Population Characteristics, Movement, and a Population Estimate of Atlantic sturgeon (*Acipenser oxyrinchus*) in Minas Basin, Bay of Fundy, during the Summer of 2007

Prepared for

Nova Scotia Power Inc.

by

Sierra Wehrell, Michael Dadswell and Anna Redden
Acadia Centre for Estuarine Research
Acadia University
Wolfville, Nova Scotia
B4P 2R6

January 2008

ACER Publication No. 90

Population Characteristics, Movement, and a Population Estimate of Atlantic sturgeon (*Acipenser oxyrinchus*) in Minas Basin, Bay of Fundy, during the Summer, 2007

Abstract

The Atlantic sturgeon has breeding populations in the Bay of Fundy (Saint John, Annapolis, and Avon Rivers) but little is known about the sturgeon found in Minas Basin during summer. Previous research has shown that sturgeon is common in the Basin between May and September. During June 7 to August 31, 2007 a total of 144 sturgeon were sampled from an intertidal fish weir and a fishing vessel in Minas Basin. The fish weir on the north shore of Minas Basin (Five Islands) was visited 56 times at low tide from June 8 to July 7. Between July 24 and August 31, six trips were made on a flounder trawler between Blomidon and Walton in the southern Basin. A total of 54 sturgeons were sampled from the weir and 90 were caught by trawling. A total of 121 sturgeon were tagged, measured, and tissue samples taken for mitochondrial DNA analysis. Captured sturgeon ranged in length from 55-190 cm. Mean fork length of sturgeon captured in the intertidal weir was 118.4 ± 32.6 cm; those caught by trawling was 137.8 ± 19.5 cm. Seasonal catch distribution from the weir and the fishing vessel and the recapture of two study tags indicates that sturgeon enter Minas Basin along the north shore in spring and depart along the southern shore in late summer. Two sturgeons were recaptured in the southern Basin during 2007 after being tagged at Five Islands; they were at large for 1-2 months. These data permitted a Petersen estimate which suggests a population of approximately 1650 sturgeon were in the Basin during the summer of 2007. Sixty pectoral spines from sturgeon caught during 2007 were removed for aging. Preliminary aging of sturgeon samples from Minas Basin suggests the size range sampled during 2007 will be from 3-20 years old. We anticipate that distant tag returns and DNA analysis will provide clues to the origin of these Atlantic sturgeon.

Prior to demonstration of in-stream tidal turbines in Minas Passage, there should be further efforts to determine the summer population size of Atlantic sturgeon and their migratory movements into and out of the Minas Basin. Population assessment will be critical to the determination of the 'status' of Atlantic sturgeon in the region and to the assessment of potential impacts of proposed tidal power developments in the Minas Passage.

Introduction

The Atlantic sturgeon, *Acipenser oxyrinchus*, is found along the Atlantic coast from Labrador to Florida (Ludwig et al. 2002). It is anadromous and breeding populations occur in rivers tributary to the Bay of Fundy (Saint John, Annapolis and Avon; Dadswell 2006). It is also common in the marine waters of the upper reaches of the Bay of Fundy (Minas and Cumberland Basin) during summer (Dadswell et al. 1984; Wehrell 2005).

Sturgeons are commercially valuable for their roe and flesh but their numbers sharply declined in the late 1800's due to over fishing (Spears 2007). Many characteristics of the life history of the Atlantic sturgeon make it vulnerable to anthropogenic disturbances and can greatly slow its rate of population growth. The Atlantic sturgeon grows slowly and takes many years to mature. Not only does the Atlantic sturgeon require about 15-20 years to mature, but once reaching sexual maturity individuals exhibit long periods between reproductive intervals, typically up to 5 years (Vladykov and Greeley 1963).

The Atlantic sturgeon is a transboundary fish species that migrates annually north and south along the eastern coast of Canada and the United States (Dadswell 2006). It uses a wide range of habitats, from upper estuaries to the edge of the continental shelf (Stein et al. 2004). They travel thousands of kilometres along their migration path, which brings them in contact with many anthropomorphic disturbances. The Atlantic sturgeon fishery was closed by 1999 along the east coast of the United States, and by 2002 in the Bay of Fundy, to allow stocks to recover (Spears 2007). Today many Atlantic sturgeon stocks remain significantly depressed and some known natal rivers are devoid of breeding adults (Grunwald et al, 2007). Other rivers, however, still support fisheries (Dadswell 2006).

There have been numerous studies on the Atlantic sturgeon populations found along the east coast of North America (Dadswell 2006) but little is known about the Atlantic sturgeon that are found in Minas Basin each summer (Wehrell 2005). Their migration route and preferred habitat while in the Basin is poorly known and their numbers and stock origins are unknown. With the development and proposed deployment of tidal, hydroelectric turbines in Minas Basin, there is a risk of injury or death to the migrating sturgeon population in the region (Dadswell and Rulifson 1994). Sufficient information on sturgeon utilising the Minas Basin needs to be gathered prior to the development of tidal power so that a proper environmental impact assessment (EIA) can be completed. Any future impacts on the summer population of Atlantic sturgeon in the Basin could then be recognized.

Methods

Sampling of Atlantic sturgeon in Minas Basin during the summer of 2007 took place in an intertidal fish weir, operated by Anthony and Corey Lewis at Five Islands along the north shore, and on a flounder trawler operated by Granville and Charles Travis in the southern Bight (Fig. 1). The fish weir was visited a total of 56 times at low tide between June 8 and July 7 and all Atlantic sturgeon taken as by-catch were examined. Sampled sturgeons were

measured for fork length and total length, had tissue removed for DNA analysis (2 gm fin clip), were tagged with an individually numbered plastic streamer tag (Floy FT-1) and then released. Only one tagged sturgeon re-entered the weir on a subsequent tide. The fishers informed us that the weir sampling missed a significant portion of the sturgeon captured by the weir during 2007 because of our late sampling start.

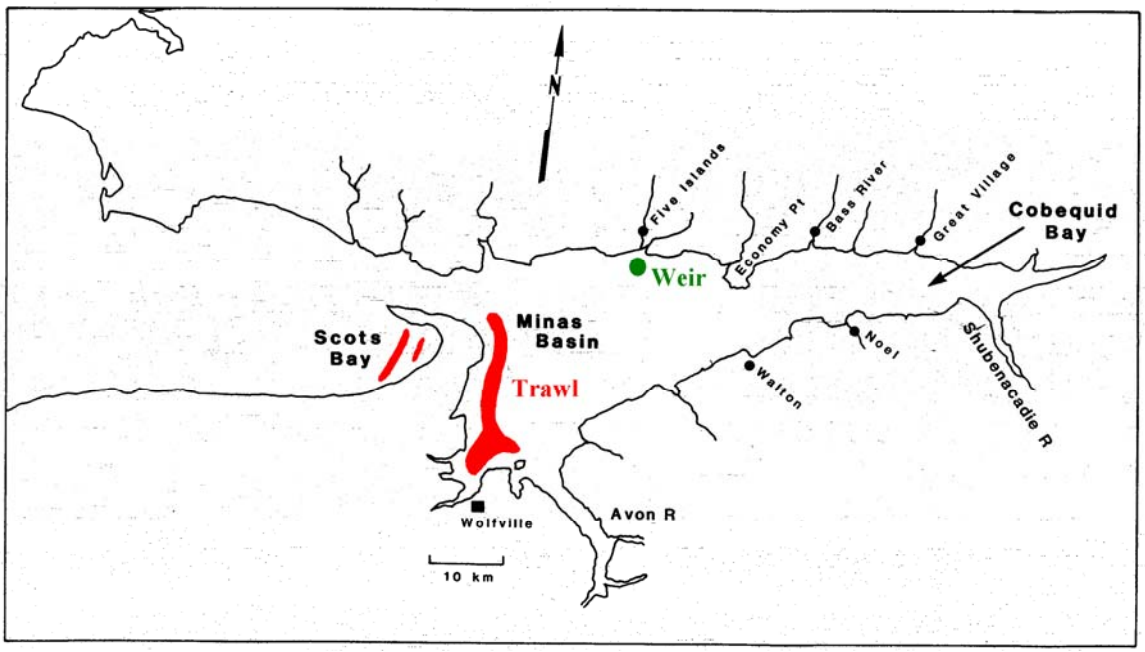

Figure 1: Map depicting the location of the fishing weir in Five Islands and the areas sampled by trawl boat during the summer of 2007.

A total of six fishing expeditions between Walton and Blomidon in the southern Bight were completed between July 24 and August 31 in 2007 (Fig. 1). Atlantic sturgeon was captured as by-catch while fishing for winter flounder. Trips were restricted to one or two a week because the flounder quota was set on a weekly basis. Captured Atlantic sturgeon were examined for tags from the weir, measured for fork and total length, had tissue removed for DNA analysis, tagged with an individually numbered plastic streamer tag and released. Only one sturgeon tagged on the trawler was subsequently recaptured by trawling on the same day. An adjusted Petersen estimate (Ricker 1975) was used to determine the estimated number of Atlantic sturgeon occurring in Minas Basin during the summer of 2007:

$$N \text{ (estimated)} = (M + 1)(C + 1) / (R + 1)$$

where: M = number of sturgeon marked at Five Islands

C = number of sturgeon captured by trawler in the Southern Bight

R = number of recaptures from Five Islands in the Southern Bight

During 2007, a stratified sample of 60 sturgeons was selected by length increment, and the first pectoral fin ray from the right side of the fish was removed for aging. Fin rays require four months of air drying before they are ready for aging. Fin rays will be sectioned in thin slices (1 mm thick) using a fine bladed coping saw. They are then cleared in 70% ethanol, and growth annuli read under a dissecting microscope.

Mitochondrial DNA (MtDNA) analysis for stock identification (Wirgin et al. 2000) will take place during the summer and fall of 2008 after the necessary laboratory materials are obtained and the techniques verified. Isolation of DNA from the tissue samples and sequencing will be done in the laboratory of Dr. D. Stewart at Acadia University. Tissue samples are stored in 95% ethanol at 5ºC.

Results and Discussion

A total of 144 Atlantic sturgeons were caught during 2007, 54 in the intertidal weir and 90 by the trawler. Of these, 121 sturgeon were measured, tagged, and tissue samples acquired for MtDNA analysis.

The catch rate in the weir was highest during early June and declined to only 1-2 sturgeon a day by the first week of July (Fig. 2). The fishers informed us that a significant number of sturgeons had been captured before we arrived on June 8 to begin sampling.

Fork length of sturgeon sampled during 2007 ranged from 54.9 cm to 190 cm (Fig. 3). Mean fork length of sturgeon captured in the weir was 118.4 ± 32.6 cm and those caught by trawling, 137.8 ± 19.5 cm (Table 1). The mean, overall fork length the sturgeon caught during the summer of 2007 was 129.1± cm. Mean lengths of sturgeon caught in the weir and those caught by trawl were significantly different (t-test, $p<0.05$).

Weir caught sturgeon were possibly smaller because the intertidal weir fishes shallower water than the trawler. The size range captured in Minas Basin during summer indicates that the population is mostly juveniles although some of the larger sturgeon may have been sexually mature males. The Atlantic sturgeon does not mature until 15-20 years of age and males mature at a smaller size than females (150cm vs. 200cm; Dadswell 2006).

Two sturgeon were recaptured in the southern Basin after being tagged in Five Islands and at large 1-2 months. An adjusted Petersen estimate suggests a population of approximately 1650 sturgeon occurred in the Basin during the summer of 2007. Although the statistical requirement for random mixing was met during 2007, we did not achieve enough recaptures to obtain an unbiased estimate of the population size (Ricker 1975). An accurate population estimate could have been obtained if there had been 4 or more tagged sturgeon recaptured. Future sampling efforts will have to be increased to obtain an unbiased estimate. Based on the results from 2007 and a possible population of around 2000 sturgeon we anticipate that 200-300 sturgeon must be sampled and tagged during a summer field season (Ricker 1975).

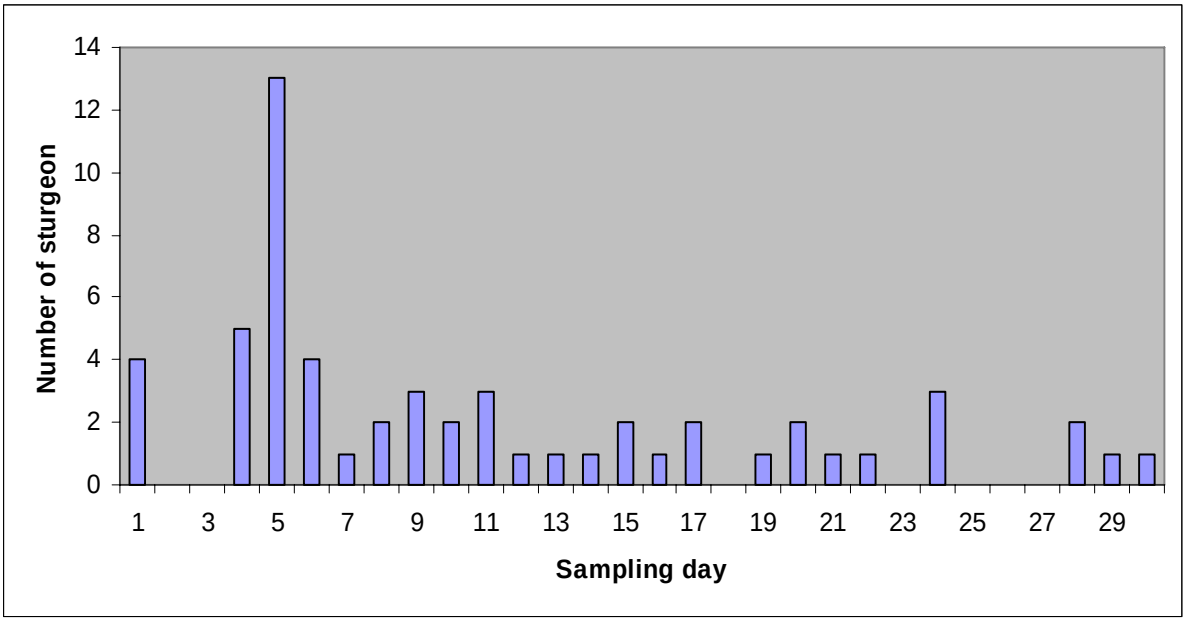

Figure 2: Frequency of Atlantic sturgeon sampled at the Five Island fishing weir from 8 June 2007 to 7 July 2007.

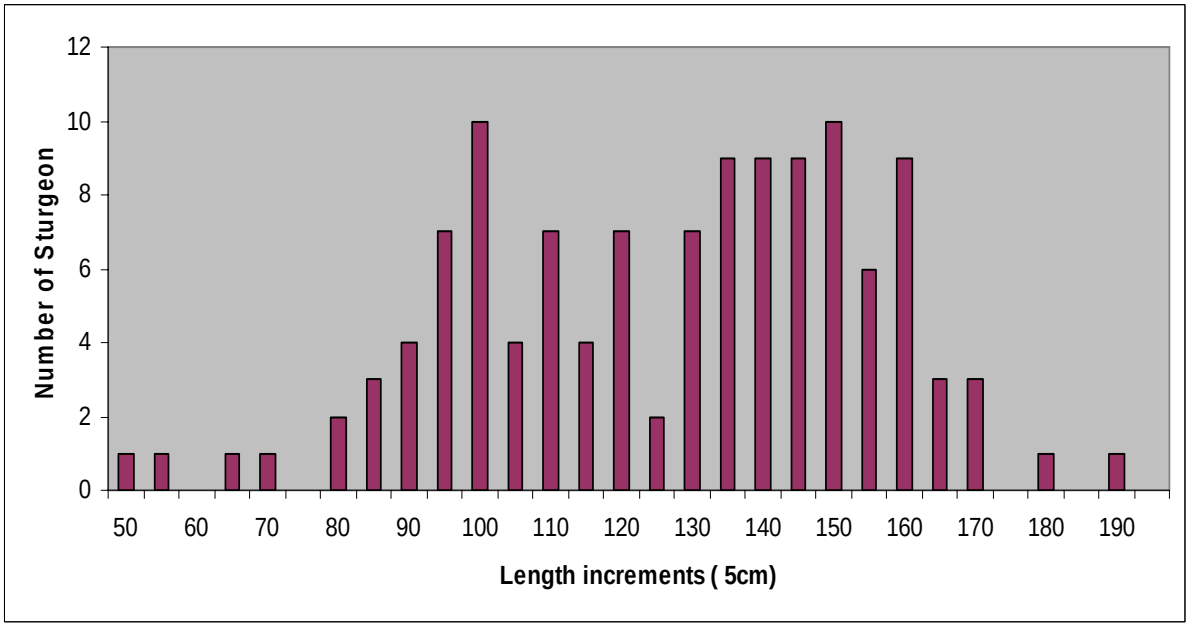

Figure 3: Fork length frequency for 121 Atlantic sturgeon caught in the Minas Basin during the summer of 2007, shown in 5cm increments.

Table 1. Mean fork length of Atlantic sturgeon caught in Minas Basin, Five Islands and the southern Bight during the summer of 2007.

Location	Mean fork length ± 1SD (cm)
All of Minas Basin	129.1 ± 27.8
Five Islands	118.4 ± 32.6
Southern Bight	137.8 ± 19.5

A total of 60 pectoral spines were removed from sturgeon caught during the summer. When these have been dried for the necessary period they will be analyzed for age. We have completed the aging of a sample of Atlantic sturgeon taken by trawler in Minas Basin during 2005. The mean fork length of the 2005 samples was 136.9 ± 18.1 cm which was not significantly different from the 2007 trawl catch (t-test, $p<0.05$). These sturgeon were between 3-20 years old.

The tissue samples were taken from 121 Atlantic sturgeons captured during 2007 for MtDNA analysis. These samples have not yet been analyzed. Results on the stock origin of the sturgeon found in the Minas Basin as determined by MtDNA will be completed when laboratory materials arrive and sequences to use have been verified.

Recommendations

We recommend that, prior to demonstration of in-stream tidal turbines in Minas Passage, further effort be applied to determining the summer population size of Atlantic sturgeon and their movements within, and into and out of, the Minas Basin. While collecting this information further characterization (morphometrics, age) of the summer population in Minas Basin is possible. Population assessment will be critical to the determination of the 'status' of Atlantic sturgeon in the Bay of Fundy. It will also be critical to the assessment of potential impacts of tidal turbine operation on sturgeon moving through the Minas Passage.

We further recommend that the stock origins of summer populations of Atlantic sturgeons in the Minas Basin be determined. This research can be conducted using further mitochondrial DNA analysis. It is possible that the sturgeons in Minas Basin during summer are from numerous stocks on the east coast of North America.

References

Cada, G., J. Ahlgrimm, M. Bahleda, T. Bigford, S.D. Stavrakas, D. Hall, R. Moursund, and M. Sale. Potential impacts of hydrokinetic and wave energy conversion technologies on aquatic environments. Fisheries. 32: 174-181.

Dadswell, M. J., R. Bradford, A. H. Leim, G. D. Melvin, R. G. Appy and D. J. Scarratt. 1984. A review of fish and fisheries research in the Bay of Fundy between 1976 and 1983. *In*. D. C. Gorden and M. J. Dadswell (Eds.). Update on marine environmental consequences of tidal power development in the upper reaches of the Bay of Fundy. Canadian Technical Report of Fisheries and Aquatic Sciences 1256:163- 294.

Dadswell, M. J. and R. A. Rulifson. 1994. Macrotidal estuaries: a region of collision between migratory marine animals and tidal power development. Biological Journal of the Linnean Society 51: 93-113.

Dadswell, M.J., R.A. Rulifson, and G.R. Daborn. 1986. Potential Impact of large-scale tidal power developments in the Upper Bay of Fundy on fisheries resources of the Northwest Atlantic. Fisheries 11: 26-34.

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: 218-229.

Grunwald, C., L. Maceda, J. Waldman, J. Stabile, and I. Wirgin. 2007. Conservation of Atlantic sturgeon *Acipenser oxyrinchus oxyrinchus*: delineation of stock structure and distinct population segments. Conserv. Genet. Online Article ISSN 1572-9737. http://www.springerlink.com/content/m287k06237w16461/

Ludwig, A., L. Debus, D. Lieckfeldt, I. Wirgin, N. Benecke, I. Jenneckens, P.Williot., J. R. Waldmen, and C. Pitra. 2002. When the American sea sturgeon swam east. Nature 419: 447- 448.

Ricker, W.E. 1975. Computation and interpretation of biological statistics of fish populations. Bulletin of the Fisheries Research Board of Canada, No. 191.

Spear, B.J. 2007. U.S. Management of Atlantic Sturgeon. American Fisheries Society Symposium. 56: 339-346.

Stein, A.B., K.D. Friedland, and M. Sutherland. 2004. Atlantic sturgeon marine distribution and habitat use along the northeastern coast of the United States. Transactions of the American Fisheries Society 133: 527-537.

Vladykov, V. D. and J. R. Greeley**.** 1963. Order Acipenseroidei. Contributions de la Departement des Pecheries. Quebec- No. 53.

Wirgin, I, J.R. Walden, J. Rosko, R. Gross, M.R. Collins, S.G. Rogers and J. Stabile. 2000. Genetic structure of Atlantic sturgeon populations based on mitochondrial DNA control region sequences. Transactions of the American Fisheries Society 129: 476-486.

Wehrell, S. 2005. A survey of the groundfish caught by the summer trawl fishery in Minas Basin and Scots Bay. Honours Thesis. Department of Biology, Acadia University, Wolfville, Canada.