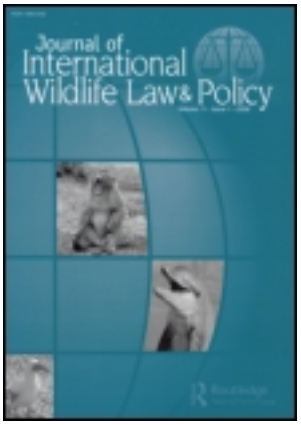

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Sustaining Atlantic Sturgeon: Stitching a Stronger Scientific and Governance Net

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1. INTRODUCTION

Predating the era of dinosaurs, the ancient family of sturgeon fishes, Acipenseridae, dates back perhaps 250 million years and has survived two ice ages and numerous asteroid blasts. The "dinosaurs of the rivers" have a wide distribution in the Northern Hemisphere, with more than 20 sturgeon species found in Europe, Asia, and North America. Eight species occur in North

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American rivers,[1] five in Canadian waters.[2] Of the five in Canada, two species occur along the Pacific coast (white and green sturgeon), two along the Atlantic coast (Atlantic sturgeon and shortnose sturgeon), while the fifth occurs in the Great Lakes and Hudson-James Bay drainage areas (lake sturgeon).[3]

The Atlantic sturgeon (*Acipenser oxyrinchus* Mitchill, 1815), also known as black sturgeon, common sturgeon, or sea sturgeon,[4] is a large, long-lived, late maturing, estuarine-dependent, anadromous species.[5] It can live up to 60 years and grow as large as four meters in length and 350 kilograms in weight. With a wide distribution in the Atlantic Ocean and bays and rivers along the Atlantic coast, the Atlantic sturgeon is supported by two major river systems in Canada: the St. Lawrence and Saint John rivers.[6]

Various reasons explain the formidable challenges for Atlantic sturgeon conservation and sustainable management. As in the case of most diadromous species, humans have put considerable pressure on the Atlantic sturgeon both through direct exploitation to obtain the most distinctive luxury food—caviar—and, more recently, through freshwater and estuarine habitat degradation and fragmentation. Further governance challenges include the complex federal-state/provincial regulatory regime for freshwater and diadromous fish which results in responsibility for sturgeon management and conservation residing in different jurisdictions. Furthermore, with one of the Canadian populations being a substantially shared stock with the United States, regional coordination and cooperation is required for sound management across its range of distribution. Finally, significant gaps in data and scientific knowledge on the life cycle of the sturgeon persist, with the most significant being the lack of information required to accurately assess their status.

This article addresses each of those challenges, with an overall focus on the shared Saint John River population. Section 2 describes the current economic and social significance of Atlantic sturgeon in eastern Canada. Section 3 reviews the current knowledge on sturgeon and the ongoing research under the Ocean Tracking Network (OTN). Section 4 discusses

[1] DOUGLAS F. WILLIAMSON, CAVIAR AND CONSERVATION: STATUS, MANAGEMENT, AND TRADE OF NORTH AMERICAN STURGEON AND PADDLEFISH 1 (2003). The North American sturgeon (Family Acipenseridae) species include the Atlantic sturgeon (Acipenser oxyrinchus oxyrinchus) and its subspecies the Gulf sturgeon (Acipenser oxyrinchus desotoi); the shortnose sturgeon (Acipenser brevirostrum); the lake sturgeon (Acipenser fulvescens); the pallid sturgeon (Scaphirhynchus albus); the shovelnose sturgeon (Scaphirhynchus platorhynchus); the Alabama sturgeon (Scaphirhynchus suttkusi); the white sturgeon (Acipenser transmontanus), and the green sturgeon (Acipenser medirostris). There is also a recognized subpopulation of the white sturgeon in the Kootenai/Kootenay River.

[2] *Id*.

[3] *Id*. at 22, 90.

[4] *Id*.

[5] W. B. Scott & M.G. Scott, *Atlantic Fishes of Canada*, CAN. BULL. FISH. AQUAT. SCI. 219 (1988).

[6] COMMITTEE ON THE STATUS OF ENDANGERED WILDLIFE IN CANADA (COSEWIC), COSEWIC ASSESSMENT AND STATUS REPORT ON THE ATLANTIC STURGEON *ACIPENSER OXYRINCHUS* IN CANADA 12 (2011).

global, transboundary, and domestic management meshes for the protection of the species. Section 5 outlines some suggestions on ways to stitch a stronger scientific and governance net with the main threads needed being the development of a Canada-United States Atlantic sturgeon strategy and action plan and the need to enhance scientific information on the status and movement of sturgeon populations and their critical habitat.

2. THE ATLANTIC STURGEON: UNDERSTANDING ECONOMIC AND SOCIAL INTERESTS

Atlantic sturgeons are an economically important commercial fish and have been sought by North American natives since they first occupied North America[7] and by European settlers since the 1600s.[8] While the species can be harvested for food, as it is typically very large, and generates twice as much edible material per pound as most fish, the main western use of the species is based on lightly salted sturgeon eggs as an expensive delicacy, caviar.[9]

The main location for the pursuit of egg-bearing sturgeon has been the Caspian and Black seas, along with their major tributaries. These bodies of water have been the principal areas for fishing beluga, Russian sturgeon, and stellate, the three species associated with the most valuable varieties of caviar (beluga, osetra, and sevruga, respectively).[10] However, depletion of the European varieties led to the exploitation of other less valuable species in the late 19th century, including North American varieties of sturgeon. The North American sturgeon species that comes closest to the Caspian varieties in the quality of eggs is the Pacific white sturgeon, a species which also happens to be North America's largest. Other varieties exploited in North America included the lake sturgeon, green sturgeon, and shortnose sturgeon. On the east coast, the most important species of sturgeon exploited is the Atlantic sturgeon.

The Atlantic sturgeon fishery for caviar was centred mainly in the Delaware River and Chesapeake Bay in the United States, and the St. Lawrence

[7] Inga Saffron, *The Decline of the North American Species*, *in* STURGEONS AND PADDLEFISHES OF NORTH AMERICA 1 (G.T.O. LeBreton, F.W.H. Beamish, & R.S. McKinley, eds., 2004). Tough demonstrates that (Manitoba) lake sturgeon (*Acipenser fulvescens*) were an important, multi-purpose resource for the Cree and Ojibwa (Frank Tough, *Depletion by the Market: Commercialization and Resource Management of Manitoba's Lake Sturgeon (Acipenser fulvescens), 1885–1935*, in FISHING PLACES, FISHING PEOPLE: TRADITIONS AND ISSUES IN CANADIAN SMALL-SCALE FISHERIES 97 (Dianne Newell & Rosemary Ommer, eds., 1999).

[8] Scott & Scott, *supra* note 5.

[9] INGA SAFFRON, CAVIAR: THE STRANGE HISTORY AND UNCERTAIN FUTURE OF THE WORLD'S MOST COVETED DELICACY (2002).

[10] The actual production of caviar from sturgeon eggs is an artisanal activity, and requires substantial skill to remove the sturgeon eggs and create the lightly salted (approximately four per cent by weight) product favoured in the marketplace (*Id*., at 43).

River and Saint John River in Canada. An intensive fishery was short-lived: it peaked in the 1890s and was depleted by 1900.[11] By 1956, catch rates had dropped to only 177.8 metric tonnes in Canada and 326.1 metric tonnes in the United States.[12]

In the United States, records suggest that the species was very abundant in the mid-1800s, and that it supported an important fishery as early as the 1600s.[13] A major commercial fishery developed after a caviar market was established in 1870, with record landings of 3,350 metric tonnes reported in 1890.[14] The fishery soon collapsed, with landings in 1901 at just a fraction of the record landings reported just ten years before.[15] Landings have remained at low levels of 1–5 per cent of the 1890 record during the 20th and 21st centuries.[16] In the 1950s, the remaining fishery started targeting Atlantic sturgeon for its flesh rather than caviar.[17]

Past abundance in eastern Canada allowed a sizeable fishery that reached 2,268 metric tonnes in the late 19th century. The fishery in the St. Lawrence River and estuary traditionally targets juveniles and sub-adult fish for its meat, not caviar.[18] Catches were large in the 1880s, but declined to an annual average of between 20 and 40 metric tonnes from 1940 to 1966.[19] The fishery disappeared between 1967 and 1975, perhaps from a DDT pollution event in 1966–1967,[20] but then recovered significantly reaching over 100 metric tonnes and peaking at 142 metric tonnes in 1990.[21] Since the 1990s, progressive fishery restrictions have limited the fishery at current levels of around 50 metric tonnes.[22]

[11] COSEWIC, *supra note* 6, at 31; M.J. Dadswell, *A Review of the Status of Atlantic Sturgeon in Canada, with Comparisons to Populations in the United States and Europe,* 31 FISHERIES 218, 220 (2006).

[12] J.G. HOFF, REVIEW OF THE PRESENT STATUS OF THE STOCKS OF THE ATLANTIC STURGEON *ACIPENSER OXYRHYNCHUS* (MITCHILL) (1980).

[13] *Id*.

[14] *Id*.; Waldman notes that shortnose sturgeon, *Acipenser brevirostrum*, was not distinguished in these landings but they probably represented a minor component (John Waldman, *Conservation and Restoration of Acipenser oxyrinchus in the USA*, *in* BIOLOGY AND CONSERVATION OF THE EUROPEAN STURGEON ACIPENSER STURIO L. 1758, 517, 519 (Patrick Williot et al., eds., 2011)).

[15] *Id*.

[16] *Id*.

[17] *Id*.

[18] Guy Verreault & Guy Trencia, *Atlantic Sturgeon (Acipenser oxyrinchus oxyrinchus) Fishery Management in the St. Lawrence Estuary, Québec, Canada in* BIOLOGY AND CONSERVATION OF THE EUROPEAN STURGEON ACIPENSER STURIO L. 1758, 527, 528 (Patrick Williot et al., eds., 2011).

[19] Catch records for the St. Lawrence River exist only from 1939.

[20] COSEWIC, *supra* note 6, at 34; Dadswell, *supra* note 11, at 224.

[21] Verreault & Trencia, *supra* note 18, at 529.

[22] *Id*.

In the Saint John River, New Brunswick, the fishery has occurred since 1878.[23] During the period 1878–1885 the adult population was fished out with annual catches as high as 212 metric tonnes per year. The fishery collapse caused a closure for seven years.[24] After reopening, the fishery has continued almost uninterrupted,[25] but has gone through several oscillating cycles of relatively high catches followed by steep declines.[26] Annual catches ranged from 10 to 15 metric tonnes between 1900 and 1970, and increased to 20–80 metric tonnes in the 1980s and 1990s.[27] The last peak catch reached 80 tonnes in 1994.[28] Since then, catches have remained at modest levels. Average landings in recent years have been around 12 metric tonnes (200–400 adults/year).[29] The fluctuations in catch reflect fishing effort, location, and market demand rather than population abundance.[30]

The difficulties in regulating sturgeon catches, and particularly illegal catches,[31] have put a considerable premium on attempts to expand sturgeon aquaculture. To date, there are two aquaculture operations in New Brunswick, both of which are located near Saint John.[32] One exclusively raises shortnose sturgeon in Pennfield, New Brunswick. The other, at Carter's Point, raises both. Shortnose may be better suited for aquaculture due to the relatively much shorter time to maturity (four to seven years, versus eight to ten), although Atlantic sturgeon eggs more closely resemble classic beluga caviar in being smaller, blacker, and closer in taste. At the same time, it must be acknowledged that caviar from shortnose sturgeon have established an upper-end market for its size (perhaps 70th percentile), broad colour array,[33] and earthy taste.

The Pennfield operation, which started in 1998, has around 50,000 sturgeon in ten large holding tanks that utilize groundwater in the tanks. The facility does separate smaller from larger fish, to overcome the modest amount of dominance among the fish when being fed. The sturgeons are maintained

[23] H.M. Rogers, The Estuary of the Saint John River: Its Physiography, Ecology, and Fisheries (1936) (unpublished Master of Arts Thesis, University of Toronto).

[24] COSEWIC, *supra* note 6, at 24.

[25] There was another one-year closure in 1900 (*id*.).

[26] *Id*.

[27] Dadswell, *supra* note 11, at 220.

[28] *Id*.

[29] DFO, *Evaluation of Atlantic Sturgeon (Acipenser oxyrinchus) in the Maritimes Region with Respect to Making a CITES Non-detriment Finding*, DFO CAN. SCI. ADVIS. SEC. SCI. ADVIS. REP. 2009/029 (2009) [DFO, Atlantic Sturgeon Non-Detriment Finding]; COSEWIC, *supra* note 6, at 24.

[30] DFO, Atlantic Sturgeon Non-Detriment Finding, *supra* note 29.

[31] For the difficulties faced by international regulatory bodies in addressing illegal trade in caviar products, *see* Saffron, *supra* note 9, at 187.

[32] The information on Atlantic sturgeon aquaculture operations in this section was obtained by Richard Apostle through interviews with industry representatives in March 2012.

[33] The firm has a number of albino shortnose and others that are decidedly lighter in colour.

at relatively low temperatures (3–4°C) through the winter, temperatures at which the fish are lethargic, just "maintaining themselves." The temperature rises gradually through the spring, and the sturgeon can reach spawning capacity at 12°C. There are a further three smaller "finishing" tanks at the front end of the facility.[34] The firm markets its product both nationally and internationally. In Canada, there has been considerable demand from Montreal and Toronto, as well as some from western Canada. The second sturgeon aquaculture facility (Carter's Point, New Brunswick) is owned and managed by Acadian Sturgeon and Caviar. The company began in 2005 as an offshoot from a salmon aquaculture facility that had considered entering sturgeon aquaculture.[35] The owner, based on his experience with sturgeon extinction on the Danube River, decided that sturgeon aquaculture could only succeed in a context where wild stocks survive, and where aquaculture can "co-exist with the river." Aquaculture can serve as "insurance" for the Saint John River wild stock.

Although the Carter's Point facility keeps some shortnose sturgeon as brood stock in tanks 40 feet in diameter, it is focused on the long-term development of Atlantic sturgeon aquaculture with the goal to develop a strong Canadian market for both caviar and meat.[36] Atlantic sturgeons are kept in various flow-through tanks, but the operator intends to develop a recirculation system in the near future. The organization has a separate processing building, with ovens for smoking meat, an area for extracting roe, and a cold storage facility.

Aquaculture operations for a long-lived species like sturgeon face several challenges that these pioneering companies have strived to overcome in their relatively short lives. Some of the most important challenges are securing a flow of funding,[37] dealing with extensive land use requirements,[38] and marketing of the product.[39]

[34] The temperature in the area was a very unseasonable 25°C when the interview was done in early March. Interestingly, the owner was not much concerned by potential climate change: for him, given their very long history, sturgeon are "survivor fish." The original stock came from the Saint John River, and was returned there.

[35] Acadia Sturgeon and Caviar, *at* http://www.acadian-sturgeon.com (visited 22 April 2013).

[36] At this point, Russia provides the only reliable market for sturgeon meat, but the owner of Carter's Point aquaculture facility believes the taste and quality of the meat will create new markets.

[37] The two sturgeon aquaculture firms have considered innovative ways to secure funding, including federal grants, and to sell sturgeon for restocking activities (e.g., to Germany and Poland), for aquaculture, or for research purposes.

[38] Sturgeon require very large tanks to avoid injury, which in turn demands more extensive land use than other aquaculture activities.

[39] The challenge is to create a brand for Atlantic sturgeon caviar that allows consolidating and opening markets for caviar.

3. SCIENTIFIC KNOWLEDGE: STATUS, ADVANCES AND CHALLENGES

3.1. Life History of the Atlantic Sturgeon

The Atlantic sturgeon is an anadromous, highly migratory fish occurring in rivers, estuaries, and in the sea along the eastern coast of North America from Labrador to Florida.[40] Atlantic sturgeon are widely distributed over the continental shelf from Georgia to Labrador during the entire year.[41] Individuals have been captured offshore as far as Sable Island.[42] Spawning stocks of Atlantic sturgeon are known from the Satilla River, Georgia, to the St. Lawrence River, Quebec. There are approximately 33 spawning populations in the United States, including the coast of the Gulf of Mexico, and five known historical spawning populations in Canada.[43]

Latitude has a great effect on both the timing and periodicity of spawning by Atlantic sturgeon. In Canada, spawning is in June and July, however, more southern populations spawn from February to June[44] and/or in the fall.[45] Adult Atlantic sturgeon migrate into fresh water in advance of the spawning season with males arriving prior to females, and return to the sea after spawning.[46] Non-annual spawning appears to be normal for Atlantic sturgeon. Most male Atlantic sturgeon spawn every 1–2 years,[47] but one study recognized a maximum of 4.5 years between spawning events for males.[48] Females appear to have longer spawning intervals with estimates ranging from 2–3 years[49] to 5+ years.[50]

Atlantic sturgeon spawn in fresh water, or as far inland as the first upstream obstacle to migration.[51] Group spawning of males and females occurs

[40] Dadswell, *supra* note 11.

[41] V.D. VLADYKOV & J.R. GREELEY, ORDER ACIPENSEROIDEI (1963); A.B. Stein, K.D. Friedland, & M.S. Sutherland, *Atlantic Sturgeon Marine Distribution and Habitat Use along the Northeastern Coast of the United States*, 133 TRANS. AMER. FISH SOC. 527 (2004).

[42] Scott & Scott, *supra* note 5.

[43] I. Wirgin et al., *Genetic Structure of Atlantic Sturgeon Populations Based on Mitochondrial DNA Control Region Sequences*, 129 TRANS. AM. FISH. SOC. 476 (2000); Dadswell, *supra* note 11; C. Grunwald et al., *Conservation of Atlantic Sturgeon Acipenser oxyrinchus oxyrinchus: Delineation of Stock Structure and Distinct Population Segments*, 9 CONSERV. GENET. 1111 (2008).

[44] Vladykov & Greeley, *supra* note 41; J.P. Van Eenennaam et al., *Reproductive Conditions of the Atlantic Sturgeon (Acipenser oxyrinchus) in the Hudson River*, 19 ESTUARIES 769 (1996).

[45] M.R. Collins et al., *Habitat Utilization and Biological Characteristics of Adult Atlantic Sturgeon in Two South Carolina Rivers*, 129 TRANS. AM. FISH. SOC. 982 (2000).

[46] T.I.J. Smith, *The Fishery, Biology, and Management of Atlantic Sturgeon, Acipenser oxyrhynchus, in North America*, 14 ENVIRON. BIOL. FISH. 61 (1985); Dadswell, *supra* note 11.

[47] Van Eenennaam et al., *supra* note 44; Collins et al., *supra* note 45; Dadswell, *supra* note 11.

[48] T.I.J. SMITH, D.E. MARCHETTE, & R.A. SMILEY, LIFE HISTORY, ECOLOGY, CULTURE AND MANAGEMENT OF ATLANTIC STURGEON, *ACIPENSER OXYRHYNCHUS OXYRHYNCHUS*, MITCHILL (1982).

[49] Vladykov & Greeley, *supra* note 41.

[50] Smith et al., *supra* note 48; Dadswell, *supra* note 11.

[51] Smith, *supra* note 46; Dadswell, *supra* note 11.

over coarse sediment or rock.[52] Eggs released by the female become adhesive after fertilization and attach to the substrate.[53] Fertilized eggs hatch within three to seven days depending on temperature.[54] On hatching, yolk sac juveniles are cryptic and remain in interstitial spaces until the yolk sac is absorbed.[55] At this stage the larvae have teeth and also feed on organisms attached to rocks. Teeth are lost at about 16 mm in length at which point the larvae swim-up and drift downstream to freshwater or estuarine habitats with soft sediments.[56] They then spend 1 to 12 years in the freshwater or mesohaline portion of estuaries before migration to sea.[57] Seaward migration occurs at 50–100 cm in length. While in the marine environment, and depending on the north-south origin of the population, they spend 5 to 15 years growing and maturing before they migrate back to spawning grounds.[58]

Maturation age and size are dependent on sex as well as latitudinal location of the natal stream.[59] On average, southern populations mature more quickly. In Georgia and South Carolina, females will spawn at 7–10 years of age and males at 5–9 years.[60] Further north, in the Hudson River, New York, females do not reach maturity until 12–20 years and males at 11–13 years.[61] These maturation ages are younger than individuals found in the St. Lawrence River, Canada, where females mature between 27–34 years and males between 22–27 years.[62]

While at sea, Atlantic sturgeon aggregations form on foraging grounds such as in the Minas Basin, Bay of Fundy, Nova Scotia, and Long Island Sound, New York, in summer and off Virginia in winter.[63] Because of the species

[52] Vladykov & Greeley, *supra* note 41.

[53] Dadswell, *supra* note 11.

[54] Smith, *supra* note 46.

[55] B. Kynard & M. Horgan, *Ontogenetic Behavior and Migration of Atlantic Sturgeon, Acipenser oxyrinchus oxyrinchus, and Shortnose Sturgeon, A. brevirostrum, with Notes on Social Behavior*, 63 ENV. BIOL. FISH. 137 (2002).

[56] *Id*.

[57] Dadswell, *supra* note 11.

[58] *Id*.

[59] Vladykov & Greeley, *supra* note 41; Dadswell, *supra* note 11.

[60] Smith, *supra* note 46; D.L. Peterson et al., *Annual Run Size and Genetic Characteristics of Atlantic Sturgeon in the Altamaha River, Georgia*, 137 TRANS. AM. FISH. SOC. 393 (2008).

[61] A.W. Kahnle, K.A. Hattala, & K.A. McKown, *Status of Atlantic Sturgeon of the Hudson River Estuary, New York, USA*, *in* ANADROMOUS STURGEONS: HABITATS, THREATS, AND MANAGEMENT 347 (J. Munro et al. eds., 2007).

[62] Scott & Scott, *supra* note 5; F. Caron, D. Hatin & R. Fortin, *Biological Characteristics of Adult Atlantic Sturgeon (Acipenser oxyrinchus) in the St. Lawrence River Estuary and the Effectiveness of Management Rules*, 18 J. APPL. ICHTHYOL. 580 (2002).

[63] R.W. Laney et al., *Distribution, Habitat Use, and Size of Atlantic Sturgeon Captured during Cooperative Winter Tagging Cruises, 1988–2006*, 56 AM. FISH. SOC. SYMP. 167 (2007); M.F. McLean et al., *Quantifying Movement Patterns of Atlantic Sturgeon (Acipenser oxyrinchus) in the Minas Basin, Bay of Fundy, Canada*, MAR. ECOL. PROG. SER. (submitted February 28, 2013).

highly migratory nature, significant stock mixing occurs at aggregation sites.[64] DNA analysis of the Minas Basin summer aggregation of Atlantic sturgeon determined that it is >60 per cent comprised of individuals natal to the Saint John River, with a 34–36 per cent contribution from the Kennebec River, Maine, about a 1–2 per cent contribution from the Hudson River, New York, and less than 1 per cent from the James River, Virginia.[65] The aggregation off Virginia in winter consists of sturgeon stocks from the St. Lawrence (2.3%), Saint John (2.3%), Hudson (41.9%), Delaware (23.2%), and the Altamaha (16.3%) rivers, and Albemarle Sound (14.0%).[66] The summer aggregation in the Minas Basin consists predominantly of individuals from 10–25 years old (60–180 cm total length) and acoustic detections indicate sturgeon occur in the Minas Basin from April to November.[67] The Virginia winter aggregation is made up predominately of juveniles from 60–151 cm total length.[68] The Virginia aggregation has only been sampled during January–February and may occur in that region for a longer duration.

Atlantic sturgeon tend to aggregate at shallow depths at sea, but also are known to occupy depths up to approximately 150 meters. The summer aggregation in Minas Basin occurs at depths of 5–15 m and feeds predominantly in the intertidal zone at high tide.[69] The winter aggregation off Virginia occurs at depths of 6–24 meters.[70] Acoustically tagged individuals have been recorded at depths of 152 m in the Minas Passage, which connects Minas Basin to the rest of the Bay of Fundy.[71] Six fish tagged in the Saint John River with pop-up satellite archival tags have been found as deep as 125 m throughout the duration of the tag deployment period (August–June).[72]

3.2. Present and Former Abundance

Past abundance in eastern Canada allowed a sizeable fishery that reached 2,268 metric tonnes in the late 19th century. Overfishing, however, caused a steep decline in abundance. Conservation measures (see Section 4) aim at keeping low fishing mortality. The impacts of these efforts in Atlantic

[64] Dadswell, *supra* note 11; Laney et al., *supra* note 63; I. Wirgin et al., *Stock Origin of Migratory Atlantic Sturgeon in the Minas Basin, Inner Bay of Fundy, Canada Determined by Microsatellite and Mitochondrial DNA Analysis*, 141 TRANS. AMER. FISH. SOC. 1389 (2012).

[65] Wirgin et al., *id*.

[66] Laney et al., *supra* note 63.

[67] S. WEHRELL, M. DADSWELL & A. REDDEN, POPULATION CHARACTERISTICS, MOVEMENT, AND A POPULATION ESTIMATE OF ATLANTIC STURGEON (ACIPENSER OXYRINCHUS) IN MINAS BASIN, BAY OF FUNDY, Acadia Center for Estuarine Research. No. 90 (2008); J. Beardsall et al., *Consequences of Incidental Otter Trawl Capture on Survival and Physiological Status of Threatened Atlantic Sturgeon Acipenser oxyrinchus in Coastal Waters of Nova Scotia*, TRANS. AM. FISH. SOC. (in press).

[68] Laney et al., *supra* note 63.

[69] McLean et al., *supra* note 63.

[70] Laney et al., *supra* note 63.

[71] Stokesbury, unpublished data.

[72] Taylor & Litvak, unpublished data.

sturgeon abundance are not easy to establish, since studies on population size remain challenging. Reliable trends in abundance are not available for Atlantic sturgeon in Canadian waters.

Using a Leslie removals population method[73] similar to that used by Secor and Waldman[74] to estimate the virgin adult population size of the Delaware River, the Saint John River virgin adult population was estimated at approximately ~450 metric tonnes. Based on the average weight of the current Saint John spawning population (50 kg)[75] the virgin adult population of the Saint John would have been about ~10,000 individuals.[76]

Based on a recent mark-recapture study using a Bayes algorithm, Fisheries and Oceans Canada (DFO) suggests that there was a range of 1,000 to 3,000 mature fish occurring in the Saint John River each year from 2009–2012.[77] The effective population size (Ne), based on a genetic analysis of 232 adult sturgeon caught in the commercial fishery during 2010 and 2011 has been estimated to be between 73 and 149 fish.[78] The number of full family groups for these 232 fish ranged from 13 to 15 families.[79] Based on the median population estimates from these two years, the average Ne to population size ratio is low (0.02–0.21). While the results from this study are preliminary, they are concerning if they represent the true genetic status of the Saint John River Atlantic sturgeon population. Further information on the population size and genetic status of this population is clearly required.

The population size of only a few populations in the United States is known. The Hudson River had an average annual spawning run size of 800–900 adults during the period 1980–1996 before the commercial fishery was closed,[80] and the total adult population has been estimated to be between 1,800–2,200 adults during that period.[81] The Altamaha River, Georgia, spawning run size during 2004 and 2005 was estimated to be approximately

[73] W.E. Ricker, *Computation and Interpretation of Biological Statistics of Fish Populations*, 191 BULL. FISH. RES. BOARD CAN. 1 (1975).

[74] D.H. Secor & J.R. Waldman, *Historical Abundance of Delaware Bay Atlantic Sturgeon and Potential Rate of Recovery*, 23 AM. FISH. SOC. SYMP. 203 (1999).

[75] C. Ceapa, Data collected during 2007–2008 fishing seasons on the Saint John River Atlantic sturgeon fishery. Acadia Sturgeon and Caviar Inc., Carter's Point N.B., Power Point presented at the 2010 CITES Atlantic Sturgeon Non-detrimental Meeting, Bedford Institute of Oceanography (2009).

[76] Dadswell, unpublished data.

[77] DFO, *Recovery Potential Assessment for Atlantic Sturgeon (Maritimes Designatable Unit)* (Draft, 9 April 2013) (on file with authors) [hereinafter DFO, Recovery Potential Assessment].

[78] *Id*.

[79] *Id*.

[80] Kahnle et al., *supra* note 61.

[81] M.J. Dadswell & S. Nack, An Analysis of the Scientific Data Used in the NOAA Listing of the USA Atlantic Coast Atlantic Sturgeon Population as Endangered (2012), *at* http://www.asmfc.org. (visited 26 June 2012).

300 adults/year,[82] and the total adult population was estimated to be 550 adults.[83] Based on the recovery of tagged Atlantic sturgeon in trawler catches, Kocik et al. estimated that the population size in oceanic waters off the northeast coast of the United States during the period 2006–2011 was 417,934 (CI 165,381–744,597) adults and large juveniles.[84] Secor and Waldman[85] estimated that the virgin adult female population occurring in the Delaware River during 1880–1899 was 180,000 individuals.

The approximate number of the Atlantic sturgeon occurring in marine aggregation sites has been determined only for Minas Basin. A Jolly-Seber (open) population estimate of the adult and sub-adult aggregation in Minas Basin during the summer of 1998 was 10,100 (95% CF 7341–11116).[86] A Schnabel (closed) population estimate based on a total capture of 1,242 individuals over the period 2004–2012, of which 798 were externally tagged and 29 were recovered in subsequent years, indicates an average annual summer population of 10,283 (95% CF 6332–14154).[87] The size of the winter aggregation off Virginia is unknown, but the annual average catch by trawl since 1988 was only eight fish per year.[88]

3.3. Habitat

Spawning areas in the St. Lawrence River are found at temperatures ranging between 14.5 and 23.4°C at depths greater than ten meters.[89] Five Atlantic sturgeon larvae (∼14 mm) were captured at river kilometre (RKM) 105 in the Saint John River in late July using D-frame drift nets.[90] This is one of the first reported captures of yolk-sac larvae throughout the northern portion of the range of the Atlantic sturgeon.[91] In the Saint John River, Ocean Tracking Network (OTN) researchers have determined that Atlantic sturgeon migrate primarily through lower portions of the river, often in mid-channel (∼6 m).[92] Acoustically tagged fish were found as far upstream as RKM 120, but many fish exhibit no upstream migration above RKM 42, which is below

[82] Peterson et al., *supra* note 60.
[83] Dadswell & Nack, *supra* note 81.
[84] J. Kocik et al., *An Atlantic Sturgeon Population Index for ESA Management Analysis*, NORTHEAST FISH. SCI. CENT. REF. DOC. 13–06 (2013), *at* http://www.nefsc.noaa.gov/publications/crd/crd1306/crd1306. (visited 24 April 2013).
[85] Secor & Waldman, *supra* note 74.
[86] Wehrell et al., unpublished data.
[87] Dadswell, unpublished data.
[88] Laney et al., *supra* note 63.
[89] Caron et al., *supra* note 62; D. Hatin, R. Fortin, & F. Caron, *Movements and Aggregation Areas of Adult Atlantic Sturgeon (*Acipenser oxyrinchus*) in the St. Lawrence River Estuary, Québec, Canada,* 18 J. APPL. ICHTHYOL. 586 (2002).
[90] Taylor & Litvak, unpublished data.
[91] *Id.*
[92] *Id.*

the freshwater–brackish interface.[93] Atlantic sturgeon adults in the Saint John River were found primarily in brackish areas over sandy substrate throughout late summer,[94] similar to river reaches described as "holding" or "resting" areas in other rivers throughout their range.[95]

In an attempt to define the link between substrate and areas of aggregation, OTN researchers have used gastric lavage to examine the diet of fish captured in the Minas Basin during summer.[96] Atlantic sturgeon preferentially fed in the intertidal zone on tube-dwelling polychaetes (Index of Relative Importance [IRI] = 99.7%). Major prey taxa included bamboo worms (Maldanidae Spp.; IRI = 52.5%) and bristleworms (Spionidae Spp.; IRI = 41.6%). The relationship between fish length and the number of prey items was tested and not found to be significant, and there was no significant difference between gut fullness on the flood or ebb tide. The demonstrated preference for sandy tube-dwelling polychaetes indicates that particular areas of the Minas Basin are more important foraging areas for Atlantic sturgeon. Baitworm harvest in the Southern Bight of the Minas Basin could impact sturgeon directly through competition with fishers for prey items and indirectly through the changes created by the harvest to the benthic community composition.[97] Off the east coast of the United States Atlantic sturgeon are consistently found over sandy substrates,[98] and feeding studies have shown they eat soft-bodied prey, mainly polychaetes.[99] In estuaries Atlantic sturgeon juveniles eat polychaetes, oligochaetes, and small crustaceans.[100]

Coinciding with the study on diet, McLean et al. used acoustic tags and new Vemco Ltd. small-scale (app. 1 km) tracking equipment to examine spatial and temporal patterns of habitat use by Atlantic sturgeon in an intertidal feeding area off Kingsport Beach in the Southern Bight of Minas Basin.[101] In this study data from tagged sturgeon relocations allowed quantitative characterization of fish movement trajectories. Atlantic sturgeon movement trajectories were categorized into three movement types: Movement Type 1 trajectories were characteristically slow and winding, Movement Type 2 were fast and

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[93] *Id*.

[94] *Id*.

[95] S.J. Fernandes et al., *Seasonal Distribution and Movements of Shortnose Sturgeon and Atlantic Sturgeon in the Penobscot River Estuary, Maine*, 139 TRANS. AM. FISH. SOC. 1436 (2010).

[96] McLean et al., *supra* note 63.

[97] *Id*.

[98] Stein et al., *supra* note 41; Laney et al., *supra* note 63.

[99] J.H. Johnson et al., *Food Habits of Atlantic Sturgeon off the Central New Jersey Coast*, 126 TRANS. AM. FISH. SOC. 166 (1997).

[100] R.G. Appy & M.J. Dadswell, *Parasites of Acipenser brevirostrum LeSueur and Acipenser oxyrhynchus Mitchill (Osteichthyes: Acipenseridae) in the Saint John River Estuary, N.B., with a Description of Caballeronema pseudoargumentosus sp.n. (Nematoda: Spirurida)*, 56 CAN. J. ZOOL. 1382 (1978); F. Guilbard et al., *Feeding Ecology of Atlantic Sturgeon and Lake Sturgeon Co-occurring in the St. Lawrence Estuarine Transition Zone*, 56 AMER. FISH. SOC. SYMP. 85 (2007).

[101] McLean et al., *supra* note 63.

tortuous, and Movement Type 3 were fast and linear. Movement Types 1 and 2 are believed to be associated with foraging and occurred primarily over the intertidal zone where sediment type was comprised of larger sand and sandy/silt particles. This association with larger grain size likely coincides with a diet preference of sand-tube dwelling polychaetes, corroborating the results of McLean et al.[102]

3.4. Threats

The greatest threats to Atlantic sturgeon populations are the denial of access to spawning rivers, mortality of adults in tidal turbines, habitat degradation of critical riverine and estuarine habitats, and commercial fishing. In the United States, several rivers were lost as spawning habitat because of hydroelectric dams.[103] These include the Susquehanna River, Maryland, the Santee-Cooper complex in South Carolina, and the Kennebec River, Maine. Partial spawning access to the Kennebec River was restored in 1999 when a tide head dam was removed. In Canada, the Maqtaquac dam was built in 1968 on the Saint John River. The dam is equipped with a fish lift but no sturgeon have been caught and lifted over the dam in more than 40 years. In the Annapolis River, Nova Scotia, construction of an estuarine tidal power turbine has impacted the adult population with annual mortalities,[104] but the population may persist as yearly ongoing mortalities occur (i.e., four dead Atlantic sturgeon found below the dam in 2009, and one dead in 2012). Future construction of open tidal turbines in Minas Passage could cause mortalities among sturgeon entering and exiting the Minas Basin summer aggregation.

Addressing habitat fragmentation and turbine mortality are challenging considering the socioeconomic trade-offs. For example, some organizations have called for the decommissioning of the Mactaquac dam,[105] but considering that hydroelectric power is "clean power" in a province that produces and utilizes nuclear energy, this position seems unlikely to move forward. The debate is set for the renewal process of the dam, with consultations beginning as early as 2014.[106]

Besides the pressure of commercial fisheries targeting Atlantic sturgeon for meat and caviar (see Section 2), commercial fishing threats to Atlantic

[102] *Id*.

[103] Smith, *supra* note 46.

[104] M. J. Dadswell & R. A. Rulifson, *Macrotidal Estuaries: A Region of Collision between Migratory Marine Animals and Tidal Power Development*, 51 BIOL. J. LINN. SOC. 51, 93 (1994).

[105] CBC, *Mactaquac Dam's Future Sparks Debate* (22 January 2013), *at* http://www.cbc.ca/news/canada/new-brunswick/story/2013/01/22/nb-mactaquac-future-1039.html (visited 17 April 2013); Global News, *Mactaquac Dam Concerns* (8 April 2013), *at* http://globalnews.ca/video/464466/mactaquac-dam-concerns (visited 17 April 2013).

[106] CBC, *Mactaquac Dam Consultations on Upgrade to Begin in 2014* (20 March 2013), *at* http://www.cbc.ca/news/canada/new-brunswick/story/2013/03/19/nb-mactaquac-dam-upgrade-consultations.html (visited 17 April 2013).

sturgeon include bycatch in trawl fisheries[107] and in gillnet fisheries.[108] Atlantic sturgeon captured as bycatch in trawl fisheries have low mortality rates,[109] and research indicates they are only minimally stressed.[110] OTN researchers used acoustic telemetry to determine that the minimum rate of survival for Atlantic sturgeon post catch and release by a 60 minute otter trawl set in the Minas Basin was 94 per cent.[111] It was demonstrated that the magnitude of blood lactate in trawl captured Atlantic sturgeon, relative to experimental controls, increased with longer handling time indicating elevated stress over time.[112] Based on these findings, it was recommended that minimizing handling time (i.e., time on deck) should be a priority in trawl fisheries that capture Atlantic sturgeon as bycatch.

Historically, a further threat for Atlantic sturgeon conservation was pollution. During the period 1900–1960 most spawning sites on the Delaware River were lost because of extreme degradation of the oxygen concentration from human pollution,[113] and the Atlantic sturgeon population was severely reduced.[114] In turn, the Saint John River has been characterized as "badly polluted by pulp and paper mills, vegetable processing plants, and raw municipal sewage."[115] Pollution has now been at least partially alleviated both in Canada and the United States.[116]

[107] Andrew B. Stein, Kevin D. Friedland, & Michael Sutherland, *Atlantic Sturgeon Marine Bycatch and Mortality on the Continental Shelf of the Northeast United States*, 24 N. AM. J. OF FISHERIES MGMT. 171 (2004); Beardsall et al., *supra* note 67.

[108] Johnson et al., *supra* note 99; Stein et al., *supra* note 41.

[109] Atlantic States Marine Fisheries Council (ASMFC), *Estimation of Atlantic Sturgeon Bycatch in Coastal Atlantic Commercial Fisheries of New England and the Mid-Atlantic* (August 2007), *at* http:// www.nefmc.org/monk/cte%20mtg%20docs/120403/bycatchReportAug07.pd/ (visited 10 September 2012); Beardsall et al., *supra* note 67.

[110] Beardsall et al., *id*.

[111] *Id*.

[112] *Id*.

[113] M.E. Chittenden Jr., *Trends in the Abundance of American Shad, Alosa sapidissima, in the Delaware River Basin*, 15 CHESAPEAKE SCI. 96 (1974).

[114] H.M. Brundage III & R.E. Meadows, *The Atlantic Sturgeon, Acipenser oxyrhynchus, in the Delaware River Estuary*, 80 U.S. FISH. WILDL. SERV. FISH. BULL. 337(1982).

[115] STANLEY GORHAM & DON MCALLISTER, THE SHORTNOSE STURGEON, ACIPENSER BREVIROSTRUM, IN THE SAINT JOHN RIVER, NEW BRUNSWICK, CANADA, A RARE AND POSSIBLY ENDANGERED SPECIES, Syllogeous Series (1974).

[116] Fisheries and Oceans Canada (DFO) now argues that "[w]ater quality is very good in the Saint John River, and no known impacts to Atlantic sturgeon have been reported" (DFO, Atlantic Sturgeon Non-Detriment Finding, *supra* note 29). Environmental standards have pushed industrial operations to install more advanced cleaning for their waste products; various levels of government have diverted construction away from shorelines; and tougher sewage regulation, even in rural areas, have all contributed to cleaner rivers. New Brunswick has the added "advantage" of a stable, or even decreasing, population, in various areas.

4. CURRENT MANAGEMENT

4.1 The Global Legal Mesh

The two global agreements applicable to Atlantic sturgeon cast a rather flimsy protective net. The United Nations Law of the Sea Convention (LOSC) provides only broad and general legal threads including cooperation responsibilities on states sharing fish populations.[117] The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) provides a very limited management lever by largely focusing upon trade controls not broader species habitat conservation needs.[118] An array of non-legally binding instruments and documents, such as the FAO Code of Conduct for Responsible Fisheries and UN General Assembly Sustainable Fisheries resolutions, may also be relevant to sturgeon conservation, for example, calling upon states to apply precautionary and ecosystem approaches, but a soft law review is beyond the scope of this article.

4.1.1 UN Convention on the Law of the Sea

Being an anadromous species, management of Atlantic sturgeon is subject to Article 66 of LOSC, which specifically sets out the general international legal framework for anadromous stocks. States in whose rivers anadromous stocks originate have the primary interest in and responsibility for such stocks, and the state of origin must ensure their conservation by the establishment of appropriate regulatory measures for fishing in all waters landward of the 200 nautical mile exclusive economic zone limit. Fisheries for anadromous stocks are generally prohibited on the high seas except where a state other than the state of origin would face economic dislocation.

LOSC also establishes general transboundary cooperation duties. Where anadromous stocks migrate into or through the waters of a state other than the state of origin, such a state must cooperate with the state of origin regarding the conservation and management of shared stocks. The state of origin and other states fishing anadromous stocks are required to make cooperative arrangements, where appropriate, through regional organizations.

Pursuant to LOSC Part XII states also have various more general responsibilities to protect the marine environment and fish habitats. For example, states have the obligation to protect and preserve the marine environment and must take necessary measures to protect and preserve rare or fragile ecosystems as well as the habitat of depleted, threatened, or endangered species and other forms of marine life.

[117] United Nations Convention on the Law of the Sea, 10 December 1982, 1833 U.N.T.S. 397 [hereinafter LOSC].

[118] Convention on International Trade in Endangered Species of Wild Fauna and Flora, 3 March 1973, 993 U.N.T.S. 243 [hereinafter CITES].

4.1.2 Convention on International Trade in Endangered Species

With all the world's sturgeon and paddlefish listed under CITES Appendices I or II, the Atlantic sturgeon is listed for protection under Appendix II. Covering species which may be threatened with extinction unless trade in specimens is subject to strict regulation, Appendix II subjects any trade in live Atlantic sturgeon or its products to export permit requirements. A permit must be obtained from the state of export verifying that in the opinion of that state's scientific authority the export will not be detrimental to the survival of the species and the management authority of the state of export must be satisfied the species was obtained legally.

A Resolution on Conservation of and Trade in Sturgeon and Paddlefish, first adopted at the 12th CITES Conference of the Parties (CoP) in 2002[119] and further amended at the 16th CoP in March 2013,[120] provides additional guidance on how to more effectively address sturgeon conservation and trade. Range states are urged to enter into regional agreements to ensure proper management and sustainable utilization of the species. Each importing, exporting, and re-exporting party is encouraged to establish a registration system for caviar processing plants, including aquaculture operations and repackaging plants, and to provide to the Secretariat a list of those facilities and their official registration codes. Parties are not to accept the import of sturgeon caviar and meat from stocks shared between different range states unless export quotas have been established. Export quotas are to be set on a yearly basis, 1 March to the end of February, and the quotas should be based on an appropriate regional conservation strategy and monitoring regime for the species concerned and not detrimental to the survival of the species in the wild. If range states do not provide timely notification to the CITES Secretariat of the proposed export quotas, the range states are considered to have a zero quota until the proper communication is made. Quotas do not have to be established for specimens from captive-breeding or aquaculture operations.

The Resolution calls upon sturgeon range states to collaborate in the development and implementation of strategies and action plans for the conservation and management of shared stocks. States are encouraged to seek cooperation with non-governmental organizations, the private sector, academia, and other expert stakeholders in supporting such strategies.

[119] CITES, *Conservation of and Trade in Sturgeons and Paddlefish*, Resolution Conf. 12.7 (Rev. CoP14) (2002).

[120] CITES, *Conservation of and Trade in Sturgeons and Paddlefish*, Resolution Conf. 12.7 (Rev. CoP16) at http://www.cites.org/eng/res/index.php (visited 20 July 2013).

Pursuant to the Resolution, a universal labelling system for the trade in and identification of caviar has been developed.[121] For example, the country of origin is to ensure its processing plants affix a non-reusable label to any primary container, with the label providing information such as the standard species code, the source country, the year of harvest, and the official registration code of the processing plant.[122]

4.2 Transboundary Cooperation

While Canada has not previously exported Atlantic sturgeon caviar from wild harvest,[123] there was potential interest in such trade and thus Canada initiated the process of developing a regional conservation strategy for the species, to meet CITES responsibilities. In December 2011, Canada advised the Secretariat that it was continuing to work with the United States on the development of a regional conservation strategy for Atlantic sturgeon and was undertaking a joint review of the scientific assessment of its proposed annual export quota of 400 kg.[124] As a result, a zero export quota of caviar for the Saint John River/Bay of Fundy shared stock was established until such time as they communicate their quota in writing to the Secretariat.[125] A draft Canada-United States Regional Conservation Strategy and Monitoring/Enforcement Regime for Atlantic Sturgeon was under preparation but not publicly released.

Outside the CITES context, Atlantic sturgeon has not been the subject of substantial bilateral discussion or cooperation. In the Gulf of Maine region, the Species at Risk Working Group of the Canada-U.S. Transboundary Resources Steering Committee has exchanged information on the status of Atlantic sturgeon listing processes.[126] A "State of the Gulf of Maine Report," published in 2010, while highlighting Canada-U.S. cooperation in addressing transboundary species at risk issues for the leatherback turtle, the North Atlantic right whale, and Atlantic salmon did not mention Atlantic sturgeon.[127]

Other bilateral cooperation avenues stand out for possible future discussions and recovery actions relating to Atlantic sturgeon. A Framework for Cooperation between the U.S. Department of the Interior and Environment Canada in the Protection and Recovery of Wild Species at Risk, adopted in

[121] CITES, *Guidelines for a Universal Labelling System for Trade in and Identification of Caviar*, in CITES, *id*., Annex 1.

[122] *Id*.

[123] Personal communication, Andrew McMaster, Senior Policy Analyst, International Affairs Directorate, Fisheries and Oceans Canada (27 March 2013).

[124] CITES, *Secretariat's Report on Sturgeon and Paddlefish, 26th Meeting of the Animals Committee, Geneva, 15–20 March 2012 and Dublin, 22–24 March 2012*, AC26 Doc. 15.1 (2012), at para. 3(b).

[125] *Id*.

[126] Minutes of the Transboundary Steering Committee Meeting held in Boston, MA, 13 September 2013 (on file with authors).

[127] COLLEEN THOMPSON, THE GULF OF MAINE IN CONTEXT: STATE OF THE GULF OF MAINE REPORT 51–52 (2010).

1997, aims to identify species needing bilateral action and pledges the promotion of joint recovery plans for endangered or threatened species.[128] Since 2001, the National Marine Fisheries Service and the Department of Fisheries and Oceans have participated in bilateral meetings to facilitate the protection of marine species.[129] Informal fisheries consultations between Canada and the United States continue to be held annually to discuss bilateral, multilateral, and global fisheries conservation and management issues.[130]

4.3 Sturgeon Management in the Atlantic United States

The anadromous Atlantic sturgeon is managed through a multi-level governance framework, with the Atlantic coastal states and the Atlantic States Marine Fishery Commission (ASMFC) playing a key role. While each state is responsible for adopting regulations for their sturgeon fishery,[131] coast-wide coordination of management and research measures is fostered by the ASMFC through the adoption of interstate fisheries management plans.[132]

In 1990, ASMFC adopted an interstate fisheries management plan for Atlantic sturgeon (1990 FMP). The plan's overarching goal was to provide a framework that would allow for Atlantic sturgeon restoration to fishable abundance throughout its range, with fishable abundance defined as 700,000 pounds per year.[133] Four management objectives were identified: to protect the species from further depletion; to improve scientific knowledge of the species; to enhance and restore the stock; and to coordinate research and management activities throughout the Atlantic coast range.[134] States were required to adopt a minimum size of seven feet (total length), or impose a moratorium of all harvest; identify, characterize, and protect critical spawning and nursery areas; establish a tagging program to delineate migratory patterns, age and growth, population estimates, and mortality rates; and identify critical habitat characteristics of staging and oceanic areas.[135] ASMFC, in turn, was tasked with several responsibilities for coast-wide coordination and cooperation with respect to data and information sharing, research, and prospects of aquaculture-based restocking activities.[136]

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[128] NATIONAL MARINE FISHERIES SERVICE (NMFS), INTERIM ENDANGERED AND THREATENED SPECIES RECOVERY PLANNING GUIDANCE, VERSION 1.3 (updated June 2010), Appendix E.

[129] *Id*. at 2.2.3.

[130] NOAA, OFFICE OF INTERNATIONAL AFFAIRS, INTERNATIONAL AGREEMENTS CONCERNING LIVING MARINE RESOURCES OF INTEREST TO NOAA FISHERIES 124–125 (2012).

[131] ASMFC, INTERSTATE FISHERY MANAGEMENT PLAN FOR ATLANTIC STURGEON, Fisheries Management Report No. 17 (1990), at 12. New York, New Jersey, and North Carolina had a small directed oceanic fishery while all other states in the range of distribution had riverine and estuarine fisheries. Primary management measures were minimum fish size and fishing season closures.

[132] *Id*.

[133] *Id*. at 21. The target is ten per cent of the 1890 record landings of seven million pounds. *See also* Waldman, *supra* note 14.

[134] ASMFC, *supra* note 131, at 21.

[135] *Id*. at 21–22.

Despite the coordinated regulatory efforts, some Atlantic sturgeon spawning stocks continued to decline. It became evident that the measures included in the 1990 FMP were insufficient.[137] In 1998, the ASMFC amended the FMP and established a moratorium on Atlantic sturgeon commercial fishing until 20-year classes of adults were established, effectively closing the fishery for 20–40 years.[138] In 1999, the National Marine Fisheries Service implemented regulations to prohibit the retention and landing of Atlantic sturgeon bycatch from federally regulated fisheries.[139] To address bycatch mortality, and in compliance with the amended FMP, many states within the riverine and estuarine range of Atlantic sturgeon adopted regulations for their inshore gillnet fisheries.[140]

Concurrently with the efforts to prevent further declines of Atlantic sturgeon populations through fisheries regulations, the government also considered listing the species as endangered under the Endangered Species Act (ESA)[141] on two occasions over the past 15 years.[142] This extended process concluded with a final determination made in February 2012.[143] The final rule identified five distinct population segments (DPS): Gulf of Maine, New York

[136] The ASMFC was required to a) encourage and coordinate a coast-wide depository of data and information to effectively monitor and assess management efforts; b) encourage an expanded aquaculture effort to develop techniques to rear Atlantic sturgeon and evaluate hatchery fish for stock restoration; c) encourage shortnose sturgeon researchers to incorporate Atlantic sturgeon into their projects; d) encourage determination of environmental tolerance levels (e.g., DO, pH, temperature, river flow, salinity) for all life stages; e) encourage the determination of effects of contaminants on all life stages; f) encourage the evaluation of existing fisheries survey data to aid in determining at-sea migratory behaviour and stock composition; g) encourage aquaculture research to identify and control early life stage diseases, synchronize spawning times of male and females, and reduce handling stress problems; h) encourage the federal agencies to manage Atlantic sturgeon in the exclusive economic zone, and i) establish an aquaculture and stocking committee to provide guidelines for aquaculture and restoration stocking of sturgeon (*id*. at 22).

[137] Additionally, the management plan needed to be modified to comply with the new standards mandated by the 1993 Atlantic Coastal Fisheries Cooperative Management Act (16 U.S.C.A. § 5104 (a)).

[138] ASMFC, AMENDMENT 1 TO THE INTERSTATE FISHERY MANAGEMENT PLAN FOR ATLANTIC STURGEON, Fishery Management Report No. 31 (1998), at 19. The amendment to the interstate management plan was preceded by closures to the targeted fishery adopted by every coastal state jurisdiction (*id*. at 28).

[139] 64 FR 19069.

[140] Rachel White, *Atlantic Sturgeon Listed as Endangered, Management Challenges Ahead*, 11 SANDBAR 6, 7 (2012).

[141] Endangered Species Act, 16 U.S.C.A. §§1531–1544 (2011) [hereinafter ESA].

[142] The NMFS added the species to the list of candidate species under the ESA in 1997 (62 FR 37560, later replaced by the designation as species of special concern, 69 FR 19975). The same year, an environmental organization requested the listing of the species under ESA, triggering a formal status review, which was completed in 1998 (NMFS AND U.S. FISH AND WILDLIFE SERVICE (USFWS), STATUS REVIEW OF ATLANTIC STURGEON (ACIPENSER OXYRINCHUS OXYRINCHUS) (1998)). However, the NMFS concluded that Atlantic sturgeon were not threatened or endangered based on any of the five factors of the ESA (*id*. at 95).

[143] 77 F.R. 5880 & 77 F.R. 5914. This second initiative was initiated during a workshop on the status and management of Atlantic sturgeon held in 2003 and organized by NMFS, USFWS, and ASMFC. The workshop concluded that, despite the moratoria, the recovering of stocks presented mixed results with some stocks showing some signs of recovery while others continue to decline (ATLANTIC STURGEON

Bight, Chesapeake Bay, Carolina, and South Atlantic. Atlantic sturgeons in four DPS were listed as endangered, while Atlantic sturgeon in the Gulf of Maine DPS was listed as threatened. The final rule became effective on 6 April 2012.

Species listed under the ESA as endangered are protected through several prohibitions. Except with a permit, no person can import or export a listed endangered species; take endangered species; or possess, sell, deliver, carry, transport, or ship, by any means, endangered species.[144] "Take" is defined as "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct."[145]

In the case of species listed as threatened, the species' protection is not automatic. The Secretary shall issue such regulations as deemed necessary and advisable to provide for the conservation of such species, including the application of any prohibition under Section 1538.[146] In June 2011, the Secretary proposed a rule extending Section 1538 prohibitions to the Gulf of Maine DPS, except for scientific research and rescue/salvage activities.[147] The final rule has not been issued.

Since the United States did not list the entire sub-species of Atlantic sturgeon as endangered, there is not a prohibition on importing Canadian wild Atlantic sturgeon into the United States. However, there are two ways in which the United States could prohibit the import in the future. The first would be to list the Canadian population based on similarity of appearance to those already listed. The second would be to revise the current ESA listing to list either the entire sub-species, including the Canadian population, or to add the Canadian distinct population to the list of threatened or endangered species.[148]

STATUS REVIEW TEAM, STATUS REVIEW OF ATLANTIC STURGEON (*ACIPENSER OXYRINCHUS OXYRINCHUS*), REPORT TO NATIONAL MARINE FISHERIES SERVICE, NORTHEAST REGIONAL OFFICE (2007), at 3). This conclusion prompted a new stock status report by the Atlantic Sturgeon Status Review Team, which was concluded in 2007 (*id*.). The 2007 Report was the basis of the listing request and listing process that led to the final determination of listing Atlantic sturgeon as endangered and threatened under the ESA.

[144] ESA, *supra* note 141, § 1538. The ESA § 1532(8) defines "fish or wildlife" as any member of the animal kingdom, including without limitation any mammal, fish, bird (including any migratory, nonmigratory, or endangered bird for which protection is also afforded by treaty or other international agreement), amphibian, reptile, mollusc, crustacean, arthropod or other invertebrate, and includes any part, product, egg, or offspring thereof, or the dead body or parts thereof. Therefore, the prohibitions apply to caviar from wild Atlantic sturgeon.

[145] *Id*. at § 1532(19).

[146] *Id*. at § 1533(d).

[147] 76 F.R. 34023. The proposed rule extends prohibitions in § 1538(a)(1)(A) through 1538(a)(1)(G), which include the prohibitions to "import, export, taking, possession, sale or offering for sale in interstate or foreign commerce, delivery, receiving of, carrying, transportation, or shipping in interstate or foreign commerce any such species, or violation of any regulation pertaining to such species" (*id.)*.

[148] Personal communication with Angela Somma, Division Chief, Endangered Species Conservation Division, Office of Protected Resources, National Marine Fisheries Service (22 April 2013).

Additionally, the ESA requires the federal government to designate critical habitat and to develop and implement recovery plans for threatened and endangered species.[149] As of the date of writing, none of these actions had been adopted for any Atlantic sturgeon DPS.[150]

4.4 Sturgeon Management in Atlantic Canada

Management of Atlantic sturgeon in Canada is subject to a patchwork of federal and provincial jurisdiction as a consequence of a complex system of delegation of federal administrative authority to the provinces and territories, which has evolved on the basis of the constitutional provisions, judicial decisions, and federal-provincial negotiations.[151] DFO has authority to manage Atlantic sturgeon in the Atlantic Provinces and to administer and enforce the provisions on fish habitat in the Fisheries Act and aquatic species at risk under the Species at Risk Act. Quebec, in turn, has authority to manage anadromous and catadromous species of fish, including sturgeon, in the waters of the province and in tidal waters, and to administer the Act Respecting Threatened or Vulnerable Species.[152] The regulatory framework for aquaculture operations in New Brunswick is, in turn, subject to shared federal and provincial jurisdiction and oversight negotiated between the federal and provincial governments.[153] The following section addresses the regulatory framework for species at risk and for fisheries management. Fish habitat protection provisions under the Fisheries Act[154] and aquaculture law and policy[155] have been extensively covered elsewhere.

4.4.1 Legislation for the Protection of Species at Risk

The Atlantic sturgeon was assessed by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) in 2011. The assessment report concluded that the two Canadian designatable units of Atlantic sturgeon (the St. Lawrence population and the Maritimes population) are threatened.[156]

Following the COSEWIC scientific assessment, the Governor in Council is left with the political decision of listing the species under Schedule I of the

[149] ESA, *supra* note 141, § 15334(a)(3)(A) & 15334(f)(1).

[150] *See* NMFS, Endangered and Threatened Marine and Anadromous Fish: List of Fish Species under NMFS' Jurisdiction, *at* http://www.nmfs.noaa.gov/pr/species/esa/fish.htm (visited 17 April 2013).

[151] L. S. Parsons, Management of Marine Fisheries In Canada 19 (1993).

[152] *Id*. at 33; Quebec Fishery Regulations 1990, SOR 90/214.

[153] Canada-New Brunswick Memorandum of Understanding on Aquaculture Development (1989).

[154] *See, for example*, Commissioner on the Environment and Sustainable Development, Report of the Commissioner of the Environment and Sustainable Development to the House of Commons: Protecting Fish Habitat (Spring 2009).

[155] *See, for example*, Aquaculture Law and Policy: Towards Principled Access and Operations (David L. VanderZwaag & Gloria Chao eds., 2006); David L. VanderZwaag et al., *Canada's International and National Commitments to Sustain Marine Biodiversity,* 20 Environ. Rev. 312 (2012).

[156] COSEWIC, *supra* note 6.

Species at Risk Act (SARA),[157] a decision that should be made within nine months after receiving the COSEWIC assessment.[158] If listed, the individuals of the threatened species and their residence are automatically protected through several prohibitions.[159] The protection of critical habitat, in turn, is not automatic. It requires, first, the identification of critical habitat in the recovery plan or action plan[160] and secondly, the assessment of the legal protection under existing acts of Parliament.[161] Additionally, the federal government has the obligation to adopt a recovery strategy and one or more action plans delineating the measures that are to be taken to implement the strategy, including measures to address threats to the species and to achieve population and distribution objectives.[162]

In the case of Atlantic sturgeon, no listing decision had been made as of the date of writing. DFO is undertaking the studies and consultations that, according to internal policies, are required to recommend a course of action to the Governor in Council.[163] Thus, the species remains without the protection provided under the federal Species at Risk Act.

At the provincial level, Quebec has taken an initial step to protect the Atlantic sturgeon under their endangered species legislation. The species is considered as likely to be designated as threatened or vulnerable[164] under

[157] Species at Risk Act, S.C. 2002, c. 29, § 27(1) [hereinafter SARA].

[158] *Id*. at § 27(1.1).

[159] According to SARA, *id*. at § 32(1) & 32(2): "No person shall kill, harm, harass, capture or take an individual of a wildlife species that is listed as an extirpated species, an endangered species or a threatened species"; and "No person shall possess, collect, buy, sell or trade an individual of a wildlife species that is listed as an extirpated species, an endangered species or a threatened species, or any part or derivative of such an individual." According to SARA § 33: "No person shall damage or destroy the residence of one or more individuals of a wildlife species that is listed as an endangered species or a threatened species, or that is listed as an extirpated species if a recovery strategy has recommended the reintroduction of the species into the wild in Canada."

[160] *Id*. at §§ 41(1)(c) & 49(1)(a).

[161] *Id*. at § 58(5). Only when it is determined that the identified critical habitat is not legally protected by provisions in, or measures under, SARA or any other Act of Parliament, the Minister shall issue an order triggering the prohibition to destroy any part of the critical habitat of the listed endangered or threatened species.

[162] *Id*. at §§ 37–55.

[163] DFO held a regional science meeting on the recovery potential of the St. Lawrence Atlantic sturgeon population in Québec City in February 2012. In turn, a regional science meeting on the recovery of the Maritimes Atlantic sturgeon population was held in January 2013, and a draft Recovery Potential Assessment has been prepared in April 2013. The record for listing marine species is not promising (*see* Arno Mooers et al., *Biases in Legal Listing under Canadian Endangered Species Legislation*, 21 CONSERV. BIOL. 572 (2007); Jeffrey Hutchings & Marco Festa-Bianchet, *Canadian Species at Risk (2006–2008), with Particular Emphasis on Fishes*, 17 ENVIRON. REV. 53 (2009); JEFFREY HUTCHINGS ET AL., SUSTAINING CANADIAN MARINE BIODIVERSITY: RESPONDING TO THE CHALLENGES POSED BY CLIMATE CHANGE, FISHERIES AND AQUACULTURE, EXPERT PANEL REPORT PREPARED FOR THE ROYAL SOCIETY OF CANADA (2012)).

[164] Ministerial Order Concerning the Establishment of a List of Threatened or Vulnerable Vascular Plant Species Which are Likely to Be so Designated and a List of Threatened or Vulnerable Wildlife Species Which Are Likely to Be so Designated, RRQ, c E-12.01, r 4 (Que).

Section 9 of the provincial Act Respecting Threatened or Vulnerable Species.[165] Contrary to the federal legislation, the designation of a species as "likely to be designated as threatened or vulnerable" does not impose the obligation to determine its listing within a certain timeframe[166] nor does it have any other legal consequence. If listed, however, prohibitions equivalent to those of SARA would protect the species, its residences, and critical habitat at the provincial level.[167]

4.4.2 Legislation for the Regulation of Fishing Activities

Both identified designatable units of Atlantic sturgeon in Canada (St. Lawrence River and the Maritimes) support commercial fisheries.[168] A relatively major fishery occurs in Quebec's St. Lawrence River, a fishery that is under the jurisdiction of the Quebec provincial government. A minor fishery occurs in the Maritimes in the Saint John River. This fishery is managed by DFO.

4.4.3 St. Lawrence Atlantic Sturgeon Fishery

The most significant Atlantic sturgeon fishery takes place in the St. Lawrence River from just east of Quebec City to about Trois-Pistoles in an approximately 90-mile or 150 km stretch. After an increase in catches in the 1980s and 1990s (see Section 2), the Quebec government adopted increasingly stringent management measures. Until 1994, provincial regulations designed to conserve Atlantic sturgeon stocks limited the number of fishing permits to 35 and mandated a minimum gillnet mesh size (stretched) of 7.2 inches (18 cm).[169] In 1995, the Minister for the Environment and Wildlife of Quebec established a fishing season from 1 May to 30 September[170] and set a minimum and maximum size limit of 40 and 68 inches (100–170 cm) fork length.[171]

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[165] Act Respecting Endangered or Vulnerable Species, R.S.Q., c. E-12.01 (Que) [hereinafter Quebec Endangered Species Act].

[166] *Id*. Indeed, the species has remained in the list of species "likely to be designated as threatened or vulnerable" for 20 years (COSEWIC, *supra* note 6, at 36).

[167] Quebec Endangered Species Act, *supra* note 165, at §§ 16–17.

[168] Contrary to other sturgeon fisheries in the United States and other countries, the traditional Canadian commercial fishery was never based on caviar harvest because the supply was too irregular to support a caviar industry. Nevertheless, wild Atlantic sturgeon from the Bay of Fundy is exported from Canada, primarily for meat and fertilized eggs for scientific purposes (DFO, *Atlantic Sturgeon and Shortnose Sturgeon, Fisheries and Oceans Canada, Maritimes Region, Summary Report*, Supplemental information presented in the 2011 Sturgeon Workshop, 8–10 February Alexandria, VA (2011), at 7, *at* NMFS http://www.nero.noaa.gov/prot_res/atlsturgeon/sws.html (visited 13 March 2013) [hereinafter DFO, Atlantic Sturgeon and Shortnose Sturgeon]).

[169] F. Caron & S. Tremblay, *Structure and Management of an Exploited Population of Atlantic Sturgeon (Acipenser oxyrinchus) in the St. Lawrence Estuary, Québec, Canada*, 15 J. APPL. ICHTHYOL. 153, 154 (1999).

[170] COSEWIC, *supra* note 6, at 36. In the tidal, freshwater zone of the St. Lawrence River upstream from Quebec City, the fishing season is closed between 1 July and 15 August to prevent mortality of sturgeon in the nets (*id*.).

[171] Verreault & Trencia, *supra* note 18, at 529–530.

The maximum size was reduced in 1996 to 60 inches (150 cm) to further protect the mature stock.[172] A standardized gillnet mesh size of 20.4 cm was adopted.[173]

In 1997, the provincial government also established a catch quota and total allowable catch (TAC) of 6,015 fish (approximately 60 metric tonnes).[174] Quebec's catch quota and TAC have gradually declined since 1997, and was set at 4,767 fish in 2000.[175] One Aboriginal licence issued to the Malecite First Nation grants access to 16 Atlantic sturgeon per year, with landings reported and counted against the 60 metric tonnes TAC.[176] Angling for sturgeon with a Quebec recreational fishing permit is allowed from 15 June to 31 October with a maximum of one fish per day.[177] No information on fishing mortality from recreational fishing is available.

At present, the province has determined that a catch level of less than 60 metric tonnes annually (the highest value reported before the crash of the fishery in 1967) is sustainable, and that the existing regulations have achieved this objective.[178]

4.4.4 Maritimes Atlantic Sturgeon Fishery

Although both Nova Scotia and New Brunswick have reported commercial fishery of Atlantic sturgeon in the past and sturgeon were commonly taken from weirs in the Minas Basin,[179] the primary fishing area has always been the estuary of the Saint John River.[180] With modest catches of about 12 metric tonnes a year,[181] the fishery is a "sunset" commercial fishery. No new licences have been issued since the mid-1980s. According to a 2013 report, there are four remaining licence holders[182] of which only one or two were regularly active.[183] Each Atlantic sturgeon fishing licence authorizes specific

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[172] COSEWIC, *supra* note 6, at 36; Verreault & Trencia, *supra* note 18 at 529; Caron & Tremblay, *supra* note 169 at 154.

[173] Verreault & Trencia, *supra* note 18 at 529–530.

[174] Williamson, *supra* note 1, at 95.

[175] *Id*.

[176] DFO & NOAA, DRAFT CANADA - UNITED STATES REGIONAL CONSERVATION STRATEGY AND MONITORING/ENFORCEMENT REGIME FOR ATLANTIC STURGEON *ACIPENSER OXYRINCHUS OXYRINCHUS* (n.d.) (on file with authors).

[177] MINISTÈRE DE RESSOURCES NATURELLES QUÉBEC, SPORT FISHING IN QUÉBEC: MAIN RULES, 1 APRIL 2012 TO 31 MARCH 2014, *at* http://www.mrn.gouv.qc.ca/english/publications/online/wildlife/fishing-regulations/ (visited 17 April 2013); Quebec Fishery Regulations 1990, SOR 90/214, §§ 28(d), 56 & Schedule 2; COSEWIC, *supra* note 6, at 36.

[178] Caron & Tremblay, *supra* note 169, at 156; Verreault & Trencia, *supra* note 18, at 529 and 534.

[179] M. J. Dadswell et al., *A Review of Fish and Fisheries Research in the Bay of Fundy between 1976 and 1983*, 1256 CAN. TECH REP. FISH AQUAT SCI. 163 (1984).

[180] With the exception of 1998, the capture of sturgeon in the Saint John River represented over 95 per cent of the catches each year between 1995 and 2002. The licence to catch Atlantic sturgeon in Shubenacadie River, Nova Scotia, has been inactive for many years (Williamson, *supra* note 1, at 95).

[181] See Section 2.

[182] DFO, Recovery Potential Assessment, *supra* note 77, at 11.

amounts and type of gear and fishing areas. According to the conditions of the remaining licences, fishing is restricted to the tidal waters in counties through which the Saint John River flows in New Brunswick and to one county in Nova Scotia where the Shubenacadie River flows.[184]

The only authorized commercial fishing gear is gillnets.[185] The legal minimum gillnet mesh size is 13.2 inches (33 cm), to ensure that the fishery targets only adult Atlantic sturgeon.[186] The minimum size limit for catchable fish is 48 inches (120 cm).[187] The season is closed from 1 June to 30 June to protect spawning fish.[188]

In 2011, an annual TAC of 350 fish with a 50:50 sex ratio was established for the commercial fishery in the Saint John River.[189] An additional 50-fish quota is intended to cover off any retention in Aboriginal fisheries, recreational fisheries, research, bycatch, and incidental mortalities from turbines.[190] In the Bay of Fundy and Saint John River area, it is prohibited to retain Atlantic sturgeon captured as bycatch in other fisheries.[191]

There are currently two Aboriginal fishing licences that authorize Atlantic sturgeon harvest in the Maritimes Region (Oromocto First Nation and the New Brunswick Aboriginal Peoples Council). These licences have reported minimal landings of sturgeon in the past years.[192]

As a result of the measures in place, Atlantic sturgeon catch in the Saint John River fishery consists mostly of sexually mature fish, averaging 74 inches long (range 60 to 92 inches) and 18 years of age (range 10 to 31 years).[193]

Recreational angling for Atlantic sturgeon is permitted in New Brunswick, Nova Scotia, and Prince Edward Island under the Maritime Provinces Fishery Regulations,[194] but it has developed only in New Brunswick.[195] The angling season is closed in June, and a minimum size of 120 cm is enforced.[196]

[183] DFO, Atlantic Sturgeon and Shortnose Sturgeon, *supra* note 168, at 6.
[184] DFO, Recovery Potential Assessment, *supra* note 77, at 10; COSEWIC, *supra* note 6, at 36.
[185] Maritime Provinces Fishery Regulations, SOR/93–55, Part VI, s. 94 [hereinafter MPFR].
[186] *Id*. at s. 96; DFO, Atlantic Sturgeon and Shortnose Sturgeon, *supra* note 168, at 6.
[187] MPFR, *supra* note 185, DFO, Atlantic Sturgeon and Shortnose Sturgeon, *supra* note 168 at 6; COSEWIC, *supra* note 6, at 36. In Canada, nearly all shortnose sturgeon are smaller than the minimum size limit for retention. Consequently, shortnose sturgeon are not retained and no shortnose sturgeon bycatch is permitted.
[188] MPFR, *supra* note 185.
[189] DFO, Atlantic Sturgeon and Shortnose Sturgeon, *supra* note 168, at 3.
[190] DFO, Atlantic Sturgeon Non-Detriment Finding, *supra* note 29, at 10.
[191] COSEWIC, *supra* note 6, at 36.
[192] DFO, Recovery Potential Assessment, *supra* note 77, at 10.
[193] *Id*.
[194] DFO, Atlantic Sturgeon and Shortnose Sturgeon, *supra* note 168, at 6.
[195] *Id*.
[196] COSEWIC, *supra* note 6, at 7.

The great majority of the fish caught in the recreational fishery are released back into the watercourse where they were caught.[197]

5. FUTURE DIRECTIONS IN SCIENCE AND FOR MANAGEMENT OF ATLANTIC STURGEON

With continuous demand for Atlantic sturgeon for meat and caviar, the challenges for Atlantic sturgeon conservation and sustainable use include scientific and management issues. While the OTN Atlantic sturgeon research project is addressing the former, management initiatives concerning fisheries and trade need to be brought together in an effective framework that addresses both conservation issues and commercial realities.

5.1 Future Scientific Directions

The major challenge confronting the management and protection of Atlantic sturgeon, as with many exploited species of sturgeon, is the lack of information that is required to accurately assess their status. As mentioned in this article, there have only been five Atlantic sturgeon larvae caught in Canada. We do not know where they spawn within their natal rivers and therefore cannot really comment on the habitat required for them to reproduce. We need to define the spawning periodicity and continue ongoing efforts to define abundance through mark and recapture experiments in order to accurately determine population sizes in Canada and elsewhere. Otherwise we may over- or underestimate the population size that uses these watersheds.

From a study performed using pop-up satellite tags in the United States it appears that these fish do migrate long distances.[198] This is corroborated by genetic work on the population that summers in the Minas Basin.[199] Ongoing OTN research using pop-up satellite tags will help define the extent of occurrence of the populations from Canada and how often they move to other jurisdictions. The findings on broad migration patterns of Atlantic sturgeon have a clear management implication: research, management, and protection of Atlantic sturgeon require bilateral cooperation for a successful conservation strategy.

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[197] Several sturgeon angling tournaments have taken place on the Saint John River. Tournament entry rules required live release of all angled sturgeons. According to the 2005 Recreational Fisheries Survey for Canada, non-tournament angling also occurs in New Brunswick. A total of 2,339 sturgeon were angled in New Brunswick in 2005, but only 41 fish were retained. The angled sturgeon likely included both shortnose and Atlantic sturgeon (DFO, Atlantic Sturgeon Non-Detriment Finding, *supra* note 29, at 5).

[198] D. L. Erickson et al., *Use of Pop-Up Satellite Archival Tags to Identify Oceanic-Migratory Patterns for Adult Atlantic Sturgeon, Acipenser oxyrinchus oxyrinchus Mitchill, 1815*, 27 J. APPL. ICHTHYOL. 356 (2011).

[199] Wirgin et al., *supra* note 64.

5.2 Future Management Directions

Strengthening the governance net for Atlantic sturgeon will depend on future national and bilateral law and policy stitchings. At the national level, further protection of sturgeon in the United States will largely depend on implementation of Endangered Species Act requirements, including the designation of critical habitat. In Canada, public consultations on potential listing of Atlantic sturgeon as threatened under the Species at Risk Act have yet to conclude. If listed, SARA's protective threads would become applicable, including a prohibition on taking with limited exceptions[200] and a requirement to develop a recovery strategy and action plan.

Future directions in bilateral cooperation may depend on whether transboundary trade in wild sturgeon caviar continues to be of interest.[201] If so, Canada and the United States would need to complete and finalize the draft recovery strategy and monitoring regime for Atlantic sturgeon, as required in the CITES resolution.[202] Such a route looks to be doubtful in light of the high priority given by the U.S. government to finalize recovery actions within the United States first,[203] and possible political sensitivity in the United States to allowing trade for a shared stock listed as endangered under U.S. law.

Even if transboundary trade is not involved, Canada and the United States still have cooperation responsibilities. LOSC requires states sharing anadromous fish stocks to cooperate in the conservation and management of such stocks.[204] The CITES Resolution on sturgeon urges range states to consider entering into a regional management agreement and calls upon range states to collaborate in the development and implementation of a conservation and management strategy and action plan for shared stocks.[205]

6. CONCLUSION

With substantial but fragmented regulatory nets already in place in both Canada and the United States to manage Atlantic sturgeon, the need to further strengthen transboundary cooperation stands out in the light of the existing limitations. No network of marine protected areas has been established in the

[200] SARA, *supra* note 157, at § 32.

[201] The current U.S. position is to allow Canadian imports of wild Atlantic sturgeon caviar and meat from Saint John River origin provided that the CITES procedures for the export of caviar and meat from shared stocks are complied with (personal communication with Pamela Scruggs, Chief, Branch of Consultation and Monitoring Division of Scientific Authority, U.S. Fish and Wildlife Service - International Affairs (22 April 2013)).

[202] See Section 4.2.

[203] Personal communication with Pamela Scruggs, Chief, Branch of Consultation and Monitoring Division of Scientific Authority, U.S. Fish and Wildlife Service - International Affairs (22 April 2013).

[204] LOSC, *supra* note 117, at Art. 66 (4).

[205] CITES, *supra* note 120, Annex. The previous draft document might be the basis for developing such a strategy and action plan.

Gulf of Maine and broader marine region.[206] Marine spatial planning in the transboundary context remains at the discussion stage.[207] Bilateral fisheries management efforts continue to be largely focused on three commercially important groundfish species: cod, haddock, and yellowtail flounder.[208]

With the recent listing of Atlantic sturgeon populations as endangered or threatened in the United States and the proposed listing as threatened in Canada, the time seems ripe to at least consider forging new bilateral meshes to specifically ensure the future conservation of sturgeons with three main stitching directions open.[209] First, Canada and the United States might negotiate a specific agreement on Atlantic sturgeon. However, this seems unlikely in light of the regional preferences to date for largely less formal cooperation arrangements and the lack of strong political support and will.[210] Second, the Transboundary Resources Steering Committee might take a more proactive role in addressing shared concerns over Atlantic sturgeon, at the least through its Species at Risk Working Group. Third, the two countries might conclude a bilateral Atlantic sturgeon strategy and action plan, as suggested by the CITES resolution on sturgeon. This latter route looks to be the most promising in light of the draft strategy that has already been developed.[211] Such a document or documents might open the door to increased scientific cooperation in tracking and understanding the movements and ecosystem relationships of Atlantic sturgeon and to coordination in recovery planning efforts. One thing is clear, the scientific and governance meshes addressing sturgeon have yet to be integrated and the cooperative stitching has hardly begun.

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[206] Progress at the domestic level has been slow. For example, Canada has not developed a national network of marine protected areas. *See* COMMISSIONER ON ENVIRONMENT AND SUSTAINABLE DEVELOPMENT, REPORT OF THE COMMISSIONER OF THE ENVIRONMENT AND SUSTAINABLE DEVELOPMENT: MARINE PROTECTED AREAS (Fall 2012).

[207] *See, for example*, Stephen Jay et al., *International Progress in Marine Spatial Planning*, 27 OCEAN Y.B. 171 (2013). Discussions on the implementation on marine spatial planning in the Gulf of Maine have just begun, with the Gulf of Maine Council on the Marine Environment establishing a Coastal and Marine Spatial Planning (CMSP) Committee with two main functions: to investigate and make recommendations on roles/activities for the Council in CMSP, and to track and exchange information on CMSP policies and activities on both sides of the border (Gulf of Maine Council on the Marine Environment, Committees and Programs, *at* http://www.gulfofmaine.org/2/committees-and-programs/coastal-and-marine-spatial-planning/ (visited 19 April 2013)).

[208] Emily J. Pudden & David L. VanderZwaag, *Canada-United States Bilateral Fisheries Management in the Gulf of Maine: Struggling towards Sustainability under the Radar Screen*, in RECASTING TRANSBOUNDARY FISHERIES MANAGEMENT ARRANGEMENTS IN LIGHT OF SUSTAINABILITY PRINCIPLES: CANADIAN AND INTERNATIONAL PERSPECTIVES 177 (Dawn A. Russell & David L. VanderZwaag eds., 2010).

[209] For a discussion of broader bilateral cooperative options, such as regional seas agreement along with protocols, see David L. VanderZwaag, *Transboundary Challenges and Cooperation in the Gulf of Maine Region: Riding a Restless Sea toward Misty Shores*, in LAW OF THE SEA: THE COMMON HERITAGE AND EMERGING CHALLENGES 265, 282–283 (Harry N. Scheiber ed., 2000).

[210] *Id*.

[211] See Section 4.2.