, while non-lethal requirements make widespread adoption of otolith aging problematic for Lake Sturgeon (Bruch *et al.* 2009). Clearly, there are some caveats associated with Lake Sturgeon aging and, therefore, also with the corresponding analyses that generally assume accurate/precise assignments (McDougall *et al.* 2014b). If true growth rate differences were subtle, aging caveats might not confound the understanding; however, the variation in growth rate among Lake Sturgeon populations (and even segments of populations) can be dramatic.

Analysis conducted in the 1990s suggested that growth-rate variation in Lake Sturgeon was related to temperature, with northern populations growing slower than those occurring farther south (Fortin *et al.* 1996; Power and McKinley 1997; Noakes *et al.* 1999). For ~10 years, the "thermal opportunity for growth" hypothesis went essentially unquestioned, although a few observations suggested that other factors were potentially influential. Most notably, Haxton and Findlay (2008) reported that, within the Ottawa River, growth rates were higher in impounded compared to unimpounded reaches, perhaps influenced by density-dependant compensation.

Since then, several studies have focused on growth rates in juveniles. Within the 41-km long Seven Sisters Reservoir on the Winnipeg River, research conducted in 2006- 2008 revealed that growth rates varied markedly among the behaviourally isolated juvenile subpopulations within the reservoir, raising questions about food availability and/or competition as potential drivers (Barth 2011; Barth and Anderson 2015). Shortly thereafter, it became evident that there was similar spatial variation in growth rate for juveniles residing within discrete basins of other Winnipeg River reservoirs, and water-velocity influenced energetics was suggested as another potential factor (McDougall 2011ab).

Haxton (2015) synthesized data from the province of Ontario and found that growth rates of juveniles in regulated rivers tended to be lower than in unregulated rivers, suggesting that food resources may be lacking.

Elaborating on previous Winnipeg River studies, McDougall *et al.* (in review) synthesized juvenile length-at-age data from across the province of Manitoba. Growth rate variation was large and more prevalent along the flow axis of a given river system as opposed to among systems. Latitude, air temperature, and a suite of other abiotic variables appeared to be weak or non-factors, while growth rates were negatively correlated with both water velocity and juvenile density. Growth rate was reasoned to be elevated in lower velocity environments, due to decreased energetic costs of foraging and potentially increased levels of in situ benthic production. The discrepancy between results from Manitoba and those of growth studies conducted during the 1990s might be explained by accounting for a broad-scale habitat gradient, wherein southern populations included in the analyses tended to inhabit more lacustrine systems while those from farther north inhabited more riverine systems (McDougall *et al.* in review.).

Lester and Haxton (in review) used a similar framework, synthesizing juvenile length-at-age data from across the province of Ontario. The most important influences on growth were waterbody type (lake or river), growing degree-days and dam presence. Lake resident fish grew faster than those resident in rivers, and as growing degree-days increased, so did growth rate. The effect of dam presence was only pronounced in riverine populations within the same drainage basin, with impounded areas exhibiting approximately 12% faster growth rates (Lester and Haxton in review).

While there are uncertainties (and potential bias) associated with aging adult Lake Sturgeon, incremental growth based on mark-recapture (e.g., in 5 years at large, a fish may have grown from 1050 mm to 1170 mm) can help to fill in gaps. This is the approach that has been taken for recent population modelling in the absence of a correction factor specific to reference populations (Nelson *et al.* in prep.); a few example length-at-age and length-weight trajectories are presented in Figure 8 and 9.

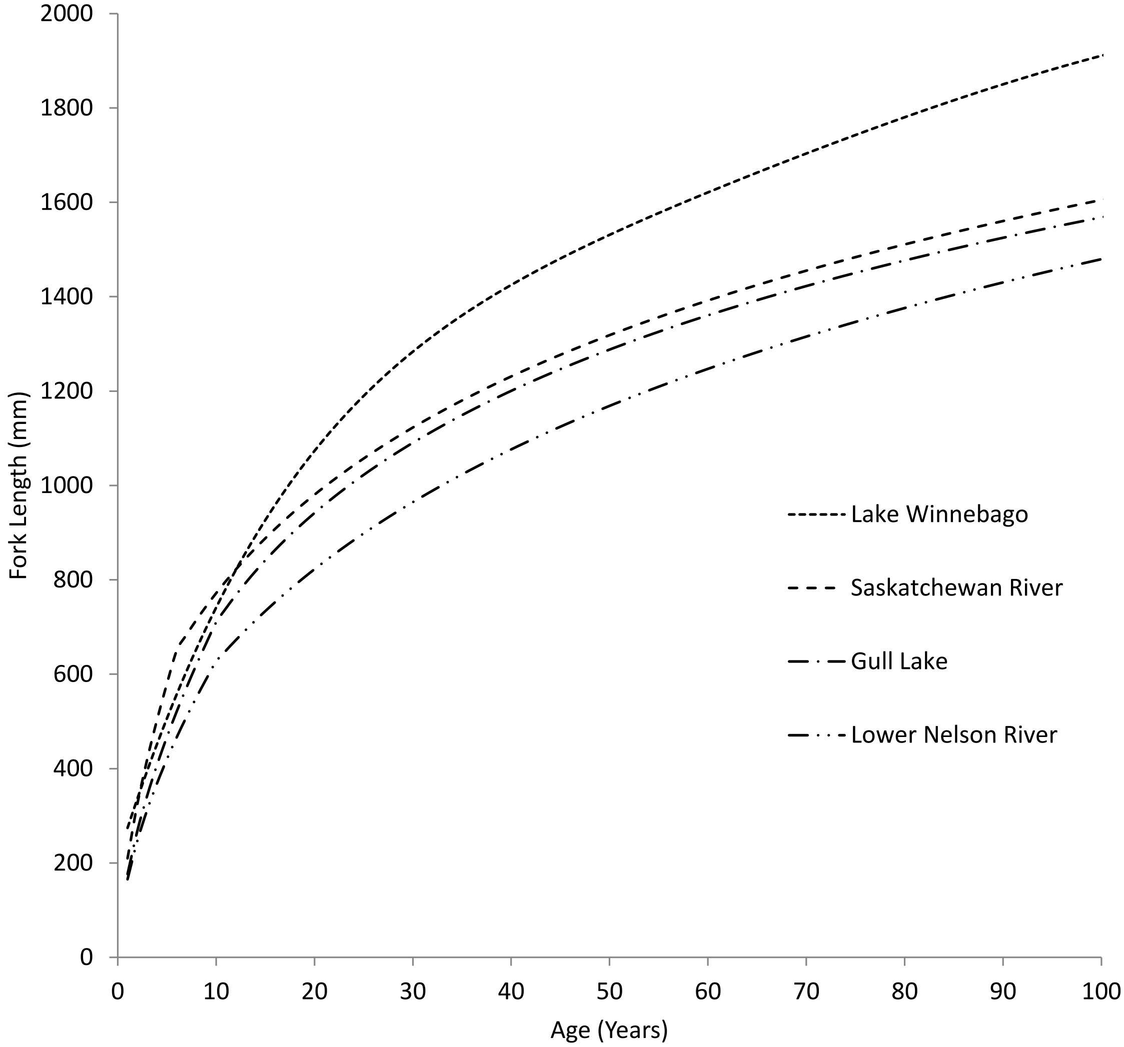

Figure 8. Length-at-age curves for four different growth trajectories. Based on aged fish from 0 to 10-14 years and incremental growth from recaptured fish using the largest recorded females to approximate maximum age. Lake Winnebago data are from Priegel and Wirth (1978), Bruch (2008), and Bruch *et al.*, 2009; Gull Lake and Lower Nelson River are from Manitoba Hydro (unpubl. data), and Saskatchewan River data are from the Saskatchewan River Sturgeon Management Board and SaskPower (unpubl. data).

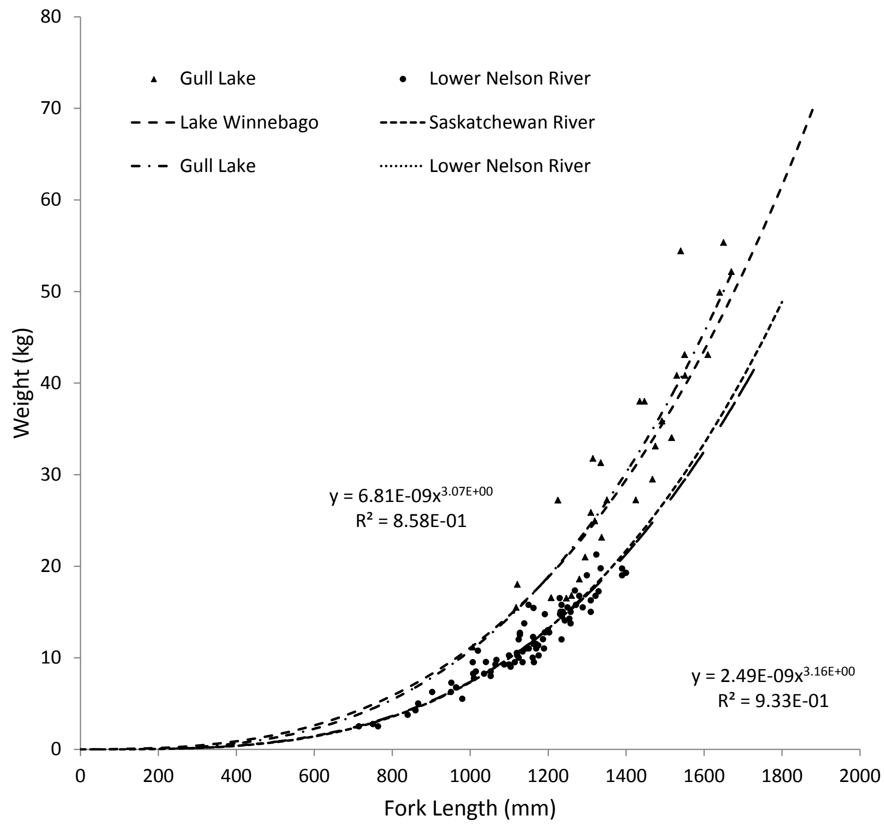

Figure 9. Length-weight relationships for 'robust' females and 'slender' females. Lake Winnebago data are from Priegel and Wirth (1978), Bruch (2008), and Bruch *et al.*, 2009; Gull Lake and Lower Nelson River are from Manitoba Hydro (unpubl. data), and Saskatchewan River data are from the Saskatchewan River Sturgeon Management Board and SaskPower (unpubl. data). Only data from mature ripe females were used.

It should be noted that growth trajectories of male and female Lake Sturgeon diverge (Bruch 1999, 2008); however, in most populations, sex-specific data are lacking in the quantities required to accurately partition. Finally, given evidence of density dependence in some systems (Haxton and Findlay 2008, Barth and Anderson 2015, McDougall *et al.* in review), it is conceivable that population-specific growth trajectories may be dynamic as recovery occurs and carrying capacity is approached.

Maturity

It is unclear if Lake Sturgeon maturation schedules are driven by size or age (or a combination) but, within any given population, males tend to mature earlier than females. Fortin *et al.* (1992) indicated that the average age and average size at sexual maturity of females of the St. Lawrence River was age 25 and 1330 mm, respectively. In Lake Winnebago, WI, the mean age at maturity for males and females was 20 and 27 years, respectively; mean size at maturity for these fish were ~1075 and ~1260 mm FL (Bruch 2008). In Black Lake, Michigan, the same metrics by sex were 985 and 1260 mm FL (Smith and Baker 2005).

Generally, age at maturity for males is considered to be in the range of 12-20 years, while females fall between 15 and 30 years. However, reported ranges seem rarely to be based on robust findings. This is potentially problematic in the context of species recovery initiatives and population modelling exercises because there is evidence of variation. In the Slave Falls Reservoir on the Winnipeg River, MB, the spawning stock consists of much smaller individuals; males and females commonly mature at 800 and 950 mm FL (McDougall *et al.* 2013b). Indeed, ripe males in the 620 – 640 mm FL range and as young as 8-y old have been captured (McDougall 2011a; Manitoba Hydro, unpubl. data), while a female measuring only 808 mm FL produced viable eggs that were subsequently reared in a hatchery (Genz *et al.* 2014). At a glance, the Slave Falls Reservoir population appears to be somewhat of an outlier in the context of maturation schedules; however, on the Nelson River, MB, ripe males as small as 757 mm FL have been captured (Hrenchuk 2013), and Harkness and Dymond (1961) reported egg counts from a 5 kg female from the Ottawa River, ON/QC. As such, it may be that, in some populations, smaller mature individuals have not been properly accounted for during contemporary spawning surveys.

For the purpose of this assessment, generation time was based on pre-disturbance age at maturity. Female age at maturity is 25 and 27 in healthy St. Lawrence and Lake Winnebago populations and, historically, the typical lifespan of Lake Sturgeon was believed to be in the neighbourhood of 55 years for males and 80 to 150 years for females (U.S. Fish and Wildlife Service 20017). There is no evidence for reproductive senescence, for example the largest, and perhaps oldest, fish ever caught in Manitoba was estimated to be 150 years old, measured 4.6 m, weighed 184.6 kg, and was “full of caviar” (Stewart and Watkinson 2004). Therefore, the generation time based on pre-disturbance females is approximately 45-40 years.

Recruitment

In the absence of anthropogenic influence (i.e., harvest, entrainment at dams), Lake Sturgeon exhibit low mortality rates after the first year of life, so recruitment to the juvenile stage should, therefore, foreshadow recruitment to the spawning stock, albeit with a lengthy lag time (Nilo *et al.* 1997; Caroffino *et al.* 2010; Haxton 2011; Dumont *et al.* 2011; McDougall *et al.* 2014b; Haxton *et al.* 2015).

Variation in the level of contribution by individual females to larval production has been observed in the Black River, MI (Duong *et al.* 2011), but this pattern does not appear to result in sweepstakes reproductive success in this system (Duong *et al.* 2013) or others (Welsh *et al.* 2015; McDougall *et al.* accepted). A typical stock-recruitment relationship likely underlies Lake Sturgeon population biology; however, as is frequently observed in fishes, contemporary Lake Sturgeon recruitment across the species’ range often seems to be variable or erratic, even in some relatively large populations (Table 2). There is evidence that suggests that the magnitude of variation may be heightened due to anthropogenic influence (Haxton *et al.* 2015), but historical populations may have also been characterized by year-classes of similar strength; recruitment consistency in sturgeon species has been reasoned a myth (Sulak and Randall 2002), likely propagated by inferences from formerly large adult stocks, in combination with inaccurate/imprecise aging assignments (McDougall and Barth 2015).

Table 2. Detailed information provided by the pre-COSEWIC meeting participants by DU (DF 2016a,b), identifying survey information, quantitative abundance, qualitative abundance, recruitment, trajectory, and threats. Codes for each category are listed as follows:

Contemporary Assessment: Adult Lake Sturgeon inventory (non-spawning) (ls:a); Adult Lake Sturgeon spawning study (ls:s); Juvenile Lake Sturgeon inventory (ls:j); Fish community inventory (fc); Qualitative Abundance: Remnant = <10 individuals; Very Low = 10 - 50 individuals; Low = 50 - 500 individuals; Moderate = 500 - 1000 individuals; High = 1000 - 5000 individuals; Very high = >5,000 individuals.

Contemporary Recruitment: Consistent - all cohorts comprising the juvenile segement of the population are represented, and they are similar in strength (varies by < 2 fold), Variable: all cohorts are represented, but strength varies by up to 2 - 5 fold; Erratic - evidence of periodic year-class failures (up to 4 in 10 years), strength of strong vs. weak cohorts varies by 5 - 100 fold; Infrequent - high rate of year-class failures (no fish produced in 5 or more years out of 10); Nil - no evidence of contemporary production of cohorts; Stocking - cohorts that can be linked to fish stocked in recent years are present in the system. In cases where wild recruitment is occurring, and stocking is also being conducted, there should be two entries.

Threats and impediments abbreviations: Dams - habitat alterations = d:hab; Dams - migratory barriers = d:mig; Dams - entrainment = d:ent; Harvest: historical (includes after-effects) = h:his; Harvest - contemporary (includes commercial, subsistence, poaching) = h:con; Invasive species - isp, Pollution - pol.

			Contemporary Assessment											
			Survey Information		Quantitative adult abundance			Qualitative Abundance		Contemporary Recruitment				
DU	DU area	Sub-area	Data Collection Years	Type	Estimate	Lower 95% CI	Upper 95% CI	Adults	Juveniles	In situ Recruitment Pattern	Trajectory	Major Threats/ imped iments	Comments
DU1	Upper Churchill River	Atik Falls to Wintego Rapids (MU1)	-	-	-	-	-	-	-	-	Unknown	h:his	
		Wintego Rapids - Island Falls HS (MU1)	2010, 2011	ls:a, ls:j	-	-	-	Not detected	Not detected	Nil	Remnant	h:his, h:con	(Johnson and Nelson 2011; Nelson and Barth 2011)
DU1	Middle Churchill River	Island Falls HS - Missi Falls CS (MU2)	2010, 2011	ls:a, ls:j	-	-	-	Not detected	Not detected	Nil	Remnant	h:his, h:con	(Johnson and Nelson 2011; Nelson and Barth 2011)
DU1	Lower Churchill River	Missi Falls CS - Redhead Rapids (MU3)	2010	ls:a	-	-	-	Remnant	Not detected	Nil	Remnant	d:hab	(NSC 2011)

DU	DU area	Sub-area	Contemporary Assessment								Trajectory	Major Threats/ imped iments	Comments
			Survey Information		Quantitative adult abundance			Qualitative Abundance		Contemporary Recruitment			
			Data Collection Years	Type	Estimate	Lower 95% CI	Upper 95% CI	Adults	Juveniles	In situ Recruitment Pattern			
		Redhead Rapids - Swallow Rapids (a.k.a. the Little Churchill River confluence area) (MU3)	2014, 2015	ls:a, fc	1,573	1,401	1,745	High	High	Erratic	Declining or stable	d:hab, h:con	(MacLean and Nelson 2005; CAMP 2014; Dolce-Blanchard and Barth 2015; Ambrose and McDougall 2016)
		Swallow Rapids - Little Beaver River (MU3)	2013	ls:a	-	-	-	Low	Unknown	Unknown	Unknown	d:hab	(Blanchard *et al.* 2013) Adult survey conducted, but most of the fish captured were juveniles (despite the gear selecting for them poorly). Located downstream of the Little Churchill area (which supports a dense, actively recruiting population). Suspected that in situ recruitment is not occurring between Swallow Rapids and Little Beaver, and that low density is a function of downstream redistribution (potentially emigration).
		Little Beaver to Churchill River weir (MU3)	2000-2007	fc	-	-	-	Very low	Not detected	Nil	Unknown	d:hab, h:con	(Holm and Bernhardt 2011) Surveys have not been spatially exhaustive, but it seems unlikely that an unsampled area is harbouring a population based on the understanding of habitat in the lower Churchill River
DU2	North Saskatchewan River	North Sask, Upper Alberta	2012	ls:a	2,681	1,956	3,711	High	Unknown	Unknown	Unknown	-	(Hegerat and Paul 2013)
		North Sask, Lower Alberta (MU1)	2012	ls:a	3,673	2,721	5,015	High	Unknown	Unknown	Unknown	-	(Hegerat and Paul 2013)

DU	DU area	Sub-area	Contemporary Assessment									Trajectory	Major Threats/ imped iments	Comments
			Survey Information		Quantitative adult abundance			Qualitative Abundance		Contemporary Recruitment				
			Data Collection Years	Type	Estimate	Lower 95% CI	Upper 95% CI	Adults	Juveniles	In situ Recruitment Pattern				
DU2	South Saskatchewan River	South Sask: confluence of Oldman and Bow rivers to AB border (MU2)	2003-2012	ls:a	6,464	4,692	8,968	High	Unknown	Unknown		Unknown	-	(Paul 2013)
DU2	North/South Saskatchewan River	AB/SK border to Nipawin (MU1)	2010-2011	ls:s, ls:s, ls:j	2,583	1,501	3,665	High	High	Variable		Stable or increasing	h:his, h:con, d:hab, d:mig	(Pollock *et al.* 2009; Pollock 2010; Pollock 2011; Pollock 2012; Wishingrad *et al.* 2014; Henderson *et al.* 2015; Henderson *et al.* 2016)
DU2	Saskatchewan River	Sask. River: Nipawin to E.B. Campbell (MU3)	Present	ls:a, ls:s	-	-	-	Moderat e	Unknown	Unknown		Unknown		(Gillespie *et al.* 2015)
		E.B. Campbell to Cedar Lake (MU4)	1994-2014	ls:s, ls:j, fc	3,099	2,442	3,756	High	High	Variable		Increasing	h:his, h:con, d:hab	(Gillespie *et al.* 2015; Nelson 2015; Nelson and Johnson 2016)
DU2	Upper Nelson River	Playgreen Lake	-	-	-	-	-	-	-	-		Unknown	h:his, h:con	Believed to have been extirpated or close to
		Little Playgreen Lake (MU1)	2014	ls:j	-	-	-	-	Moderate (stocked)	Nil + Stocking		Increasing (stocking)	h:his, h:con	(Burnett and McDougall 2015) Believed to have been extirpated or close to
		Sea Falls - Sugar Falls (MU1)	2012-2015	ls:a, ls:j	-	-	-	Very low	High (stocked)	Nil + Stocking		Increasing (stocking)	h:his, h:con	(McDougall and Pisiak 2012; 2014; McDougall *et al.* 2014; McDougall and Nelson 2015; in prep) Believed to have been extirpated or close to
		Cross + Pipestone lakes (MU1)	2013-2015	ls:s, ls:j	-	-	-	Very low	Moderate (stocked)	Infrequent + stocking		Increasing (stocking)	h:his, h:con	(McDougall and Pisiak 2014; Henderson *et al.* 2015; Aiken and McDougall in prep; Bell *et al.* in prep.)

DU	DU area	Sub-area	Contemporary Assessment									Trajectory	Major Threats/ imped iments	Comments
			Survey Information		Quantitative adult abundance			Qualitative Abundance		Contemporary Recruitment				
			Data Collection Years	Type	Estimate	Lower 95% CI	Upper 95% CI	Adults	Juveniles	In situ Recruitment Pattern				
		Sipiwesk Lake (MU2)	2015	ls:j	-	-	-	-	Moderate	Infrequent		Unknown	h:his, h:con, d:hab	(Henderson and McDougall in prep.) A small amount of subsistence harvest from the Bladder Rapids confirms that adults are present within the area, but nothing quantitative can be surmised (D. MacDonald pers.comm.)
		Landing River area (MU2)	2006-2014	ls:a, ls:s, ls:j	3,257	1,515	2,302	High	Low	Erratic		Increasing	h:his, h:con	(D. Macdonald, MFB, unpub. data; Groening *et al.* 2013; McDougall *et al.* 2014; McDougall *et al.* in prep)
DU2	Middle Nelson River	Kelsey GS/Grass River/Split Lake	2001-2015	ls:s, ls:j	426	254	598	Low	Moderate	Erratic + stocking		Stable or increasing	h:his, h:con, d:hab	(Henderson *et al.* 2016b)
		Burntwood River (MU3)	2001-2015	ls:s, ls:j	570	426	714	Moderat e	Moderate	Variable + stocking		Stable or increasing	h:his, h:con, d:hab	(Henderson *et al.* 2016b)
		Clark Lake - Gull Rapids	2001-2015	ls:s, ls:j	596	431	946	Moderat e	Moderate	-		Stable or increasing	h:his, h:con, d:hab	(Hrenchuk *et al.* 2015)
		Stephens Lake (MU3)	2001-2014	ls:s, ls:j	-	-	-	Low	Moderate	Erratic + stocking		Stable or increasing	h:con	Area unlikely to have supported a self-sustaining population prior to backwatering from Kettle GS as SNP-based population genetics show individuals are consistent with Gull Lake genotypes (Gosselin *et al.* 2015). Also, based on sibship analyses, immigration of Lake Sturgeon from Gull Lake is influential demographically.

			Contemporary Assessment											
			Survey Information		Quantitative adult abundance			Qualitative Abundance		Contemporary Recruitment				
DU	**DU area**	**Sub-area**	**Data Collection Years**	**Type**	**Estimate**	**Lower 95% CI**	**Upper 95% CI**	**Adults**	**Juveniles**	**In situ Recruitment Pattern**	**Trajectory**	**Major Threats/ imped iments**	**Comments**
DU2	Lower Nelson River	Long Spruce Forebay (MU4)	2006, 2011	ls:s, ls:j	-	-	-	Very low	Low	Nil	Stable or increasing	h:con, d:ent	(Ambrose *et al.* 2008; Lavergne and Barth 2012a; Lavergne and Barth 2012b) Area unlikely to have supported a population prior to backwatering from Long Spruce GS. Current population genetics based on SNPs indicate a historical break in gene flow between middle and lower Nelson River. Transient migrants from Lower Nelson population inhabiting this reach were likely displaced downstream after Long Spruce construction. If anything, habitat alterations have improved population level suitability for Lake Sturgeon. However, maybe not to the point of allowing a self-sustaining population to establish. Immigration of Gull Lake genotypes is influential demographically

DU	DU area	Sub-area	**Contemporary Assessment**											
			Survey Information		**Quantitative adult abundance**			**Qualitative Abundance**		**Contemporary Recruitment**			
DU	**DU area**	**Sub-area**	**Data Collection Years**	**Type**	**Estimate**	**Lower 95% CI**	**Upper 95% CI**	**Adults**	**Juveniles**	**In situ Recruitment Pattern**	**Trajectory**	**Major Threats/ imped iments**	**Comments**
		Limestone Forebay (MU5)	-	ls:s, ls:j	-	-	-	Very low	Very low	Nil	Stable or increasing	h:con, d:ent	Area unlikely to have supported a population prior to backwatering from Long Spruce GS. Current population genetics based on SNPs indicate a historical break in gene flow between middle and lower Nelson River. Transient migrants from Lower Nelson population inhabiting this reach were likely displaced downstream after Long Spruce construction. If anything, habitat alterations have imrpoved population level suitability for Lake Sturgeon. However, maybe not to the point of allowing a self-sustaining population to establish.
		Limestone GS to Hudson Bay (MU6)	1996-2013	ls:a, ls:s, ls:j	8,413	6,498	10,758	High		Variable	Stable	d:hab, h:con	(MacDonell 1995; 1997a; 1998; Barth and MacDonell 1999; Holm *et al.* 2006; Ambrose *et al.* 2008; 2009; 2010a; 2010b; Pisiak *et al.* 2011; Henderson *et al.* 2014b)
DU2	East-side tributaries to Lake Winnipeg (upstream of impassable barriers)	All	-	-	-	-	-	Unknown	Unknown	Unknown	Unknown	h:his, h:con	Not separated into sub-areas for the purposes of this table, as there is essentially no contemporary (i.e., post-2006) information regarding this area. Juvenile inventory methods were applied in one small section of the Pigeon River in 2015, with n=2 confirming presence of the life stage.

			Contemporary Assessment										
			Survey Information		Quantitative adult abundance			Qualitative Abundance		Contemporary Recruitment			
DU	DU area	Sub-area	Data Collection Years	Type	Estimate	Lower 95% CI	Upper 95% CI	Adults	Juveniles	In situ Recruitment Pattern	Trajectory	Major Threats/ imped iments	Comments
DU2	Lake Winnipeg (and tributaries downstream of impassable barriers)	Downstream of Pine Falls	2013, 2016	fc, ls:s	-	-	-	Moderat e or greater	Low	Unknown	Unknown	h:his, h:con	Lowden and Queen 2013; L. Henderson pers. comm.; D. Watkinson pers. comm.
DU2	Lake Winnipeg (and tributaries downstream of impassable barriers)	All other areas	-	-	-	-	-	-	-	-	Unknown	h:his, h:con	
DU2	Red and Assiniboine Rivers	Lower Assinibione + Red River (downstream of Portage Diversion) (MU2 and MU3)	-	-	-	-	-	Low	Low	Stocking	Increasing (stocking)	d:mig, d:hab, h:con	Large quantites stocked upstream in Minnesota; many captures in the Red River and lower Assiniboine River by anglers have been reported in the last 10 years. Some fish have tags linking back to these stockings. Some fish are now of adult size/age (D. Watkinson pers. comm.), but little is known about quantities.
DU2	Assiniboine Rivers	Upper Assiniboine (upstream of Portage diversion) (MU1)	2010, 2013	ls:a, ls:s, ls:j	-	-	-	Unknown	Unknown	Stocking	Increasing (stocking)	d:mig, d:hab, h:con	Native populations are assumed to have been extirpated since at least the 1970s; stocking with multiple broodstocks has occurred since. Some fish are approaching adult size/age, juveniles are present, but at present it seems most likely that these were stocked as opposed to having been produced in situ. Recent inventory studies have yielded small numbers of LKST, but little can be said with confidence regarding contemporary abundance.

DU	DU area	Sub-area	Contemporary Assessment: Survey Information: Data Collection Years	Contemporary Assessment: Survey Information: Type	Contemporary Assessment: Quantitative adult abundance: Estimate	Contemporary Assessment: Quantitative adult abundance: Lower 95% CI	Contemporary Assessment: Quantitative adult abundance: Upper 95% CI	Contemporary Assessment: Qualitative Abundance: Adults	Contemporary Assessment: Qualitative Abundance: Juveniles	Contemporary Assessment: Contemporary Recruitment: In situ Recruitment Pattern	Trajectory	Major Threats/ imped iments	Comments
DU2	English River	Upstream of Caribou Falls GS (MU2)	2011, 2012		-	-	-	Low-Moderat e	Low-Moderate	erratic	Unknown		Fish up to 80+ years of age were captured (Josh Peacock and Mary Duda pers. comm).
DU2	Winnipeg River	Norman/Kenora dams - Whitedog Falls GS (MU3)	2008, 2009, 2014	ls:a, ls:s, ls:j	-	-	-	Remnant	Not detected	Nil	Increasing	h:con, poll, sp	(Duda 2008; 2009; Johnson *et al.* 2014)
		Whitedog Falls GS - Pointe du Bois GS (includes English R. downstream of Caribou Falls GS) (MU4)	2007-2015	ls:a, ls:s, ls:j	-	-	-	Low	Moderate	Erratic	Unknown	h:his, h:con, sp	(Duda 2008; 2009; McDougall *et al.* 2008a; 2008b; McDougall and MacDonell 2009; Peacock 2014; Henderson and McDougall 2015; McDougall and Barth 2015)
		Pointe du Bois GS - Slave Falls GS (MU5)	2006-2015	ls:a, ls:s, ls:j	2,323	1,372	3,931	High	Very high	Errratic	Stable or increasing	h:con	(McDougall *et al.* 2008a; 2008b; McDougall and MacDonell 2009; Koga *et al.* 2013; Henderson *et al.* 2014; McDougall *et al.* 2014; Lacho *et al.* 2015; Lacho *et al.* in prep.)
		Slave Falls GS - Seven Sisters GS (MU6)	2006-2014	ls:a, ls:s, ls:j	5,005	1,469	17,047	Very high	Very high	Likely erratic	Stable or increasing	h:con	(Barth *et al.* 2009; Barth *et al.* 2011; Sparks 2011; Henderson 2012; K. Kansas, MFB, unpub. data; McDougall *et al.* in prep.) Abundance estimates are based only on Nutimik/Numao; likely underestimated abundance relative to the entire reach

			Contemporary Assessment										
			Survey Information		Quantitative adult abundance			Qualitative Abundance		Contemporary Recruitment			
DU	**DU area**	**Sub-area**	**Data Collection Years**	**Type**	**Estimate**	**Lower 95% CI**	**Upper 95% CI**	**Adults**	**Juveniles**	**In situ Recruitment Pattern**	**Trajectory**	**Major Threats/ imped iments**	**Comments**
		Seven Sisters GS - MacArthur GS (MU7)	2014	ls:a, ls:s, ls:j	>500	-	-	Moderate	High	Erratic	Increasing	h:his, h:con	(Hrenchuk 2011; D. Kroeker, MFB, unpub. data)
		MacArthur GS - Great Falls GS (MU8)	2010, 2011	ls:a, ls:s, ls:j	-	-	-	Very low	Moderate	Erratic	Stable or increasing	h:his, h:con	(Murray and Gillespie 2011; McDougall 2011; Henderson and McDougall 2012; K. Kansas, MFB unpub. data)
DU2	English and Wabigoon Rivers	(MU1)	2011, 2012	ls:a ls:j	-	-	-	Low/ Moderate	Low/ Moderate	Erratic	Unknown	d:hab, pol	(J. Peacock pers. comm.)
DU2	Lake of the Woods and Rainy River	Lake of the Woods/Rainy River (MU5)	1987-90, 2004, 2007, 2014	ls:a, ls:s, ls:j	92,286	45,816	201,875	High	Unknown	Variable	Increasing	d:hab, h:his, h:con, pol, isp	Stewig 2005; Mosindy and Rusak 1991; Mosindy 1987; Hienrich and Friday 2014
DU2	Rainy Lake	Seine River (MU4)	1993-95, 2011-15	ls:a, ls:s, ls:j, fc	-	-	-	Low	Moderate	Variable	Increasing	h:his, h:con, d:hab	McDougall and Cooley 2013; Groening *et al.* 2015; Jackson 2014 (draft); Jackson and Godwin 2014; Godwin 2012; Adams *et al.* 2006; Adams 2004; Haxton *et al.* 2014; Haxton *et al.* 2015
		Rainy Lake - South Arm (MU4)	2002-2005, 2015	ls:a, ls:s	-	-	-	moderate	Unknown	Variable	Increasing	d:hab, h:his	Adams 2004; Adams *et al.* 2006; Lebron 2012
		Rainy Lake - Redgut Bay (MU4)	2008-09	ls:a	-	-	-	Low	Unknown	Erratic	Stable	h:his	MNRF unpublished data

DU	DU area	Sub-area	Contemporary Assessment											
			Survey Information		Quantitative adult abundance			Qualitative Abundance		Contemporary Recruitment			
			Data Collection Years	Type	Estimate	Lower 95% CI	Upper 95% CI	Adults	Juveniles	In situ Recruitment Pattern	Trajectory	Major Threats/ imped iments	Comments
		Namakan Reservoir (Namakan, Sand Point, Little Vermilion) (MU3)	2007-2013	ls:a, fc	-	-	-	Moderat e	Unknown	Variable	Increasing	h:his, h:con	DesLaurier 2012; Shaw 2010; Shaw *et al.* 2010; Shaw *et al.* 2012; Shaw *et al.* 2013; Trembath *et al.* 2011
		Namakan River (Little Eva Lake Only) (MU2)	2006-2015	ls:a, ls:s, ls:j; fc	2,729	1,218	6,824	High	High	Variable	Increasing	d:hab, h:his	McLeod 2008a; McLeod 2008b; McLeod and Martin; 2015; Trembath 2013; Welsh 2008; Welsh and McLeod 2010; Haxton *et al.* 2014; Haxton *et al.* 2015; Burchfield 2015 (in prep)
		Sturgeon Lake	2008-10	ls:a	2,048	1,307	3,383	Moderat e	Unknown	Consistent	Stable	none	Solomon and Baljko 2011
		Lac La Croix (MU1)	2010-11	ls:a	-	-	-	Moderat e	Unknown	Erratic	Stable or increasing	h:his	Jackson 2015 (draft)
		Little Turtle (Big and Little Turtle Rivers)	2015	ls:a; ls:j, fc	-	-	-	Low	Low	Erratic	Unknown	h:his	MNRF data; Jackson 2015 (draft)
DU3	Hayes River	Upper Fox River (upstream of Rainbow Falls)	2004, 2005	ls:a	646	312	980	Moderat e	Unknown	Unknown	Unknown	h:his, h:con	(Pisiak and MacLean 2007)
		Upper Gods and Hayes rivers	-	-	-	-	-	-	-	-	-	h:his, h:con	
		Lower Fox, Gods and Hayes river complex	2011	ls:s, ls:j, fc	-	-	-	Moderat e	Low	Unknown	Unknown	h:his, h:con	(Klassen 2012; CAMP 2014; Ambrose and MacDonell 2015; Milling and MacDonell in prep.)
DU3	Severn	Severn	-	-	-	-	-	-	-	-	-	-	

			Contemporary Assessment											
			Survey Information		Quantitative adult abundance			Qualitative Abundance		Contemporary Recruitment				
DU	DU area	Sub-area	Data Collection Years	Type	Estimate	Lower 95% CI	Upper 95% CI	Adults	Juveniles	In situ Recruitment Pattern	Trajectory	Major Threats/ imped iments	Comments
DU3	Winisk	Winisk	-	-	-	-	-	-	-	-	-	-	
DU3	Attawapiskat	Attawapiskat	-	-	-	-	-	Low-Moderate	Low-Moderate	Unknown	Unknown	-	T. Haxton pers. comm.
DU3	Albany/Kenogami		-	-	-	-	-	Low	Low	Unknown	unknown	-	(Sandilands 1987: Haxton *et al.* 2014b; T. Haxton pers. comm.)
DU3	Moose/Mattagami/ Abitibi	Little Long Reservoir	2012	-	9,894	8,675	11,284	High	-	-	-	-	(Hatch 2014)
		Frederick House River	1983	-	186	-	-	-	-	-	-	-	(Payne 1987)
		Abitibi River	1984	-	994	-	-	-	-	-	-	-	(Gibson *et al.* 1984)
		Moose River	1980-1982	-	7,088	5,774	8,919	-	-	-	-	-	(Threader and Brousseau 1986)
DU3	Harricana	Harricana	-	-	-	-	-	Unknown	Unknown	-	Unknown	h:con	Latest report : Synthèse de la pêche commerciale en Abitibi-Témiscamingue, 1986

			Contemporary Assessment											
			Survey Information		Quantitative adult abundance			Qualitative Abundance		Contemporary Recruitment			
DU	DU area	Sub-area	Data Collection Years	Type	Estimate	Lower 95% CI	Upper 95% CI	Adults	Juveniles	In situ Recruitment Pattern	Trajectory	Major Threats/ imped iments	Comments
DU3	Nottaway	Olga, Matagami, Goéland and Scott lakes	2011	fc	-	-	-	Unknown	Unknown	Unknown	Unknown	d:hab, h:his, h:con	(Biofilia 2012; Beaudet and La Haye 2004)
DU3	Nottaway	Maicasagi river	2012-2014	ls:s	-	-	-	Unknown	Unknown	Consistent	Stable	d:hab, h:con	A monitoring program (including drifting larvae and egg deposition) started in 2012 to ensure the spawning ground would still be used by sturgeon of the Maicasagi river even if a bridge has been build over the spawning area in 2012. The final field campaign will occur in May-June 2016 to complete the portrait.
DU3	Rupert	Rupert and Nemiscau rivers	2010-2014	ls:s, ls:j	-	-	-	Unknown	Unknown	Stocking-Erratic	Unknown	d:hab, d:mig, h:con	This is a major watershed to consider regarding Lake Sturgeon habitat and reproduction in which Hydro-Qc has been working and collecting data for years. Many natural spawning areas have been monitored over the past 10 years and HQ also created many artificial spawning grounds to compensate for the effects of diversion of Rupert River.
DU3	Eastmain	Eastmain river	2007-2014	ls:s, ls:j, fc	-	-	-	Moderat e	Low	Erratic	Declining	d:hab, d:mig, h:con	Hydro-Qc monitoring; Since the diversion of the Eastmain river in 2009, the representation of juvenile Lake Sturgeons is declining drastically while individuals born before the diversion seem to be in great numbers.

			Contemporary Assessment											
			Survey Information		Quantitative adult abundance			Qualitative Abundance		Contemporary Recruitment			
DU	**DU area**	**Sub-area**	**Data Collection Years**	**Type**	**Estimate**	**Lower 95% CI**	**Upper 95% CI**	**Adults**	**Juveniles**	**In situ Recruitment Pattern**	**Trajectory**	**Major Threats/ imped iments**	**Comments**
DU3	La Grande	Opinaca reservoir and river	2002-2014	ls:a	-	-	-	Unknown	Unknown	Stocking-Variable	Unknown	d:hab, h:con	Stocking was initiated following the begining of the hydroelectric powerplant project to compensate for the cohort loss due to river diversions (historical spawning grounds no longer accessible by spawners). The last stocking campaign occurred in 2012 and had been conducted since 2008. The subsistence harvest is very important in this system.
DU4	Lake Nipigon	Ombabika Bay (MU2)	2006, 2009	ls:s, ls:a				Low	Moderate	Variable	Unknown	h:his, h:con	C. Avery, Anishinabek/Ontario Fisheries Resource Centre, cavery@aofrc.org, personal communication
		Namewaminikan River (MU2)	2006-2008	ls:s, ls:a						Variable	Unknown	h:his, h:con	C. Avery, Anishinabek/Ontario Fisheries Resource Centre, cavery@aofrc.org, personal communication
DU4	Northwestern Lake Superior	Pigeon River (MU1)	2003-2015	ls:s				Very Low	Not detected	Nil	Unknown	h:his	E.J. Isaac, Grand Portage Band of Lake Superior Chippewa, ejisaac@boreal.org, personal communication
		Kaministiquia (MU1)	2001	ls:s	196			Low	Low	Variable	Stable	h:his, d:hab, pol	(Welsh *et al.* 2015) Effective # breeders; 2005 = 54 (47-63); 2006 = 73 (60-90)
		Wolf River											Believed to be extirpated
DU4	Northern Lake Superior	Black Sturgeon River (MU3)	2003-2004	ls:s	96	47	240	Low	Low	Unknown	Unknown	h:his, d:mig	2003 spawner estimate 89 (54-138); Mike Friday, Ontario Ministry of Natural Resources and Forestry, mike.friday@ontario.ca, personal communication

DU	DU area	Sub-area	Contemporary Assessment									Trajectory	Major Threats/ imped iments	Comments
			Survey Information		Quantitative adult abundance			Qualitative Abundance		Contemporary Recruitment				
			Data Collection Years	Type	Estimate	Lower 95% CI	Upper 95% CI	Adults	Juveniles	In situ Recruitment Pattern				
		Nipigon River (MU3)	2008-2015	ls:s, ls:j	-	-	-	Remnant	Remnant	Unknown		Unknown	h:his, d:hab	C. Avery, Anishinabek/Ontario Fisheries Resource Centre, cavery@aofrc.org, personal communication
		Gravel River (MU3)	2011, 2013	ls:j	-	-	-	Not detected	Not detected	Unknown		Unknown	h:his	Believed to be extirpated
		Prairie River (MU3)	2011, 2013	ls:j	-	-	-	Remnant	Remnant	Unknown		Unknown	h:his	Low catches in standardized juvenile assessment gear (0.6 and 0.4 fish/net); C. Avery, Anishinabek/Ontario Fisheries Resource Centre, cavery@aofrc.org, personal communication; T.C. Pratt, Fisheries and Oceans Canada, thomas.pratt@dfo-mpo.gc.ca, personal communication
		Pic River (MU3)	2008-2011	ls:s, ls:j	-	-	-	Low	Moderate	Unknown		Unknown	h:his, h:con	(Ecclestone 2012a); 159 fish captured as part of telemetry experiment, C. Avery, Anishinabek/Ontario Fisheries Resource Centre, cavery@aofrc.org, personal communication; second highest juvenile catches in juvenile assessment gear (3.6 fish/net - joint survey with White R) T.C. Pratt, Fisheries and Oceans Canada, thomas.pratt@dfo-mpo.gc.ca, personal communication

DU	DU area	Sub-area	Contemporary Assessment: Survey Information: Data Collection Years	Type	Quantitative adult abundance: Estimate	Lower 95% CI	Upper 95% CI	Qualitative Abundance: Adults	Juveniles	Contemporary Recruitment: In situ Recruitment Pattern	Trajectory	Major Threats/ imped iments	Comments
		White River (MU3)	2010-2012	ls:s, ls:j	-	-	-	Low	Moderate	Unknown	Unknown	h:his, h:con	144 fish captured as part of spawning surveys and telemetry experiment, C. Avery, Anishinabek/Ontario Fisheries Resource Centre, cavery@aofrc.org, personal communication; second highest juvenile catches in juvenile assessment gear (3.6 fish/net, joint survey with Pic R) T.C. Pratt, Fisheries and Oceans Canada, thomas.pratt@dfo-mpo.gc.ca, personal communication
DU4	Eastern Lake Superior	Michipicoten River (MU4)	2011-2014	ls:s, ls:j	-	-	-	Remnant	Remnant	Unknown	Unknown	h:his, d:hab	Fifteen fish captured over three years in spawning survey, C. Avery, Anishinabek/Ontario Fisheries Resource Centre, cavery@aofrc.org, personal communication; low catches in standardized juvenile assessment gear (0.4 fish/net) T.C. Pratt, Fisheries and Oceans Canada, thomas.pratt@dfo-mpo.gc.ca, personal communication
		Batchawana River (MU4)	2010-2015	ls:j	-	-	-	Low	High	Variable	Stable	h:his, h:con	T.C. Pratt, Fisheries and Oceans Canada, thomas.pratt@dfo-mpo.gc.ca, personal communication. A population estimate of 4,490 was calculated for this river that included primarily juveniles and subadults.
		Chippewa River (MU4)	2010-2015	ls: j				Unknown	Unknown	Unknown	Unknown	h:his, h:con	Juvenile fish regularly captured off mouth of river, T.C. Pratt, Fisheries and Oceans Canada, thomas.pratt@dfo-mpo.gc.ca, personal communication

DU	DU area	Sub-area	Contemporary Assessment									Trajectory	Major Threats/ imped iments	Comments
			Survey Information		Quantitative adult abundance			Qualitative Abundance		Contemporary Recruitment				
			Data Collection Years	Type	Estimate	Lower 95% CI	Upper 95% CI	Adults	Juveniles	In situ Recruitment Pattern				
		Harmony River	-	-	-	-	-	-	-	-		-	-	Believed to be extirpated
		Stokely Creek (MU4)	-	-	-	-	-	-	-	-		-	-	Believed to be extirpated
		Goulais River/Goulais Bay (MU4)	2010-2015	ls: j	-	-	-	Low	High	Variable		Stable	h:his, h:con	(Pratt *et al.* 2014); updated through 2015, T.C. Pratt, Fisheries and Oceans Canada, thomas.pratt@dfo-mpo.gc.ca, personal communication. A population estimate of 8,965 was calculated for this river that included primarily juveniles and subadults.
DU4	Lake Huron/North Channel	St. Marys River (MU5)	2000-2007	ls:a	505	388	692	Low	Unknown	-		-	-	(Bauman *et al.* 2011)
		Mississagi River (Tunnel Lake) (MU5)	2010	ls:a, ls:j	-	-	-	Very low	Very low	Nil		Unknown	d:hab; d:mig	Haxton et al 2014, 2015
		Mississagi River (Redrock and up) (MU5)	2010	ls:a, ls:j	-	-	-	Very low	Very low	Nil		Unknown	d:hab; d:mig	Haxton et al 2014, 2015
		Serpent River (MU5)	2012	ls:a, ls:j	-	-	-	-	-	-		-	-	Believed to be extirpated
		Spanish River (Espanola to Nairn Centre) (MU5)	2010	ls:a, ls:j	-	-	-	Very low	Very low	Nil		Unknown	d:hab; d:mig	Haxton et al 2014, 2015
DU4	Lake Huron/Georgian Bay	Magnetawan River (MU7)	-	-	-	-	-	Low	Low	Unknown		Unknown	-	(A/OFRC 2015)
		Nottawasaga River (MU7)	-	-	-	-	-	Low	Low	Unknown		Unknown	-	(COSEWIC 2006)
		Moon River (MU7)	-	-	-	-	-	Very Low	Unknown	Erratic		Unknown	-	(McIntyre 2010); OMNR 2015; S. Scholten
		Nairn Centre to High Falls (MU7)	2010	ls:a, ls:j	-	-	-	Very low	Very low	Nil		Unknown	d:hab; d:mig	Haxton et al 2014, 2015

DU	DU area	Sub-area	Contemporary Assessment								Trajectory	Major Threats/ imped iments	Comments
			Survey Information		Quantitative adult abundance			Qualitative Abundance		Contemporary Recruitment			
			Data Collection Years	Type	Estimate	Lower 95% CI	Upper 95% CI	Adults	Juveniles	In situ Recruitment Pattern			
DU4	Lake Nipissing	Lake Nipissing (MU6)	1991-2003	-	-	-	-	-	-	Consistent	Increasing	-	(OMNR 2009; Pratt 2008; McKee 2004; OMNRF 2009)
DU4	Lake Huron-Erie Corridor	Upper St. Clair River/Southern Lake Huron (MU8)	1994 - Present	ls:s; ls:j	35,484	45,030	25,939	Very High	Unknown	Variable	Stable	d:hab	Manny and Kennedy 2002;Chiotti *et al.* in prep
		North Channel St. Clair River (MU8)	1996 - Present	ls:s; ls:a; ls:j	11,720	16,083	7,356	Very High	Moderate	Variable	Stable	d:hab	Thomas and Haas 2002; Manny and Kennedy 2002; Nichols *et al.* 2003; Boase *et al.* 2011; Boase *et al.* 2014; Chiotti *et al.* in prep
		St. Clair River/Lake St. Clair (MU8)	1996-2000	ls:a, ls:j	45,506	24,230	86,190	-	-	-	-	-	(Thomas and Haas 2002)
		Detroit River (MU8)	2003 - Present	ls:s; ls:a; ls:j	4,068	7,268	869	High	Low	Variable	Stable	d:hab	Caswell *et al.* 2004;Chiotti *et al.* in prep
DU4	Lake Ontario and Tributaries	Lower Niagara River (MU9)	1998-2000	-	-	-	-	Low	Low	-	-	-	(Hughes *et al.* 2015; Hayashida *et al.* 1999)
		Trent River (Percy and Frankford Reaches) (MU10)	2011, 2015	ls:a, ls:j	-	-	-	Very low	Very low	Nil	Unknown	d:hab; d:mig	
DU4	Ottawa River	Lac Dollard des Ormeaux (MU11)	2001, 2002, 2004, 2009	ls:a, ls:j	-	-	-	Low	Moderate	Consistent	Increasing	d:hab; d:mig; d:ent; h:h, pol	Haxton 2002; Haxton and Findlay 2008; Haxton and Findlay 2009; Haxton 2011
		Lac Deschenes (MU11)	2000, 2002, 2003, 2009	ls:a, ls:j, ls:s	202	93	378	Low	Low	Erratic	Declining	d:hab; d:mig; d:ent; h:h, pol	Haxton 2002; Haxton 2006; Haxton and Findlay 2008; Haxton and Findlay 2009; Haxton 2011
		Lac des Chats (MU11)	1997, 2002, 2003, 2009	ls:a, ls:j	-	-	-	Low	Low	Erratic	Declining	d:hab; d:mig; d:ent; h:h, pol	Haxton 2002; Haxton and Findlay 2008; Haxton and Findlay 2009; Haxton 2011; Haxton *et al.* 2014, 2015
		Lac du Rocher Fendu (MU11)	1997, 2000, 2002, 2003, 2009	ls:a, ls:j	-	-	-	Low	Low	Infrequent	Declining	d:hab; d:mig; d:ent; h:h, pol	Haxton 2002; Haxton and Findlay 2008; Haxton and Findlay 2009; Haxton 2011

			Contemporary Assessment										
			Survey Information		Quantitative adult abundance			Qualitative Abundance		Contemporary Recruitment			
DU	**DU area**	**Sub-area**	**Data Collection Years**	**Type**	**Estimate**	**Lower 95% CI**	**Upper 95% CI**	**Adults**	**Juveniles**	**In situ Recruitment Pattern**	**Trajectory**	**Major Threats/ imped iments**	**Comments**
		Lac Coulonge, Lower Allumette, Upper Allumette (MU11)	1997, 1998, 2000, 2001, 2002, 2003 2008, 2010, 2015	ls:a, ls:j	-	-	-	High	High	Consistent	Stable	d:hab; d:mig; d:ent; h:h, pol	Haxton 2002; Haxton and Findlay 2008; Haxton and Findlay 2009; Haxton 2011; Haxton *et al.* 2014, 2015
DU4	Ottawa River	Holden Lake/ Lac la Cave (MU11)	1998, 1999, 2003, 2004 2009, 2010	ls:a, ls:j	-	-	-	Low	Remnant	Nil	Declining	d:hab; d:mig; d:ent; h:h, pol	Haxton 2002; Haxton and Findlay 2008; Haxton and Findlay 2009; Haxton 2011; Haxton *et al.* 2014, 2015
		Lake Temiscaming (MU11)	2008	ls:a, ls:j	-	-	-	Low	Remnant	Infrequent	Declining	d:hab; d:mig; d:ent; h:h, pol	Haxton 2002; Haxton and Findlay 2008; Haxton and Findlay 2009; Haxton 2011
DU4	St. Lawrence River	Downstream Beauharnois dam (MU12)	1995-2015	ls:a, ls:s, ls:j, fc	>100,000	-	-	Very High	Very High	Variable	Stable or increasing	d:hab, d:mig, h:con, h:his	(Dumont *et al.* 2011; Dumont and Mailhot 2013; Thiem *et al.* 2013)
		Lake St. Francis (upstream Beauharnois dam) (MU10)	1996, 2004, 2009, 2014	fc	-	-	-	Low	Low	Unknown	Stable or declining	d:hab, d:mig; h:con	(Mohr *et al.* 2007 in Pratt 2008)
DU4	Lake Champlain and Richelieu River	Upstream Chambly Dam and Missisquoi Bay (MU12)	2003, 2012	fc				Not Detected	Not detected		Unknown	d:hab, d:mig, isp, pol	

Several studies have specifically examined the recruitment patterns of wild Lake Sturgeon populations. Nilo *et al.* (1997) targeted juvenile Lake Sturgeon over a three-year period in the St. Lawrence River and observed a 7:1 ratio between the strongest and weakest cohorts, although the ratio was 2:1 when the oldest cohort was excluded. Positive correlations were observed between year-class strength and rate of increase in mainstem temperature during May and June, and June flow volumes in the major spawning tributary. In the most reliable portion of the dataset, a negative correlation was observed between a given cohort and the one produced in the following year, perhaps indicative of density-dependent interactions (Nilo *et al.* 1997).

Dumont *et al.* (2011) examined recruitment in the St. Lawrence River following the construction of spawning beds downstream of a hydroelectric dam on the Des Prairies river tributary. Larval production increased following enhancements, and the ratio of strongest to weakest cohorts was 5:1. Strong juvenile cohorts were produced in years when larvae were numerous; however, high larval production did not always result in a strong cohort. Consistent with the results of Nilo (1997) in the same system, cohort strength was correlated with high June flow volumes. The 2011 analysis also revealed a negative correlation between larval production and commercial landings during the three previous years, attributed to reduced numbers of spawners on the spawning grounds (Dumont *et al.* 2011). Mailhot *et al.* (2011) elaborated on the same dataset, highlighting the strength of the negative relationship between larval production and commercial landings of one year prior.

McDougall *et al.* (2014b) reported on recruitment patterns derived from captures of juvenile Lake Sturgeon in the Winnipeg and Nelson rivers, MB. Results suggested that recruitment in these systems is contemporarily erratic, with large and seemingly unpredictable inter-annual fluctuations in cohort strength observed in all populations examined. Even in the "healthy" Slave Falls Reservoir population, which supports a large adult stock known to release massive quantities of eggs on an annual basis (Gillespie *et al.* in prep.), year-class failures (3 in 11 years) were evident (McDougall *et al.* 2014b). A lack of consistency in the cohort-frequency distributions of the three reservoirs suggested that flow averaged over a monthly interval during the spawning/larval drift period (such as was predictive in the St. Lawrence; Nilo *et al.*1997; Dumont *et al.* 2011) was unlikely to be a primary and consistent determinant of cohort-strength along the Winnipeg River flow axis (McDougall *et al.* 2014b).

Haxton *et al.* (2015) examined juvenile recruitment in Ontario waterbodies using a variability index and a coefficient of determination. Recruitment was highly variable in both undeveloped systems and those regulated for hydroelectric purposes, but more so in the latter. The degree of negative impact of hydroelectric production was attributed to operating regime, with winter reservoir systems being linked to persistent recruitment failure, peaking systems having an intermediate level of impact, and run-of-the-river being most benign (Haxton *et al.* 2015).

Cohort frequency (year-class strength) distributions generated from adult Lake Sturgeon can also provide information regarding Lake Sturgeon recruitment patterns and dynamics. For example, if size-related gear selectivity can be accounted for, or if size-structured mark-recapture analyses can be conducted, conclusions regarding broad recruitment dynamics (increasing, decreasing, or stable adult recruitment) over a scale of decades should be robust (Noakes *et al.* 1999). However, random aging error is likely problematic when examining inter-annual variation; even assignment errors of +/-1 year have the potential to mute differences between adjacent strong and weak cohorts, which would make recruitment seem more consistent than it really is (McDougall *et al.* 2014b). Furthermore, bomb-radiocarbon signatures suggested a systematic bias associated with ages assigned to older Lake Sturgeon in Lake Winnebago, and variation in biological processes between populations would make the widespread utility of the correction factor (derived solely based on the Lake Winnebago population) questionable (Bruch *et al.* 2009).

A few studies have examined recruitment patterns based on aging structures collected from adult Lake Sturgeon. Adams *et al.* (2006) found that recruitment in Rainy Lake, ON/MN, was erratic based on aging assignments, although it was noted that aging accuracy could not be validated. Unfortunately, analysis regarding the determinants of cohort strength would likely be of little value given that presumed aging assignment bias associated with larger/older fish (Bruch *et al.* 2009) was not accounted for.

Shaw *et al.* (2012) examined cohort strength in the Namakan Reservoir, ON/MN, applying the correction factor derived by Bruch *et al.* (1999) for the Lake Winnebago population to all fish assigned ages of 14 years or older; however, no validation of transferability to the Namakan Reservoir was conducted and, therefore, the results of downstream analysis linking environmental variables with occurrences of strong cohorts (via an odds ratio approach) have to be considered suspect. Recruitment within the reservoir was deemed consistent (Shaw *et al.* 2012) but, even without accounting for some assumed degree of random aging error, the cohort-frequency distribution presented suggested inter-annual variation (i.e., variable recruitment in the context of classifications used in this report).

Several other studies have been conducted that shed light on the processes that influence recruitment. In the Peshtigo River, WI, Caroffino (2010) observed an order of magnitude variation in mortality rates from larval to age-0 based on studies conducted in sequential years, suggesting that large variation in early life-stage survival may be common.

Based on results of stocking in the St. Louis River, MN/WI, differential survival of age-0s as a function of body size seems to occur (Schram *et al.* 1999). Stocked age-0s (undersized relative to wild conspecifics) have generally survived very poorly in the upper Nelson River, MB (McDougall *et al.* 2014d), and a size-related overwintering threshold has been hypothesized (McDougall and Nelson 2015). If such a pattern truly exists, length of first growing season as well as first winter severity is probably also influential, although perhaps only in northern populations.

In Black Lake/Black River, MI, an apparent recruitment bottleneck is suspected to relate to predation; spawning is known to occur, larvae are hatching and drifting from the spawning sites, but cohorts are ultimately not being produced (E. Baker pers. comm.).

In summary, there are many factors (biological, environmental, anthropogenic) that seem to influence Lake Sturgeon recruitment. There are also varying perceptions on the implications of variability (and especially the nature of anthropogenic influence) for species recovery. For example, Haxton *et al.* (2015) stressed that inconsistent recruitment seemed to be the limiting factor in the regulated Ontario rivers that they studied. Conversely, McDougall *et al.* (2014b), referencing the large and "healthy" Slave Falls Reservoir population, suggested that erratic recruitment is not always a problem that needs to be remedied but, rather, could be an innate characteristic of the species that needs to be accounted for in species recovery plans.

POPULATION SIZES AND TRENDS

The following sections are primarily based on wild Lake Sturgeon. However, some stocking of early life stages (fry, age-0, age-1) and/or transfers of juveniles/adults has occurred in DUs 2, 3 and 4 (e.g., MCWS 2012; Klassen 2014; McDougall *et al.* 2014d; Welsh *et al.* 2015; D. Gibson pers. comm.). All stocking/transfer events in Canadian waters have occurred within the same DU.

In cases where stocking has been conducted to supplement natural recruitment, it has generally not been possible to discriminate hatchery-reared from wild-spawned individuals captured in field surveys. As such, in a few populations, contemporary understanding of abundance (particularly juvenile) may be influenced by the presence of stocked fish. No attempt has been made to exclude the influence of stocked individuals. Furthermore, on a DU scale, the influence of stocking in terms of proportional numbers is very small, and excluding stocked fish would not change DU-scale generalizations regarding trajectory and/or extinction probability.

DU1 – Western Hudson Bay

Cleator *et al.* (2010a) identified three Lake Sturgeon management units in the Churchill River, delineated by natural river features and/or contemporary dams. MU1 spans 112 km from Atik Falls on the Reindeer River and Kettle Falls on the Churchill River downstream to Island Falls Generating Station (GS); MU2 spans 430 km from Island Falls GS downstream to Missi Falls Control Structure (CS); and MU3 spans 440 km from the Missi Falls downstream CS to the Churchill River estuary (Figure 10).

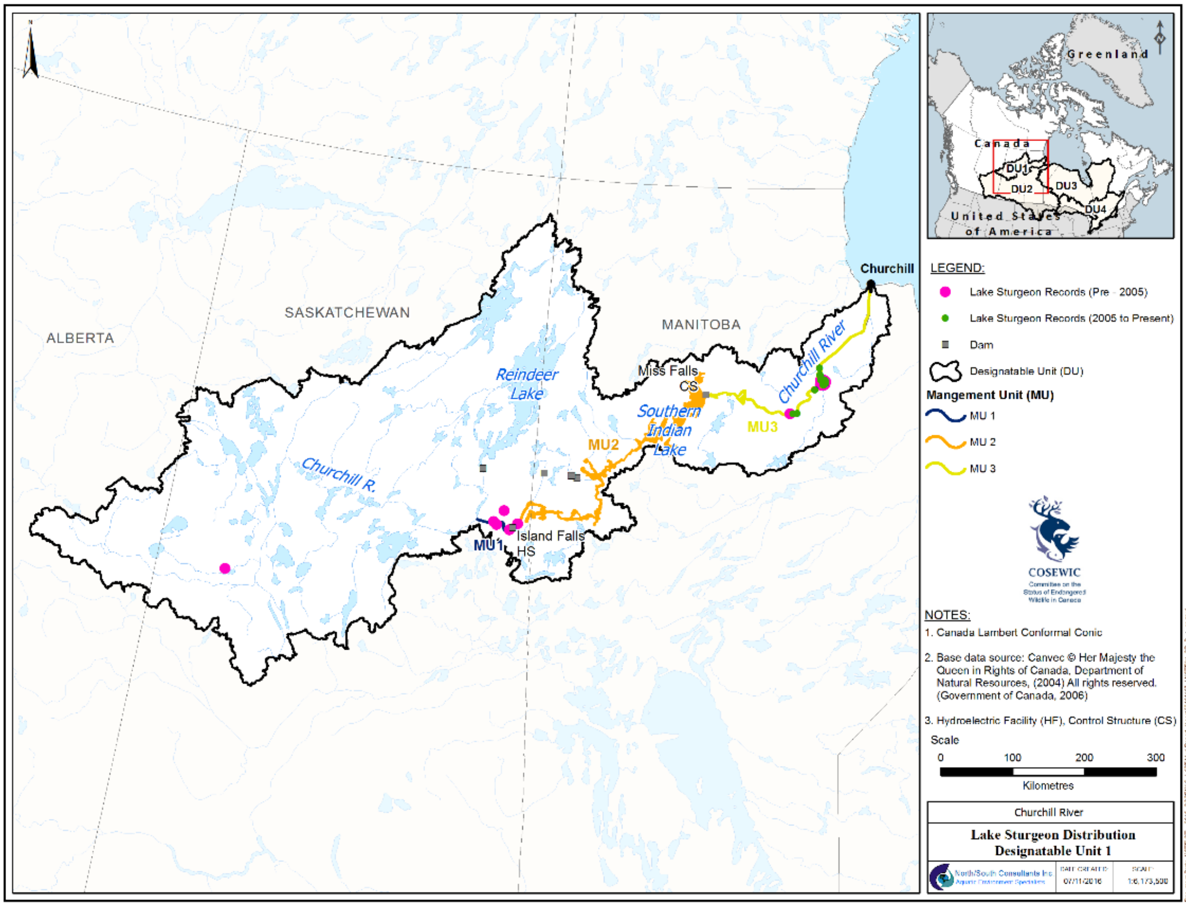

Figure 10. Historical and contemporary Lake Sturgeon distribution in the Churchill River (DU1), showing the location of falls/rapids, dams, topography, and current management units.

In MU1, the species has been reported as far upstream as Kettle Falls on the Churchill River and Atik Falls on the Reindeer River (Sawchyn 1975). MU1 offers numerous falls/rapids typical of Lake Sturgeon spawning locations and a diversity of aquatic habitats likely to satisfy all life history requirements (Larter *et al.* 2015). Recent juvenile and adult Lake Sturgeon surveys conducted in MU1 (2010 and 2011) failed to capture any Lake Sturgeon, suggesting that abundance is low (Johnson and Nelson 2011; Nelson and Barth 2011). The last reported capture of Lake Sturgeon in this MU occurred in 2001/2002 when two large individuals were captured in the vicinity of Wintego Rapids (Mark Duffy pers. comm.). Contemporary recruitment is unlikely to be occurring and the trajectory is considered remnant (Table 2).

Little information exists regarding the historical abundance of Lake Sturgeon from the Saskatchewan portion of MU2. Harvest is known to have occurred during, and after, the construction of Island Falls Hydroelectric Station (HS), but harvest quantities are unknown (Morin 2002). Skaptason (1926) reported that commercial fishing occurred between Duck and Pukatawagan lakes in the winter of 1924–1925 and small commercial harvests were reported again in 1938 and 1946 (Stewart 2009). Small quantities of harvest were reported annually in 1953-1961, after which the fishery was closed for 11 years (Stewart 2009). In 1976, the year Missi Falls CS was completed, water levels increased on Southern Indian Lake and considerable flow volumes were diverted down the Churchill River Diversion route to the Nelson River. There have never been any focused Lake Sturgeon studies conducted in MU2. Several incidental captures of very large fish have occurred over the past two decades and one report of a juvenile (Manitoba Conservation and Water Stewardship, unpubl. data). The population trajectory in MU2 is considered remnant (Table 2).

The Lower Churchill River (MU3) extends from the Missi Falls CS at the natural outlet of Southern Indian Lake (SIL) to the Churchill River Estuary. There is a near absence of historical Lake Sturgeon information from the lower Churchill River prior to 1976. Between 1977 and 1987, small periodic harvests amounting to <1,200 kg annually were reported (Stewart 2009). Recent information suggests that the Missi Falls CS to Redhead Rapids reach is essentially devoid of Lake Sturgeon (NSC 2011; CAMP 2014). Lake Sturgeon is relatively abundant and known to be recruiting in the Churchill River between Redhead Rapids and Swallow Rapids (MacLean and Nelson 2005;; CAMP 2014; Blanchard *et al.* 2014; Ambrose and McDougall 2016). A Lincoln-Peterson population estimate conducted in 2003 estimated the quantity of Lake Sturgeon > 800 mm present in the reach to be 2,005 (95% CI: 1,441 – 2,569) (MacLean and Nelson 2005). A preliminary Jolly-Seber estimate based on 2014 and 2015 data was 1,573 (1,401-1,745) suggesting that the population is either stable or decreasing (Ambrose and McDougall 2016) (Table 2). Lake Sturgeon is believed to be rare between Swallow Rapids and the estuary (Remnant and Bernhardt 1994; Remnant 1995; Peake and Remnant 2000; Bernhardt 2000, 2001, 2002; Bernhardt and Holm 2003; Bernhardt and Caskey 2009; Hertam *et al.* 2014) and it is unclear if the fish present are due to recruitment in the reach or the result of downstream movement (Blanchard *et al.* 2014) (Table 2).

<u>Summary</u>

The historical abundance of Lake Sturgeon in this DU is poorly understood. The species was present along much of the Churchill River in Saskatchewan and Manitoba historically but, based on commercial catch records, and reports from commercial fishers, may not have been as abundant as other nearby rivers, such as the Nelson River. According to Cleator *et al.* (2010a), Lake Sturgeon may have declined by as much as 98% in the Churchill River in 1920-1939 due to overharvest. It is possible that small recruiting populations still exist in the Eden Lake system, or in the Churchill River in Manitoba upstream of Southern Indian Lake; however, focused studies have not been conducted. Downstream of the Missi Falls CS, a population composed of approximately 1,500 individuals is the only known sizable population that remains in this DU with documented contemporary recruitment.

DU2 – Saskatchewan-Nelson River

DU2 is a combination of five previously separate DUs from the 2006 assessment: Saskatchewan River populations (formerly DU2), the Nelson River populations (formerly DU3), the Red-Assiniboine rivers and Lake Winnipeg populations (formerly DU4), the Winnipeg River-English River populations (formerly DU5), and the Lake of the Woods-Rainy River populations (formerly DU6). The discussion of DU2 will move from south to north, beginning with the Assiniboine and Red River drainages.

The Red and Assiniboine river drainages were divided into three distinct MUs (Figure 11) by Cleator *et al.* (2010d): the Assiniboine River and tributaries upstream of the Portage la Prairie Diversion Control Structure (MU1); the Red River and tributaries upstream of Lockport, including the Assiniboine River to Portage la Prairie Diversion Control Structure (MU2); and the Red River downstream of Lockport (MU3). Historically, Lake Sturgeon was found in the Assiniboine River and its tributaries (Cleator *et al.* 2010d). It is thought that commercial harvest occurred in the river in the late 1800s to early 1900s; however, harvest quantities were likely recorded as Lake Winnipeg production. The dam constructed at Lockport in 1910 may also have influenced Lake Sturgeon abundance in the river, assuming that individuals moved between Lake Winnipeg and the Assiniboine River prior to its construction. Lake Sturgeon was believed to be completely extirpated from the Assiniboine River circa 1970 (Cleator *et al.* 2010d). The MU1 portion of the river was stocked with Lake Sturgeon from 1996 to 2008. Based on angler reports and one focused study (Aiken *et al.* 2013), it is known that these stocked fish have dispersed throughout much of the river and are reaching adult size (MCWS 2012). The abundance of Lake Sturgeon in the MU1 portion of the Assiniboine River is largely unknown; however, it is believed to be increasing due to stocking (Table 2). To date, there is no conclusive evidence of stocked fish reproducing in the river.

The lower Assiniboine River and the Red River comprise MU2 and MU3. The St. Andrews Lock and Dam (est. 1910) at Lockport is the only dam on the Red River mainstem in Canada. It likely acts as a barrier to upstream movement, as the fishway does not facilitate upstream Lake Sturgeon passage (MCWS 2012). Historical abundance is largely unknown but it is believed that Lake Sturgeon was extirpated from the Red River by the mid-1900s (Cleator *et al.* 2010d).

More recently, Lake Sturgeon have been caught by anglers on the Assiniboine and Red rivers within the Winnipeg city limits, and it is thought that at least some of these fish have dispersed into Canada from annual stocking efforts in the Minnesota portion of the Red River. The current abundance of Lake Sturgeon in the Red River is poorly understood as there has been no directed Lake Sturgeon research conducted in the Manitoba portion of the Red River (MU2 and MU3) in recent years. Since 1997, stocking has been undertaken throughout in the Red River system in Minnesota by the Minnesota Department of Natural Resources and the White Earth Nation. Recaptures of tagged individuals that correspond to stocking events in Minnesota have occurred in the Red River in Manitoba, both upstream and downstream of Lockport (MCWS 2012) (Table 2). To date, there is no conclusive evidence of stocked fish reproducing.

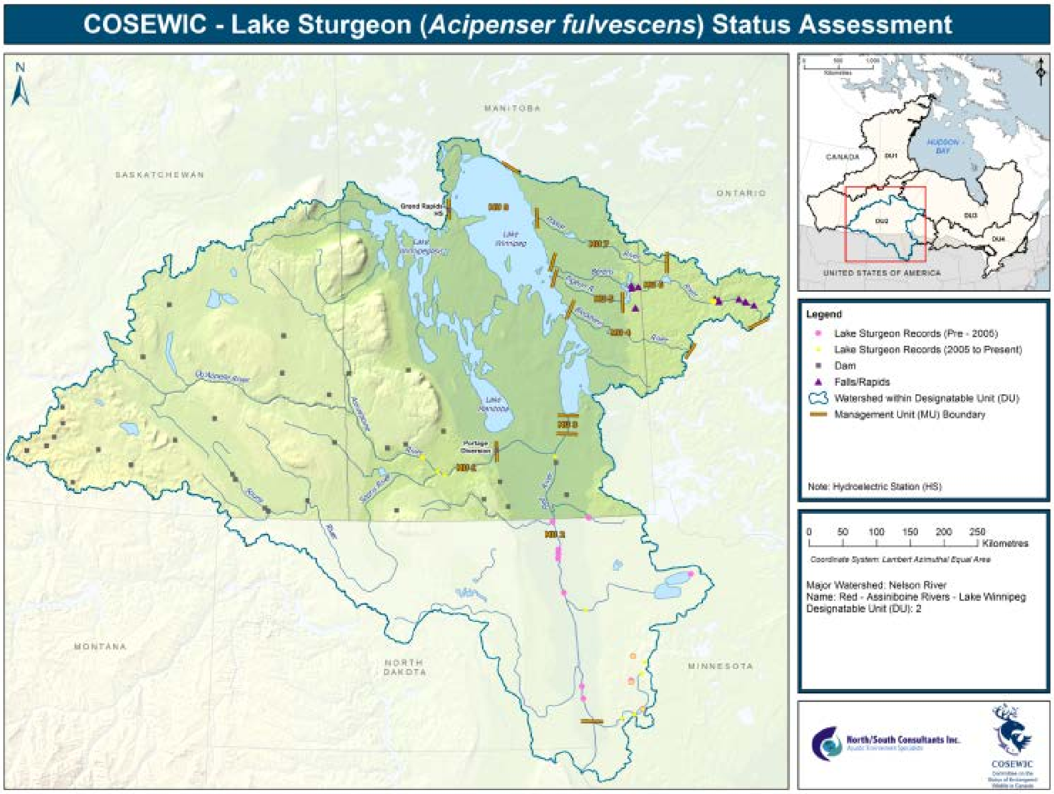

Figure 11. Historical and contemporary Lake Sturgeon distribution in Lake Winnipeg and tributaries (DU2), showing falls/rapids, dams, topography, and current management units.

Several unregulated tributaries flow west into Lake Winnipeg (formerly in DU4) and are known to contain Lake Sturgeon populations. These include the Bloodvein, Pigeon, Berens and Poplar rivers (Cleator *et al.* 2010d) (Figure 11). 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 (MCWS 2012). According to Dick (2006), subsistence harvest is known to occur in each tributary; however, the only population estimate comes from the Round Lake portion of the Pigeon River, which was estimated to have a population of 800-1,000 fish with very few spawning females (Dick 2006). The only recent information comes from a small section of the Pigeon River (NSC unpubl. data) and from the upper Berens River in Ontario (Haxton *et al.* 2014b). In summary, very little is known with respect to Lake Sturgeon abundance and population trajectories in Lake Winnipeg's eastern tributaries (Table 2).

Lake Sturgeon was once extremely abundant in Lake Winnipeg. For example, 3,221,958 kg (marketed weight) were harvested from Lake Winnipeg and associated smaller tributaries (e.g., Bloodvein, Assiniboine, Red) from 1876 to 1988/89, the year when the last harvest was recorded. Harvest peaked in 1900 at 445,110 kg and there were a number of stretches where no harvest was recorded (1878-84, 1897, 1912-16, 1928-37, 1946-53, 1955/56, 1970-75, 1976-78, 1980-84, 1986-88, 1989-present) (Harkness 1980).

The Rainy River – Lake of the Woods system (formerly DU6) consists of numerous lakes and rivers located throughout northwestern Ontario and parts of northern Minnesota (Figure 12). The Rainy River – Lake of the Woods system was divided into a series of management units: Sturgeon Lake – Lac la Croix system (MU1); Namakan River connecting Lac la Croix and the Namakan Reservoir (MU2); Namakan Reservoir (MU3); Rainy Lake – Seine River (MU4); and Rainy River from Fort Frances GS to the outlet of Lake of the Woods (MU5).

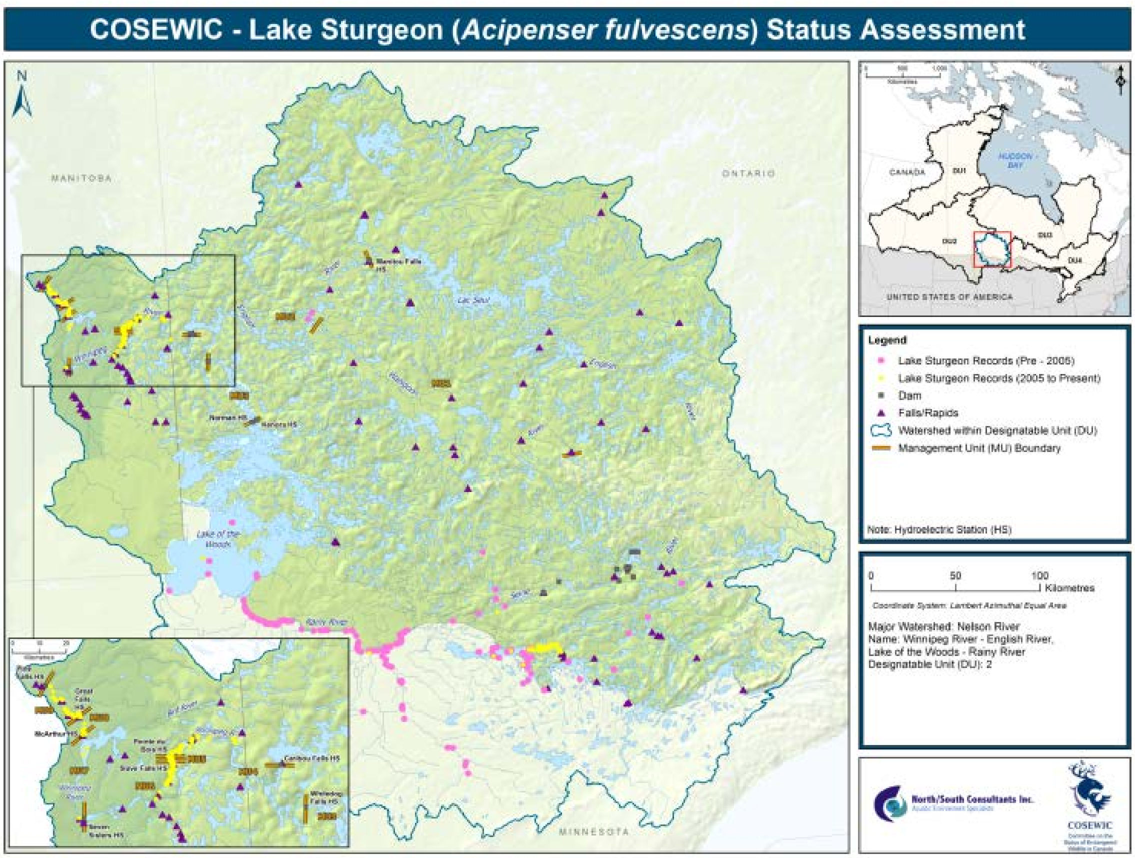

Figure 12. Historical and contemporary Lake Sturgeon distribution in the Winnipeg River (DU2), showing falls/rapids, dams, topography, and current management units.

Lake Sturgeon within the Rainy River – Lake of the Woods system were subjected to extensive commercial harvest in the late 1800s and early 1900s. The commercial fishery on Lake of the Woods alone accounted for 39% of the total sturgeon catch in Ontario in 1895. Fisheries on the other major lakes and rivers in the region (Lac la Croix, Namakan

Reservoir, Rainy Lake) were not as large but still had major impacts on Lake Sturgeon stocks (Harkness and Dymond 1961).

CPUE data suggest that adults are moderately abundant (population estimate 2,048 individuals) in the Sturgeon Lake – Lac la Croix System (MU1), while work on the juvenile segment of the population has not been conducted (Solomon and Baljko 2011). Lac la Croix is believed to support a self-sustaining population that is either stable or increasing (Table 2) (Solomon and Baljko 2011).

Lake Sturgeon is known to occur throughout the Namakan River system (MU2) from the outlet of Lac La Croix downstream to the Namakan Reservoir (McLeod 2008a). There is no record of commercial fishing on the Namakan River proper; however, according to Pearson (1963), a commercial pound-net fishery for Lake Sturgeon existed on both the Namakan Reservoir and Lac La Croix in the 1890s. CPUE data from the Namakan River suggest the number of adults and juveniles in the river is high and the population may be increasing (population estimate 2,729 individuals measuring > 1,000 mm TL) (McLeod 2008a) (Table 2). More recent work conducted by Trembath (2013) and Haxton *et al.* (2014b) suggested that adults and juveniles are at least moderately abundant.

Total harvest from the Namakan Reservoir (MU3) (probably included some fish that frequented the Namakan River) between 1924 and 1999 was 33,090 kg (McLeod 2008a). Although a population estimate has not been developed, CPUE data suggest that adult Lake Sturgeon are present at low-moderate abundances (Shaw *et al.* 2012; Shaw *et al.* 2013).

Rainy Lake (MU4) consists of three large basins: the North Arm, Redgut Bay, and the South Arm (Adams *et al.* 2006). Historically, commercial harvest occurred throughout Rainy Lake in both Canadian (until 1990) and American (until 1940) waters with catches peaking at 2,762 kg in 1959 (Canadian waters only). By 1964 harvest had declined to 1,007 kg and was almost zero from 1974-78. In Canada, from 1979-1990, catches averaged 345 kg until the closure of the fishery in 1990 (Adams *et al.* 2006).

A population of Lake Sturgeon still exists within Rainy Lake at low to moderate abundances, but it has not been studied extensively (Table 2). Between 2002 and 2004, Adams *et al.* (2006) captured 322 Lake Sturgeon in the South Arm of Rainy Lake using gillnets. Lake Sturgeon recruitment was found to be inconsistent, as cohort strength was variable (Adams *et al.* 2006).

The Rainy River runs 131 km from Fort Frances, ON to the southeastern end of Lake of the Woods (MU5). Lake Sturgeon in Lake of the Woods were once extremely abundant and the lake was once described as the greatest sturgeon pond in the world (Evermann and Latimer 1910). Commercial harvests were very large, peaking at 809,000 kg in 1893 and totalling > 4 million kg from 1892 – 1898. By the 1930s, the population had declined to the point where it was virtually non-existent (Mosindy 1987).

Mosindy (1987) suggested that increases in the annual commercial harvest (circa 1987) provided evidence that Lake Sturgeon were making a gradual recovery in Lake of the Woods. Indeed, successive population estimates conducted by Mosindy and Rusak (1991) in 1990, Stewig (2005) in 2004, and most recently Heinrich and Friday (2014) suggest that the population is increasing, with the most recent estimate suggesting 92,286 (45,816 - 201,875 95% CIs) individuals longer than 999 mm in length. Heinrich and Friday (2014) suggested that the Lake Sturgeon population within Lake of the Woods/Rainy River (MU5) is in a continued state of recovery and the population is increasing steadily (Table 2).

The Winnipeg River flows 260 km prior to emptying into Lake Winnipeg. Three hydroelectric GSs have been built on the Ontario side of the Winnipeg River (Norman Dam, Kenora Dam, and the Whitedog Falls GS) and six (Pointe du Bois, Slave Falls, Seven Sisters, MacArthur Falls, Great Falls and Pine Falls) have been built in Manitoba. The English River joins the Winnipeg River in Tetu Lake. The Wabigoon River is a tributary to the English River. The Winnipeg River was partitioned into nine MUs consistent with the recovery potential assessment for the Winnipeg/English rivers (formerly DU5; Cleator *et al.* 2010e). Hydroelectric generating stations generally delineate the following Winnipeg/English River MUs: Wabigoon River (MU1); English River: Manitou Falls GS – Caribou Falls GS (MU2), Winnipeg River: Norman GS – Whitedog Falls GS (MU3); Winnipeg/English River: Caribou Falls GS and Whitedog Falls GS – Pointe du Bois GS (MU4); Winnipeg River: Pointe du Bois GS – Slave Falls GS (MU5); Winnipeg River: Slave Falls GS – Seven Sisters GS (MU6); Winnipeg River: Seven Sisters GS – MacArthur GS (MU7); Winnipeg River: MacArthur GS – Great Falls GS (MU8); and Winnipeg River: Great Falls GS to Pine Falls GS (MU9) (Figure 12).

Although specific harvest locations are largely unknown, the Manitoba portion of the Winnipeg River was subject to a large commercial harvest (Stewart 2009). Stewart (2009) reported an initial Lake Sturgeon harvest of 78,835 kg taken from the Winnipeg River in 1910/11, and Harkness (1980) reported that this catch came from Lac du Bonnet. Harvest was also reported in 1930-1948 (135,437 kg), and 1957-1960 (28,799 kg) (Stewart 2009). A conservation closure on sturgeon harvest (including for subsistence) was invoked from the Manitoba/Ontario border downstream to the Pine Falls GS in 1994.

Focused Lake Sturgeon studies have not been conducted in the Wabigoon River (MU1) and there are no confirmed current or historical records of Lake Sturgeon occurring in the river. Little information exists for MU2, although Lake Sturgeon is known to be present. The reach was sampled briefly by the Ontario Ministry of Natural Resources and Forestry (OMNRF) in 2011 and 2012 for the purpose of collecting genetic samples; Lake Sturgeon were captured with relative ease and both juveniles of several age classes and older fish were represented in the catch (J. Peacock pers. comm) (Table 2).

Little is known historically with respect to Lake Sturgeon in MU3. In recent years, extensive gillnetting surveys were conducted to assess adult and juvenile abundance and only two adult Lake Sturgeon were captured (Duda 2008). In 2014, the MU3 reach was once again sampled using standard gillnet methods for adults and juveniles. Despite considerable effort, no Lake Sturgeon were captured (Johnson *et al.* 2014). Based on these data, the population was qualitatively assessed as remnant (Table 2).

While harvest records are largely uninformative on the MU scale, Eaglenest Lake in MU4 was at one time reported to be the best sturgeon fishing ground in southern Manitoba (McLeod 1943). Lake Sturgeon studies focused on both spawning adults and juveniles were conducted on the Ontario side of MU4 in 2007-2012 (Duda 2008, 2009; Peacock 2014) and 2014-2015 (McDougall and Barth 2015; Henderson *et al.* 2015c). Numerous studies have also been conducted on the Manitoba side since 2007 (McDougall *et al.* 2008a,b; McDougall and MacDonell 2009; Koga and MacDonell 2011; CAMP 2014; Henderson and McDougall 2015). A synthesis of data suggests that the population is actively recruiting as a result of spawning downstream of the Caribou Falls GS, while contributions from spawning below the Whitedog GS, Boundary Falls or Lamprey Rapids may be minimal (Peacock 2014; McDougall and Barth 2015; Henderson and McDougall 2015). Adult population estimates have never been derived for the reach, but cumulative results from the past 10 years indicate that adult abundance is low, while juvenile abundance is low-moderate, owing to a few strong year-classes produced since 2002 (Peacock 2014; McDougall and Barth 2015; Henderson and McDougall 2015) (Table 2).

The Pointe du Bois GS to Slave Falls GS reach (MU5) of the Winnipeg River is ~10 km long. The first population estimate was conducted during the mid- to late 1990s and, although confidence intervals were wide, mean annual estimates suggested that 360-1,100 adults existed in the reach (Block 2001). Since that time, Lake Sturgeon have been the focus of extensive environmental monitoring in relation to Pointe du Bois GS Spillway Replacement Project (e.g., McDougall *et al.* 2008a,b, 2014c; McDougall and MacDonell 2009; Koga and MacDonell 2011, 2012; Gillespie and MacDonell 2013, 2105; Koga *et al.* 2013; Henderson *et al.* 2014a;; Lacho *et al.* 2015b). The most recent POPAN analysis produced mean annual estimates of 2,323 – 2,929 adults (>800 mm FL) for 2008 and 2009 (Table 2). Juveniles are abundant within the reach, and the most recent POPAN analysis based on juvenile gillnetting conducted in 2013-2015 yielded mean estimates of 6,961, 7,560 and 10,286 fish <800 mm FL in 2013, 2014 and 2015, respectively (McDougall *et al.* in prep). Based on these data, the abundance of adult and juvenile Lake Sturgeon in MU5 is high and very high, respectively (Table 2). It is suspected that the small reservoir may be at, or approaching, carrying capacity.

The Slave Falls GS to Seven Sisters GS reach (MU6) is ~41 km long and characterized by a series of shield lakes separated by short riverine sections. A long-term monitoring program was initiated in this reach by Manitoba Fisheries Branch during the early 1980s. Focusing exclusively on Nutimik and Numao lakes during early summer, Jolly-Seber estimates based on Lake Sturgeon susceptible to capture in 5.5, 9 and 12” meshes in 1993-1999 ranged from 3,333-10,571 fish (Block 2001; MCWS 2012). Subsequent estimates (from 2007-2014 mean annual estimates have ranged from 21,418-34,960) suggest the population is increasing (D. Kroeker pers. comm.). Much research has been conducted within the reach (Barth *et al.* 2009, 2011, 2013; Barth 2011; Labadie 2011; Sparks 2011; Henderson 2013; Klassen 2014; Barth and Anderson 2015; McDougall *et al.* accepted). The cumulative results corroborate that Lake Sturgeon abundance is high and that there is ongoing recruitment.

The Seven Sisters GS to McArthur GS reach (MU7) of the Winnipeg River is ~35 km long. Harkness (1980) reported that the 1910/1911 commercial harvest of 78,835 kg came from Lac du Bonnet, suggesting that a very large population existed in this MU historically. Although a formal population estimate has never been derived, based on angler captures research, and results of unpublished MCWS experimental-netting programs, the adult population is likely composed of at least several hundred individuals (Hrenchuk 2011; Struthers 2016; D. Kroeker pers. comm.) (Table 2). Juveniles also appear to be abundant within the reach (Hrenchuk 2011; D. Kroeker pers. comm.)

The McArthur GS – Great Falls GS reach of the Winnipeg River (MU8) is ~8.5 km long, making it the smallest Winnipeg River impoundment. Little is known about the abundance of Lake Sturgeon in this reach historically. Several studies have been conducted in MU8 and, in summary, these suggest that the abundance of adult and juvenile Lake Sturgeon within MU8 is believed to be very low and moderate, respectively (D. Kroeker pers. comm.; McDougall 2011b; Murray and Gillespie 2011; Henderson and McDougall 2012; McDougall and Gillespie 2012; McDougall *et al.* 2014c) (Table 2).

The Great Falls to Pine Falls GS reach of the Winnipeg River (MU9) is ~20 km long. Little is known about Lake Sturgeon populations in this reach historically. Studies conducted since 2010 have improved the understanding of populations within the MU9 reach of the Winnipeg River (McDougall 2011b; Murray and Gillespie 2011; Henderson and McDougall 2012; McDougall *et al.* 2014b). At present, abundance of adult and juvenile Lake Sturgeon within MU9 is believed to be low and high, respectively (Table 2).

Downstream of the Pine Falls GS, a recent study indicated that Lake Sturgeon is persisting and may spawn downstream of the Pine Falls GS (Lowden and Queen 2013). Based on CPUE values and the number of recaptures, it is likely that several hundred Lake Sturgeon occupy this area (Doug Watkinson pers. comm.).

The Saskatchewan River proper begins at the confluence of the South Saskatchewan and North Saskatchewan rivers in the province of Saskatchewan and flows ~550 km prior to emptying into Lake Winnipeg (formerly in DU2; Rosenberg *et al.* 2005) (Figure 13). The Saskatchewan River proper is currently dammed in three locations: at the Nipawin and E.B. Campbell hydroelectric stations in Saskatchewan, and at the Grand Rapids GS in Manitoba. The Saskatchewan River is broken into four Lake Sturgeon management units (MUs) and encompasses parts of Alberta, Saskatchewan, and Manitoba: North Saskatchewan River: Bighorn GS – The Forks, South Saskatchewan River: Coteau Creek HS – The Forks (MU3), and Saskatchewan River: The Forks – Nipawin HS (MU1); South Saskatchewan River: upstream of Gardiner GS (MU2); Saskatchewan River: Nipawin HS – E.B. Campbell HS (MU3); and Saskatchewan River: E.B. Campbell HS – Grand Rapids GS (MU4).

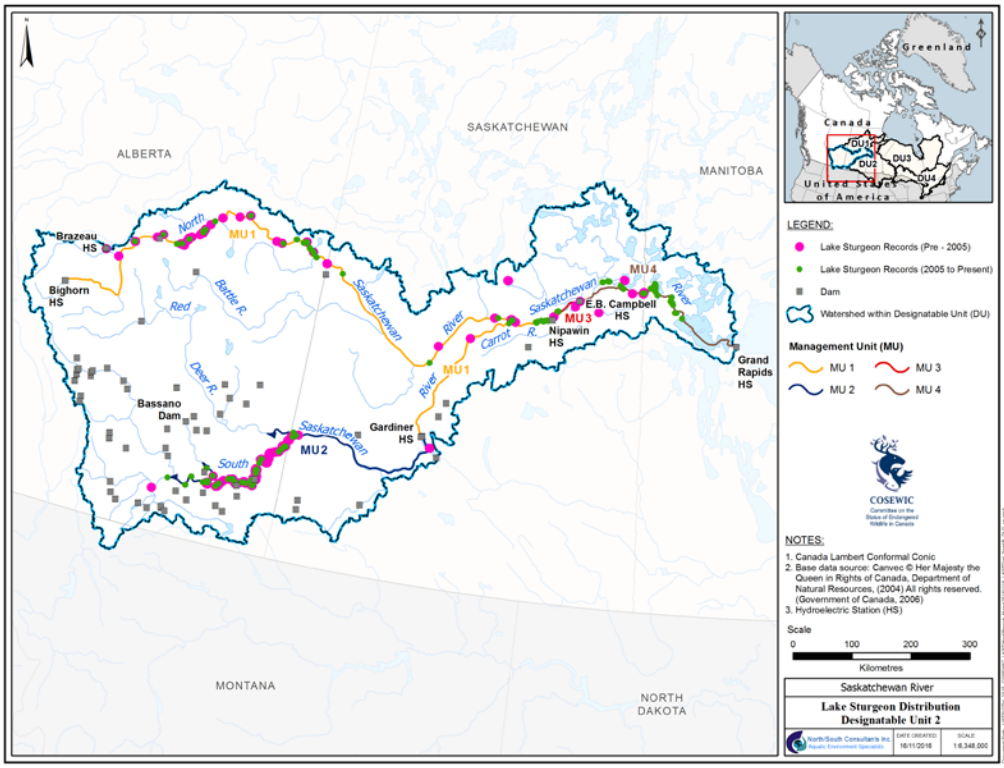

Figure 13 Historical and contemporary Lake Sturgeon distribution in the Saskatchewan River (DU2), showing falls/rapids, dams, topography, and current management units.

Based on commercial harvest records, Lake Sturgeon was once abundant in the Saskatchewan River drainage. Commercial Lake Sturgeon harvest was first reported from the Saskatchewan River in 1898 and over the next century 511,698 kg were harvested, primarily at the onset of the fishery (Stewart 2009). Little is known with respect to specific harvest locations in the Saskatchewan River drainage with the exception of a few reports (McLeod *et al.* 1999; Stewart 2009).

Despite several records and reports (Nelson and Paetz 1992; Smith 2003; Saunders 2006), little is known about the historical abundance of Lake Sturgeon in MU1. The 100 km reach immediately downstream of the Gardiner Dam is presently not considered suitable Lake Sturgeon habitat because of low water temperatures (associated with cold-water releases from Gardiner Dam) and scarcity of suitable food (Smith 2003).

Lake Sturgeon is known to move extensively among the North Saskatchewan, South Saskatchewan, and Saskatchewan rivers (Pollock 2012; Wishingrad 2014) and have been tracked as far upstream as Drayton Valley west of Edmonton (Owen Watkins pers. comm.). In the Saskatchewan River, Lake Sturgeon is known to be abundant at the Forks during all seasons, and has been detected as far downstream as Codette Lake, upstream of the

Nipawin Hydroelectric Station (HS) (Pollock 2012; Wishingrad 2014; Henderson *et al.* 2015d;, 2016a). Juvenile Lake Sturgeon have been found in high abundances in the Saskatchewan River at the upstream end of Codette Lake at Wapiti Provincial Park (Henderson *et al.* 2015d;, 2016a).

The most current population estimate in the North Saskatchewan River in Alberta comes from 2012 and splits the North Saskatchewan in two sections: the upstream reach from Drayton Valley to Smoky Lake where the adult population was estimated at 2,681 individuals and the downstream reach from Smoky Lake to the Alberta border where the adult population was estimated at 3,673 individuals (Table 2) (Hegerat and Paul 2013). White (2015) noted that these population estimates, derived from the North Saskatchewan River mark-recapture data, should be interpreted with caution because of the relatively low recapture rate. The most recent population estimate from the vicinity of the Forks and including the lower stretches of the North and South Saskatchewan rivers and the Saskatchewan River up to Codette Lake in 2011 was 4,197 individuals (Pollock 2012) (Table 2).

The most recent population estimate for MU2 on the South Saskatchewan River from the confluence of the Bow and the Oldman rivers to the Alberta border was 6,464 in 2012 (Paul 2013).

There is no historical information specific to Lake Sturgeon in MU3 from the 70 river km between the Nipawin HS and the E.B. Campbell HS; however, this reach has been used as a source for eggs and milt for stocking initiatives (Ron Hlasny pers. comm.). There have been no population estimates derived for this MU, and the population trajectory was classified as unknown in 2010 by Cleator *et al.* (2010b) (Table 2). Recent studies suggest that an actively recruiting population of Lake Sturgeon spawns below the Nipawin HS (Gillespie *et al.* 2015) and extensively use the Saskatchewan River downstream of Nipawin HS into Tobin Lake (McDougall *et al.* 2016).

In MU4, Lake Sturgeon were historically found in Saskatchewan at Cumberland Lake, the Torch River, the Tearing River, and Namew Lake, and downstream into Manitoba to Grand Rapids at Lake Winnipeg (Cleator *et al.* 2010b). Populations were thought to be large prior to the commercial fishery. Contemporarily, Lake Sturgeon is known to spawn in the E.B. Campbell tailrace (Gillespie *et al.* 2015) and other suspected spawning locations include the Torch River, the Bigstone Rapids, the Missipuskiow River, the Mossy River, and islands in the north end of Cumberland Lake (Wallace 1999; Smith 2003). The population estimate based on mark-recapture data from 1994 to 2014 indicates the population increased over the 20-year period with a current estimate of 3,099 individuals (Nelson 2015) (Table 2).

The Nelson River originates at the north end of Lake Winnipeg and flows 660 km to its outlet at Hudson Bay (formerly in DU3; Cleator *et al.* 2010c) (Figure 14). The Nelson River is impounded by five hydroelectric generating stations (from upstream to downstream): Jenpeg (built in 1976); Kelsey (1957); Kettle (1966); Long Spruce (1971); and Limestone (1985) (Figure 14). An additional station is currently under construction at Gull Rapids

(Keeyask GS) located between the Kelsey GS and Kettle GS. For the purposes of this assessment, the Nelson River was divided into six MUs, following Cleator *et al.* (2010c): Playgreen Lake – Whitemud Falls (MU1); Whitemud Falls – Kelsey GS (MU2); Kelsey GS – Kettle GS; lower Burntwood River between First Rapids and Split Lake (MU3); Kettle GS – Long Spruce GS (MU4); Long Spruce GS – Limestone GS (MU5); and Limestone GS – Hudson Bay (MU6).

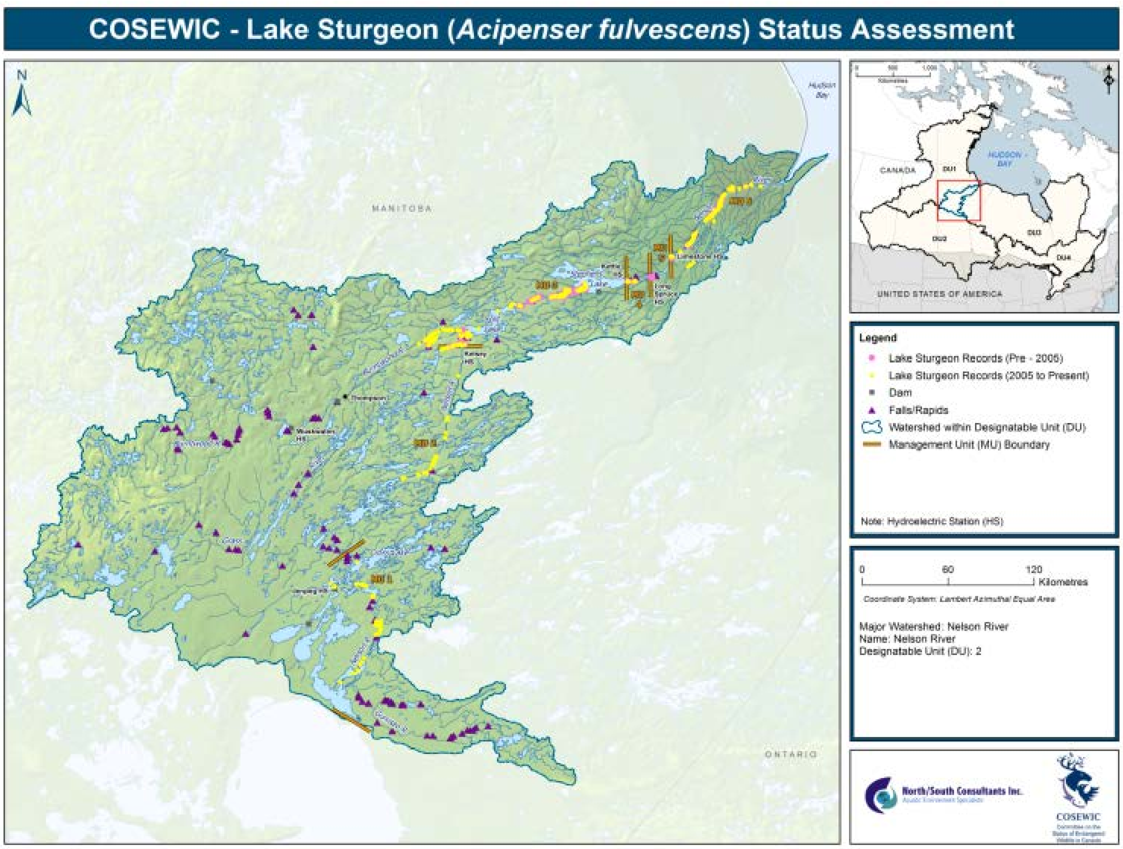

Figure 14. Historical and contemporary Lake Sturgeon distribution in the Nelson River (DU2), showing falls/rapids, dams, topography, and current management units.

Based on ATK, Hudson's Bay Company reports, and a fisheries survey from the early 1900s (i.e., Comeau 1915 in Skaptason 1926, Lytwyn 2002, FLCN 2008), Lake Sturgeon was historically abundant throughout the Nelson River. Sturgeon fishing for isinglass became an important part of regional trade economy of Aboriginal communities circa 1832 (Holzkamm and McCarthy 1988; Northern Lights Heritage 1994). It was estimated that an average annual harvest of 40,450 kg sturgeon (89,176 lbs headless dressed) was needed to supply the isinglass trade 1832-1892. Commercial harvest of Lake Sturgeon for shipment south began in the Nelson River in 1902 (Stewart 2009). During the first four years of the fishery (1902–1905), 297,199 kg of Lake Sturgeon were marketed, with the largest harvest occurring in 1903 (Stewart 2009). From 1906 to 1910, the Nelson River Lake Sturgeon harvest declined substantially, with stocks showing signs of overharvest. In 1910, a federal Royal Commission announced that sturgeon in the region (MU1) were on the verge of extinction and the fishery was closed. The fishery was reopened and closed again several times over the next eight decades, with harvests declining in each successive opening. The Nelson River commercial fishery was closed for the last time in 1991.

Based on commercial harvest data, it is clear that Lake Sturgeon abundance was high in MU1 and MU2 prior to the start of the commercial fishery. By the 1990s, Nelson River sturgeon stocks were on the verge of collapse; MU1 populations were believed nearly extirpated, while MU2 populations were declining. A Conservation Closure was invoked in the Landing River area of MU2 in 1994 to conserve sturgeon stocks (MCWS 2012). Lake Sturgeon abundance was found to be low in a study that targeted adults downstream of the Jenpeg GS (Henderson *et al.* 2015e). A conservation stocking program was initiated in 1994 in MU1 to recover Nelson River populations. The effectiveness of the stocking program has been evaluated and results indicate that stocking has led to the re-establishment of juvenile Lake Sturgeon in the reach of the Nelson River between Sea Falls and Sugar Falls (McDougall and Pisiak 2012; McDougall and Pisiak 2014; McDougall and Nelson 2015).

Farther downstream in MU2, data collected from two periods, 1993–2000 and 2006–2014, have been used to derive a Peterson population estimate for adults in the vicinity of the Landing River tributary. The population showed a decreasing trend in abundance from 1993 to 2000 but, since 2006, the population appears to be rebounding, with the most recent estimate (2013) at 3,257 adult individuals (D. Macdonald pers. comm.) (Table 2). The relative abundance of juveniles in the vicinity of the Landing River was also studied in 2013 (Groening *et al.* 2014a). Results indicated that erratic recruitment was occurring in the reach and that juvenile abundance was relatively low.

Although commercial harvest of Lake Sturgeon in the Nelson River began in 1902, it is likely that commercial exploitation of lower Nelson River stocks (MUs 3-6, between the Kelsey GS and the Nelson River estuary) was not as extensive as farther upstream. From 1970–1982, only 4,305 kg (or 330 fish assuming a 13 kg average) of Lake Sturgeon were commercially harvested from the Kelsey GS to Kettle GS reach (Patalas 1988; MacDonell 1997b).

It is now clear from genetic analyses that three distinct populations are present in MU3 including one in the Burntwood River, one in the Nelson River below the Kelsey GS, and one in the Nelson River between Clark Lake and Gull Rapids (Gosselin *et al.* 2015). Adult population estimates have been derived for all three of these populations (Nelson and Barth 2012; Hrenchuk *et al.* 2015; Henderson *et al.* 2016b). Results suggest that adult abundance is low and there is no clear increasing or decreasing trend for any of the populations (Table 2). In addition, studies focused on juveniles from each of these three populations found that they are present at low-moderate abundances (MacDonald 2008; 2009; Michaluk and MacDonald 2010; Henderson *et al.* 2011, 2013, 2015a; Henderson and Pisiak 2012). Results also indicate that recruitment is erratic, as only one strong year class, the 2008 cohort, was observed over an 11-year period from 2002–2012 in Gull and Stephens lakes (Henderson *et al.* 2015a).

The Long Spruce and Limestone reservoirs, MU4 and MU5, are 16 and 23 km long respectively. Based on considerable data collected from 1985 – 2013, the abundance of Lake Sturgeon in each of MU4 and MU5 is low (Baker 1990; Swanson *et al.* 1991; Kroeker and Horne 1993; MacDonell and Horne 1994; Bretecher and Horne 1997; Bretecher and MacDonell 2000; Johnson *et al.* 2004; Holm *et al.* 2006; Ambrose *et al.* 2008; Ambrose *et al.* 2009) and it is unknown if recruitment has occurred within each reservoir since the GSs were built. Lake Sturgeon younger than each reservoir have been captured; however, downstream movement from upstream populations has been documented (tagged fish from upstream have been tracked into these MUs) and is known to occur based on results of genetic analyses (Gosselin *et al.* 2015; Lacho *et al.* 2015a).

Historical harvest was likely minimal from the reach of the Nelson River between the Limestone GS and the Nelson River estuary (MU6), primarily due to access difficulties (Stewart 2009). Environmental studies beginning in the mid-1980s and continuing until present have revealed that the Lake Sturgeon population in this section of river is the most abundant population in the Nelson River, and one of the largest populations in Manitoba (MacDonell 1995, 1997a, 1998; Barth and MacDonell 1999; Holm *et al.* 2006; Ambrose *et al.* 2008, 2009, 2010a, 2010b; Pisiak *et al.* 2011). Mark-recapture based population estimates for adults (i.e., those greater than or equal to 800 mm FL) were derived in 2005 and 2013. The estimate from 2005 was 5,595 adults, while the most recent estimate from 2013 was 8,413 adults (Henderson *et al.* 2014b) (Table 2). In summary, the abundance of both adult and juvenile Lake Sturgeon in MU6 is high with the 2013 population estimate suggesting the population may be increasing (Table 2).

<u>Summary</u>

Lake Sturgeon populations in DU2 are generally well studied. Information on population trends and abundance exists for most populations in the DU, with the exception of tributaries draining into the east side of Lake Winnipeg. Overall, abundance within the DU is considered to be stable or increasing, although populations exist at a fraction of their historical abundance, thereby exhibiting the ‘ski-jump’ effect (IUCN Standards and Petitions Subcommittee 2017). While successful reproduction of stocked fish has yet to be observed, high rates of post-stocking contribution to the juvenile/subadult stages have been observed in the Red-Assiniboine drainage and sections of the Nelson River. The Rainy-River/Lake of the Woods system likely supports the largest population in the DU (approximately 90,000 individuals) and this population is considered to be increasing. Winnipeg River populations are among the most well-studied populations across the species’ range. Populations in Winnipeg River MUs are highly variable in terms of their abundance and trajectories, with some populations assessed as remnant and one considered to be near carrying capacity. Of the four MUs in the Saskatchewan River, each MU was qualitatively assessed as having a moderate to high abundance with an unknown, stable or increasing trajectory. Finally, Lake Sturgeon abundance in the Nelson River is highly variable among its six MUs. Remnant populations exist in MUs 1, 4 and 5, while 2, and 3 are considered low but stable;

MU6 populations were assessed as high and stable. The probability of the rescue effect originating from outside Canada is high due to Lake Sturgeon restoration activities in Minnesota. Stocking progeny of Rainy River broodstock in the Red River drainage in Minnesota has been ongoing since 1996 and is the most logical explanation for increased Lake Sturgeon captures in the Manitoba portion of the Red River.

DU3 – Southern Hudson Bay-James Bay

This area includes all drainages of northwestern Quebec, Ontario, and northeastern Manitoba that drain to Hudson/James bays (Figure 15). Relative to the other DUs, information on Lake Sturgeon is rather sparse for many of the watersheds in DU3. In general, the watersheds contain long rivers and available Lake Sturgeon information often comes from only a small section of each watershed. The only historical data available are from commercial harvest records. Harvest quantities were low relative to other systems discussed in this document.

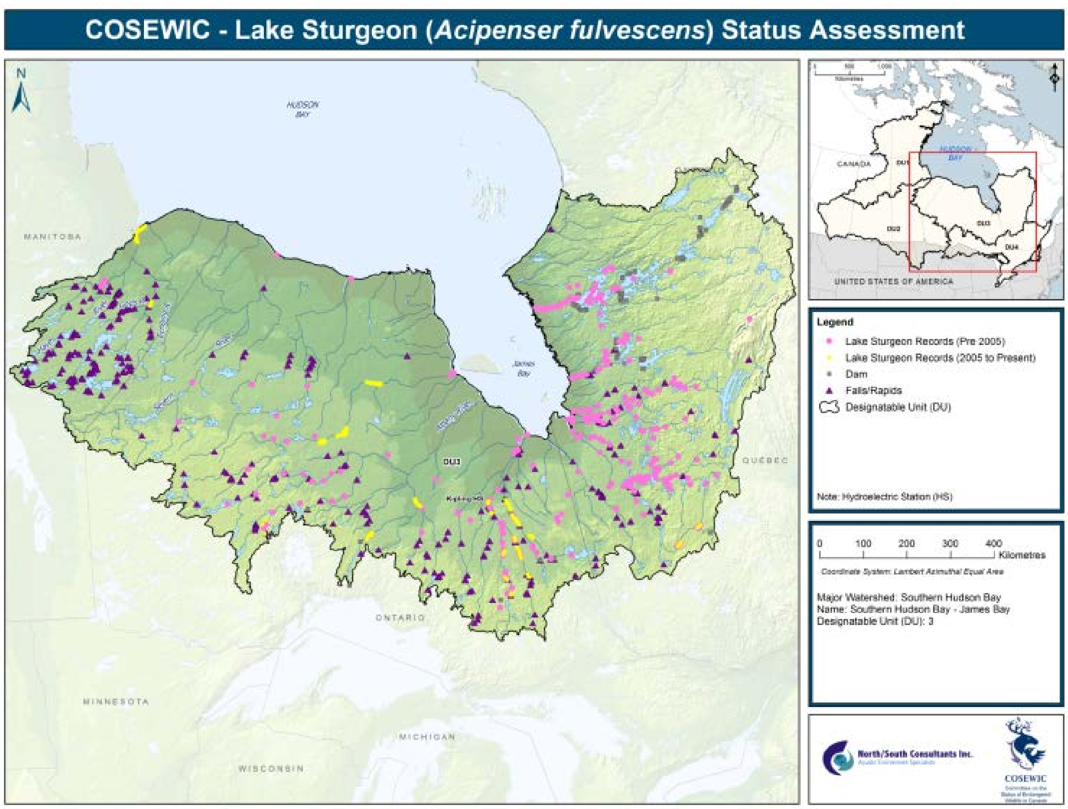

Figure 15. Historical and contemporary Lake Sturgeon distribution in the Southern Hudson Bay-James Bay (DU3), showing falls/rapids, dams, and topography.

The Hayes River system originates in Molson Lake in northeastern Manitoba. Lake Sturgeon populations in the Hayes River were commercially harvested, but stocks were never depleted to the same extent as in other Manitoba river systems (MCWS 2012). There is little quantitative information on Lake Sturgeon abundance in the Hayes River watershed, but populations are generally thought to be healthy (MCWS 2012). The only population estimate produced from the watershed comes from a stretch of the Fox River between Great Falls and Rainbow Falls. Pisiak and Maclean (2007) reported that the population was composed of 646 adults, based on the Petersen single-census estimate in 2004 (Table 2).

The Sturgeon, Severn, Winisk, Ekwin and Attiwapiskat rivers in Ontario flow northward, originating on the Boreal Shield and transitioning into Hudson Plain before entering into James Bay or Hudson Bay (Baldwin *et al.* 2000). To date, there are no hydroelectric developments on any of these rivers or their tributaries in the watershed. Based on anecdotal reports and ATK, Lake Sturgeon is known to exist in each of these rivers (T. Haxton pers. comm.). Focused Lake Sturgeon study has only been conducted in the Attawapiskat River in 2015 and, based on these data, adults and juveniles are present in low-moderate abundances (T. Haxton pers. comm.; Haxton *et al.* 2014b) (Table 2).

The Albany River flows from Lake St. Joseph to James Bay beginning on the Boreal Shield, transitioning to Hudson Plain (Baldwin *et al.* 2000). Historically, it is unknown if Lake Sturgeon in the Kenogami/Albany River watershed were harvested commercially. Sandilands (1987) suggested that, by the mid-1980s, commercial harvest was not occurring and relatively small numbers of Lake Sturgeon were taken by subsistence harvesters. The abundance of Lake Sturgeon in this system was quantified by mark-recapture in 1984 and 1985 (Sandilands 1987) and more recently in 2011 by Haxton *et al.* 2014b). Based on these data, the population was qualitatively assessed as low for adults and juveniles (Haxton *et al.* 2014b; T. Haxton pers. comm.) (Table 2).

The Moose River drains an area of roughly 109,000 km^2 and includes Canadian Shield and Hudson Plain habitats. The major tributaries of the basin include the Missinaibi, Mattagami, Groundhog, and Abitibi rivers. Lake Sturgeon was historically found throughout the Moose River basin, but is now confined to the lower reaches of the watershed in the Hudson Plain regions and is no longer found on the Canadian Shield (Seyler *et al.* 1997a). A number of artificial obstacles to upstream fish movement have been constructed in the basin, particularly in the Mattagami and Abitibi rivers, which are heavily fragmented. Commercial and subsistence harvest of Lake Sturgeon in the watershed started in the early 1900s but, by the 1980s, catches had declined dramatically and the commercial fisheries were closed (OMNR 2008). In summary, the abundance of Lake Sturgeon within the Moose River varies by location. The most recent estimate from the Little Long GS forebay suggested that approximately 10,000 – 12,000 Lake Sturgeon are present, a population considered to be the largest in northeastern Ontario (OMNR 2008; Hatch 2014) (Table 2). Within the Abitibi and Frederick House rivers, Lake Sturgeon is thought to be present at low abundances (Haxton *et al.* 2014b). In the lower Moose River, downstream of the Kipling GS, a population estimate in the 1980s suggested approximately 7,000 individuals (Threader and Brousseau 1986); however, no recent work has been conducted (Table 2).

The Harricana and Nottaway rivers run through western Quebec and northeastern Ontario. The majority of these rivers flow through the Boreal Shield, and transition to Hudson Plain near their outlets. Historically, Lake Sturgeon was considered rare in the Nottaway River, but little information is available (Ferguson and Duckworth 1997). More recently, commercial fishing on the river was carried out in 1989-1994 by the Cree communities of Mistissini, Waswanipi, and Ouje-Bougoumou (Fortin *et al.* 1992; Environnement Illimité Inc. 2012b). Based on limited data, the abundance and trajectory of these populations are unknown (Table 2).

The Rupert River flows from the head of the Temiscamie River at Mistassini Lake to Rupert Bay, north of the outlet of the Broadback River. Historically, Lake Sturgeon was abundant in the Rupert River and surrounding tributaries (Ferguson and Duckworth (1997). Contemporarily, the abundance of Lake Sturgeon is unknown and the river has been impacted by hydroelectric development (Table 2). Several artificial spawning areas have been built on the lower section of the river.

The Eastmain River flows through Boreal Shield and has undergone significant hydroelectric development as part of the James Bay Project. Unlike the Rupert River, subsistence fishing in the Eastmain River is much less extensive and not well documented (Environnement Illimité Inc. 2012b). The main spawning site in the Eastmain River prior to construction of the Eastmain-1 dam was located 215 km upstream of James Bay (Environnement Illimité Inc. 2004). Once the dam became operational, the spawning site was no longer suitable and, as a result, three separate artificial spawning sites were created. Since their creation, spawning has been observed at only one of the three new sites and has not been consistent every year (Environnement Illimité Inc. 2012b). The abundance of Lake Sturgeon in the Eastmain River has not been quantified by a population estimate; however, based on CPUE data adult and juvenile abundance was considered moderate and low, respectively (Burton *et al.* 2006; Table 2).

The La Grande/Opinaca River runs solely through the Boreal Shield region of northern Quebec. It is highly regulated, with eight hydroelectric dams along its length, which are cumulatively known as the La Grande Hydroelectric Complex. Abundance of both adults and juveniles is unknown, and stocking is occurring on this system (Table 2). Similar to the Eastmain River, no commercial Lake Sturgeon fishery currently exists in the Opinaca River and subsistence fishing is not well understood (Y. Paradis pers. comm.).

<u>Summary</u>

In summary, several rivers in DU3 are relatively pristine, whereas others have been developed extensively for their hydroelectric potential. The carrying capacity of Lake Sturgeon in these rivers is likely lower relative to larger rivers and lakes found in other DUs. Small-scale commercial fisheries existed historically, and domestic harvest still occurs on many of the DU3 rivers. Populations are thought to be highly variable throughout the region, but the understanding of population trends and abundance is often limited to relatively short sections of river. Rivers in Quebec have received considerable study in relation to the large-scale hydroelectric developments in the region. The largest population in DU3 is thought to occur in the Mattagami River (Little Long Reservoir), where the population has been estimated at ~12,000 individuals.

DU4 – Great Lakes-Upper St. Lawrence

The Great Lakes and St. Lawrence River basins cover 489,562 km^2 stretching from the northwest arm of Lake Superior to the upper St. Lawrence River estuary (Mailhot *et al.* 2011).

Historically, the Great Lakes and their tributaries supported exceptionally large Lake Sturgeon populations (Haxton *et al.* 2014a). Circa 1860, Lake Sturgeon was a valuable species for commercial fishers, which led to a 40-year period of unregulated harvest and the collapse of Lake Sturgeon populations throughout the Great Lakes (Harkness and Dymond 1961; Auer 1999). According to catch data, Lake Sturgeon harvest peaked in 1885 with ~7 million pounds taken (Baldwin *et al.* 2009). Two predictive models, used to estimate historical biomass in the Great Lakes, suggested that Lake Sturgeon biomass may have been as high as 25 million kilograms (37 $kg\ ha^{-1}$) in the late 1800s (Haxton *et al.* 2014a).

Similar to the Great Lakes, the St. Lawrence River and its tributaries were believed to support abundant Lake Sturgeon populations before hydroelectric development and overharvest reduced their numbers (Mailhot *et al.* 2011). In the 1990s, the Lake Sturgeon commercial fishery in the lower St. Lawrence River was one of the largest in North America, reaching 200 tonnes annually (Dumont *et al.* 2013). Harvest rose to over 250 tonnes by the mid-1990s; however, a new management plan, introduced in 2000, reduced the commercial catch by 60% over a three-year period (Mailhot *et al.* 2011). Currently, there is still a commercial fishery for Lake Sturgeon in the St. Lawrence River, but quotas have been reduced to 80 tonnes since 2002 and a slot size limit was implemented in 2012 with the revised management plan (Dumont *et al.* 2013) to increase spawner protection.

Within DU4, 12 MUs based on weak genetic structure and known barriers to movement were established by Pratt (2008).

The Pigeon and Kaministiquia rivers comprise MU1 (Figure 16). The Lake Sturgeon population within the Pigeon River is currently considered to be extant; however, its size is unknown (Mohr *et al.* 2007; Pratt 2008). In the Kaministiquia River, however, Lake Sturgeon has received considerable study. Based on mark-recapture data (2001), the population was estimated at 196 individuals and considered stable (M. Friday unpubl. data) (Table 2). Subsequent studies, including gillnetting and a determination of the effective number of breeders, suggested that both adult and juvenile abundance is low (Table 2) (M. Friday pers. comm; Haxton *et al.* 2014b).

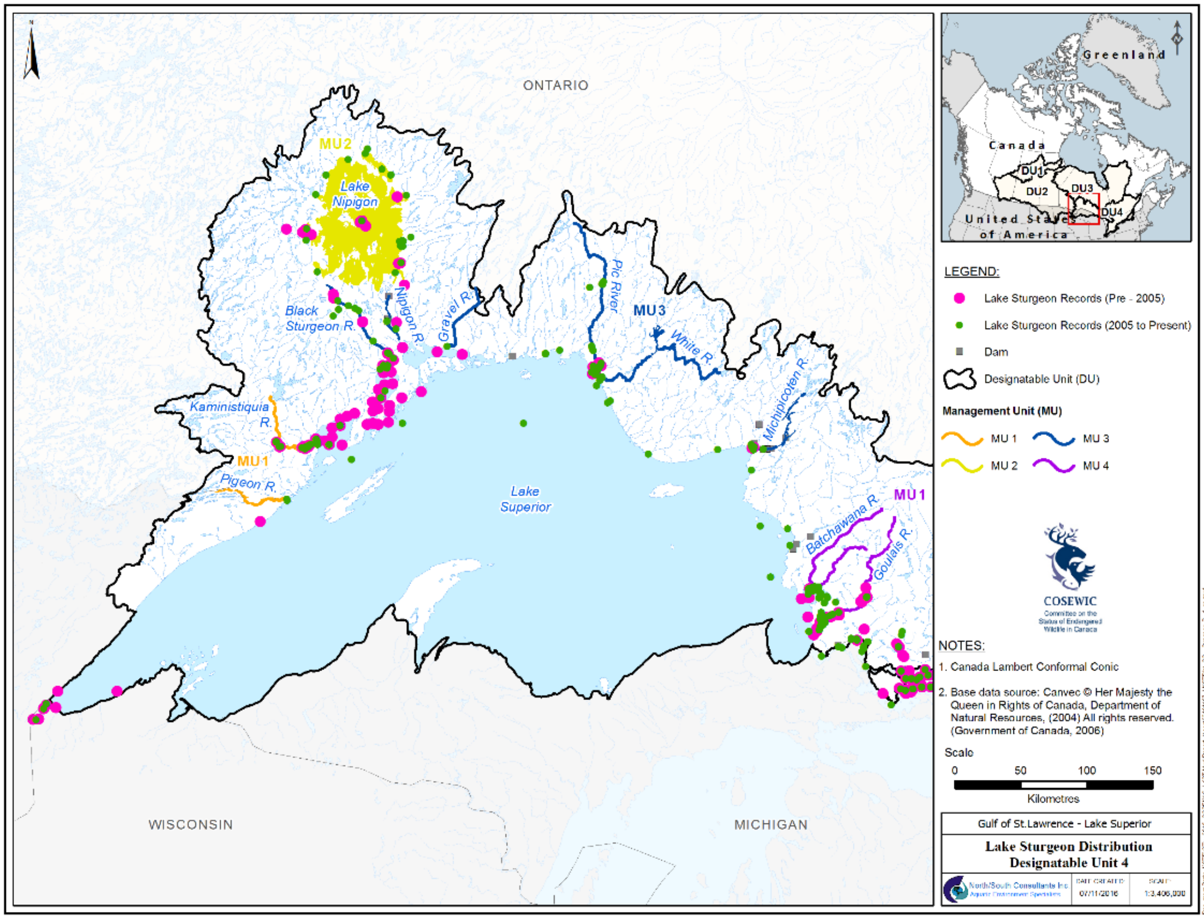

Figure 16. Historical and contemporary Lake Sturgeon distribution in Lake Superior and its tributaries (DU4; MU1-MU4), showing falls/rapids, dams, topography, and current management units.

Lake Nipigon (MU2) is a large lake connected to Lake Superior by the Nipigon River (Figure 16). Commercial harvest in Lake Nipigon peaked in 1924 at 37,706 kg. It is believed that Lake Sturgeon is still present in the lake, but at significantly reduced levels (Rick Salmon pers. comm.).

The tributaries of northern Lake Superior with historical Lake Sturgeon populations in MU3 include the Wolf, Black Sturgeon, Nipigon, Gravel, Prairie, Pic, White, and Michipicoten rivers (Figure 16). Lake Sturgeon is believed to be extirpated in two of the eight tributaries (Wolf and Prairie rivers) and the population within a third (Gravel River) is considered unknown/extirpated (Pratt 2008). The remaining five tributaries appear to support populations (Pratt 2008). By all indications, Lake Sturgeon abundance in the Black Sturgeon River is low (Haxton *et al.* 2014b; M. Friday pers. comm.). A population estimate carried out in 2003 and 2004 estimated the abundance to be 89 and 96 adults, respectively (M. Friday pers. comm.). Lake Sturgeon in the Nipigon River is restricted to the reach of river downstream of the Alexander GS. Contemporary abundance in this reach is believed to be very low and it is unknown if recruitment has occurred due to spawning in the river over at least the last decade (Avery 2013, 2015; Henderson *et al.* 2015b). Lake Sturgeon inhabits the lower 103 km of the Pic River between Lake Superior and the naturally occurring Manitou Falls (Ecclestone 2012a). The adult segment of the population is likely composed of at least several hundred individuals (Ecclestone 2012a). In the nearby White River, Lake Sturgeon only has access to the lower 4.5 km of the river and, based on available information, a small number (perhaps several hundred individuals) continue to utilize the river (Ecclestone 2012b). In the Michipicoten River, Lake Sturgeon has access to 17 km of the river upstream of Lake Superior (Ecclestone 2012c; A/OFRC 2014). Several studies have suggested that adult abundance in the Michipicoten River is low (Ecclestone 2012c; A/OFRC 2014; Schloesser *et al.* 2014) (Table 2).

Historically, in MU4, the Batchawana, Chippewa, Harmony, and Goulais rivers and Stokely Creek supported Lake Sturgeon populations (Figure 16). Lake Sturgeon is believed to be extirpated in the Harmony River and Stokely Creek and its status in the Chippewa River is unknown (Pratt 2008). Lake Sturgeon has access to >50 km of habitat in the Goulais River before upstream movement is restricted (Pratt *et al.* 2014). The most recent adult information suggested that the population was extant (< 50 individuals) (S. Greenwood pers. comm. cited in Pratt 2008) and juvenile assessments suggested that juvenile abundance was high (4,977 individuals) (Table 2).

The North Channel of Lake Huron (MU5) is believed to have nine tributaries that historically supported Lake Sturgeon populations (Figure 17). Lake Sturgeon is considered extirpated in the Root River with the remaining eight (Serpent, Echo, Blind, St. Marys, Garden, Thessalon, Mississagi, and Spanish rivers) supporting small populations (Pratt 2008). Lake Sturgeon abundance in the St. Marys River is believed to be low, with the population estimated at 505 sub-adult and adult individuals (Bauman *et al.* 2011). In the Garden River, since 2012, focused Lake Sturgeon work has confirmed that a small population exists in the river (Nawwegahbow 2015). Lake Sturgeon has access to the lower 31 km of the Mississagi River (Zanatta and Woolnough 2011) and, based on focused assessments, Tremblay (2013a) suggested that the population may consist of at least several hundred individuals. In the Spanish River, Lake Sturgeon has access to the lower 52 km upstream of Spanish Bay. Presently, it is thought that the river supports a small spawning population and a small amount of harvest (Table 2) (Gillies 2010).

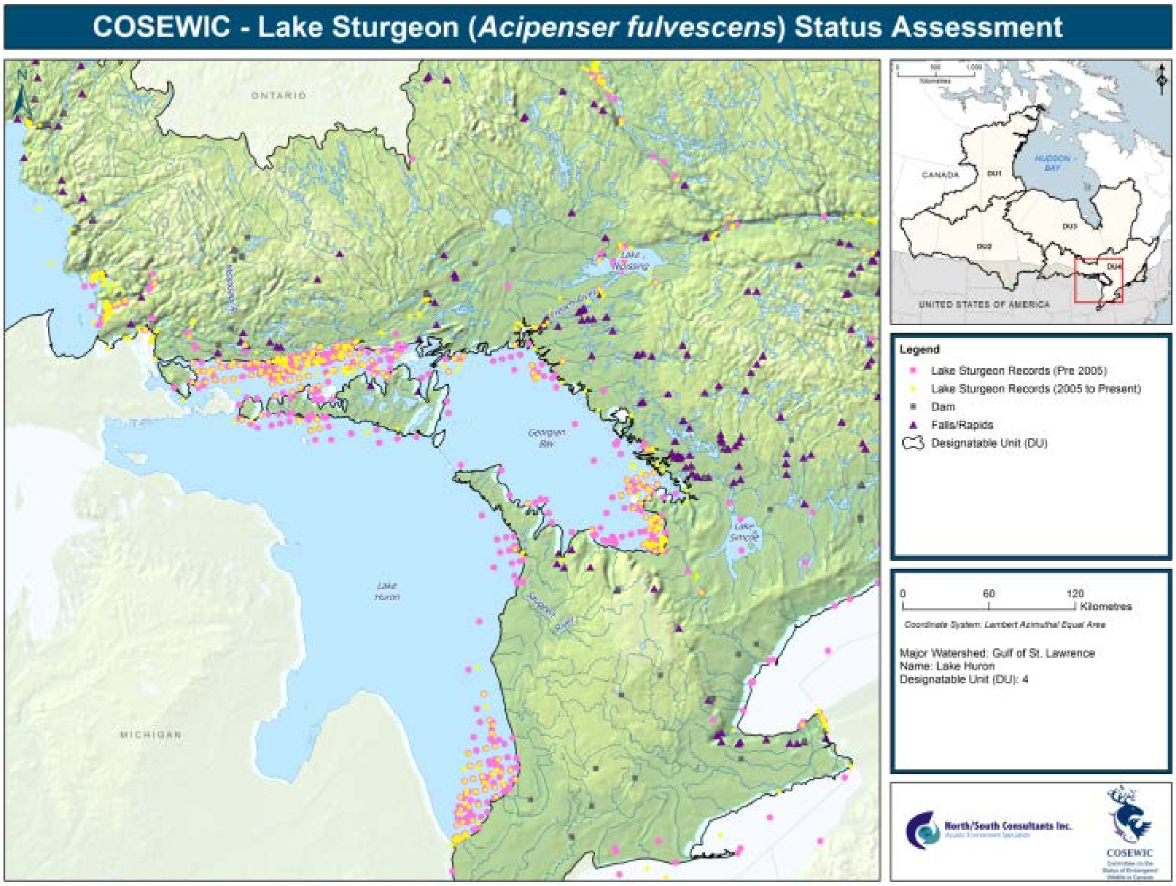

Figure 17. Historical and contemporary Lake Sturgeon distribution in Lake Huron and tributaries (DU4), showing falls/rapids, dams, topography, and current management units.

The Lake Sturgeon commercial harvest from Lake Nipissing (MU6; Figure 17) peaked at 86,000 kg in 1903. 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 (Commanda 2011 cited in Goulet 2014). A small fishery remained on the lake in 1971-1982 with annual catches averaging 4,725 kg (OMNR 2009). Contemporarily, spawning is believed to occur within the lake and in two of its tributaries (Sturgeon and South rivers) (Golder Associates Ltd. 2011). Lake Sturgeon stock assessments have determined that successful recruitment is occurring and that populations may be increasing (Table 2) (Pratt 2008; OMNR 2009). Mark-recapture studies, conducted in 2008, estimated the adult population in the South River to be 410 (95% confidence interval of 460 and 361) and were inconclusive for the Sturgeon River (Commanda 2011 cited in Goulet 2014).

There are 13 Canadian tributaries and one lake draining into Georgian Bay/Lake Huron (MU7) that were historically known to have supported Lake Sturgeon populations

(Figure 17). Populations in four tributaries (Seguin, Manitou, Saugeen, and Ausable rivers) and Lake Simcoe are considered extirpated (Pratt 2008; L. Mohr pers. comm.). Tributaries believed to support extant populations include the Go Home, 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 is sparse (McIntyre 2010). Lake Sturgeon is considered extant in the Magnetawan River (A/OFRC 2015). In the Nottawasaga River, several years of adult spring assessments suggest an adult population in excess of 350 adults (OMNRF, unpubl. data, 2010-2015).

The Huron/Erie Corridor (MU8) flows 160 km in a southward direction connecting Lake Huron and Lake Erie (Figure 18) (Manny and Kennedy 2002). Lake Huron once supported large numbers of Lake Sturgeon, and commercial harvest peaked at 250 tonnes in 1909. Commercial harvest within Lake St. Clair was also high with mean annual harvest peaking at 2.4 million kg in 1870 (Baldwin *et al.* 2009); assuming an average weight of 15 kg per individual, this would equal a peak annual harvest of 160,000 fish. Haxton *et al.* (2014), using a surplus production model, estimated historical abundance to be 96,227 (73,182 – 187,818) adults. Current estimates put the population at 20,000-40,000 individuals (Hay-Chmielewski and Whelan 1997; Thomas and Haas 2002; Boase and Mohr 2015).

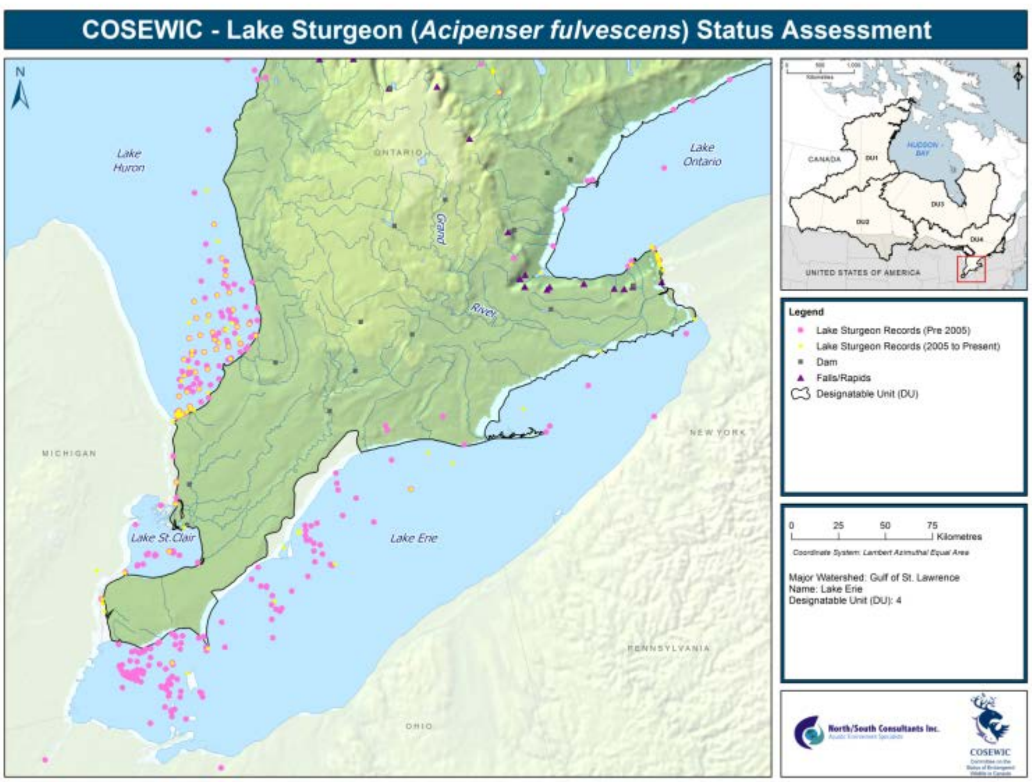

Figure 18. Historical and contemporary Lake Sturgeon distribution in Lake Erie and tributaries (DU4), showing falls/rapids, dams, topography, and current management units.

The lower Niagara River connects Lake Erie and Lake Ontario (MU9) (Figure 19). Historically, the Lower Niagara River supported an abundant population of Lake Sturgeon. Commercial and recreational harvest occurred on the Lower Niagara River until the early 1940s but, by 1950, abundance was deemed to be very low and the fishery collapsed (Hughes *et al.* 2005). Hughes *et al.* (2005) suggested that Lake Sturgeon is present in the river at low abundances (Table 2). Biesinger *et al.* (2014) reported a mark-recapture population estimate of 2,856 (95% CI, 1,637 to 5,093) mature and immature fish.

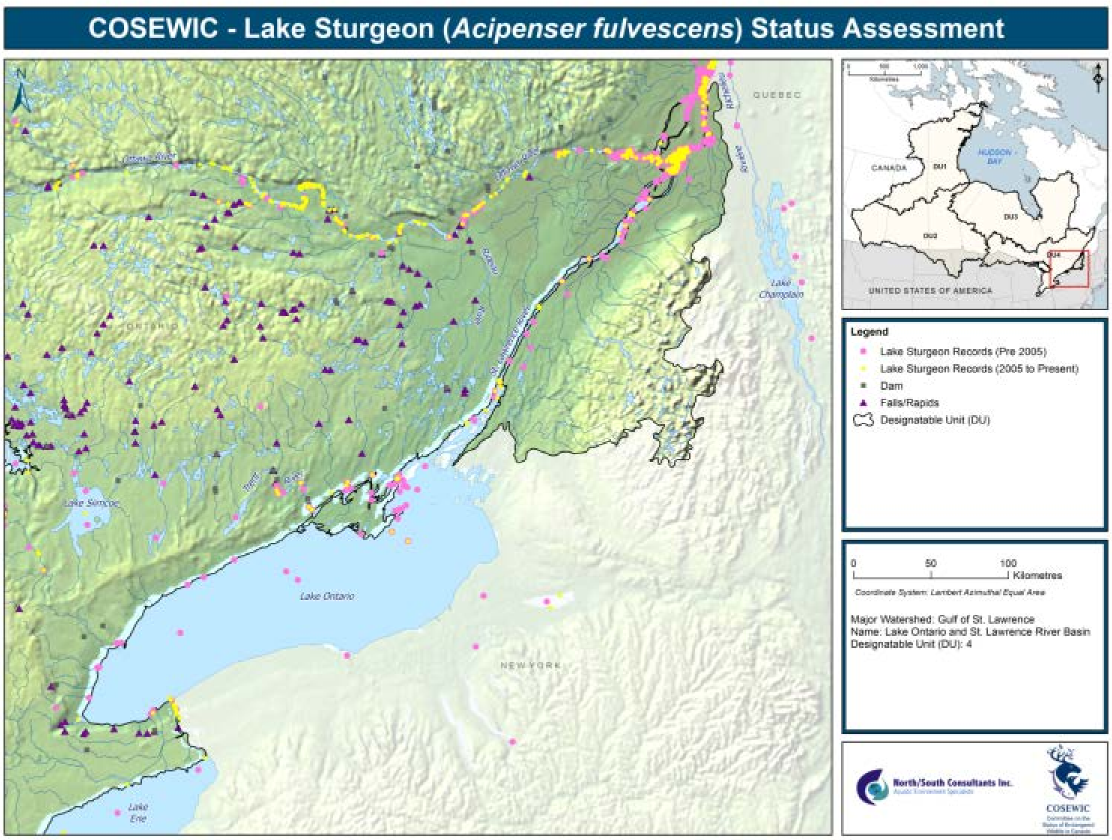

Figure 19. Historical and contemporary Lake Sturgeon distribution in Lake Ontario and Upper St. Lawrence River (DU4), showing falls/rapids, dams, topography, and current management units.

MU10 encompasses the Upper St. Lawrence River and the main tributaries of northeastern Lake Ontario, specifically the Trent River (Figure 19). Lake Sturgeon is believed to be extant in the Trent River, but the current population size and trajectory are unknown (Pratt 2008). The St. Lawrence River is the outflow of the Great Lakes and is one of the largest rivers in Canada (Mailhot *et al.* 2011). The upper St. Lawrence River is separated from the lower reach of the river by the Moses-Saunders GS (completed in 1958) upstream and the Beauharnois–Les Cedres GS (1961) downstream (Mailhot *et al.* 2011). In the St. Lawrence River (upstream of Moses-Saunders Dam), numbers of Lake Sturgeon counted at or near two artificial spawning beds constructed in the vicinity of the Iroquois Dam ranged between 122 and 395 at peak spawning activity in 2008-2013 (New York State DEC 2013). The population in Lake St. Francis was considered depleted as of the 1940s (Mailhot *et al.* 2011). Presently, the abundance of Lake Sturgeon remaining in Lake St. Francis is low and recruitment is virtually non-existent (Table 2) (Dumont *et al.* 2013).

The Ottawa River (MU11) is a highly fragmented river stretching 1,130 km before reaching 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 (Figure 20). During preliminary recovery planning to inform Species at Risk Listing consultations within the Great Lakes-Upper St. Lawrence populations, the recovery team recommended subdivisions within the Ottawa River; however, the process was suspended until a listing decision was issued, but nothing formal was published to reflect this recommendation (S. Dunn pers. comm.). Historically, Lake Sturgeon was abundant in the Ottawa River and its many tributaries with commercial catches peaking at 28,780 kg in 1898 (Dymond 1939). Between 1880 and 1964, seven hydroelectric generating stations were built on the Ottawa River and a further 36 dams were built on its tributaries (Haxton 2002, 2011). Commercial fishing activities for Lake Sturgeon in the Ottawa River were closed in 2012-2013 as there was no quota allocated (T. Haxton pers. comm.).

Currently, Lake Sturgeon is known to exist in all major reaches of the Ottawa River from Lake Temiscaming to the Carillon GS with spawning believed to occur below most generating stations (Haxton 2008). Until recently, little research has been done to establish the status and trajectory of Lake Sturgeon populations within the different reaches of the Ottawa River. Currently, most populations in the various segments of the Ottawa River are considered to be at low abundances with declining trajectories; the exception being three contiguous middle river reaches where populations are considered to be stable or increasing (Table 2).

The lower St. Lawrence River (MU12) stretches ~350 km from Lac St. Louis downstream of the Beauharnois–Les Cedres GS to the St. Lawrence estuary downstream of the city of Québec (Mailhot *et al.* 2011). This reach also includes the Ottawa River downstream of the Carillon Dam to the confluence with the St. Lawrence River (Figure 21). There are a number of important tributaries for Lake Sturgeon in this stretch of the river including several known spawning tributaries, Des Prairies, Des Mille-Îles, l'Assomption, Ouareau, Richelieu, Saint-François, Saint-Maurice, Batiscan, Chaudière, and Montmorency (LaHaye *et al.* 1992; Fortin *et al.* 1993; Dumont *et al.* 2011; Thiem *et al.* 2013). There are 16 known spawning areas in MU12 (Valiquette 2016).

Commercial harvest records in the St. Lawrence River date back to the 1920s, with annual catch reaching >200 tonnes in the 1990s (Fortin *et al.* 1993; Mailhot *et al.* 2011). Sturgeon populations in the lower St. Lawrence River still support a commercial fishery and a successful management plan appears to be maintaining populations within the region (Table 2) (Mailhot *et al.* 2011). As of 2012, the commercial fishing management plan

(Dumont *et al.* 2013) included the following measures: a quota of 80 tonnes; a size limit of 800-1305 mm for protection of juveniles and spawners; mesh size restrictions of 19 - 20.3 cm; a fishing season from June 14 to July 31 and September 14 to October 31; identification of each sturgeon captured with a numbered seal and fish weight on a barcode ticket; and a sustained effort to control poaching in the main fishing sectors. The protection offered to the spawning stock by applying a slot size to commercial catches was extended to sport fishing. For sport fishing, the new management plan included the following measures: a daily bag limit of one sturgeon; a season from June 14 to October 31; and a slot size limit of 800-1305 mm. Currently, the Lake Sturgeon population from Lac St. Louis to the upper estuary is believed to consist of >100,000 individuals and is increasing (Mohr *et al.* 2007 in Pratt 2008; Y. Paradis pers. comm.; Dumont *et al.* 2013).

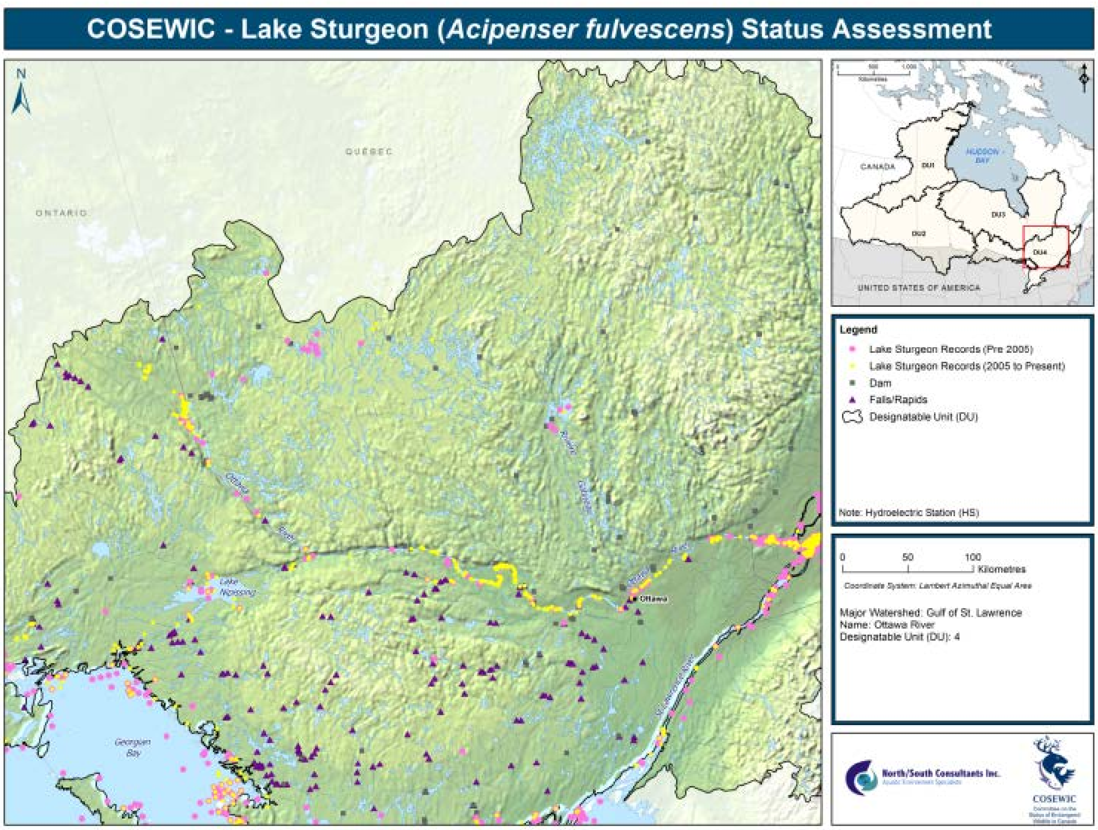

Figure 20. Historical and contemporary Lake Sturgeon distribution in the Ottawa River (DU4), showing falls/rapids, dams, topography, and current management units.

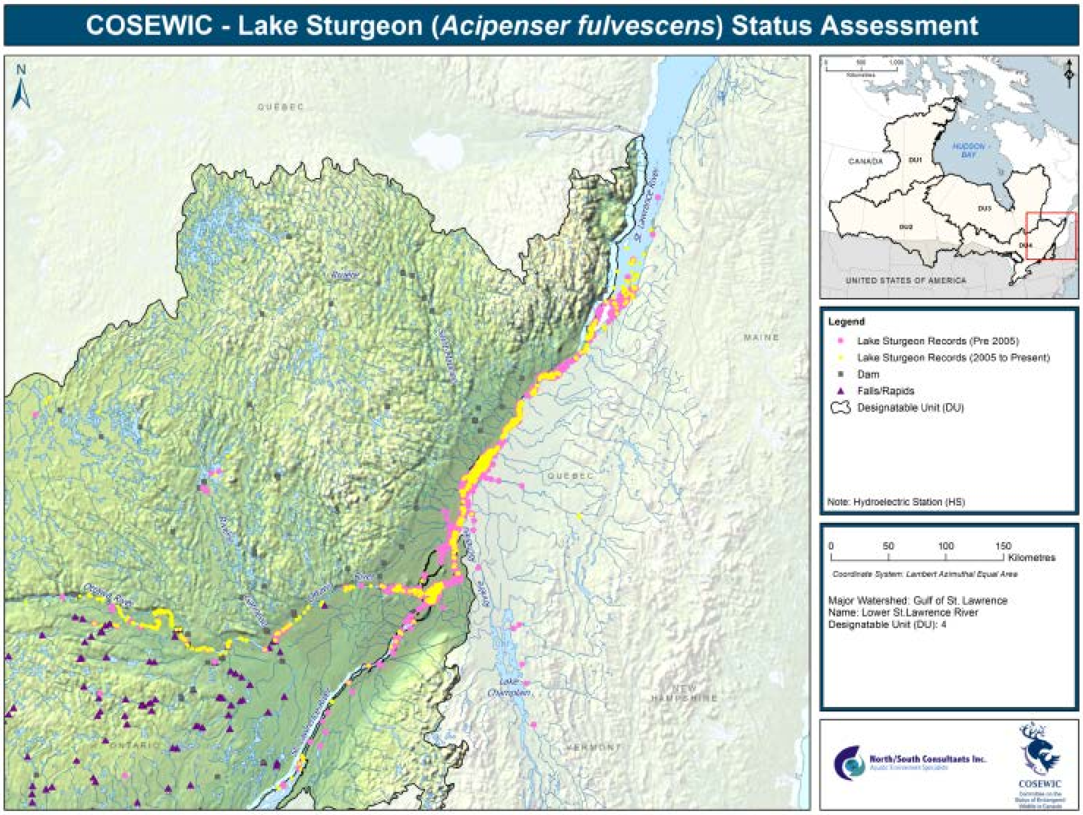

Figure 21. Historical and contemporary Lake Sturgeon distribution in the St. Lawrence River and tributaries (DU4; MU6), showing falls/rapids, dams, topography, and current management units.

Summary

Of the 12 MUs that comprise DU4, population sizes and trajectory vary considerably. The MU12 population is the largest population in the DU and the largest in Canada. It supports a sustainable commercial harvest of 80 tonnes annually. The population is estimated to be composed of >100,000 individuals, which may be increasing. Populations in MU8 are the only other populations in DU4 where adult abundance is thought to be high or very high. Most of the MUs in the central to western portion of the DU (MUs 3, 4, 5, 7, 9) have rivers that support small populations, with many other rivers where populations are considered extant or remnant with unknown trajectories. The trajectories of populations in the western portion of the DU, MU1 and MU2, are small and considered stable and unknown, respectively. Within the remaining two MUs, Lake St. Francis (MU10) and Ottawa River (MU11), populations are generally considered to be at low abundances with declining trajectories, except for a few segments of the Ottawa River either increasing or stable. A rescue effect within DU4 is likely. It should be noted that analyses conducted to date suggest that observed incidences of straying between Great Lakes tributary populations does not appear to be resulting in effective dispersal (Homola *et al.* 2012). However, as tributary populations on the American side of the Great Lakes increase in abundance, due to natural processes and stocking, the probability of effective dispersal and possible rescue effect into Canadian tributaries to the Great Lakes and the St. Lawerence River will likely increase.

THREATS AND LIMITING FACTORS

The Lake Sturgeon life-history strategy is contingent on individuals making primary contributions to the next generation once they have attained large size/age; large females are highly fecund and reproductive senescence has never been reported. It is problematic to qualify the protracted juvenile stage (i.e., late age-at-maturity) and lagged contributions to the next generation as a limiting factor in itself because the species exhibits high annual survival rates after age-1; however, this pattern dictates that increases in population sizes will be a slow (lagged) process and also that anthropogenic mortality (e.g., harvest, entrainment at dams) during later life stages can have a pronounced negative effect on population trajectories (Gross *et al.* 2002; Vélez-Espino and Koops 2009; Schueller and Hayes 2010a; Nelson *et al.* in prep.).

Threats to sustainability and/or impediments to recovery of Lake Sturgeon populations include: after-effects of historical harvest; contemporary harvest; habitat alterations (primarily due to dams); barriers to migration (dams); entrainment losses (dams); invasive species; and pollution (Harkness and Dymond 1961; Scott and Crossman 1973; Auer 1996a; Secor *et al.* 2002; COSEWIC 2006; Peterson *et al.* 2007; Haxton and Findlay 2008; Goulet 2014; Pollock *et al.* 2015). A synthesis of data and expert opinion regarding populations across the range suggests that different threats are relevant to different populations spread across DUs 1-4 (Table 2).

The overall threats by DU are presented using the same headings from the Threats Calculator (calculated by consensus July 7, 2016; see technical summaries and appendices 1-4 for details).

The overall threat impacts by DU were as follows: DU1, High; DU2, Low; DU3, Low; and DU4, Medium-Low. For specific threats, only DUs in which the threat was present and was scored higher than negligible are discussed below using the threat subheadings from the threats calculator.

Transportation & Service Corridors

Transportation & service corridors

For DU2, impact is negligible. Roads and railroads were identified as having aggregate issues, but not proximate and with negligible threat. For DU3, impact is negligible. Some roads and bridges are being constructed over Lake Sturgeon habitat. For DU4, impact is low. The combined impacts of the expansion of the port of Montréal in the channel habitat of the St. Lawrence River and the extensive shipping lanes in the St.

Lawrence, Detroit, and St. Clair rivers, and Lake St. Clair pose threats. In addition, dredging has unknown impacts.

Biological Resource Use

<u>Historical and current harvest</u>

Lake Sturgeon adult stocks experienced near range-wide declines, primarily due to over-harvest of adults (Harkness and Dymond 1961; Scott and Crossman 1973; Bogue 2000; Stewart 2009; Haxton *et al.* 2014a). For the most part, populations have been slow to recover, which would not be surprising even if commercial harvest was the only factor responsible for the declines given the Lake Sturgeon life-history strategy. Not only did adult stocks decline dramatically during the first few years of the fishery, there tended to be re-openings and re-allocation of effort in subsequent years (Bogue 2000; Haxton 2008; Stewart 2009; Haxton *et al.* 2014a). This means that juveniles may not have been susceptible to the first wave of fishing pressure, but would have been susceptible perhaps a decade later, having attained adult size but yet to make meaningful contributions to the next generation.

The link between harvest and recruitment may also be important. In the St. Lawrence River, a negative correlation was observed between larval production and commercial landings in the previous three years, attributed to a reduced number of spawners being available (Dumont *et al.* 2011; Mailhot *et al.* 2011). On the Nelson River, MB, younger Lake Sturgeon were rare in gillnet catches (5.5, 9, 12" mesh) independent of the commercial/subsistence fishery during the 1990s (Macdonald 1998). A Conservation Closure was invoked in 1996 and, since 2006 (when monitoring was resumed using same gear and netting locations), younger Lake Sturgeon have consistently dominated the catches; not only did harvest severely impact the adult stock, it likely also compromised recruitment (McDougall *et al.* in prep.).

Although the harvest of many populations has now been curtailed, the quantity and demographics of Lake Sturgeon remaining at the time harvest ceased would be a primary driver of contemporary rebound. Late maturation, generally low survival to age-0, and variable/erratic recruitment cumulatively dictate that “natural” recovery trajectories will follow an exponential relationship until carrying capacity is approached; census population sizes are expected to increase very slowly during early years (decades), followed by rapid increases, and finally tapering off and reaching an equilibrium plateau (Gross *et al.* 2002; Vélez-Espino and Koops 2009; Schueller and Hayes 2010a; Haxton *et al.* 2014a; Nelson *et al.* in prep.). The specific nature of the trajectories will be influenced by population-specific individual growth, maturity, and recruitment parameters and habitat availability; for example, in some systems, spawning habitat may be limiting, in others juvenile foraging habitat and/or prey abundance, and others overwintering habitat.

Population declines are known to have genetic consequences to subsequent generations, but Lake Sturgeon life-history strategy has apparently buffered populations from genetic loss; inbreeding depression has yet to be observed, and contemporary populations almost all display high levels of genetic diversity (DeHaan *et al.* 2006; Welsh *et al.* 2008; Kjartanson 2009; McDermid *et al.* 2011). However, a 65% decline in effective population size (N_e) has been observed in the Ottawa River, attributed to a combination of over-harvest and population fragmentation by dams (McDermid *et al.* 2014).

For DU1, impact is high to medium. Subsistence harvest is the main threat to DU.

For DU2, impact is low. Subsistence harvest occurs within the DU, but the degree varies considerably by location. Angling in DU2 is restricted to catch-and-release (Alberta, Saskatchewan, and Manitoba) or prohibited (Ontario), although some transboundary populations are subject to legal harvest by anglers in the United States. Poaching is also known, but not a pervasive threat.

For DU3, impact is unknown. Subsistence harvest is known or probably ongoing throughout much of the DU. Angling in DU3 is regulated by small limits in Quebec or prohibited (Ontario).

For DU4, impact is low. Commercial fishing in the St. Lawrence River is rigorously monitored and regulated by a management plan. Subsistence harvest is known or probably occurring throughout much of the DU, more so in Quebec than Ontario. Angling in the Ontario portion of DU4 is prohibited, although some transboundary harvest in the US occurs. Angling in the Quebec portion of DU4 is regulated by small harvest limits.

Natural System Modifications

Dams & water management/use

Habitat alteration

Dams alter aquatic habitats, with the nature and magnitude of change being driven by river geomorphology, infrastructure, and operating regime (Baxter 1977; Rosenberg *et al.* 1999, 2000). Ultimately, every river and every dam is different, and so are the nature of alterations and the population-level consequences. Observations from systems that have been studied in detail are summarized herein, but results should be considered in the context of river type (e.g., stepped-gradient shield river versus meandering prairie river) and dam type (e.g., low-head weir, small run-of-the-river hydro dam, large peaking hydro dam).

McKinley *et al.* (1993) examined variation in plasma non-sterified fatty acids (thought to reflect nutritional status) of Lake Sturgeon in the vicinity of hydroelectric stations that operate on peaking schedules on the Mattagami River, ON. Differences in upstream and downstream compositions were attributed to changes in habitat, with areas downstream of the Kipling GS having diminished nutritional value as a consequence of flow regime. Patterns were essentially opposite for Lake Sturgeon in the impoundment upstream of the

Little Long GS (the farthest upstream dam on the Mattagami River complex), potentially due to improved, but artificial habitat, created via backwatering (McKinley 1993); based on recent analysis regarding determinants of Lake Sturgeon growth (Lester and Haxton in review; Barth *et al.* in prep.), reductions in water velocity may increase growth rate.

Auer (1996b) examined abundance of females and males, and various reproductive parameters, in the context of flow regime downstream of the Prickett Hydroelectric Station on the Sturgeon River, MI. Over a six-year period, spawning activity was monitored as the station transitioned from peaking and ponding to run-of-the-river operation. Under near-run-of-the-river flows, 74% more fish were observed at spawning sites located downstream of the dam, adults spent 4-6 weeks less at spawning sites, and fish had increased reproductive readiness.

Haxton and Findlay (2008) examined Lake Sturgeon abundance and growth variation among Ottawa River reaches, testing hypotheses related to anthropogenic stressors (commercial harvest, contaminants, water power management) potentially impeding recovery of populations. By synthesizing dam-related threats (i.e., habitat alterations, migratory barriers, entrainment), they concluded that Lake Sturgeon was most negatively affected by waterpower management. Relative abundance of Lake Sturgeon was greater in unimpounded versus impounded reaches, and faster growth in impounded versus unimpounded reaches was reasoned to be indicative of density-dependent compensation.

More recently, Haxton *et al.* (2015) used a randomized sampling design and gillnet captures to examine the effect of hydroelectric development on Lake Sturgeon abundance in Ontario rivers. The magnitude of effect on abundance was large in peaking and winter reservoir systems, and lowest in run-of-the-river systems. Growth was faster and condition factor greater in unregulated systems than in regulated systems. Variable levels of recruitment were observed in both regulated and unregulated systems, and recruitment failure was particularly associated with peaking systems.

Dewatering occurs downstream of some hydroelectric dams, which can result in stranding of adults (M. Friday pers. comm.) and desiccation of eggs (Ferguson and Duckworth 1997; Caroffino *et al.* 2010); this is particularly problematic to Lake Sturgeon populations because spawning often occurs immediately downstream of hydroelectric generating stations.

The potential impacts of coldwater releases from dams on Lake Sturgeon populations downstream of some hydroelectric dams have been largely unstudied. This is known to occur downstream of some dams with large reservoirs (e.g., Gardiner Dam on the South Saskatchewan River).

Several First Nations have attributed declines in Lake Sturgeon populations to construction of dams (Split Lake Cree FN 1996; MacDonell 1997a; Hannibal-Paci 2000; Agger 2012; MFN 2013; CNP 2012; Goulet 2014).

A synthesis of contemporary evidence suggests that large Lake Sturgeon populations and dams are not necessarily incompatible. Most notably, populations in most Winnipeg River reservoirs seem to be recovering following implementation of a Conservation Closure in 1994, which made all harvest illegal (McDougall *et al.* in prep; D. Kroeker pers. comm.). Most Winnipeg River dams operate as run-of-the-river and the degree to which they backwater upstream areas is relatively minor; in other words, the cascading reservoirs that define the river today are not far removed from what the river looked like historically (Johnston 1915; Denis and Challies 1916). However, discharge is regulated at the outlets of Lake of the Woods and in the English River (LWCB 2002), and numerous historical falls and rapids are now inundated. As such, the number of spawning sites has likely been reduced. Given evidence of historical population structure likely attributable to asymmetric gene flow at historical control points (McDougall 2011a; McDougall *et al.* accepted), the same inundation process seems likely to have erased true barriers to upstream movement, likely facilitating the merger of previously distinct populations in some areas of the river (McDougall 2011a; Henderson and McDougall 2015). There is evidence of high (likely elevated) rates of contemporary downstream gene flow in one area of the Winnipeg River (McDougall 2011a; McDougall *et al.* accepted), and Lake Sturgeon abundance now tends to be skewed towards the upstream ends of impoundments (Barth *et al.* 2011; McDougall *et al.* 2014b; Barth and Anderson 2015; Henderson and McDougall 2015; McDougall and Barth 2015). In at least one area (e.g., the Slave Falls Reservoir), it is suspected that backwatering has actually increased population-level suitability for Lake Sturgeon, as a result of increased depth and reduced velocities (McDougall *et al.* accepted). A lack of understanding regarding historical population structure and relative influence of historical overharvest, which occurred during and after the construction of dams on the Winnipeg River, precludes definitive assessment of why some populations are currently depressed. With the exception of the nearly extirpated reach between the Norman Dam and the Whitedog Falls GS, recruitment appears to be occurring all along the Winnipeg River flow axis (Barth *et al.* 2009; Peacock 2014; McDougall *et al.* 2014b; Barth and Anderson 2015b; McDougall *et al.* in prep.). Hypothesized gene-flow impacts aside (McDougall 2011a; McDougall *et al.* accepted), this suggests that habitat alterations related to Winnipeg River dams probably have not compromised the ability of populations to persist.

Habitat alterations due to dams may also influence Lake Sturgeon growth. Synthesizing data collected throughout Manitoba, both Barth *et al.* (in prep.) and Lester and Haxton (in review) examined the factors influencing juvenile Lake Sturgeon growth. Although density was also influential, growth rates tended to be highest in lacustrine/reservoir environments, potentially a function of reduced energetic cost of foraging or increased benthic production (Lester and Haxton in review; Barth *et al.* in prep.).

Low-gradient systems, such as prairie and lowland rivers, tend to be dramatically altered by the construction of dams; whereas stepped-gradient systems tend to consist of alternating riverine and lacustrine habitats and low-gradient systems tend to be relatively homogenous. Due to an absence of both lakes and a concentrated hydraulic gradient (such as at falls and rapids), backwatering by large dams on prairie rivers results in a shift from lotic to lentic habitat, with depths increasing and velocities decreasing with distance downstream from the river-reservoir transition zone that will develop. Depending on the size of the dam relative to the river, reservoir stratification can occur, which could result in population and inter-population level (e.g., dispersal, gene flow) consequences. As discussed previously, the spatial distribution of juvenile Lake Sturgeon in Muskegon Lake, MI, appeared to be strongly influenced by dissolved oxygen concentrations (Altenritter *et al.* 2013).

Migratory barriers

Dams impede numerous historical Lake Sturgeon spawning migrations (Harkness and Dymond 1961; Auer 1996a; Bruch 1999; Smith and Baker 2005; Thiem *et al.* 2011, 2013). In most cases, Lake Sturgeon are now forced to spawn at the base of powerhouse and spillway outflows, as engineered passage for Lake Sturgeon remains elusive (Thiem *et al.* 2011; McDougall *et al.* 2013a). Habitat and conditions (flow) below generating stations may not always be suitable for spawning and/or larval hatch (Auer 1996b), and the quantity of nursery habitat (particularly for tributary spawning populations) can be reduced (Caroffino *et al.* 2010).

Genetic consequences associated with migratory barriers are conceivable. Reduced tributary habitat for Lake Superior populations has been reasoned to be cause for concern from the perspective of genetic integrity, as rates of straying seem to be inversely correlated with the amount of riverine habitat downstream of dams (Homola *et al.* 2012). In large riverine systems that historically contained panmictic populations, hydroelectric dams also artificially preclude upstream gene flow between reservoirs (Wozney *et al.* 2011).

Entrainment

Lake Sturgeon that occur upstream of hydroelectric dams are known to move within the vicinity of turbine intakes and spillway gates and, subsequently, become entrained (Seyler *et al.* 1996; McKinley *et al.* 1998; McDougall *et al.* 2014a). Even if entrainment events are survived, downstream displacement will generally be permanent, which incurs a demographic loss to the source population (McDougall *et al.* 2014c). As noted previously, population modelling indicates that Lake Sturgeon populations are hypersensitive to mortality of middle to later life stages (Gross *et al.* 2002; Vélez-Espino and Koops 2009; Schueller and Hayes 2010a; Nelson *et al.* in prep.), so a high rate of entrainment could theoretically impede population recovery, lead to source-sink dynamics, or even compromise sustainability of an otherwise healthy population.

High rates of adult entrainment have been observed at the Adam Creek Control Structure on the Mattagami River, ON; up to 400 Lake Sturgeon were reported to have been recovered annually from Adam Creek, the area downstream of the control structure, and then transported back upstream into the reservoir (Seyler *et al.* 1996; McKinley *et al.* 1998). Efforts to return entrained Lake Sturgeon upstream of the Adam Creek Control Structure continue to occur each spring.

At the Slave Falls GS on the Winnipeg River, MB, large juveniles (subadults) resident in the lowermost basin were determined to be highly susceptible (~21.1% entrained per year), but large quantities resident in upstream zones are essentially unsusceptible due to never frequenting the vicinity of the Slave Falls GS (McDougall *et al.* 2013b; 2014a). Adults tagged throughout the Slave Falls Reservoir were entrained at a rate of ~3.1% per year, and at least 91% of observed entrainment events were survived (McDougall *et al.* 2014a). While ongoing demographic losses owing to downstream displacement following entrainment via bottom-draw sluice gates seem likely (McDougall *et al.* 2014a,c), the degree of entrainment at the Slave Falls GS does not, in itself, appear to constitute a threat to sustainability of the Slave Falls Reservoir population; the Slave Falls GS has been in operation since ~1930, so it is unlikely that entrainment is a recent phenomenon. Recent population estimates suggest that Lake Sturgeon abundance within the reservoir has increased since the 1990s (Block 2001; McDougall *et al.* in prep.).

Entrainment has been observed on the Nelson River (Ambrose *et al.* 2010a; Hrenchuk and McDougall 2012), Saskatchewan River (Henderson *et al.* 2016a), and elsewhere on the Winnipeg River (M. Duda, OMNRF, unpubl. data; D. Kroeker, MCWS, unpubl. data), but telemetry data suggest that the rate of observation is not an artifact of survival; rather, it seems that these events are relatively rare (Ambrose *et al.* 2010a; Henderson *et al.* 2016a; Hrenchuk and Barth 2016; Lacho and Hrenchuk 2016; McDougall *et al.* 2016; Struthers 2016). Entrainment susceptibility is likely dictated by habitat, because habitat seems to influence movement and spatial distributions of Lake Sturgeon. It is probably overly simplistic to approach population-level risk in terms of dam separation distance alone; McDougall *et al.* (2014c) suggested that, assuming limited spatial extent of larval drift, patterns in large riverine systems may scale better to the number of river features that restrict movements of sturgeon located between upstream spawning sites and the next downstream generating station. The physical configuration of generating stations probably also plays a role when Lake Sturgeon do frequent the immediate upstream vicinity of hydroelectric infrastructure; both the facilities at which high rates of Lake Sturgeon entrainment have been observed (Adam Creek Control Structure, Slave Falls GS) possess bottom-draw sluice gates.

The threat of dams and their associated impacts listed above (i.e., habitat alterations, migratory barriers, entrainment) was assessed as pervasive for Lake Sturgeon within each DU. Threat severity was assessed as serious for DUs 1 and 4, moderate in DU2, and extreme in DU3. The threat of dams continues within each DU and timing of this threat was assessed as high.

<u>Dams & water management/use threats summary</u>

For DU1, impact is low. Flow regulation from Missi Falls Control Structure (CS) sets the baseflow for the only remaining population in the DU.

For DU2, impact is low. Dams and water management/use incur some mortality via downstream passage as well as artifically preclude upstream passage in some instances, possibly contributing to the population density (recruitment); however, there was not consensus as to the magnitude of this threat impact throughout the DU.

For DU3, impact is low. Dams and water management/use plans exist in Quebec (e.g., Rupert Diversion).

For DU4, impact is low. All populations in Quebec are exposed to the effects of dams, but not all in Ontario.

Invasive & Other Problematic Species and Genes

There is some concern regarding the effects of invasive species on Lake Sturgeon populations in DU2 and DU4. Sea Lamprey attacks have been documented to have severe negative consequences on Lake Sturgeon (Patrick *et al.* 2009; Sepúlveda *et al.* 2012); however, the current incidence rate appears to be low (Pratt *et al.*, DFO, unpubl. data), likely, in part, a function of the Sea Lamprey Control Program reducing abundance of Sea Lamprey (O'Connor *et al.* 2016).

In Black River/Black Lake, MI, a recruitment bottleneck is evident in the Lake Sturgeon population (Baker and Borgeson 1999). It is presently unclear to what degree predation by Rusty Crayfish (*Orconectes rusticus*) is responsible, but crayfishes in general (including native species) are known to consume eggs, larvae, and age-0 Lake Sturgeon (E. Baker pers. comm.). Rusty Crayfish is spreading in several Canadian watersheds.

Zebra Mussel (*Dreissena polymorpha*) has also been flagged as potentially of cause for concern; however, it should be noted that healthy Lake Sturgeon populations persist in the Winnebago system and the Huron-Erie corridor, despite Zebra Mussel being well established. Round Goby (*Neogobius melanostomus*), abundant in the Great Lakes region, has also been suggested as a significant predator on Lake Sturgeon eggs (T. Haxton pers. comm.).

For DU2, the impact is unknown. Zebra Mussel, Spiny Waterflea (*Bythotrephes longimanus*), Rusty Crayfish, Common Carp, and Rainbow Smelt may cause ecosystem modification. Lake Winnipeg is subject to the effects of Zebra Mussel. Adult Lake Sturgeon feed on Rusty Crayfish but, in recovering populations, net gain or loss is unknown. The overall impact of ecosystem modification by invasive species is unknown.

For DU4, the impact is negligible. Rusty Crayfish and Round Goby eat eggs. Lake Sturgeon also prey on Round Goby and Zebra Mussel; therefore, the net threat impact is unknown. Round Goby does not occur beyond the Great lakes. Sea Lamprey population control programs occur throughout the Great Lakes and present a moderate threat. Threats of potential invaders such as Silver Carp (*Hypophthalmichthys molitrix*), Bighead Carp (*Hypophthalmichthys nobilis*), and Black Carp (*Mylopharyngodon piceus*) are unknown. The overall impact of ecosystem modification by invasive species is negligible.

Pollution

Due to increasingly stringent environmental regulations, the threat of present-day pollution to Lake Sturgeon populations is likely decreasing. However, pollution, particularly wood-fibre discards and effluents associated with the pulp-and-paper industry, was likely an important factor in the diminishment of Lake Sturgeon populations historically and, much like harvest, the after-effects of historical pollution are still likely impeding recovery of some Lake Sturgeon populations; substrates in many of the rivers in DU4 scoured by 1920-60s log drives have yet to recover to natural states and deposited bark and wood fibres continue to cover considerable quantities of habitat ((T. Haxton pers. comm.). For example, in Lac Des Deux Montagnes (Ottawa River), pollution caused an important Lake Sturgeon overwintering location to become anoxic resulting in widespread mortality (Harkness and Dymond 1961).

In reference to the Lake of the Woods/Rainy River population, Carlander (1942) reported that wood-fibre accumulation had buried spawning sites. While overfishing was reasoned for depleted adult stocks, loss of spawning habitat in the Rainy River and its tributaries due to pollution from upstream paper mills and agricultural development likely also had a negative influence on recruitment (Mosindy 1987). In general, it wasn't until the 1960s and 1970s that pollution-control laws came into effect and, subsequently, water quality and habitat began to slowly improve (Heinrich and Friday 2014). Decades later, it was noted that Lake Sturgeon overwintering locations were consistent with areas where recovery of benthic communities following past upstream pulp-and paper-pollution had occurred to the greatest degree (Rusak and Mosindy 1997).

On both the Kaministiquia and Kapuskasing rivers, ON, there appears to be a temporal relationship between increased Lake Sturgeon abundance and improved water-quality conditions, attributed to reductions in effluent loadings (D. Gibson pers. comm.). It also seems relevant to note that the only reach of the Winnipeg River in which Lake Sturgeon appears to be at remnant levels contemporarily is the Norman/Kenora to Whitedog Falls GS reach, located immediately downstream of a major pulp-and-paper mill; anecdotal reports suggest wood-fibre discards and effluent probably had a negative influence on benthic communities over a prolonged period (J. Peacock pers. comm.). Given contemporary knowledge of Lake Sturgeon early life-history habitat requirements and preferences, it is conceivable that recruitment in these reaches may have been compromised over lengthy intervals by pollution.

For the purposes of this report, the lampricidesTFM (3-trifluoromethyl-4-nitrophenol and niclosamide (2',5-dichloro-4'-nitrosalicylanilide) were considered "pollutants". This is probably not the best classification, as these compounds are highly specific, non-persistent, rapidly degraded in the environment by photolysis and bacterial metabolism, non-carcinogenic and non-mutagenic (Dawson 2003; Hubert 2003). TFM and niclosamide are applied in Great Lakes tributaries to curb Sea Lamprey abundance, with the intent of limiting damage (mortality) to the native fish community and introduced salmonids that support recreational, commercial and Indigenous fisheries. Of the 97 Great Lakes tributaries known to be frequented by Lake Sturgeon contemporarily, or for which historical evidence of utilization exists, 46 receive lampricide treatment on a regular basis (O'Connor *et al.* 2016). Field observations by DFO field staff since the 1958 provide little indication that age-0 Lake Sturgeon have been negatively impacted, with no correlation being observed between treatment history and population viability of populations (Sutton 2004). Based on recent in situ experiments, factors such as TFM concentration, stream alkalinity, stream pH, and temperature were found to be predictive of Lake Sturgeon survival. Most notably, in low-alkalinity waters typical of Canadian tributaries, survival averaged 84% (range: 80 – 99%) (O'Connor *et al.* 2016). Although net cost/benefits are unknown, it should be reiterated that lampricide treatments probably reduce the quantity of Sea Lamprey attacks on Lake Sturgeon via ongoing supression of the Sea Lamprey populations (Patrick *et al.* 2009; Sepúlveda *et al.* 2012; O'Connor *et al.* 2016).

<u>Pollution threats summary</u>

The threat of pollution to Lake Sturgeon in DU1 was not assessed. In DU2, and DU3, the threat of pollution was assessed as negligible, while DU4 was assessed as low-medium.

NUMBER OF LOCATIONS

In DU1 and DU2, the number of locations generally follows the management unit structure used in the Lake Sturgeon Recovery Potential Assessments (Cleator *et al.* 2010a,b,c,d,e) where boundaries delineating populations were set at barriers to movement (i.e., typically dams). Lake Winnipeg and tributaries that drain into the lake from the east, and the Lake of the Woods – Rainy River system are notable exceptions. Because an MU structure has not been previously established in DU3 and because the watersheds are very large, for the purposes of this assessment, each river system was considered a location. In DU4, the number of locations generally follows that described by Pratt (2008) wherein 12 MUs were identified. The only deviation from Pratt (2008) occurs in the Ottawa River, which was divided into nine locations. The locations identified in all four DUs are largely consistent with the spatial scale of the most plausible threats.

In DU1, three locations were identified following the MU structure outlined in Cleator *et al.* (2010a). These include: from Atik Falls on the Reindeer River and Kettle Falls on the Churchill River downstream to Island Falls GS; Churchill River from Island Falls GS to the Missi Falls CS; and Churchill River from the Missi Falls CS to the Churchill River estuary.

The number of locations in DU2 also follows the MU structure described in Cleator *et al.* (2010b,c,d,e). Three locations were identified for the Red/Assiniboine drainage: Assiniboine River and tributaries upstream of the Portage la Prairie Diversion Control Structure; Red River and tributaries upstream of Lockport, including the Assiniboine River to Portage la Prairie Diversion Control Structure; and Red River downstream of Lockport.

For the purposes of this assessment, Lake Winnipeg was considered a location. Similarly, Bloodvein, Pigeon, Berens, and Poplar rivers were each considered locations (Cleator *et al.* 2010d).

The Rainy River – Lake of the Woods system consists of numerous lakes and rivers located throughout northwestern Ontario and parts of northern Minnesota. Five locations were identified: Sturgeon Lake – Lac la Croix system (includes the Maligne River); Namakan River (the 30 km long stretch that includes three small lakes between Lac la Croix and the Namakan Reservoir); Namakan Reservoir; Rainy Lake from the dam at the outlet of the Namakan Reservoir to the Fort Frances GS; and Rainy River from Fort Frances GS to the outlet of Lake of the Woods.

The Winnipeg River was partitioned into nine locations consistent with the recovery potential assessment for the Winnipeg/English rivers (Cleator *et al.* 2010e). These include: Wabigoon River; English River from Manitou Falls GS to Caribou Falls GS; Winnipeg River from Norman GS to Whitedog Falls GS; English River from Caribou Falls GS and the Winnipeg River from Whitedog Falls GS to Pointe du Bois GS; Winnipeg River from Pointe du Bois GS to Slave Falls GS; Winnipeg River from Slave Falls GS to Seven Sisters Falls GS; Winnipeg River from Seven Sisters Falls GS to MacArthur GS; Winnipeg River from MacArthur GS to Great Falls GS; and Winnipeg River from Great Falls GS to Pine Falls GS.

The Saskatchewan River proper is currently dammed in three locations: Nipawin GS; E.B. Campbell GS; and Grand Rapids GS. The Saskatchewan River is divided into six Lake Sturgeon management units (Cleator *et al.* 2010d), considered locations here: North Saskatchewan River: Bighorn GS - The Forks; South Saskatchewan River upstream of Gardiner GS; South Saskatchewan River from Gardiner GS to The Forks; Saskatchewan River from The Forks to François-Finley GS; Saskatchewan River from François-Finley GS to E.B. Campbell GS; and Saskatchewan River from E.B. Campbell GS to Grand Rapids GS.

The number of locations in the Nelson River follows the management unit structure established by Cleator *et al.* (2010c), who partitioned the Nelson River into six MUs with boundaries occurring at natural and artificial barriers: Playgreen Lake to Whitemud Falls; Whitemud Falls to Kelsey GS; Kelsey GS to Kettle GS and lower Burntwood River between First Rapids and Split Lake; Kettle GS to Long Spruce GS; Long Spruce GS to Limestone GS; and Limestone GS to Hudson Bay.

In DU3, each river was designated as a location. DU3 locations included: Hayes River system; Sturgeon River; Severn River; Winisk River; Ekwin River; Attawapiskat River; Kenogami/Albany rivers; Moose River watershed (includes the major tributaries Missinaibi, Mattagami, Groundhog, Abitibi, Kapuskasing, Ground Hog, Frederick House rivers); Harricana River; Nottaway River; Broadback River; Rupert River; Eastmain River; Opinaca River; and La Grande River.

Pratt (2008) partitioned DU4 into 12 management units largely used as locations for this assessment: western Lake Superior Pigeon and Kaministiquia rivers; Lake Nipigon; northern Lake Superior (Black Sturgeon, Nipigon, Gravel, Pic, White, and Michipicoten rivers); eastern Lake Superior (Batchawana, Chippewa, and Goulais rivers, Goulais Bay); Lake Huron North Channel (St. Marys, Garden, Thessalon, Mississagi, and Spanish rivers); Lake Nipissing; Georgian Bay-Lake Huron (French, Key, Magnetawan, Naiscoot, Moon, Go Home, Severn, Sturgeon, and Nottawasaga rivers); Lake Huron/Erie Corridor (Main Basin Lake Huron, St. Clair River, Lake St. Clair, Detroit River, and Lake Erie); Lower Niagara River; eastern Lake Ontario/upper St. Lawrence River; Ottawa Rivers; and the lower St. Lawrence River. The Ottawa River was partitioned into nine locations including: Lake Temiscaming; Lac la Cave; Holden Lake; Allumette Lake; Lac Coulonge; Lac du Rocher Fendu; Lac des Chats; Lac Deschenes; and Lac Dollard des Ormeaux.

PROTECTION, STATUS AND RANKS

Legal Protection and Status

Federal Protection

The revised *Fisheries Act* protects fishes and fish habitat that are part of, or support, commercial, recreational, or Aboriginal fisheries; therefore Lake Sturgeon and its habitat are protected under the *Fisheries Act.*

Although the 2006 COSEWIC report recommended "Threatened" or "Endangered" status for several of the eight DUs considered at that time, a decision to list any of the Lake Sturgeon DUs under Schedule 1 of the *Species at Risk Act* has not yet been made. Therefore, the species is not currently protected by this Act.

Provincial Protection

- Alberta: *Wildlife Act* - Threatened
- Saskatchewan: Angler harvest prohibited
- Manitoba: Conservation closures on upper Nelson River and Winnipeg River, angler harvest prohibited
- Ontario: *Endangered Species Act* - Threatened for Great Lakes – Upper St. Lawrence River and Northwestern Ontario, and Special Concern for Southern Hudson Bay/James Bay

- Quebec: Included on the list of wildlife species likely to be designated threatened or vulnerable (Liste des espèces susceptibles d'être désignées menacées ou vulnérables). The commercial fishery is strictly managed; management actions include harvest quotas, season and gear restrictions, size limits to protect juveniles and spawners. The sport fishery is also managed through daily bag limits and size limits. North of the 49th parallel, Lake Sturgeon is reserved for the exclusive use of the Cree; sport fishing is prohibited.

Non-Legal Status and Ranks

- NatureServe status rankings:
    - Global Status: G3G4 (2008)
    - Rounded Global Status: G3 – Vulnerable
    - United States National Status: N3N4 (2001) - Alabama (SX – presumed extinct), Arkansas (S1 – critically imperilled), Georgia (S1 – critically imperilled), Illinois (S2 – critically imperilled), Indiana (S1 – critically imperilled), Iowa (S1 – critically imperilled), Kansas (SH – possibly extirpated), Kentucky (S1 – critically imperilled), Michigan (S2 - imperilled), Minnesota (S3 - vulnerable), Missouri (S1 – critically imperilled), Nebraska (S1 – critically imperilled), New York (S1S2 – critically imperilled/imperilled), North Carolina (SX – presumed extinct), North Dakota (SX – presumed extinct), Ohio (S1 – critically imperilled), Pennsylvania (S1), Tennessee (S1 – critically imperilled), Vermont (S1 – critically imperilled), West Virginia (SX – presumed extinct), Wisconsin (S3 – vulnerable)

- Canada National Status: N3N4 (2015) - Alberta (SU – unrankable), Manitoba (S2S3 – critically imperilled/imperilled), Ontario (S3 - imperilled), Quebec (S3 – imperilled), Saskatchewan (S2 – critically imperilled)

- IUCN Red List: Least Concern

- Convention for International Trade in Endangered Species of Wild Fauna and Flora: Appendix II

- American Fisheries Society: Vulnerable (2008)

Habitat Protection or Ownership

- Canada's *Fisheries Act* provides protection to Lake Sturgeon and its habitat.

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BIOGRAPHICAL SUMMARY OF REPORT WRITERS

C.A. McDougall received a BEnvSci in 2005 and an MSc in 2011, both from the University of Manitoba (UM). Craig's 13+ year fisheries career has focused on Lake Sturgeon, primarily in relation to hydroelectric development on the Winnipeg, Nelson, Saskatchewan and Churchill rivers. Since joining North/South Consultants in 2006, Craig has designed and/or led juvenile abundance/distribution/recruitment asessments, stocking feasibility and success evaluations, fine-scale spawning investigations, telemetry monitoring of movements in relation to entrainment susceptibility, and population abundance/trajectory estimation studies for various clients. His Master's Thesis examined downstream passage of Lake Sturgeon through a Winnipeg River generating station, focusing on coarse-scale movements and entrainment susceptibility, fine-scale movements and the downstream passage phenomenon, and the novel application of genetic methods to quantify rates of inter-reservoir demographic contribution.

P. A. Nelson received a BSc in 1994 and a PhD in 2005, both from the UM. As a graduate student at the Department of Fisheries and Oceans, Patrick was involved with instream flow needs, as well as DFO's productive capacity and defensible methods initiatives. Patrick's PhD focused on biogeography, diet, and habitat partitioning among sympatric sucker species in the Assiniboine River, Manitoba. Since starting at North/South in 2004, Patrick was involved in developing a Lake Sturgeon spawning Habitat Suitability

Index model for the Pointe du Bois Spillway Replacement Project, as well as dynamic hydraulic flow models for the proposed Conawapa Project. Patrick designed Lake Sturgeon population monitoring studies for the Proposed Keeyask (now under construction) and Potential Conawapa project study areas to estimate survival, recapture, abundance, and recruitment parameters for adaptive management. Patrick also developed population viability models to study the effects of entrainment, stocking, and recruitment on Lake Sturgeon recovery potential.

C. C. Barth received a BSc in 1996, an MNRM in 2001, and a PhD in 2011, all from the UM. Since joining North/South Consultants in 1997, Cam's professional career has focused on Lake Sturgeon, having conducted research and environmental monitoring focused on each life stage. He has worked with numerous populations in Alberta, Saskatchewan, Manitoba, Ontario, and Wisconsin. Cam's PhD dissertation focused on habitat use, movement, diet, and growth of juvenile Lake Sturgeon in the Winnipeg River, and provided insights into how hydroelectric developments may impact the distribution and mortality of young Lake Sturgeon in large regulated rivers. Prior to, during, and following his doctoral research, Cam has been involved with baseline data collection, field study, design and implementation, and writing of Lake Sturgeon sections for Environmental Impact Statements (EISs) for the Keeyask and Conawapa GSs on the Nelson River, Manitoba.

All three writers are members of the North American Sturgeon and Paddlefish Society.

COLLECTIONS EXAMINED

None.

Appendix 1. Threats assessment for Lake Sturgeon: Western Hudson Bay populations.

Species or Ecosystem Scientific Name	*Acipenser fulvescens* - Lake Sturgeon DU 1 Western Hudson Bay		
Element ID		**Elcode**	
Date (Ctrl + ";" for today's date):	07/07/2016		
Assessor(s):	Nick Mandrak (co-chair), Dwayne Lepitzki (Facilitator and Molluscs SSC co-chair), Cam Barth, Patrick Nelson, Craig McDougall (writers), Margaret Docker, Doug Watkinson (SSC members), Dan Benoit (ATK SC co-chair), Mike Friday, Josh Peacock (OMNR), Yves Paradis (MFFP - QC), Isabelle Gauthier (MFFP and COSEWIC member for Quebec), Mike Pollock (SK), Josée Brunelle (HFTCC), Shane Petry, Robin Gutsell (AB), Angèle Cyr (COSEWIC Secretariat), Chantal Sawatzky (DFO), Alan Penn (Cree Nation).		
References:	draft report & threats calculator; telecon 7 July 2016		

Overall Threat Impact Calculation Help:

Threat Impact		Level 1 Threat Impact Counts: high range	Level 1 Threat Impact Counts: low range
A	Very High	0	0
B	High	1	0
C	Medium	0	1
D	Low	1	1
Calculated Overall Threat Impact:		High	Medium

Assigned Overall Threat Impact:	**B = High**
Impact Adjustment Reasons:	n/a
Overall Threat Comments	Generation time 32-34; considering 96-102 yrs into the future. Some threats are overlapping and overquantified. Overall threat impact was adjusted to reflect. Most individuals in Churchill River mainstem Redhead Rapids to Swallows.

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
1	Residential & commercial development						
1.1	Housing & urban areas						not applicable
1.2	Commercial & industrial areas						not applicable
1.3	Tourism & recreation areas						not applicable
2	Agriculture & aquaculture						
2.1	Annual & perennial non-timber crops						not applicable
2.2	Wood & pulp plantations						not applicable
2.3	Livestock farming & ranching						not applicable

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
2.4	Marine & freshwater aquaculture						not applicable
3	Energy production & mining						
3.1	Oil & gas drilling						not applicable
3.2	Mining & quarrying						not applicable
3.3	Renewable energy						not applicable
4	Transportation & service corridors						
4.1	Roads & railroads						not applicable
4.2	Utility & service lines						not applicable
4.3	Shipping lanes						not applicable
4.4	Flight paths						not applicable
5	Biological resource use	BC	High - Medium	Pervasive (71-100%)	Serious - Moderate (11-70%)	High (Continuing)	
5.1	Hunting & collecting terrestrial animals						not applicable
5.2	Gathering terrestrial plants						not applicable
5.3	Logging & wood harvesting						not applicable
5.4	Fishing & harvesting aquatic resources	BC	High - Medium	Pervasive (71-100%)	Serious - Moderate (11-70%)	High (Continuing)	Overharvesting is the main threat to this unit. Subsistence harvest (unregulated) with only one viable population in this unit. 3% population decline over past three generations for example.
6	Human intrusions & disturbance		Negligible	Restricted (11-30%)	Negligible (<1%)	High (Continuing)	
6.1	Recreational activities						not applicable
6.2	War, civil unrest & military exercises						not applicable
6.3	Work & other activities			Restricted (11-30%)	Negligible (<1%)	High (Continuing)	some research activities restricted to tagging. Population estimate studies ending in 2016. 60-70% tag return. Some incidental mortality (less than 1%).
7	Natural system modifications	D	Low	Pervasive (71-100%)	Slight (1-10%)	High (Continuing)	
7.1	Fire & fire suppression						not applicable
7.2	Dams & water management/use	D	Low	Pervasive (71-100%)	Slight (1-10%)	High (Continuing)	dams
7.3	Other ecosystem modifications						not applicable
8	Invasive & other problematic species & genes						
8.1	Invasive non-native/alien species						not applicable

Threat		**Impact (calculated)**		**Scope (next 10 Yrs)**	**Severity (10 Yrs or 3 Gen.)**	**Timing**	**Comments**
8.2	Problematic native species						not applicable
8.3	Introduced genetic material						not applicable
9	Pollution						
9.1	Household sewage & urban waste water						not applicable
9.2	Industrial & military effluents						not applicable
9.3	Agricultural & forestry effluents						not applicable
9.4	Garbage & solid waste						not applicable
9.5	Air-borne pollutants						not applicable
9.6	Excess energy						not applicable
10	Geological events						
10.1	Volcanoes						not applicable
10.2	Earthquakes/tsunamis						not applicable
10.3	Avalanches/landslides						not applicable
11	Climate change & severe weather		Unknown	Pervasive (71-100%)	Unknown	High (Continuing)	
11.1	Habitat shifting & alteration						not applicable
11.2	Droughts						not applicable
11.3	Temperature extremes						Churchill River experiencing effects of climate change via thinner ice, shorter winter season, flooding. Thompson as well.
11.4	Storms & flooding						not applicable
Classification of Threats adopted from IUCN-CMP, Salafsky *et al.* (2008).							

Appendix 2. Threats assessment for Lake Sturgeon: Saskatchewan-Nelson River populations.

Species or Ecosystem Scientific Name	*Acipenser fulvescens* - Lake Sturgeon DU 2 Saskatchewan-Nelson River		
Element ID		**Elcode**	
Date (Ctrl + ";" for today's date):	07/07/2016		
Assessor(s):	Nick Mandrak (co-chair), Dwayne Lepitzki (Facilitator and Molluscs SSC co-chair), Cam Barth, Patrick Nelson, Craig McDougall (writers), Margaret Docker, Doug Watkinson (SSC members), Dan Benoit (ATK SC co-chair), Mike Friday, Josh Peacock (OMNR), Yves Paradis (MFFP - QC), Isabelle Gauthier (MFFP and COSEWIC member for Quebec), Mike Pollock (SK), Josée Brunelle (HFTCC), Shane Petry, Robin Gutsell (AB), Angèle Cyr (COSEWIC Secretariat), Chantal Sawatzky (DFO), Alan Penn (Cree Nation).		
References:	draft report & threats calculator; telecon 7 July 2016		

Overall Threat Impact Calculation Help:

Threat Impact		Level 1 Threat Impact Counts: high range	low range
A	Very High	0	0
B	High	0	0
C	Medium	0	0
D	Low	2	2
Calculated Overall Threat Impact:		Low	Low

Assigned Overall Threat Impact:	**D = Low**
Impact Adjustment Reasons:	n/a
Overall Threat Comments	Generation time 32-34; considering 96-102 yrs into the future. Most individuals in Lake of the Woods - Rainy Bay (45% of ~100,000). Some threats are overlapping and overquantified. Overall, populations are generally considered to be stable or increasing. Overall threat impact was adjusted to reflect this.

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
1	Residential & commercial development		Negligible	Small (1-10%)	Negligible (<1%)	High (Continuing)	most of population in this DU is in Lake of the Woods, Rainy Bay
1.1	Housing & urban areas						not applicable
1.2	Commercial & industrial areas						not applicable
1.3	Tourism & recreation areas		Negligible	Small (1-10%)	Negligible (<1%)	High (Continuing)	trailer parks, new marinas, spawning area very close to hydroelectric dam and impacted mostly in the past. Future impact of threat in this category affecting very small proportion of the population.

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
2	Agriculture & aquaculture						
2.1	Annual & perennial non-timber crops						not applicable
2.2	Wood & pulp plantations						not applicable
2.3	Livestock farming & ranching						expansion of lifestock ranching in the south. Flow based water withdrawal accounted for under ecosystem modification.
2.4	Marine & freshwater aquaculture						not applicable
3	Energy production & mining						
3.1	Oil & gas drilling						fracking not applicable as a threat.
3.2	Mining & quarrying						not applicable
3.3	Renewable energy						not applicable
4	Transportation & service corridors		Negligible	Negligible (<1%)	Slight (1-10%)	High (Continuing)	
4.1	Roads & railroads		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	some aggregate issues but negligible. Not a proximate threat.
4.2	Utility & service lines		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	pipeline drilling.
4.3	Shipping lanes		Negligible	Negligible (<1%)	Slight (1-10%)	High (Continuing)	dredging proposed in the Red River
4.4	Flight paths						not applicable
5	Biological resource use	D	Low	Pervasive (71-100%)	Slight (1-10%)	High (Continuing)	
5.1	Hunting & collecting terrestrial animals						not applicable
5.2	Gathering terrestrial plants						not applicable
5.3	Logging & wood harvesting						not applicable
5.4	Fishing & harvesting aquatic resources	D	Low	Pervasive (71-100%)	Slight (1-10%)	High (Continuing)	catch and release in SK with some subsistence harvesting (minimal), Lake of the Woods catch and release (prohibited target fishing) except in the US, MB is catch and release only. Sport angling over entire range with subsistence harvest (regulated with tags) but mostly catch and release. Commercial fishing is bycatch.
6	Human intrusions & disturbance		Negligible	Large (31-70%)	Negligible (<1%)	High (Continuing)	
6.1	Recreational activities						not applicable
6.2	War, civil unrest & military exercises						not applicable
6.3	Work & other activities			Large (31-70%)	Negligible (<1%)	High (Continuing)	some research activities. Mark and recapture programs.
7	Natural system modifications	D	Low	Pervasive (71-100%)	Slight (1-10%)	High (Continuing)	

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
7.1	Fire & fire suppression						not applicable
7.2	Dams & water management/use	D	Low	Pervasive (71-100%)	Slight (1-10%)	High (Continuing)	dams, water management and water flow. Red River, Assiniboine, Lake Winnipeg. East side tributaries. Some mortality through fish passage as well as one way passage possibly contributing to the population density (recruitment). Non-consensus as to the magnitude of this threat impact throughout the DU.
7.3	Other ecosystem modifications		Unknown	Large (31-70%)	Unknown	High (Continuing)	Zebra Mussel (ZM), Spiny Waterflea, Rusty Crayfish, Common Carp and Rainbow Smelt also causing ecosystem modification. Lake Winnipeg subject to the effects of ZM. Sturgeon also predate ZM so may be beneficial. net gain or loss unknown. overall impact of ecosystem modification unknown.
8	Invasive & other problematic species & genes		Unknown	Large (31-70%)	Unknown	High (Continuing)	
8.1	Invasive non-native/alien species		Unknown	Large (31-70%)	Unknown	High (Continuing)	Rusty Crayfish, Round Goby (eat eggs), Common Carp,. Lake Sturgeon also prey on Round Goby therefore unknown net threat impact. Rusty Crayfish report confirming predation on Lake Sturgeon eggs. Likely ecosystem modification for Carp in general.
8.2	Problematic native species						not applicable
8.3	Introduced genetic material						not applicable
9	Pollution		Negligible	Pervasive (71-100%)	Negligible (<1%)	High (Continuing)	
9.1	Household sewage & urban waste water		Unknown	Pervasive (71-100%)	Unknown	High (Continuing)	applicable but severity is unknown.
9.2	Industrial & military effluents		Unknown	Large (31-70%)	Unknown	High (Continuing)	applicable but severity is unknown. Some slaughter houses.
9.3	Agricultural & forestry effluents		Negligible	Pervasive (71-100%)	Negligible (<1%)	High (Continuing)	most of range is exposed to effects of agricultural runoff. Eutrophication.
9.4	Garbage & solid waste						not applicable
9.5	Air-borne pollutants						not applicable
9.6	Excess energy						not applicable
10	Geological events						
10.1	Volcanoes						not applicable
10.2	Earthquakes/tsunamis						not applicable
10.3	Avalanches/landslides						not applicable
11	Climate change & severe weather		Unknown	Pervasive (71-100%)	Unknown	High (Continuing)	overall impact of climate change on the range in this unit is likely via extreme weather and all of the subcategories in threat 11
11.1	Habitat shifting & alteration						applicable

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
11.2	Droughts						applicable
11.3	Temperature extremes						applicable
11.4	Storms & flooding						applicable
Classification of Threats adopted from IUCN-CMP, Salafsky *et al.* (2008).							

Appendix 3. Threats assessment for Lake Sturgeon: Southern Hudson Bay-James Bay populations.

Species or Ecosystem Scientific Name	*Acipenser fulvescens* - Lake Sturgeon DU 3 Southern Hudson Bay-James Bay		
Element ID		**Elcode**	
Date (Ctrl + ";" for today's date):	07/07/2016		
Assessor(s):	Nick Mandrak (co-chair), Dwayne Lepitzki (Facilitator and Molluscs SSC co-chair), Cam Barth, Patrick Nelson, Craig McDougall (writers), Margaret Docker, Doug Watkinson (SSC members), Dan Benoit (ATK SC co-chair), Mike Friday, Josh Peacock (OMNR), Yves Paradis (MFFP - QC), Isabelle Gauthier (MFFP and COSEWIC member for Quebec), Mike Pollock (SK), Josée Brunelle (HFTCC), Shane Petry, Robin Gutsell (AB), Angèle Cyr (COSEWIC Secretariat), Chantal Sawatzky (DFO), Alan Penn (Cree Nation).		
References:	draft report & threats calculator; telecon 7 July 2016		

Overall Threat Impact Calculation Help:

Threat Impact		Level 1 Threat Impact Counts: high range	Level 1 Threat Impact Counts: low range
A	Very High	0	0
B	High	0	0
C	Medium	0	0
D	Low	1	1
Calculated Overall Threat Impact:		Low	Low

Assigned Overall Threat Impact:	**D = Low**
Impact Adjustment Reasons:	n/a
Overall Threat Comments	Generation time 32-34; considering 96-102 yrs into the future. Most individuals in Moose/Mattagami/Abitibi (15000/17000 = 88%). Overall, population is apparently stable / increasing. Some threats are overlapping and overquantified. Overall threat impact was adjusted to reflect.

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
1	Residential & commercial development						
1.1	Housing & urban areas						not applicable
1.2	Commercial & industrial areas						not applicable
1.3	Tourism & recreation areas						not applicable
2	Agriculture & aquaculture						
2.1	Annual & perennial non-timber crops						not applicable
2.2	Wood & pulp plantations						not applicable
2.3	Livestock farming & ranching						not applicable

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
2.4	Marine & freshwater aquaculture						not applicable
3	Energy production & mining		Unknown	Pervasive (71-100%)	Unknown	High (Continuing)	
3.1	Oil & gas drilling						not applicable
3.2	Mining & quarrying		Unknown	Pervasive (71-100%)	Unknown	High (Continuing)	ring of fire in Ontario is subject to mining. Current mines as well as future mines considered.
3.3	Renewable energy						not applicable
4	Transportation & service corridors		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	
4.1	Roads & railroads		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	some roads and bridges being built over sturgeon habitat.
4.2	Utility & service lines						not applicable
4.3	Shipping lanes						not applicable
4.4	Flight paths						not applicable
5	Biological resource use		Unknown	Pervasive (71-100%)	Unknown	High (Continuing)	
5.1	Hunting & collecting terrestrial animals						not applicable
5.2	Gathering terrestrial plants						not applicable
5.3	Logging & wood harvesting						some logging occurring but mitigation should be prevalent.
5.4	Fishing & harvesting aquatic resources		Unknown	Pervasive (71-100%)	Unknown	High (Continuing)	Subsistence harvesting. Cree to be consulted wrt harvest levels. Mostly first nations fishing activities.
6	Human intrusions & disturbance		Negligible	Small (1-10%)	Negligible (<1%)	High (Continuing)	
6.1	Recreational activities						not applicable
6.2	War, civil unrest & military exercises						not applicable
6.3	Work & other activities			Small (1-10%)	Negligible (<1%)	High (Continuing)	some research activities. Mark and recapture programs.
7	Natural system modifications	D	Low	Large (31-70%)	Slight (1-10%)	High (Continuing)	
7.1	Fire & fire suppression						not applicable

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
7.2	Dams & water management/use	D	Low	Large (31-70%)	Slight (1-10%)	High (Continuing)	dams, water management and water flow. Rupert diversion. Many major rivers have diversion plans in place to mitigate the threat of dams in Quebec. In Ontario, not as many dam diversions.
7.3	Other ecosystem modifications						not applicable
8	Invasive & other problematic species & genes						
8.1	Invasive non-native/alien species						not applicable
8.2	Problematic native species						not applicable
8.3	Introduced genetic material						stocking from the same DU (not a threat).
9	Pollution		Negligible	Negligible (<1%)	Unknown	High (Continuing)	
9.1	Household sewage & urban waste water		Negligible	Negligible (<1%)	Unknown	High (Continuing)	applicable but severity is unknown.
9.2	Industrial & military effluents						not applicable
9.3	Agricultural & forestry effluents						southern portion of James Bay subject to forestry but no fertilization. Not applicable.
9.4	Garbage & solid waste						not applicable
9.5	Air-borne pollutants						not applicable
9.6	Excess energy						not applicable
10	Geological events						
10.1	Volcanoes						not applicable
10.2	Earthquakes/tsunamis						not applicable
10.3	Avalanches/landslides						not applicable
11	Climate change & severe weather		Unknown	Pervasive (71-100%)	Unknown	High (Continuing)	overall impact of climate change on the range in this unit is likely via extreme weather and all of the subcategories in threat 11
11.1	Habitat shifting & alteration						applicable
11.2	Droughts						applicable
11.3	Temperature extremes						applicable
11.4	Storms & flooding						applicable

Classification of Threats adopted from IUCN-CMP, Salafsky *et al.* (2008).

Appendix 4. Threats assessment for Lake Sturgeon: Great Lakes-Upper St. Lawrence populations.

Species or Ecosystem Scientific Name	*Acipenser fulvescens* - Lake Sturgeon DU 4 Great Lakes-Upper St. Lawrence			
Element ID		**Elcode**		
Date (Ctrl + ";" for today's date):	07/07/2016			
Assessor(s):	Nick Mandrak (co-chair), Dwayne Lepitzki (Facilitator and Molluscs SSC co-chair), Cam Barth, Patrick Nelson, Craig McDougall (writers), Margaret Docker, Doug Watkinson (SSC members), Dan Benoit (ATK SC co-chair), Mike Friday, Josh Peacock (OMNR), Yves Paradis (MFFP - QC), Isabelle Gauthier (MFFP and COSEWIC member for Quebec), Mike Pollock (SK), Josée Brunelle (HFTCC), Shane Petry, Robin Gutsell (AB), Angèle Cyr (COSEWIC Secretariat), Chantal Sawatzky (DFO), Alan Penn (Cree Nation).			
References:	draft report & threats calculator; telecon 7 July 2016			

Overall Threat Impact Calculation Help:

Threat Impact		Level 1 Threat Impact Counts: high range	low range
A	Very High	0	0
B	High	0	0
C	Medium	1	0
D	Low	3	4
Calculated Overall Threat Impact:		High	Medium

Assigned Overall Threat Impact:	**CD = Medium - Low**
Impact Adjustment Reasons:	n/a
Overall Threat Comments	Generation time 32-34; considering 96-102 yrs into the future. Most individuals in Lac des Deux-Montagnes-Lac St. Louis (100,000/ 200,000; 50% if use). Overall, population is observed stable / increasing. Some threats are overlapping and overquantified. Overall threat impact was adjusted to reflect this.

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
1	Residential & commercial development		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	
1.1	Housing & urban areas						not applicable
1.2	Commercial & industrial areas						not applicable
1.3	Tourism & recreation areas		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	some new and expanding marinas but minimal impact. Unlikely to be build on spawning beds.
2	Agriculture & aquaculture						
2.1	Annual & perennial non-timber crops						not applicable
2.2	Wood & pulp plantations						not applicable
2.3	Livestock farming & ranching						not applicable

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
2.4	Marine & freshwater aquaculture						no aquaculture in this DU other than Manitoulin Islands in Lake Huron which may have aquaculture. Overlap with Lake Sturgeon unknown. Threat unknown.
3	Energy production & mining						
3.1	Oil & gas drilling						not applicable
3.2	Mining & quarrying						not applicable
3.3	Renewable energy						not applicable
4	Transportation & service corridors	D	Low	Large (31-70%)	Slight (1-10%)	High (Continuing)	
4.1	Roads & railroads		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	not applicable
4.2	Utility & service lines			Small (1-10%)	Negligible (<1%)	High (Continuing)	
4.3	Shipping lanes	D	Low	Large (31-70%)	Slight (1-10%)	High (Continuing)	expansion of the port of Montréal included in 4.2. main habitat in the St. Lawrence channel. Substantial proportion of the population are exposed to shipping lanes in the navigation channel of the St. Lawrence. Detroit River and St.Clair River and Lake St.Clair as well. Spawning reefs being build in southern Ontario to mitigate this threat. Dredging impact is unknown. may be detrimental but also may have created spawning habitat.
4.4	Flight paths						not applicable
5	Biological resource use	D	Low	Large (31-70%)	Slight (1-10%)	High (Continuing)	
5.1	Hunting & collecting terrestrial animals						not applicable
5.2	Gathering terrestrial plants						not applicable
5.3	Logging & wood harvesting						not applicable

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
5.4	Fishing & harvesting aquatic resources	D	Low	Large (31-70%)	Slight (1-10%)	High (Continuing)	Orden Creek. Subsistence harvest fishing. Threat impact from fishing is moderate in Ontario part of range in this DU compared to Quebec range. Poaching is also a threat but not a major threat. Catch and release in Ontario. Targetted fishing is prohibited for this species in Ontario. Somewhat of an issue in Detroit River where boundaries are shared and targetted fishing is permitted in the US. Harvest quotas in QC seem to be sustainable. Commercial fishing in St. Lawrence is a major threat (needs rigorous regulating) because fishing pressure is quite high in this range.
6	Human intrusions & disturbance		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	
6.1	Recreational activities						not applicable
6.2	War, civil unrest & military exercises						not applicable
6.3	Work & other activities		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	some research activities
7	Natural system modifications	D	Low	Large (31-70%)	Slight (1-10%)	High (Continuing)	
7.1	Fire & fire suppression						not applicable
7.2	Dams & water management/use	D	Low	Large (31-70%)	Slight (1-10%)	High (Continuing)	Existing development. all of the population in Quebec is exposed to the effects of dams but not all in Ontario. Water management also impacts the species. Mitigation measures are critical to the subsistence.
7.3	Other ecosystem modifications		Unknown	Large (31-70%)	Unknown	High (Continuing)	Zebra/Quagga mussels also causing ecosystem modification. Lake Winnebago populations stable to the effects of ZM. Sturgeon also predate ZM so may be beneficial. net gain or loss unknown. Benthification of the Great Lakes Basin is unknown. Phragmites also an issue in the GL.
8	Invasive & other problematic species & genes		Negligible	Large (31-70%)	Negligible (<1%)	High (Continuing)	

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
8.1	Invasive non-native/alien species		Negligible	Large (31-70%)	Negligible (<1%)	High (Continuing)	Rusty Crayfish and Round Goby (eat eggs). Lake Sturgeon also prey on Round Goby therefore unknown net threat impact. Round Goby not throughout Ontario range for LS. RG does not occur in the inland range for this DU. Sea Lamprey population control program - moderate threat. threat of Asian Carp is unknown. Likely ecosystem modification for Carp in general.
8.2	Problematic native species						Sea Lamprey native in Quebec (St. Lawrence). Silver Lamprey in Lake St. Clair not causing direct mortality.
8.3	Introduced genetic material						Stocking in the Great Lakes from Winnebago Lake fish (which would be same DU though US) and not suspected to be a threat.
9	Pollution	CD	Medium - Low	Large (31-70%)	Moderate - Slight (1-30%)	High (Continuing)	
9.1	Household sewage & urban waste water		Unknown	Pervasive (71-100%)	Unknown	High (Continuing)	applicable but severity is unknown.
9.2	Industrial & military effluents	CD	Medium - Low	Large (31-70%)	Moderate - Slight (1-30%)	High (Continuing)	lampricide restricted to inland but industrial effluent is throughout. Some mitigation of this threat based on delayed TFM application only occurred in 2012. applied every 3-4 yrs.
9.3	Agricultural & forestry effluents	D	Low	Large (31-70%)	Slight (1-10%)	High (Continuing)	eutrophication has a major impact on the spawning sites for this species.
9.4	Garbage & solid waste						not applicable
9.5	Air-borne pollutants						not applicable
9.6	Excess energy						not applicable
10	Geological events						
10.1	Volcanoes						not applicable
10.2	Earthquakes/tsunamis						not applicable
10.3	Avalanches/landslides						not applicable
11	Climate change & severe weather		Unknown	Pervasive (71-100%)	Unknown	High (Continuing)	overall impact of climate change on the range in this unit is likely extreme weather and all of the subcategories in threat 11
11.1	Habitat shifting & alteration						water level in the St. Lawrence River will likely be affected by climate change over the next 100 yrs

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
11.2	Droughts						applicable
11.3	Temperature extremes						applicable
11.4	Storms & flooding						applicable
Classification of Threats adopted from IUCN-CMP, Salafsky *et al.* (2008).							