Atlantic sturgeon, Lake sturgeon

Acipenser oxyrinchus oxyrinchus and *Acipenser fulvescens*

Image © NY Dept. of Environmental Conservation

Canada

Bottom gillnet

March 27, 2015

Zach Siders, Consulting Researcher

Disclaimer

Seafood Watch® strives to have all Seafood Reports reviewed for accuracy and completeness by external scientists with expertise in ecology, fisheries science and aquaculture. Scientific review, however, does not constitute an endorsement of the Seafood Watch® program or its recommendations on the part of the reviewing scientists. Seafood Watch® is solely responsible for the conclusions reached in this report.

About Seafood Watch®

Monterey Bay Aquarium's Seafood Watch® program evaluates the ecological sustainability of wild-caught and farmed seafood commonly found in the United States marketplace. Seafood Watch® defines sustainable seafood as originating from sources, whether wild-caught or farmed, which can maintain or increase production in the long-term without jeopardizing the structure or function of affected ecosystems. Seafood Watch® makes its science-based recommendations available to the public in the form of regional pocket guides that can be downloaded from www.seafoodwatch.org. The program's goals are to raise awareness of important ocean conservation issues and empower seafood consumers and businesses to make choices for healthy oceans.

Each sustainability recommendation on the regional pocket guides is supported by a Seafood Report. Each report synthesizes and analyzes the most current ecological, fisheries and ecosystem science on a species, then evaluates this information against the program's conservation ethic to arrive at a recommendation of "Best Choices," "Good Alternatives" or "Avoid." The detailed evaluation methodology is available upon request. In producing the Seafood Reports, Seafood Watch® seeks out research published in academic, peer-reviewed journals whenever possible. Other sources of information include government technical publications, fishery management plans and supporting documents, and other scientific reviews of ecological sustainability. Seafood Watch® Research Analysts also communicate regularly with ecologists, fisheries and aquaculture scientists, and members of industry and conservation organizations when evaluating fisheries and aquaculture practices. Capture fisheries and aquaculture practices are highly dynamic; as the scientific information on each species changes, Seafood Watch®'s sustainability recommendations and the underlying Seafood Reports will be updated to reflect these changes.

Parties interested in capture fisheries, aquaculture practices and the sustainability of ocean ecosystems are welcome to use Seafood Reports in any way they find useful. For more information about Seafood Watch® and Seafood Reports, please contact the Seafood Watch® program at Monterey Bay Aquarium by calling 1-877-229-9990.

Guiding Principles

Seafood Watch defines sustainable seafood as originating from sources, whether fished[1] or farmed, that can maintain or increase production in the long-term without jeopardizing the structure or function of affected ecosystems.

Based on this principle, Seafood Watch had developed four sustainability **criteria** for evaluating wild-catch fisheries for consumers and businesses. These criteria are:

- How does fishing affect the species under assessment?
- How does the fishing affect other, target and non-target species?
- How effective is the fishery's management?
- How does the fishing affect habitats and the stability of the ecosystem?

Each criterion includes:

- Factors to evaluate and score
- Guidelines for integrating these factors to produce a numerical score and **rating**

Once a rating has been assigned to each criterion, we develop an overall recommendation. Criteria ratings and the overall recommendation are color-coded to correspond to the categories on the Seafood Watch pocket guide and the Safina Center's online guide:

Best Choice/Green: Are well managed and caught in ways that cause little harm to habitats or other wildlife.

Good Alternative/Yellow: Buy, but be aware there are concerns with how they're caught.

Avoid/Red: Take a pass on these for now. These items are overfished or caught in ways that harm other marine life or the environment.

1 "Fish" is used throughout this document to refer to finfish, shellfish and other invertebrates.

Summary

This report provides analysis and recommendations for Québec, Canada's St. Lawrence River fisheries for Atlantic sturgeon and lake sturgeon. This report does not provide a recommendation for the Atlantic sturgeon fishery in New Brunswick, Canada's St. John River. Both species are large bodied, slow growing, and late maturing, and are particularly susceptible to overexploitation. The Atlantic sturgeon fishery in the St. Lawrence River is highly restrictive, has little bycatch, has closely monitored total allowable catch (TAC) quotas, and has minimal impacts on habitats and ecosystems, but scores as "Avoid" due to tenuous evidence for recovery. The lake sturgeon fishery in the St. Lawrence River scored as "Avoid" because the current population size is unknown, the impacts of commercial harvest are unknown, and there is no evidence to suggest whether current management practices are sustainable.

Atlantic sturgeon is a wide ranging anadromous species found from Florida, United States to Labrador, Canada. In Canada, Atlantic sturgeon spends most of its life in riverine estuaries, and only migrates outside of estuaries occasionally as an adult. Mature females reach 2–3 m and 100–200 kg; mature males reach 1.5–2 m and 50–100 kg. The Québec stock is located in the Lower St. Lawrence River around Québec City and forms the St. Lawrence River Designatable Unit (all Designatable Units are defined by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC)).. Lake sturgeon is a freshwater fish living in freshwater drainages throughout Canada and the Mississippi River basin in the United States. The Canadian fishery is only in the Great Lakes-Upper St. Lawrence River Designatable Unit, located in the Upper St. Lawrence River near Montréal. Fish are typically less than 2 m and below 36 kg in this exploited stretch of the St. Lawrence River.

The primary gear is bottom gillnets, minimum 20.4 cm, in the St. Lawrence River and estuary for both Atlantic and lake sturgeon fisheries. Both harvested sturgeon species are extremely susceptible to overexploitation and have been subject to intense regulations in 1998, 1999, and 2002 across the various fisheries as a consequence of intense exploitation. The Atlantic sturgeon is evaluated as Threatened by COSEWIC in all (two) Designatable Units, including the St. Lawrence River Designatable Unit. Atlantic sturgeon in both units is being considered for listing under Canada's Species at Risk Act (SARA). Lake sturgeon is evaluated as Threatened in the Great Lakes-Upper St. Lawrence River Designatable Unit. The large gillnet size and restriction to riverine habitats greatly eliminates the chance of bycatch, and the only impacted species are the undersized or oversized individuals of the targeted species. It has largely been assumed that discarded individuals have very high survival rates and thus do not add appreciable impacts onto fishery practices; however, there is only anecdotal evidence.

The intensive regulations are ubiquitous in all Canadian sturgeon fisheries, involving gear restrictions, season closures, total allowable catch quotas, catch registration, size restrictions, and intense enforcement. The effectiveness of these regulations is relatively unknown but there are recent tagging programs, other fishery-independent monitoring, and fisheries-dependent monitoring. The Québec Atlantic sturgeon fishery has a tenuous estimated adult population between 1,597 and 7,723 individuals, potentially supporting the size of the current commercial fishery. The lake sturgeon fishery is suspected to support the current size of the current commercial fishery but the population size is unknown.

- The gear type used has no documented appreciable impact on the habitat. Habitat destruction is a threat to sturgeon via habitat modification from dams, impoundments, dredging, and other non-fishery anthropogenic threats.

The availability of Atlantic sturgeon to the North American market is limited to Canada because Atlantic sturgeon is listed in the United States as an Endangered Species under the Endangered Species Act. Lake sturgeon is exported to the United States (typically to northern states) and is a local product within Canada. "Sturgeon," comprising both Atlantic and lake sturgeon fishery products, total approximately 100–120 tonnes of product per annum. This makes up the dominant share of the market for smoked flesh, with some small quantities available from recreational fisheries and caviar from aquaculture productions, though considerable amounts of caviar are imported from European aquaculture facilities.

Table of Conservation Concerns and Overall Recommendations

Stock / Fishery	Impacts on the Stock	Impacts on other Spp.	Management	Habitat and Ecosystem	Overall Recommendation
Lake sturgeon Canada St. Lawrence River - Large mesh bottom gillnet	Red (1.00)	Green (5.00)	Red (1.00)	Green (3.46)	**Avoid (2.040)**
Atlantic sturgeon Canada St. Lawrence River Estuary - Large mesh bottom gillnet	Red (1.53)	Green (5.00)	Red (1.00)	Green (3.46)	**Avoid (2.267)**

Scoring Guide

Scores range from zero to five where zero indicates very poor performance and five indicates the fishing operations have no significant impact.

Final Score = geometric mean of the four Scores (Criterion 1, Criterion 2, Criterion 3, Criterion 4).

- **Best Choice/Green** = Final Score >3.2, **and** no Red Criteria, **and** no Critical scores
- **Good Alternative/Yellow** = Final score >2.2-3.2, **and** neither Harvest Strategy (Factor 3.1) nor Bycatch Management Strategy (Factor 3.2) are Very High Concern[2], **and** no more than one Red Criterion, **and** no Critical scores
- **Avoid/Red** = Final Score <=2.2, **or** either Harvest Strategy (Factor 3.1) or Bycatch Management Strategy (Factor 3.2) is Very High Concern **or** two or more Red Criteria, **or** one or more Critical scores.

[2] Because effective management is an essential component of sustainable fisheries, Seafood Watch issues an Avoid recommendation for any fishery scored as a Very High Concern for either factor under Management (Criterion 3).

Table of Contents

Introduction

Scope of the analysis and ensuing recommendation

This analysis covers two species of sturgeon, Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*) and lake sturgeon (*Acipenser fulvescens*) in the St. Lawrence River. The St. John River fishery for Atlantic sturgeon in the Maritimes Designatable Unit is not covered in this report. Atlantic sturgeon is caught in the St. Lawrence River in the lower St. Lawrence estuary downstream of Trois-Rivières in Québec. Gear type is - bottom gillnet (20.4 cm stretched mesh size) and fishing is limited by gear restrictions, season closures, size limits, and total allowable catch (TAC) restrictions. Lake sturgeon is caught commercially in the Designatable Unit 8-Great Lakes and Upper St. Lawrence River in Québec in the upper St. Lawrence estuary upstream of Trois-Rivières, with minimal overlap with Atlantic sturgeon (Designatable Units are defined by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC)). Gear type is 20.4 cm bottom gillnet and limited by gear restrictions, season closures, size limits, and total allowable catch restrictions.

Overview of the species and management bodies

Sturgeon fisheries in Canada traditionally comprised a diverse set of species on both Atlantic and Pacific coasts. High catchability, low productivity, and intense fishing effort resulted in incredibly high catch rates and, by the turn of the 20th century, many species had become rare throughout their ranges. Many species were fished to the extent of local extirpation or below profitability and have not subsequently recovered to join the two current sturgeon fisheries in Canada.

In Québec, a commercial fishery for Atlantic sturgeon has been ongoing for centuries with a dip in landings from 1967 to 1975. After this lull in pressure, catches reached high levels in the 1990s with subsequent fishery restrictions going into place in 1997 and 1998 (Caron et al. 2002). Spawning sites are unknown in the St. Lawrence River.

Atlantic sturgeon were evaluated in two separate Designatable Units (Maritimes and St. Lawrence) as Threatened by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) (COSEWIC 2011) (DFO 2013b). The Maritimes Designatable Unit encompasses all the sturgeon habitat throughout the Canadian Maritimes Provinces, and the fishery for Atlantic sturgeon in this Designatable Unit is not covered in this report. The St. Lawrence Designatable Unit is in the St. Lawrence River, and the population is mainly found east of Trois-Rivières, into the estuary and past the Gulf of St. Lawrence, into the Atlantic until Ungava Bay in the north, and along the northeastern coast of Newfoundland in the south. COSEWIC evaluation of a stock is independent from the formal federal listing status in Canada under the Species at Risk Act (SARA). Public consultations regarding the addition of this population (as well as the Martimes population) to the List of Wildlife Species at Risk under the Species at Risk Act (SARA) were held from November 17, 2014 to February 27, 2015. No other stocks of Atlantic sturgeon are fished; the remaining stocks are listed as Endangered in the United States under the Endangered Species Act. Currently, Atlantic sturgeon are fished recreationally, as well as in subsistence, social, and ceremonial fisheries.

Lake sturgeon population declines were attributed to overfishing and large-scale habitat destruction (Mailhot et al. 2011) and assessed in 2006 as Threatened in the Great Lakes-Upper St. Lawrence River Designatable Unit 8 under COSEWIC (COSEWIC 2006). Two subpopulations of lake sturgeon exist in this Designatable Unit: one in Lac-St. François and another in a 350-km stretch of the St. Lawrence River (Mailhot et al. 2011). Other stocks of lake sturgeon in Canada and the United States are fished recreationally.

Atlantic sturgeon and lake sturgeon in Quebec are overseen jointly by the Ministère des Forêts, de la Faune e des Parcs and Fisheries and Oceans Canada. The management process is as follows: COSEWIC evaluates stock designation; then the federal government conducts consultation, recovery potential assessments, and management scenarios to determine if the species will be listed under the Species at Risk Act (SARA).

Production Statistics

The Atlantic sturgeon fishery existed throughout this species range, from Georgia, United States to the St. Lawrence River, Canada, but after precipitous declines throughout the U.S. stocks, all U.S. fisheries were closed. Currently, fisheries for this species only occur in Canada, and are dominated by the St. Lawrence River fishery, which is 10 times larger than the St. John River fishery (>3,000 vs. 350 fish) (COSEWIC 2011) (DFO 2013) (Verreault & Trencia 2011). Landings have declined after intensive regulations of both fisheries in the late 1990s, and are now around 2,000–4,000 fish in the St. Lawrence River and capped at 350 fish in the St. John River (though rarely met) with a 50:50 sex ratio regulation (COSEWIC 2011) (DFO 2013b) (Verreault & Trencia 2011).

The lake sturgeon fishery is limited to the contiguous United States and Canada. Insignificant lake sturgeon fisheries existed throughout those contiguous United States, and the majority of current production occurs in Canada's Great Lakes-Upper St. Lawrence River area. Production has declined after intensive regulations and is capped at 80 tonnes (approximately 12,000 fish). There has been a reduction in effort in recent years, because the commodity price has fallen (COSEWIC 2006) (Mailhot et al. 2011).

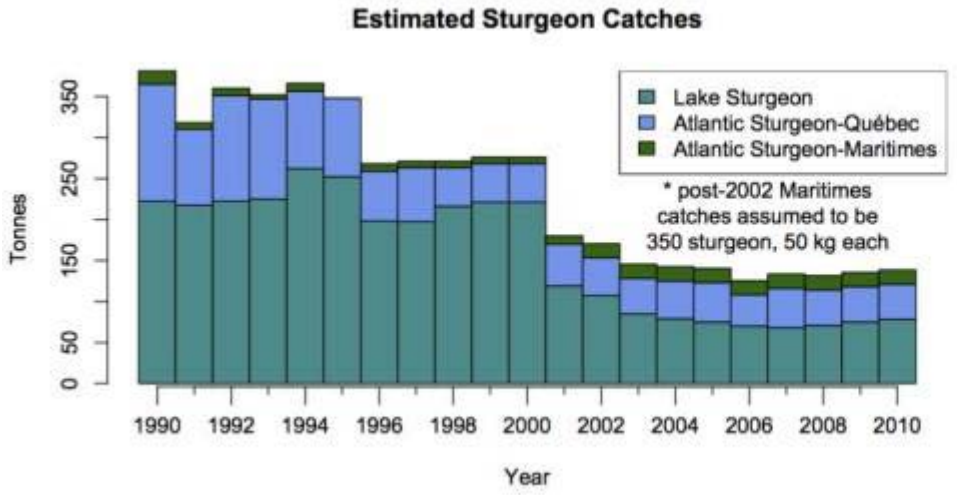

Figure 1: Production of lake sturgeon from Québec and Atlantic sturgeon from Québec and Maritimes from 1990 to 2010. Production of Atlantic Sturgeon from the Maritimes was assumed to be 350 fish per annum at 50 kg each, following COSEWIC (2011) and DFO (2013).

Importance to the U.S./North American market

The market for wild-capture sturgeon fishery products, comprising both Canadian Atlantic and lake sturgeon fishery products, is in smoked flesh and represents $19,363,608 since 1975 in exports to the U.S. (5,736 tonnes of product). This has represented $537,878 per annum but wide variation exists based on the market price and import quantity. In recent years (2008–present), smoked flesh has decreased in market share of U.S. imports, and subsequently the export importance of fisheries for sturgeon within Canada. The increasingly dominant market share is from caviar aquaculture facilities in Canada (NOAA NMFS FSED 2014). In the most recent year, sturgeon fishery production was close to 150 tonnes, with an approximate availability on the market of 90–100 tonnes of smoked flesh and 528 kg of caviar (from the Canadian Maritimes) (estimated as 60% of the total production following dressed weight values of the Maritimes fishery (DFO 2013c)).

The availability of Atlantic sturgeon to the North American market is limited to Canada (where it is a local product) because it is listed in the United States as an Endangered Species. Lake sturgeon is exported to the United States typically to the northern United States and is a local product within Canada. Sturgeon make up approximately 100–120 tonnes of product per annum. This is the dominant share of the market for smoked flesh, with some small quantities available from recreational fisheries and caviar from aquaculture productions, though considerable amounts of caviar are imported from aquaculture facilities in Europe.

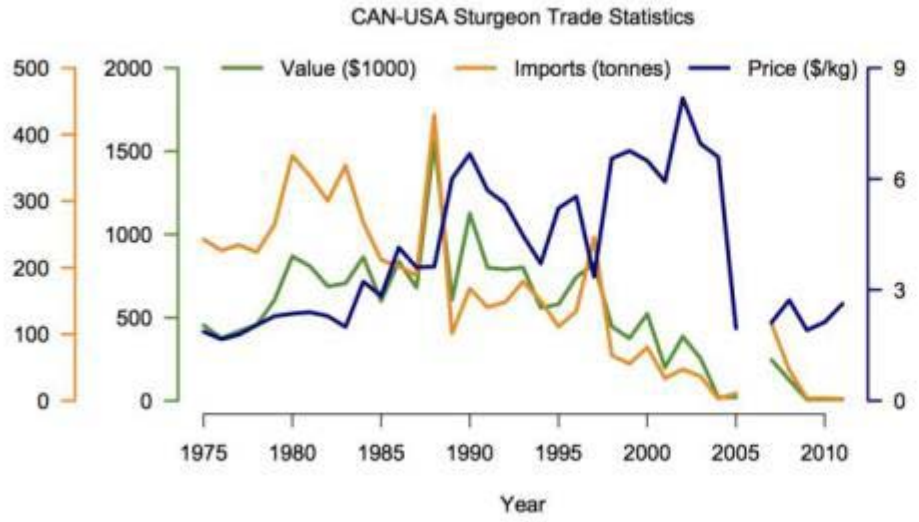

Figure 2: Records of exports from Canada to the United States from 1975 to 2011 of "sturgeon." This encompasses both lake and Atlantic sturgeon from Québec and the Maritimes. The relative contribution of each fishery is unknown but is suspected to be close to the proportion of the allocated catch of each fishery of the total available for "sturgeon" in Canada.

Common and market names

Lake sturgeon and Atlantic sturgeon are marketed generically as sturgeon in the US.

Primary product forms

Atlantic and lake sturgeon are marketed in North America in two forms, smoked flesh and caviar. Lake and Atlantic sturgeon fisheries in Québec only produce smoked flesh (Mailhot et al. 2011) (Verreault & Trencia 2011) and the Maritimes fishery produces both smoked flesh and caviar (DFO 2013c), though caviar is primarily produced from aquaculture operations. Infrequently and not recently, isinglass was marketed, but production from Canada has not been documented in many years.

Assessment

This section assesses the sustainability of the fishery(s) relative to the Seafood Watch Criteria for Fisheries, available at http://www.seafoodwatch.org.

Criterion 1: Impacts on the species under assessment

This criterion evaluates the impact of fishing mortality on the species, given its current abundance. The inherent vulnerability to fishing rating influences how abundance is scored, when abundance is unknown.

The final Criterion 1 score is determined by taking the geometric mean of the abundance and fishing mortality scores. The Criterion 1 rating is determined as follows:

- *Score >3.2=Green or Low Concern*
- *Score >2.2 and <=3.2=Yellow or Moderate Concern*
- *Score <=2.2=Red or High Concern*

Rating is Critical if Factor 1.3 (Fishing Mortality) is Critical.

Criterion 1 Summary

ATLANTIC STURGEON				
Region / Method	**Inherent Vulnerability**	**Stock Status**	**Fishing Mortality**	**Subscore**
Canada St. Lawrence River Estuary Large mesh bottom gillnet	1.00:High	1.00:Very High Concern	2.33:Moderate Concern	**Red (1.526)**

LAKE STURGEON				
Region / Method	**Inherent Vulnerability**	**Stock Status**	**Fishing Mortality**	**Subscore**
Canada St. Lawrence River Large mesh bottom gillnet	1.00:High	1.00:Very High Concern	1.00:High Concern	**Red (1.000)**

Criterion 1 Assessment

ATLANTIC STURGEON

Factor 1.1 - Inherent Vulnerability

Scoring Guidelines

- *Low—The FishBase vulnerability score for species is 0-35, OR species exhibits life history characteristics that make it resilient to fishing, (e.g., early maturing (*
- *Medium—The FishBase vulnerability score for species is 36-55, OR species exhibits life history characteristics that make it neither particularly vulnerable nor resilient to fishing,*

(e.g., moderate age at sexual maturity (5-15 years), moderate maximum age (10-25 years), moderate maximum size, and middle of food chain).

- *High—The FishBase vulnerability score for species is 56-100, OR species exhibits life history characteristics that make is particularly vulnerable to fishing, (e.g., long-lived (>25 years), late maturing (>15 years), low reproduction rate, large body size, and top-predator). Note: The FishBase vulnerability scores is an index of the inherent vulnerability of marine fishes to fishing based on life history parameters: maximum length, age at first maturity, longevity, growth rate, natural mortality rate, fecundity, spatial behaviors (e.g., schooling, aggregating for breeding, or consistently returning to the same sites for feeding or reproduction) and geographic range.*

Canada St. Lawrence River Estuary, Large mesh bottom gillnet

High

Atlantic sturgeon has a very high inherent vulnerability (FishBase score of 85 out of 100) (Froese & Pauly 2014). Atlantic sturgeon is long-lived (40–60 years) (Stevenson & Secor 1999), late maturing (16–24 years of age in males, 27–28 years of age in females) and, once mature, spawns approximately every 3 years (males) to 4–5 years (females) (COSEWIC 2011) (DFO 2013) (DFO 2013b) (Smith 1985) (pers. comm., Dadswell 2015).

Factor 1.2 - Stock Status

Scoring Guidelines

- *5 (Very Low Concern)—Strong evidence exists that the population is above target abundance level (e.g., biomass at maximum sustainable yield, BMSY) or near virgin biomass.*
- *4 (Low Concern)—Population may be below target abundance level, but it is considered not overfished*
- *3 (Moderate Concern) —Abundance level is unknown and the species has a low or medium inherent vulnerability to fishing.*
- *2 (High Concern)—Population is overfished, depleted, or a species of concern, OR abundance is unknown and the species has a high inherent vulnerability to fishing.*
- *1 (Very High Concern)—Population is listed as threatened or endangered.*

Canada St. Lawrence River Estuary, Large mesh bottom gillnet

Very High Concern

The St. Lawrence River populations of Atlantic sturgeon are evaluated as Threatened by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC 2011). The spawning locations are unknown within the St. Lawrence River (though efforts are underway (pers. comm., Verreault 2014)), the breeding

population is small and occurs within a relatively small area, and there is uncertainty over the population effects of the commercial and recreational fisheries. The St. Lawrence populations are not listed under the Species at Risk Act (SARA), but are being considered for listing under this act. The species is listed as Near Threatened by the IUCN (St. Pierre 2006), and Endangered under the US Endangered Species Act (ESA) (NOAA NMFS FSED 2014).

From (DFO 2013b): "The abundance of Atlantic sturgeon, St. Lawrence population, has never been formally established. The current size is unknown." There is a tenuous estimate (to be used with caution) that the population contains between 500 and 1000 individuals (DFO 2013b). The absence of an analytical model prevented estimating the size of the minimum viable population (MVP) for Atlantic Sturgeon in the St. Lawrence River but, based on other MVP studies, an MVP of 5,000–6,000 adults would ensure survival of the species for 500 years.*

Stock status scores as "very high" concern because the St. Lawrence River populations of Atlantic sturgeon are evaluated as Threatened by COSEWIC and listed by the IUCN as Near Threatened (St. Pierre 2006).

Rationale:
* Modeling the St. Lawrence population of Atlantic sturgeon has been regarded by managers as very tenuous; the following quote is from (pers. comm., Verreault 2014):
"The exercise was very risky given the weakness of available biological parameters (M, F, Z, growth, maturity, etc.). Depending [on] the hypothesis used, we estimated the abundance for spawners over 36 years old, between approximately 2,659 and 8,019 individuals. This estimate needs to be validated and a mark-recapture analysis is being performed this year [2014]."

The RPA provides a tenuous population projection of between 1,597 and 7,723 spawning adults in 40 years (DFO 2013b).

Factor 1.3 - Fishing Mortality

Scoring Guidelines

- *5 (Very Low Concern)—Highly likely that fishing mortality is below a sustainable level (e.g., below fishing mortality at maximum sustainable yield, FMSY), OR fishery does not target species and its contribution to the mortality of species is negligible (≤ 5% of a sustainable level of fishing mortality).*
- *3.67 (Low Concern)—Probable (>50%) chance that fishing mortality is at or below a sustainable level, but some uncertainty exists, OR fishery does not target species and does not adversely affect species, but its contribution to mortality is not negligible, OR fishing*

mortality is unknown, but the population is healthy and the species has a low susceptibility to the fishery (low chance of being caught).

- *2.33 (Moderate Concern)—Fishing mortality is fluctuating around sustainable levels, OR fishing mortality is unknown and species has a moderate-high susceptibility to the fishery and, if species is depleted, reasonable management is in place.*
- *1 (High Concern)—Overfishing is occurring, but management is in place to curtail overfishing, OR fishing mortality is unknown, species is depleted, and no management is in place.*
- *0 (Critical)—Overfishing is known to be occurring and no reasonable management is in place to curtail overfishing.*

Canada St. Lawrence River Estuary, Large mesh bottom gillnet

Moderate Concern

Current fishing mortality is unknown because the current population size is unknown (COSEWIC 2011) (DFO 2013b). Population size is depleted. This was thought to be due to historical overexploitation in the late 1800s and early 1900s (Limburg & Waldman 2009) but this did not occur (pers. comm., Dadswell 2015). The current population size is due to exploitation in the late 1900s (Dadswell 2006) (pers. comm., Dadswell 2015). There is evidence that management is rebuilding the stock's age structure; larger individuals are escaping the fishery and young recruits are appearing and filling the space left by larger fish (Verreault & Trencia 2011). But because the population size is unknown, it is impossible to determine if management is effective in curtailing overfishing.

Fishing mortality is thought to be the highest cause of mortality to the population (habitat degradation and loss of preferred habitat are also major threats), but neither fishing mortality nor these other sources have been quantified.

Fishing mortality scores as "moderate" concern because the current level of fishing mortality is supporting the current total allowable catch (TAC) and positive population structure modification is ongoing.

Rationale:
Fishing mortality from the commercial sector is estimated to be the highest cause of mortality to the population, but numerous other threats exist within Quebec to the stock (from (COSEWIC 2011) (DFO 2013b)). These threats include:
1) Dredging is a primary concern of fishery managers because it has been known to disrupt spawning, displace juveniles and subadults, and destroy macrobenthos assemblages of the primary Atlantic sturgeon prey items (McQuinn & Nellis 2007) (Nellis et al. 2007) (Nellis et al. 2007b).
2) Port development is a likely high-level threat to Atlantic sturgeon habitat (DFO 2013b).
3) Contamination is a likely low-level threat to Atlantic sturgeon populations (DFO 2013b).
4) Maritime accidents are an unlikely high-level threat to Atlantic sturgeon populations (DFO 2013b).

5) Climate change and variations in freshwater flow are a threat of unknown consequence to Atlantic sturgeon populations (DFO 2013b).

LAKE STURGEON

Factor 1.1 - Inherent Vulnerability

Scoring Guidelines

- *Low—The FishBase vulnerability score for species is 0-35, OR species exhibits life history characteristics that make it resilient to fishing, (e.g., early maturing (*
- *Medium—The FishBase vulnerability score for species is 36-55, OR species exhibits life history characteristics that make it neither particularly vulnerable nor resilient to fishing, (e.g., moderate age at sexual maturity (5-15 years), moderate maximum age (10-25 years), moderate maximum size, and middle of food chain).*
- *High—The FishBase vulnerability score for species is 56-100, OR species exhibits life history characteristics that make is particularly vulnerable to fishing, (e.g., long-lived (>25 years), late maturing (>15 years), low reproduction rate, large body size, and top-predator).*
  Note: The FishBase vulnerability scores is an index of the inherent vulnerability of marine fishes to fishing based on life history parameters: maximum length, age at first maturity, longevity, growth rate, natural mortality rate, fecundity, spatial behaviors (e.g., schooling, aggregating for breeding, or consistently returning to the same sites for feeding or reproduction) and geographic range.

Canada St. Lawrence River, Large mesh bottom gillnet

High

Lake sturgeon has a very high inherent vulnerability (FishBase score is 89 out of 100) (Froese & Pauly 2014). Lake sturgeon is long-lived (up to 150 years), late maturing (13–33 years of age) and has a long generational time (33.4 years in the upper St. Lawrence population) (Vélez-Espino & Koops 2009).

Factor 1.2 - Stock Status

Scoring Guidelines

- *5 (Very Low Concern)—Strong evidence exists that the population is above target abundance level (e.g., biomass at maximum sustainable yield, BMSY) or near virgin biomass.*
- *4 (Low Concern)—Population may be below target abundance level, but it is considered not overfished*

- *3 (Moderate Concern) —Abundance level is unknown and the species has a low or medium inherent vulnerability to fishing.*
- *2 (High Concern)—Population is overfished, depleted, or a species of concern, OR abundance is unknown and the species has a high inherent vulnerability to fishing.*
- *1 (Very High Concern)—Population is listed as threatened or endangered.*

Canada St. Lawrence River, Large mesh bottom gillnet

Very High Concern

Lake sturgeon were evaluated as Threatened by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) in the upper St. Lawrence Designatable Unit 8 (COSEWIC 2006), and is listed as a species of Least Concern by the IUCN (St. Pierre & Runstorm 2004). This stock is not listed under the Species at Risk Act (SARA) in Canada, but it is scheduled for consideration under this Act. There is no evidence to suggest that the stock is either above or below reference points because the stock's abundance is unknown (DFO 2008) (Vélez-Espino & Koops 2009). The stock is thought to be severely depleted from a century of overexploitation and has not demonstrated full recovery (Mailhot et al. 2011). But increased numbers of juveniles have been observed throughout the St. Lawrence River, and catch-per-unit-effort (CPUE) has doubled in one of the fishing sectors (Mailhot et al. 2011).

Stock status scores as "very high" concern because the lake sturgeon populations in the Upper St. Lawrence River are evaluated as Threatened by COSEWIC.

Factor 1.3 - Fishing Mortality

Scoring Guidelines

- *5 (Very Low Concern)—Highly likely that fishing mortality is below a sustainable level (e.g., below fishing mortality at maximum sustainable yield, FMSY), OR fishery does not target species and its contribution to the mortality of species is negligible (≤ 5% of a sustainable level of fishing mortality).*
- *3.67 (Low Concern)—Probable (>50%) chance that fishing mortality is at or below a sustainable level, but some uncertainty exists, OR fishery does not target species and does not adversely affect species, but its contribution to mortality is not negligible, OR fishing mortality is unknown, but the population is healthy and the species has a low susceptibility to the fishery (low chance of being caught).*
- *2.33 (Moderate Concern)—Fishing mortality is fluctuating around sustainable levels, OR fishing mortality is unknown and species has a moderate-high susceptibility to the fishery and, if species is depleted, reasonable management is in place.*

- *1 (High Concern)—Overfishing is occurring, but management is in place to curtail overfishing, OR fishing mortality is unknown, species is depleted, and no management is in place.*
- *0 (Critical)—Overfishing is known to be occurring and no reasonable management is in place to curtail overfishing.*

Canada St. Lawrence River, Large mesh bottom gillnet

High Concern

Current fishing mortality is unknown because the current population size is unknown (DFO 2008). Regulations intensified in 2000, but the stock has not recovered from historical overexploitation (Mailhot et al. 2011). Due to the lack of information about this stock, it is unknown whether the management in place facilitates recovery of this depleted stock, so fishing mortality scores as “high” concern.

Criterion 2: Impacts on other species

All main retained and bycatch species in the fishery are evaluated in the same way as the species under assessment were evaluated in Criterion 1. Seafood Watch® defines bycatch as all fisheries-related mortality or injury to species other than the retained catch. Examples include discards, endangered or threatened species catch, and ghost fishing.

To determine the final Criterion 2 score, the score for the lowest scoring retained/bycatch species is multiplied by the discard rate score (ranges from 0-1), which evaluates the amount of non-retained catch (discards) and bait use relative to the retained catch. The Criterion 2 rating is determined as follows:

- *Score >3.2=Green or Low Concern*
- *Score >2.2 and <=3.2=Yellow or Moderate Concern*
- *Score <=2.2=Red or High Concern*

Rating is Critical if Factor 2.3 (Fishing Mortality) is Critical.

Criterion 2 Summary

Atlantic sturgeon: Canada St. Lawrence River Estuary, Large mesh bottom gillnet

Subscore:: **5.000** **Discard Rate:** **1.00** **C2 Rate:** **5.000**

Species	Inherent Vulnerability	Stock Status	Fishing Mortality	Subscore
ATLANTIC STURGEON	High	1.00: Very High Concern	2.33: Moderate Concern	**1.526**

Lake sturgeon: Canada St. Lawrence River, Large mesh bottom gillnet

Subscore:: **5.000** **Discard Rate:** **1.00** **C2 Rate:** **5.000**

Species	Inherent Vulnerability	Stock Status	Fishing Mortality	Subscore
LAKE STURGEON	High	1.00: Very High Concern	1.00: High Concern	**1.000**

Criterion 2 Assessment

Factor 2.4 - Discard Rate

Canada/St. Lawrence River, Large mesh bottom gillnet

< 20%

The 20.4 cm gillnet mesh size used in this fishery minimizes bycatch of all species, except for non-landed

Atlantic sturgeon. This mesh size reduces landings of large reproductive individuals (Mailhot et al. 2011). Non-selected lake sturgeon individuals are assumed to be released alive. A discard survival rate is not available for this fishery.

Bait is not used in this gillnet fishery.

Canada/St. Lawrence River Estuary, Large mesh bottom gillnet

< 20%

The 20.4 cm gillnet mesh size used in this fishery minimizes bycatch of all species (<1% of the catch) except for non-landed Atlantic sturgeon (Verreault & Trencia 2011). This mesh size reduces landings of large reproductive individuals (Mailhot et al. 2011). Atlantic sturgeon are selected for, at the fisher's discretion, below the maximum size limit (>150 cm (fork length)). Individuals released by fishers are assumed to be released alive and constitute 56.5% of the total catch (Verreault & Trencia 2011). The dead discards + bait/landings score for the St. Lawrence population would be 0% (Verreault & Trencia 2011), assuming 100% post-release survival.

Bait is not used in the Atlantic sturgeon gillnet fishery.

Criterion 3: Management effectiveness

Management is separated into management of retained species (harvest strategy) and management of non-retained species (bycatch strategy).

The final score for this criterion is the geometric mean of the two scores. The Criterion 3 rating is determined as follows:

- *Score >3.2=Green or Low Concern*
- *Score >2.2 and <=3.2=Yellow or Moderate Concern*
- *Score <=2.2 or either the Harvest Strategy (Factor 3.1) or Bycatch Management Strategy (Factor 3.2) is Very High Concern = Red or High Concern*

Rating is Critical if either or both of Harvest Strategy (Factor 3.1) and Bycatch Management Strategy (Factor 3.2) ratings are Critical.

Criterion 3 Summary

Region / Method	Management of Retained Species	Management of Non-Retained Species	Overall Recommendation
Canada St. Lawrence River Large mesh bottom gillnet	1.000	All Species Retained	Red(1.000)
Canada St. Lawrence River Estuary Large mesh bottom gillnet	1.000	All Species Retained	Red(1.000)

Factor 3.1: Harvest Strategy

Scoring Guidelines

Seven subfactors are evaluated: Management Strategy, Recovery of Species of Concern, Scientific Research/Monitoring, Following of Scientific Advice, Enforcement of Regulations, Management Track Record, and Inclusion of Stakeholders. Each is rated as 'ineffective,' 'moderately effective,' or 'highly effective.'

- *5 (Very Low Concern)—Rated as 'highly effective' for all seven subfactors considered.*
- *4 (Low Concern)—Management Strategy and Recovery of Species of Concern rated 'highly effective' and all other subfactors rated at least 'moderately effective.'*
- *3 (Moderate Concern)—All subfactors rated at least 'moderately effective.'*
- *2 (High Concern)—At minimum, meets standards for 'moderately effective' for Management Strategy and Recovery of Species of Concern, but at least one other subfactor rated 'ineffective.'*

- *1 (Very High Concern)—Management exists, but Management Strategy and/or Recovery of Species of Concern rated 'ineffective.'*
- *0 (Critical)—No management exists when there is a clear need for management (i.e., fishery catches threatened, endangered, or high concern species), OR there is a high level of Illegal, unregulated, and unreported fishing occurring.*

Factor 3.1 Summary

Factor 3.1: Management of fishing impacts on retained species							
Region / Method	**Strategy**	**Recovery**	**Research**	**Advice**	**Enforce**	**Track**	**Inclusion**
Canada St. Lawrence River Large mesh bottom gillnet	Moderately Effective	Ineffective	Moderately Effective	Highly Effective	Highly Effective	Moderately Effective	Highly Effective
Canada St. Lawrence River Estuary Large mesh bottom gillnet	Moderately Effective	Ineffective	Moderately Effective	Highly Effective	Highly Effective	Moderately Effective	Highly Effective

Subfactor 3.1.1 – Management Strategy and Implementation

Considerations: What type of management measures are in place? Are there appropriate management goals, and is there evidence that management goals are being met? To achieve a highly effective rating, there must be appropriate management goals, and evidence that the measures in place have been successful at maintaining/rebuilding species.

Canada St. Lawrence River Estuary, Large mesh bottom gillnet

Moderately Effective

The Atlantic sturgeon fishery in the St. Lawrence River is highly regulated with seasonal closures, size limits, fish registration, license reductions, catch monitoring, gear restrictions, and limited market opportunities for processing. There is evidence that the population is stable enough to support the current total allowable catch (TAC) because 34.1% of recruitment cohorts are escaping the fishery (Verreault & Trencia 2011). But due to the lack of stock assessment, it is unknown if the current management strategy is allowing for the recovery of this depleted stock.

Harvest management strategy scores as "moderately effective" because the fishery is highly regulated, the population is stable at the current TAC, and there is evidence that management is sufficiently precautionary. It was not scored as "highly effective" because the long-term recovery is uncertain due to the uncertainties in the stock's abundance.

Rationale:
—Gear restrictions (limited to 20.4 cm mesh size) (DFO 2013b) are chosen to select for small non-reproductive individuals, allowing escapement of large individuals to contribute back to the stock.

—Harvestable quota is set annually at 60 mt (approximately 2,000–4,000 fish (Verreault & Trencia 2011) (pers. comm., Verreault 2014)
—Size limit of <150 cm in legal length is chosen to select for small non-reproductive individuals.
—Seasonal closures: May 1 to September 30 is open, except upstream of Québec City, where it is closed July 1 to August 15 (DFO 2013b) (pers. comm., Verreault 2014) to decrease mortality during summer months when water temperature may be >20°C.
—Tag enforcement: every fish retained is implanted with a non-destructable tag and reported weekly to an independent service along with the fish's length (pers. comm., Verreault 2014).
—Fishers are active stakeholders and two fishers are employed by the Ministère des Forêts, de la Faune e des Parcs as index fishers, catching 44% (by quantity) of annual landings since 2002 (Verreault & Trencia 2011).
—Fishers actively "choose" which fish to retain (Verreault & Trencia 2011), resulting in 56.5% of the Atlantic sturgeon caught in the fishery to be discarded alive.

Canada St. Lawrence River, Large mesh bottom gillnet

Moderately Effective

The lake sturgeon fishery in the St. Lawrence River is highly regulated with seasonal closures, size limits, fish registration, license reductions, catch monitoring, gear restrictions, and limited market opportunities for processing. The stock is highly depleted, but there is some evidence that the stock may be improving; the population has seen increased juvenile abundance, and fishery CPUE has doubled in one fishing sector (Mailhot et al. 2011). But because there is no stock assessment, it is uncertain whether the current management strategy will allow this threatened population to recover from depletion.

Harvest management strategy scores as "moderately effective" because is unknown whether current management is sufficiently precautionary.

Rationale:
Current fishing restrictions (COSEWIC 2006) are:
—Total allowable catch (TAC) quotas set at 80 tonnes (≈12,000 fish).
—Seasonal closures (the fishery is open June 14 to July 31 and September 13 to October 15); the fishery does not encompass the spawning period of May and early June.
—Landed fish are required to be implanted with bar-code plastic tags and declared to wholesalers.
—Gear restriction (20 cm mesh size gillnet) is chosen to actively select for smaller non-reproductive individuals. This allows escapement of large reproductive fish from the fishery to contribute back to the stock (Mailhot et al. 2011).

Subfactor 3.1.2 – Recovery of Species of Concern

Considerations: When needed, are recovery strategies/management measures in place to rebuild overfished/threatened/ endangered species or to limit fishery's impact on these species and what is their likelihood of success? To achieve a rating of Highly Effective, rebuilding strategies that have a high likelihood of success in an appropriate timeframe must be in place when needed, as well as measures to minimize mortality for any overfished/threatened/endangered species.

Canada St. Lawrence River Estuary, Large mesh bottom gillnet

Ineffective

There is some evidence that, after 16 years of active management and population monitoring, the Atlantic sturgeon population in the St. Lawrence River is on a trajectory toward recovery: 34.1% of recruitment cohorts are escaping the fishery (the fishery targets sub-adult fish) (Verreault & Trencia 2011), and annual adult abundances (based on the number of fish reaching age 19) projected 40 years range from 1,597 to 7,723 individuals, which is an increase over the current but highly tenuous estimate of 500–1,000 adults (DFO 2013b). Despite this evidence, it is highly uncertain whether the population will recover and in what time frame; actual abundance is unknown and no stock assessment exists for this population. Due to the lack of accurate abundance information, it is not possible to determine a long-term recovery trajectory necessary to create a formal recovery strategy (DFO 2013b).

The Recovery Potential Assessment (RPA) suggests a Minimum Viable Population (MVP) between 5,000–6,000 Atlantic sturgeon to ensure the survival of this population for 500 years (DFO 2013b). Based on the 40-year projection, it is unclear whether this population will achieve the MVP in this time frame. The RPA suggests a reduction in fishing mortality (via a reduction in TAC) to decrease recovery time, but it is unclear whether managers have implemented this suggested reduction.

A lack of knowledge of precise spawning locations and juvenile feeding locations adds uncertainty to the recovery of the St. Lawrence Atlantic sturgeon population, due to habitat degradation and loss associated with dredging and other human activities that may occur in preferred Atlantic sturgeon habitats (DFO 2013b).

Recovery scores as "ineffective" because the evidence for recovery is tenuous and there is no stock assessment to judge the extent of recovery by.

Canada St. Lawrence River, Large mesh bottom gillnet

Ineffective

Due to the lack of a stock assessment for this threatened population, it is uncertain whether recovery is

occurring in the St. Lawrence River lake sturgeon population. There is evidence that management has reduced the population's decline; effort has stabilized, catch rates have doubled since the mid-2000s for one sector, and fishing regulations have limited the catch to 40% (80 tonnes) of pre-2002 levels (200 tonnes) (Mailhot et al. 2011). A recovery target of 1,188 spawning females per year was set for all 12 lake sturgeon Designatable Units in Canada. In the St. Lawrence River, it is estimated that the population will reach the recovery target within 1–3 generations (Randall 2008) (Vélez-Espino & Koops 2009), but there is no recovery plan in place for this population. These estimates are uncertain due to underlying uncertainty in the fishing mortality rate on this stock.

Recovery of stocks of concern scores as "ineffective" because there is no recovery strategy in place and it is uncertain whether the the current management strategy will result in recovery of this threatened stock.

Subfactor 3.1.3 – Scientific Research and Monitoring

Considerations: How much and what types of data are collected to evaluate the health of the population and the fishery's impact on the species? To achieve a Highly Effective rating, population assessments must be conducted regularly and they must be robust enough to reliably determine the population status.

Canada St. Lawrence River Estuary, Large mesh bottom gillnet

Moderately Effective

A partnership of fishers, goverment agencies, and universities gather data (COSEWIC 2011) (DFO 2013b) on the following:
1) Genetics of all landed fish (Grunwald et al. 2008) (Wirgin et al. 2012)
2) Length, weight, age, and sex of both fishery-dependent and fishery-independent surveys (Caron & Tremblay 1999) (Caron et al. 2002)
3) Mark and recapture (PIT and t-bar tags) of some released fish (Caron et al. 2002)
4) Acoustic tracking of select individuals (Caron et al. 2002)
5) Index fishers are selected to record fishing effort, with CPUE recorded annually (Caron et al. 2002) (Verreault & Trencia 2011) (pers. comm., Verreault 2014)
6) Fate and length of caught fish are recorded by index fishers (Verreault & Trencia 2011)
7) Every landed fish is registered and tagged, recording data of capture, fishing zone, and legal length (Verreault & Trencia 2011) (pers. comm., Verreault 2014)
8) Assessment of dredging activities on distribution and food availability (Hatin et al. 2007) (Hatin et al. 2007b) (McQuinn & Nellis 2007) (Nellis et al. 2007) (Nellis et al. 2007b)

An independent robust stock assessment has not been completed due to the lack of

stock information (DFO 2013b) (pers. comm., Verreault 2014).

Canada St. Lawrence River, Large mesh bottom gillnet

Moderately Effective

A partnership of fishers, goverment agencies, and universities gather data (COSEWIC 2006) (DFO 2008) (Mailhot et al. 2011) on the following:
1) Genetics from some landed fish (Ferguson & Duckworth 1997) (McDermid et al. 2011)
2) Length and weight on captured fish
3) Sonar and trawl surveys of the distribution in relation to dredging spoils (Hatin et al. 2007b) (McQuinn & Nellis 2007) (Nellis et al. 2007)
4) Ages of some landed fish
5) Daily monitoring of fishing effort, and CPUE indices are in development
6) Monitoring of spawning sites and spawning aggregations in select areas (Dumont et al. 2011) (Johnson et al 2006)
7) Recruitment monitoring began in 1991 using experimental multi-mesh nets (LaHaye et al. 1992) (Nilo et al. 1997)
8) Juvenile and subadult monitoring (in numbers and mass) have been conducted since 1995 (Fortin et al. 1993)

An independent robust stock assessment has not been completed due to the lack of abundance information.

Subfactor 3.1.4 – Management Record of Following Scientific Advice

Considerations: How often (always, sometimes, rarely) do managers of the fishery follow scientific recommendations/advice (e.g. do they set catch limits at recommended levels)? A Highly Effective rating is given if managers nearly always follow scientific advice.

Canada St. Lawrence River Estuary, Large mesh bottom gillnet

Highly Effective

Management in the St. Lawrence Atlantic Sturgeon fishery followed a conservative approach starting in 1994 to counterbalance the lack of knowledge of population dynamics. Scientific review of historical records set the TAC to 60 tonnes and divided the harvest quota between the two fishing areas (Trencia et al. 2002). Size limits were set and reduced to 150 cm (fork length) in 1996 to protect the reproductive individuals in the population. A quota was placed on the number of fish to encourage the release of small fish, based on fisher and gear selectivity as well as life-history characteristics (Trencia et al. 2002). This quota is adjusted yearly, based on scientific monitoring of the stock through tagging and

registration of landings, to keep the TAC below 60 tonnes (Verreault & Trencia 2011).

Canada St. Lawrence River, Large mesh bottom gillnet

Highly Effective

Management set ineffective TAC quotas in 1987, with the declared catch increasing to over 250 tonnes. As a result of scientific evidence for stock declines, management instituted a quota reduction starting in 2000 to a TAC of 80 tonnes in 2002, and reduced the fishing season's length by 2 months (Mailhot et al. 2011). Due to evidence of poaching (COSEWIC 2006), fishers were required to tag each sturgeon after landing the fish (Mailhot et al. 2011). In 2001, due to evidence of systematically choosing larger fish, management responded by implementing bar-code plastic tags and bar-coded declaration coupons to declare the weight of each fish landed (Mailhot et al. 2011).

Subfactor 3.1.5 – Enforcement of Management Regulations

Considerations: Do fishermen comply with regulations, and how is this monitored? To achieve a Highly Effective rating, there must be regular enforcement of regulations and verification of compliance.

Canada St. Lawrence River Estuary, Large mesh bottom gillnet

Highly Effective

The Ministère des Forêts, de la Faune e des Parcs strongly enforces regulations in this fishery via heavy monitoring of TAC, gear restrictions, and seasonal closures. The processing market is limited and adds a layer of additional monitoring, reducing illegal take (Verreault & Trencia 2011) (pers. comm., Verreault 2014). TAC is monitored via individual fish registration and the reporting of weights of fish landed (Trencia et al. 2002).

Canada St. Lawrence River, Large mesh bottom gillnet

Highly Effective

The Ministère des Forêts, de la Faune e des Parcs strongly enforces regulations in this fishery via heavy monitoring of TAC, gear restrictions, and seasonal closures (COSEWIC 2006) (DFO 2008). All fish landed are tagged with bar-code plastic tags, effectively tracking the TAC (Mailhot et al. 2011).

Subfactor 3.1.6 – Management Track Record

Considerations: Does management have a history of successfully maintaining populations at sustainable levels or a history of failing to maintain populations at sustainable levels? A Highly Effective rating is given if measures enacted by management have been shown to result in the long-term maintenance of species overtime.

Canada St. Lawrence River Estuary, Large mesh bottom gillnet

Moderately Effective

Prior to 1996, there was a poor track record of responding quickly to stock declines (the fishery was non-regulated), resulting in very low stock sizes. Since 1996, management instituted rigorous restrictions and a conservation strategy. This strategy includes: annual monitoring of the sturgeon population and the fishery, measuring key population dynamics parameters, and regulations to conserve and protect the fishery resource (Verreault & Trencia 2011). These regulations have evolved into seasonal closures, size limits, spatial limits, annual monitoring programs, registration of all landings, and gear restrictions (DFO 2013b) (Verreault & Trencia 2011) (pers. comm., Verreault 2014).

Management track record scores as “moderately effective,” despite improvement in size and age structure, because it is unknown whether the management in place has yet to recover the stock to appropriate levels. (It cannot be said that appropriate levels have been achieved if there is no stock assessment and there is high uncertainty over the abundance of this stock.)

Canada St. Lawrence River, Large mesh bottom gillnet

Moderately Effective

Prior to 2000, management had a poor track record of responding quickly to stock declines, which resulted in very low stock sizes. After 2000, management instituted rigorous catch and effort restrictions to aid in sturgeon recovery. Management’s track record has since been highly responsive, with intensive fishery-independent monitoring of annual recruitment, juvenile and subadult relative abundance, and spawning aggregations. Fishers are required to use bar-code plastic tags, and managers utilize this information to track changes in fishery effort and landings (Mailhot et al. 2011).

Management track record scores as “moderately effective” because measures enacted by management have not been in place long enough to know whether they will result in the recovery of this highly vulnerable stock.

Subfactor 3.1.7 – Stakeholder Inclusion

Considerations: Are stakeholders involved/included in the decision-making process? Stakeholders are individuals/groups/organizations that have an interest in the fishery or that may be affected by the management of the fishery (e.g., fishermen, conservation groups, etc.). A Highly Effective rating is given if the management process is transparent and includes stakeholder input.

Canada St. Lawrence River Estuary, Large mesh bottom gillnet

Highly Effective

DFO and Ministère des Forêts, de la Faune e des Parcs have provisions in their management strategy for consultation (DFO 2004). The process has guidelines for transparency and for stakeholders to actively engage with managers to contribute to the implementation and design of management (DFO 2004) (DFO 2013b) (pers. comm., Verreault 2014). Fishers were involved annually in the decision-making process to find suitable restrictions and compliance in response to management objectives (Verreault & Trencia 2011) (pers. comm., Verreault 2014).

Canada St. Lawrence River, Large mesh bottom gillnet

Highly Effective

DFO and Ministère des Forêts, de la Faune e des Parcs have provisions in their management strategy for consultation during Recovery Potential Assessments (DFO 2004). The process has guidelines for transparency and for stakeholders to actively engage with managers to contribute to the implementation and design of management (DFO 2004) (DFO 2008) (Mailhot et al. 2011).

Bycatch Strategy

Factor 3.2: Management of fishing impacts on bycatch species						
Region / Method	**All Kept**	**Critical**	**Strategy**	**Research**	**Advice**	**Enforce**
Canada St. Lawrence River Large mesh bottom gillnet	Yes	N/A	N/A	N/A	N/A	N/A
Canada St. Lawrence River Estuary Large mesh bottom gillnet	Yes	N/A	N/A	N/A	N/A	N/A

The only recorded bycatch is of the target species that are discarded due to size restrictions or catch limits.

Criterion 4: Impacts on the habitat and ecosystem

This Criterion assesses the impact of the fishery on seafloor habitats, and increases that base score if there are measures in place to mitigate any impacts. The fishery's overall impact on the ecosystem and food web and the use of ecosystem-based fisheries management (EBFM) principles is also evaluated. Ecosystem Based Fisheries Management aims to consider the interconnections among species and all natural and human stressors on the environment.

The final score is the geometric mean of the impact of fishing gear on habitat score (plus the mitigation of gear impacts score) and the Ecosystem Based Fishery Management score. The Criterion 2 rating is determined as follows:

- *Score >3.2=Green or Low Concern*
- *Score >2.2 and <=3.2=Yellow or Moderate Concern*
- *Score <=2.2=Red or High Concern*

Rating cannot be Critical for Criterion 4.

Criterion 4 Summary

Region / Method	Gear Type and Substrate	Mitigation of Gear Impacts	EBFM	Overall Recomm.
Canada St. Lawrence River Large mesh bottom gillnet	3.00:Low Concern	1.00:Strong Mitigation	3.00:Moderate Concern	**Green (3.464)**
Canada St. Lawrence River Estuary Large mesh bottom gillnet	3.00:Low Concern	1.00:Strong Mitigation	3.00:Moderate Concern	**Green (3.464)**

Justification of Ranking

Factor 4.1 – Impact of Fishing Gear on the Habitat/Substrate

Scoring Guidelines

- *5 (None)—Fishing gear does not contact the bottom*
- *4 (Very Low)—Vertical line gear*
- *3 (Low)—Gears that contacts the bottom, but is not dragged along the bottom (e.g. gillnet, bottom longline, trap) and is not fished on sensitive habitats. Bottom seine on resilient mud/sand habitats. Midwater trawl that is known to contact bottom occasionally (*
- *2 (Moderate)—Bottom dragging gears (dredge, trawl) fished on resilient mud/sand habitats. Gillnet, trap, or bottom longline fished on sensitive boulder or coral reef habitat. Bottom seine except on mud/sand*
- *1 (High)—Hydraulic clam dredge. Dredge or trawl gear fished on moderately sensitive habitats (e.g., cobble or boulder)*

- *0 (Very High)—Dredge or trawl fished on biogenic habitat, (e.g., deep-sea corals, eelgrass and maerl)*
  Note: When multiple habitat types are commonly encountered, and/or the habitat classification is uncertain, the score will be based on the most sensitive, plausible habitat type.

Canada St. Lawrence River Estuary, Large mesh bottom gillnet

Low Concern

The large-mesh bottom gillnets used in this fishery have low impacts on benthic substrates; the gillnet is fished over sand, mud, and gravel of mixed sizes (Caron et al. 2002) (Hatin et al. 2007) (Hatin et al. 2007b) (McQuinn & Nellis 2007) (Trencia et al. 2002) (Verreault & Trencia 2011). This warrants a score of “low” concern.

Canada St. Lawrence River, Large mesh bottom gillnet

Low Concern

The large-mesh bottom gillnets used in this fishery have low impacts on benthic substrates; the gillnet is fished over sand, mud, and a mix of gravel (DFO 2008) (Fortin et al. 1993) (Hatin et al. 2007b) (Mailhot et al. 2011). This warrants a score of “low” concern.

Factor 4.2 – Mitigation of Gear Impacts

Scoring Guidelines

- *+1 (Strong Mitigation)—Examples include large proportion of habitat protected from fishing (>50%) with gear, fishing intensity low/limited, gear specifically modified to reduce damage to seafloor and modifications shown to be effective at reducing damage, or an effective combination of ‘moderate’ mitigation measures.*
- *+0.5 (Moderate Mitigation)—20% of habitat protected from fishing with gear or other measures in place to limit fishing effort, fishing intensity, and spatial footprint of damage caused from fishing.*
- *+0.25 (Low Mitigation)—A few measures are in place (e.g., vulnerable habitats protected but other habitats not protected); there are some limits on fishing effort/intensity, but not actively being reduced.*
- *0 (No Mitigation)—No effective measures are in place to limit gear impacts on habitats.*

Canada St. Lawrence River Estuary, Large mesh bottom gillnet

Strong Mitigation

Fishing effort is highly restricted in spatial extent (limited to two key areas), temporal extent, and intensity through TAC quotas and gear restrictions (Caron et al. 2002) (Trencia et al. 2002) (Verreault & Trencia 2011) (pers. comm. Verreault 2014). See Criterion 1 for full description of regulations of fishing mortality. Because it is likely that at least 50% of the representative habitat is protected from the gear used in this fishery, mitigation of gear impacts scores as "strong."

Canada St. Lawrence River, Large mesh bottom gillnet

Strong Mitigation

Fishing effort is highly restricted in spatial footprint, temporal extent, and intensity (COSEWIC 2006) (DFO 2008) (Mailhot et al. 2011) (Randall 2008). See Criterion 1 for all restrictions on fishing mortality. Because it is likely that at least 50% of the representative habitat is protected from the gear used in this fishery, mitigation of gear impacts scores as "strong."

Factor 4.3 – Ecosystem-Based Fisheries Management

Scoring Guidelines

- *5 (Very Low Concern)—Substantial efforts have been made to protect species' ecological roles and ensure fishing practices do not have negative ecological effects (e.g., large proportion of fishery area is protected with marine reserves, and abundance is maintained at sufficient levels to provide food to predators).*
- *4 (Low Concern)—Studies are underway to assess the ecological role of species and measures are in place to protect the ecological role of any species that plays an exceptionally large role in the ecosystem. Measures are in place to minimize potentially negative ecological effect if hatchery supplementation or fish aggregating devices (FADs) are used.*
- *3 (Moderate Concern)—Fishery does not catch species that play an exceptionally large role in the ecosystem, or if it does, studies are underway to determine how to protect the ecological role of these species, OR negative ecological effects from hatchery supplementation or FADs are possible and management is not place to mitigate these impacts.*
- *2 (High Concern)—Fishery catches species that play an exceptionally large role in the ecosystem and no efforts are being made to incorporate their ecological role into management.*

- *1 (Very High Concern)—Use of hatchery supplementation or fish aggregating devices (FADs) in the fishery is having serious negative ecological or genetic consequences, OR fishery has resulted in trophic cascades or other detrimental impacts to the food web.*

Canada St. Lawrence River Estuary, Large mesh bottom gillnet

Moderate Concern

Atlantic sturgeon is not considered to be an "exceptional species." This species occupies a low trophic position within the food web (3.4 score, consumers of benthic invertebrates (Froese & Pauly 2014)) and does not represent a substantial link to upper trophic levels (low levels of natural mortality). This factor scores as "moderate" concern because the fishery does not catch "exceptional species" and scientific assessment and management of ecosystem impacts are not yet underway.

Canada St. Lawrence River, Large mesh bottom gillnet

Moderate Concern

Lake sturgeon is not considered to be an "exceptional species." This species occupies a low trophic position within the food web (3.3 score, consumers of benthic invertebrates (Froese & Pauly 2014)) and does not represent a substantial link to upper trophic levels (low levels of natural mortality). This factor scores as "moderate" concern because the fishery does not catch "exceptional species" and scientific assessment and management of ecosystem impacts are not yet underway.

Acknowledgements

Scientific review does not constitute an endorsement of the Seafood Watch® program, or its seafood recommendations, on the part of the reviewing scientists. Seafood Watch® is solely responsible for the conclusions reached in this report.

Seafood Watch® would like to thank Cornel Ceapa, PhD (Acadian Sturgeon and Caviar Inc.), Dr. Mike Dadswell (Acadia University), Guy Verreault (Ministère du Développement durable, de l'Environnement, de la Faune et des Parcs) and two anonymous reviewers for graciously reviewing this report for scientific accuracy.

References

Caron F., Tremblay S. 1999. Structure and management of an exploited population of Atlantic sturgeon (Acipenser oxyrinchus) in the St. Lawrence Estuary, Québec, Canada. Journal of Applied Ichthyology, 15: 153-156.

Caron F., Hatin D., Fortin R. 2002. Biological characteristics of adult Atlantic sturgeon (Acipenser oxyrinchus) in the St. Lawrence River estuary and the effectiveness of management rules. Journal of Applied Ichthyology, 18: 580-585.

Ceapa C. personal communication with reviewer. April 2014.

COSEWIC. 2011. COSEWIC assessment and status report on the Atlantic Sturgeon Acipenser oxyrinchus in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. xiii + 50 pp. (www.sararegistry.gc.ca/status/status_e.cfm).

COSEWIC. 2011a. Response Statement - Atlantic Sturgeon, Maritimes populations (http://www.sararegistry.gc.ca/virtual_sara/files/statements/rs_1155_425_2011-9_e.pdf).

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).

Dadswell M.J. 2006. A Review of the Status of Atlantic Sturgeon in Canada, with Comparisons to Populations in the United States and Europe. Fisheries, 31 (5): 218-229.

Dadswell, M.J. and R.A. Rulifson. 1994. Macrotidal estuaries: a region of collision between migratory marine mammals and tidal power development. Biol. J. Linn. Soc. 51: 93-113.

Dadswell D. personal communication with SFW. December 2014-February 2015.

DFO. 2013. Evaluation of Atlantic Sturgeon (Acipenser oxyrinchus) from the Bay of Fundy Population to Inform a CITES Non-Detriment Finding. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2013/047.

DFO. 2013. Recovery Potential Assessment for Atlantic Sturgeon (Maritimes Designatable Unit). DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2013/022.

DFO. 2013. Recovery Potential Assessment for the Atlantic Sturgeon, St. Lawrence population. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2013/040.

DFO. 2008. Recovery Potential Assessment of Great Lakes and St. Lawrence River watersheds (Designatable Unit 8) Lake Sturgeon (Acipenser fulvescens) population. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2008/042.

DFO, 2004. Consultation Framework. Fisheries and Oceans Canada. DFO/2004-066

Dumont P., D'Amours J., Thibodeau S., Dubuc N., Verdon R., Garceau S., Bilodeau P., Mailhot Y., Fortin R. 2011. Effects of development of a newly created spawning ground in the Des Prairies River (Québec, Canada) on the reproductive success of lake sturgeon (Acipenser fulvescens). Journal of Applied Ichthyology, 27: 394-404.

Ferguson M.M. Duckworth G.A. 1997. The status and distribution of lake sturgeon, Acipenser fulvescens, in the Canadian provinces of Manitoba, Ontario and Quebec: a genetic perspective. Environmental Biology of Fishes, 48: 299-309.

Fortin R, Mongeau J., Desjardins G., Dumont P. 1993. Movements and biological statistics of lake sturgeon (Acipenser fulvescens) populations from the St. Lawrence and Ottawa River system, Quebec. Canadian Journal of Zoology, 71: 638-650.

Froese R. Pauly D. 2014. FishBase. World Wide Web electronic publication. www.fishbase.org. version (01/2014).

Grunwald C., Maceda L., Waldman J., Stabile J., Wirgin I. 2008. Conservation of Atlantic sturgeon Acipenser oxyrinchus oxyrinchus:delineation of stock structure and distinct population segments. Conservation Genetics, 9: 1111-1124.

Hatin D., Lachance S., Fournier D. 2007b. Effect of Dredged Sediment Deposition on Use by Atlantic Sturgeon and Lake Sturgeon at an Open-Water Disposal Site in the St. Lawrence Estuarine Transition Zone. American Fisheries Society Symposium, 56: 235-255.

Hatin D., Munro J., Caron F., Simons R.D. 2007. Movements, Home Range Size, and Habitat Use and Selection of Early Juvenile Atlantic Sturgeon in the St. Lawrence Estuarine Transition Zone. American Fisheries Society Symposium, 56: 129-155.

Johson J.H., LaPan S.R., Klindt R.M., Schiavone A. 2006. Lake Sturgeon spawning on artificial habitat in the St. Lawrence River. Journal of Applied Ichthyology, 22: 465-470.

LaHaye M., Branchaud A., Gendron M., Verdon R., Fortin R. 1992. Reproduction, early life history, and characteristics of the spawning grounds of the lake sturgeon (Acipenser fulvescens) in Des Prairies and L'Assomption rivers, near Montréal, Quebec. Canadian Journal of Zoology, 70: 1681-1689.

Limburg K.E. Waldman J.R. 2009. Dramatic Declines in North Atlantic Diadromous Fishes. BioScience, 59 (11): 955-965.

Mailhot Y., Dumont P., Vachon N. 2011. Management of Lake Sturgeon Acipenser fulvescens population in the lower St. Lawrence River (Québec, Canada) from 1910s to the present. Journal of Applied Ichthyology, 27: 405-410.

McDermid J.L., Wozney K.M., Kjartanson S.L., Wilson C.C. 2011. Quantifying historical, contemporary, and anthropogenic influences on the genetic structure and diversity of lake sturgeon (Acipenser fulvescens) populations in northern Ontario. Journal of Applied Ichthyology, 27 (Suppl. 2): 12-23.

McQuinn I.H. Nellis P. 2007. An Acoustic-Trawl Survey of Middle St. Lawrence Estuary Demersal Fishes to Investigate the Effects of Dredged Sediment Disposal on Atlantic Sturgeon and Lake Sturgeon Distribution. American Fisheries Society Symposium, 56:257-271.

Nellis P., Munro J., Hatin D., Desrosiers G., Simons R.D., Guilbard F. 2007. Macrobenthos Assemblages in the St. Lawrence Estuarine Transition Zone and Their Potential as Food for Atlantic Sturgeon and Lake Sturgeon. American Fisheries Society Symposium, 56: 1-24.

Nellis P., Senneville S., Munro J., Drapeau D., Desrosiers G., Saucier F.J. 2007. Tracking the Dumping and Bed Load tRansport of Dredged Sediment in the St. Lawrence Estuarine Transition Zone and Assessing Their Impacts on Macrobenthos in Atlantic Sturgeon Habitat. American Fisheries Society Symposium, 56: 215-234.

Nilo P., Dumont P., Fortin R. 1997. Climatic and hydrological determinants of year-class strength of St. Lawrence River lake sturgeon (Acipenser fulvescens). Canadian Journal of Fisheries and Aquatic Sciences, 54: 774-780.

NOAA NMFS FSED. 2014. National Oceanographic and Atmospheric Administration: National Marine Fisheries Service: Fisheries Statistics and Economics Division, 2014. "Foreign Trade by Country". http://www.st.nmfs.noaa.gov/commercial-fisheries/foreign-trade/index

Percy, J. 2007. Field Notes: The Quarterly Newsletter of the Annapolis Field Naturalists' Society. December 2007.

Randall R.G. 2008. Narrative description and quantification of the habitat requirements of Lake Sturgeon Acipenser fulvescens in the Great Lakes and upper St. Lawrence River. Canadian Science Advisory Secretariat, Research Document 2008/015.

Smith T.I.J. 1985. The fishery, biology, and management of Atlantic sturgeon, Acipenser oxyrhynchus, in North America. Environmental Biology of Fishes, 14 (1): 61-72.

St. Pierre R (U.S. Fish Wildlife Service), 2006. Acipenser oxyrinchus ssp. oxyrinchus. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.2. .

St. Pierre, R. Runstrom, A. (U.S. Fish Wildlife Service) 2004. Acipenser fulvescens. The IUCN Red List of Threatened Species. Version 2014.2.

Stevenson J.T. Secor D.H. 1999. Age determination and growth of Hudson River Atlantic sturgeon, Acipenser oxyrinchus. Fisheries Bulletin, 97: 153-166.

Stewart ND, Dadswell, MJ, Leblanc, P, Bradford RG, Ceapa C Stokesbury MJW. 2015 in press. Age and growth of Atlantic Sturgeon from the Saint John River, New Brunswick, Canada. Transactions of the American Fisheries Society.

Stokesbury KDE, Stokesbury MJW, Balazik MT Dadswell MJ. 2014. Use of the SAFE Index to Evaluate the Status of a Summer Aggregation of Atlantic Sturgeon in Minas Basin, Canada, and the Implication of the

Index for the USA Endangered Species Designation of Atlantic and Shortnose Sturgeons. Reviews in Fisheries Aquaculture 22:193-206.

Trencia G., Verreault G., Georges S., Pettigrew P. Atlantic sturgeon (Acipenser oxyrinchus oxyrinchus) fishery management in Québec, Canada, between 1994 and 2000. Journal of Applied Ichthyology, 18: 455-462.

Vélez-Espino L.A. Koops M.A. 2009. Recovery Potential Assessment for Lake Sturgeon in Canadian Designatable Units. North American Journal of Fisheries Management, 29 (4): 1065-1090.

Verreault G., Trencia G. 2011. Atlantic Sturgeon (Acipenser oxyrinchus oxyrinchus) Fishery Management in the St. Lawrence Estuary, Québec, Canada. Biology and Conservation of the European Sturgeon Acipenser studio L. 1758. Springer-Verlag, Berlin, Germany. Chapter 40: 527-538.

Verreault G. personal communication with reviewer. March 2014.

Wehrell, SA. 2014. Atlantic Sturgeon in the inner Bay of Fundy during summer: Population characteristics and local transboundary movements. Thesis submitted in partial fulfillment of the requirements for the Degree of Master of Sciences (Biology), Acadia University, Canada

Wirgin I., Breece M, Fox D, Maceda L. Wark W King T. 2012. Origin of Atlantic Sturgeon Collected off the Delaware Coast during Spring Months. North American Journal of Fisheries Management 35: 20-30

Wirgin I., Maceda L., Waldman J.R., Wehrell S., Dadswell M., King T. 2012. Stock Origin of Migratory Atlantic Sturgeon in Minas Basin, Inner Bay of Fundy, Canada, Determined by Microsatellite and Mitochondrial DNA Analyses. Transactions of the American Fisheries Society, 141 (5): 1389-1398.