STUDY PERFORMANCE REPORT

State: Michigan **Project No.:** F-81-R-16

Study No.: 230563 **Title:** Lake Sturgeon *Acipenser fulvescens* population status in the Cheboygan River watershed lakes, Michigan

Period Covered: October 1, 2014 – September 30, 2015

Study Objectives: The objectives of this study are to: (1) assess Lake Sturgeon population status in Burt and Mullett lakes; and (2) monitor Lake Sturgeon reproduction by hatchery and wild adults in the upper Black River.

Summary: During this performance period, we continued data analysis associated with all study jobs, continued laboratory processing of genetic material, and maintained juvenile Lake Sturgeon in the hatchery for ESD portion of project (Job 11). We also continued working on various manuscripts tied to study jobs. Manuscripts are in various stages of preparation and will be published in the near future.

Findings: Jobs 9 and 10 were active during 2014-15. Although Job 11 was not active during this reporting period, the incomplete status of the ESD work is the reason for the extended study end-date and below is an update on work associated with this job to date. Findings for all three jobs are reported below.

Job 9. Publish Report.–This annual progress report was written as scheduled. However, this study was amended to extend the project end date to September 2016 due to the ongoing work on Job 11 (see text below) and manuscripts and reports are still in preparation.

Job 10. Write Final Report.–Data analysis is continuing and final report preparation continues. The study was amended, and the final report is now scheduled for completion in 2016. This annual report was prepared and submitted. In addition, a study summary was completed (Attachment 1).

Job 11. Evaluate Environmental Sex Determination (ESD) in Lake Sturgeon.–

Histological Summary timeline (3 months–29 months): At 3 months the gonads can be identified, but are undifferentiated. In both cold and warm incubated fish, the gonadal ridge can be identified and is lined with simple cuboidal epithelium. At 6 months, there is an increase in gonadal tissue size relative to the 3-month samples, yet the gonads are still undifferentiated. Increase in size is associated with an increase in adipose tissue within the gonad, but no demonstrative epithelial changes were observed. At 14-17 months the gonads are still undifferentiated, but with some notable differences relative to the 6-month-old fish. Gonadal epithelium changed from simple cuboidal to pseudostratified along the gonadal ridge in some, but not all, samples. These epithelial changes observed are consistent with females (simple cuboidal to pseudostratified) in another species of Sturgeon (Shortnose Sturgeon; Flynn and Benfy 2007). However, in the some samples, we identified tubular structures consistent with potential male gonadal development in the presence of the pseudostratified epithelium. At 1 year, gonads are still undifferentiated, but with some changes consistent with gonadal growth and development. Although a strong trend toward sexual differentiation is observed, sex cannot be conclusively determined at the 1 year point. At 1.5 years, this trend toward gonadal differentiation was not consistent throughout the gonad and highlights the need to section multiple parts of the gonad for the same fish. For example, in one individual (ID: 460E4D1E03) in two separate sections there was evidence of

either the pseudostratified epithelium consistent with potential female differentiation, but in one section (the more posterior section) these epithelial changes were not present. At 29 months, the gonad is still not differentiated, but with some notable differences relative to the 17month time point. In contrast to the 17-month samples, where epithelial changes were only observed in a subsample of fish, now we see evidence of gonadal epithelial differentiation in all samples. In all samples, a large increase in adipose tissue within the gonad along with differential epithelial changes between the fatty end and the gonadal ridge was identified. We also begin to observe changes consistent with sexual development. For example, in one individual, the gonads showed extensive folding along the gonadal ridge, with pseudostratified epithelium. There is a large amount of both brown and white adipose tissue in the majority of samples. Differences in the proportion of brown:white adipose may be associated with rearing temperature, sexual differences, or both, but limited sample sizes and sex ambiguity at the 29-month stage precludes statistical analyses. As with the 17-month samples, in a subset of our 29-month-old samples, changes in the gonadal epithelia from simple cuboidal to pseudostratified associated with female development were identified (Flynn and Benfy 2007), but with duct differentiation consistent with male development (extensive ducts within the gonadal tissue).

Histological Results at 41 months following report extension:

Gross Anatomical Features: Eight fish, ages of 41 months, were sampled. Seven of the eight fish were notably larger in size than at the previous sampling point, with the remaining fish roughly the same size as a 29-month-old. Gonads were visibly larger, in some cases had a bright yellow coloration with some bulging and folds present.

Histological Features: Sex could be determined in two (25%) of the eight sample fish. Five (62.5%) showed advanced development and differentiation relative to the 29-month sampling but the gonads were still in an undifferentiated state; therefore, positive sex determination was not possible. The single remaining fish (12.5%) that was smaller in overall body size than the other seven fish demonstrated the same developmental stage as a 29-month-old fish. The two fish in which sex could be determined were both female and demonstrated clear identifiable, unambiguous ova present in well-defined ovarian tissue (Figure 7). In all five samples showing advanced differentiation, variation with regard to gonadal differentiation was noted, with more differentiation occurring more anterior relative to posterior within the gonadal tissue. In all five samples, the presence/absence of pseudostratified epithelia versus simple cuboidal epithelia used in determining sex in White Sturgeon was inconsistent and does not coincide with sex identification in great lake Sturgeon. Notable differences in the clustering of early-differentiation state cells within the gonadal tissue were observed, with some samples showing enlarged and distinct cells clustered into bundles (Figure 8 D,F) and other samples showed these gonadal cells arranged into string-like patterns string-like patterns (Figure 8 E). In two of the five undifferentiated fish, there is the start of compartmentalization within the gonadal region that is consistent with posterior locations in the two mature female fish. The remaining single fish showed only immature gonads, consistent in size and developmental status to the 29-month-old fish. This fish was also the sample that was substantially smaller in overall body size than the other 7 fish. Because the majority of the samples could not have sex definitively assigned, we recommend allowing the fish another year to mature, where patterns between temperature and sex can be better evaluated.

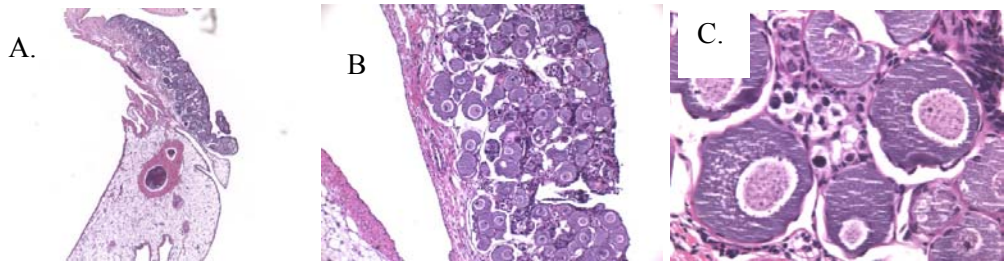

Figure 7.–A female identified histologically at 41 months under A) 2.5X, B) 10X, and C) 40X magnification

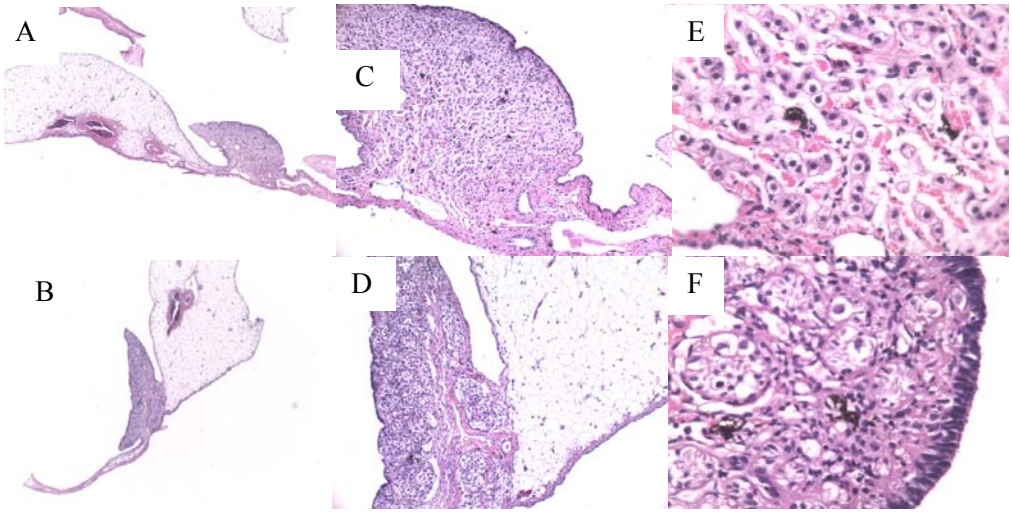

Figure 8.–Immature 41-month-old fish under A-B) 2.5X, C-D) 10X, and E-F) 40 X magnification where the developing gonadal tissue shows distinction between string formation (E) and bundle formation (F).

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Lake Sturgeon Studies in the Cheboygan River Watershed

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Background

Lake Sturgeon is the largest fish found in the Great Lakes. Prior to extensive European settlement of the Great Lakes region, Lake Sturgeon was one of the most abundant species of fish in the Great Lakes and many of the large river systems connected to the Great Lakes. Sturgeon populations were reduced globally by overharvest, habitat destruction and pollution to remnant populations by 1920 and Lake Sturgeon are currently listed as a threatened species in Michigan. The Cheboygan River system, which includes Burt, Mullett, and Black lakes, is home to one of the few remaining Lake Sturgeon populations in Michigan. Black Lake supports a popular winter spear harvest fishery for Lake Sturgeon but harvest is prohibited in Burt and Mullett lakes due to low numbers. A collaborative research effort between Fisheries Division and Michigan State University has been studying Lake Sturgeon in the Cheboygan River watershed lakes since 2001 with research focused on learning more about Lake Sturgeon biology as well as development of Lake Sturgeon rehabilitation actions that can be applied statewide to other remnant populations.

Research on the Black Lake Sturgeon population in recent years has focused specifically on improving stocking practices for population restoration. There are multiple Great Lakes tributaries that are currently being stocked with Lake Sturgeon as part of efforts to restore self-sustaining Lake Sturgeon where they historically existed but are currently absent. Stocking targets, including the appropriate number and size of fish to stock, were initially set based on best professional judgement of fishery managers because there were no data available to guide these decisions. To provide better guidance of stocking decisions the Michigan DNR and Michigan State University began stocking Lake Sturgeon in Black Lake in 2001 and over the course of several years have varied the number and size of fish stocked. In 2013, a gill-net survey was conducted in Black Lake to evaluate the stocking program and attempt to determine the relationship between fish size at stocking and subsequent survival. This relationship is important to know because it will help guide decisions on numbers of fish to stock to achieve management targets.

The objectives of the study are 1) to determine abundance of stocked year classes in Black Lake and 2) to examine the relationship between stocked year class abundance and the number and size of fish stocked by year.

Photo 1. Juvenile Lake Sturgeon captured during gill-net survey in Black Lake.

Key results

There were 283 individual Lake Sturgeon captured during the survey and most of the fish were juveniles (Photo 1). The smallest fish captured was 22” and the largest fish

was 71". Fin ray samples and fin tissue were collected from the fish to allow for age determination and genetic analysis. The analysis indicates that the stocked fish are surviving and doing well. The analysis also indicates that size of the fish at stocking does influence survival and is an important consideration when planning for a Lake Sturgeon rehabilitation stocking program. There is an apparent threshold at about 6" where post-stocking survival increases rapidly and fish that are at least that size when stocked have very high survival (Figure 1).

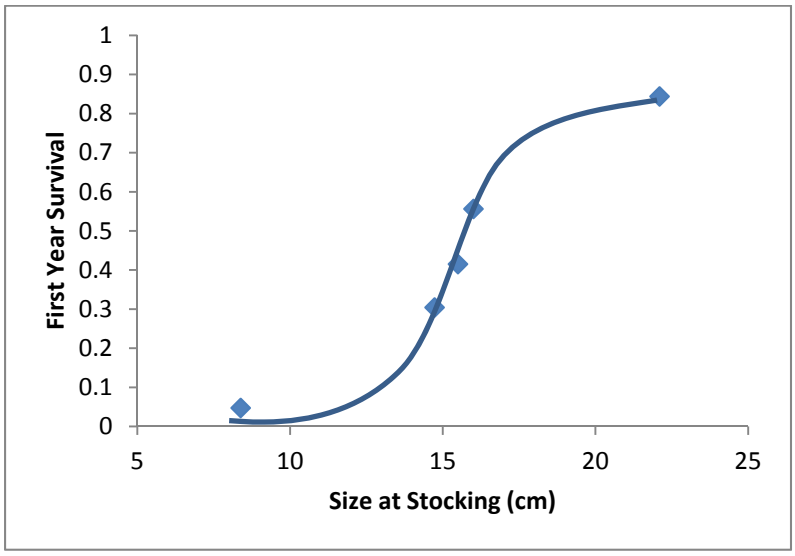

Figure 1. Relationship between Lake Sturgeon size at stocking and first year survival.

Based on the results of the gill-net survey survival of stocked Lake Sturgeon is considerably higher than assumed. Because survival is higher, particularly for larger stocked fish, the stocking target for Black Lake has been reduced from 3,250 fish to 500 fish annually with a target size at stocking of at least 6" (15 cm). The survey results are also being used to set realistic stocking targets for other Lake Sturgeon rehabilitation efforts around the Great Lakes.

Additional Information

Detailed project information is available at http://www.michigan.gov/dnr/0,4570,7-153-10364_52259_19056-333302--,00.html.