Lake Sturgeon Rehabilitation Using Streamside Rearing Facilities

Project Number: 2005.671

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Research Final Report

PROJECT ABSTRACT

Title: Lake Sturgeon Rehabilitation Using Streamside Rearing Facilities.

Abstract body: Lake sturgeon rehabilitation is currently a focus of many Great Lakes agencies. Strategies to increase their numbers have been identified and implemented because lake sturgeon populations are extremely small and believed to be a fraction of their historical abundance. Stocking has traditionally been conducted in a manner where gametes are collected, hatched and reared at a hatchery off-site from where the fish will be stocked. However, concerns have been raised with this practice because of the risks posed by stocked fish straying into rivers other than where they were stocked and spawning at disproportionately high rates with non-stocked remnant populations (Holtgren et al. 2007, Welsh et al. 2010). Within the Lake Michigan Basin genetically distinct remnant populations have been identified and the protection of these populations is a priority (DeHaan et al. 2006). The Lake Michigan Lake Sturgeon Rehabilitation Plan being drafted by the Lake Sturgeon Task Group outlines these concerns and streamside rearing facilities have been identified as a method that may maximize the likelihood of imprinting and thus minimize the risk of stocked fish straying.

Therefore in 2005, four management agencies in the Lake Michigan Basin (Wisconsin Department of Natural Resources, Michigan Department of Natural Resources, US Fish and Wildlife Service and Little River Band of Ottawa Indians (LRBOI)) began meeting to determine if streamside rearing facilities (SRF), patterned after the initial successful Manistee River trailer operated by LRBOI, could be deployed in Wisconsin and Michigan to begin the rehabilitation of lake sturgeon in important historical streams. This group decided to pursue internal and external funding to accomplish this task with five specific goals for the project including:

1. Design and build streamside rearing facilities on the Milwaukee and Manitowoc Rivers (later moved to Kewaunee River), Wisconsin and Cedar and Whitefish Rivers, Michigan.
2. Use streamside rearing facilities to annually rear and stock lake sturgeon in each river.
3. Compare growth and condition factors of SRF lake sturgeon to traditional-hatchery reared and wild lake sturgeon.
4. Assess short-term movement patterns and river retention of stocked lake sturgeon.
5. Collect, analyze and archive tissue samples from adult broodstock and representative progeny to determine a) genetic diversity of stocked fish, b) genetic diversity of returning adults in future years, and c) straying rates in future years.

Four new SRFs were constructed during the fall and winter of 2005 and delivered in April 2006. They were deployed on the Whitefish River and Cedar River in Michigan and the Milwaukee River in Wisconsin. The fourth trailer was to be deployed on the Manitowoc River, WI but WDNR did not have the site prepared for the trailer and could not raise fish at this site in 2006. The Manitowoc River trailer was utilized on the Manitowoc in 2007 but sat idle in 2008 and was moved for the 2009 rearing season to the Kewaunee River as a more suitable and more permanent location.

These trailers have been used since 2006 to produce large fingerling lake sturgeon for rehabilitation in selected Lake Michigan streams. From 2006-2011, over 13,500 lake sturgeon were raised and stocked using SRF's.

Growth and condition varied by facility and year, but in all cases were comparable to what was observed in traditional hatcheries. Variation across SRF's was likely influenced by the combination of water temperature/quality, length of growing season, density of fish in rearing facility tanks, and feeding regimes. In most years, Manistee, Milwaukee, and Kewaunee SRF reared fish maintained a larger size during the growing season and reached a larger mean size at release than Whitefish River and Cedar River SRF fish. Growth and condition of SRF reared fish was also similar to that observed in wild Lake Michigan populations.

Two movement studies were conducted as part of this grant. Wisconsin investigated the movement patterns of recently stocked lake sturgeon fingerlings in the Milwaukee and Kewaunee Rivers from egg donor populations while LRBOI investigated the movement patterns of wild and SRF-reared lake sturgeon in the Big Manistee River. In Wisconsin's study, the hydrophone receivers recorded movement at night, indicating that fingerling lake sturgeon must move almost exclusively during night time hours. Secondly, the Wisconsin study showed that these fish, in general, moved rapidly down the river and into the harbor or lower estuary of each river after about 30 days. This pattern of downstream dispersal of age 0 lake sturgeon, predominantly at night, during summer to early fall has also been documented in wild populations (Holtgren and Auer 2001, Auer and Baker 2002, Benson et al 2005, Caroffino et al. 2009). Because these fish appear to be acting similar to wild fish and they were raised and imprinted on local river water there are minimal concerns about these SRF reared fish straying from home streams to spawn with established populations when they become sexually mature.

The LRBOI study shows that the movement patterns and habitat selected between SRF-reared and wild lake sturgeon were very similar. The average weekly distances traveled by SRF fish ranged from 0.05–

2.28 km (of 46 km surveyed) while wild fish traveled 0.04–2.81 km (Mann et al. 2011). Both SRF and wild fish used common benthic habitats. Indications from this research suggest that by September of each year the SRF-reared age-0 lake sturgeon attained a size similar to that of their wild cohorts and exhibited similar movement patterns and substrate association.

FINAL NARRATIVE REPORT

Project Title:	Lake Sturgeon Rehabilitation Using Streamside Rearing Facilities
Project Number:	2005.671
Grantee Organization:	US Fish and Wildlife Service (financial fiduciary)
Project Team:	Mr. Bradley Eggold, Mr. Michael Baumgartner, Mr. Steve Fajfer - Wisconsin Department of Natural Resources
	Dr. J. Marty Holtgren - Little River Band of Ottawa Indians
	Dr. Edward Baker - Michigan Department of Natural Resources
	Mr. Robert Elliott - U.S. Fish and Wildlife Service
	Mrs. Mary Holleback - Riveredge Nature Center, Inc
Contact Person:	Mr. Bradley Eggold, Wisconsin DNR, Bradley.Eggold@Wisconsin.gov
	Mr. Robert Elliott, USFWS, Robert_Elliott@fws.gov
Grant Amount:	$583,212
Start and End Dates:	January 2006 – December 2012
Key Search Words:	Lake Sturgeon, Streamside Rearing, Restoration, Rehabilitation

THE INFORMATION PROVIDED BELOW IS TO AUGMENT THE FULL TECHNICAL REPORT THAT WAS PROVIDED TO THE GLFT ON 12/19/2012.

BACKGROUND / OVERVIEW

1. PROJECT DESCRIPTION AS OUTLINED IN THE ORIGINAL PROPOSAL

The main goal of this project was to design, build, deploy and operate four trailers converted to streamside rearing facilities (SRF) and to continue operation of a 5th streamside facility to raise fingerling lake sturgeon for stocking in the Lake Michigan Basin in Michigan and Wisconsin. The Great Lakes Fishery Trust grant provided funding for this multi-agency collaboration which included the Little River Band of Ottawa Indians (LRBOI), Michigan DNR (MDNR), Wisconsin DNR (WDNR) and the United States Fish and Wildlife Service (USFWS). Northern Environmental, Inc. was selected to build the four new rearing trailers. The SRF design was based on a facility they had designed and built with LRBOI for use

on the Big Manistee River, MI (Holtgren et al. 2007). Over the course of several years of operation by LRBOI several key modifications were identified that were incorporated into the design of the four new trailers. The main changes were to increase the number of rearing tanks from 2 to 4, increase the stream water filtering capabilities and installation of an improved emergency alarm system.

The main goal for the use of these trailers is for 25 years to annually stock up to 1,500 fingerling lake sturgeon originating from at least 4 and preferably 8 females per river into reintroduction rivers and to collect up to 10% of wild produced eggs and/or larvae to rear to fall fingerling size for release back into rehabilitation rivers (Welsh et al. 2010). It is expected that these efforts should build up a spawning stock of lake sturgeon in each river system capable of naturally reproducing and providing a sustainable population in the future.

The four new SRFs were delivered in April 2006. Three of the trailers were immediately deployed and set up on the West Branch Whitefish River and Cedar River in Michigan and the Milwaukee River in Wisconsin (Table 1.). The fourth trailer was deployed on the Manitowoc River in 2007 and then moved to the Kewaunee River in 2009. .

The four new SRFs are managed by Michigan and Wisconsin DNRs utilizing a mixture of permanent fisheries staff, limited term employees, Department staff from other bureaus and volunteers. The Milwaukee River SRF is installed on property owned by Riveredge Nature Center, Inc. in Newburg, Wisconsin. Riveredge is responsible for the daily operations of this trailer and provides staff and 20 – 30 volunteers for this program. Without the efforts from Riveredge staff and volunteers, the rehabilitation efforts on the Milwaukee River would not be as successful. The Little River Band of Ottawa Indians has managed and operated the Big Manistee River facility since 2004 and have released fish annually that were reared from wild captured eggs and larvae.

Table 1. Description of the four Streamside Rearing Facilities

Date Deployed	Location of SRF	Duration	Rearing Technique	Lake Sturgeon status	Targeted number for stocking
April 2006	West Branch Whitefish River, MI	2006 to present *	Forced egg collection	Extirpated	1,500 per year
April 2006	Cedar River, MI	2006 to present **	Forced egg collection	Extirpated	1,500 per year
April 2007	Manitowoc River, WI	2007	Forced egg collection	Extirpated	1,500 per year

April 2006	Milwaukee River, WI	2006 to present	Forced egg collection	Extirpated	1,500 per year
April 2009	Kewaunee River, WI	2009 to present	Forced egg collection	Extirpated	1,500 per year
April 2004	Manistee River, MI	2004 to present	Wild larvae and eggs	Remnant population	50% of wild production
* No fish were available in 2008					
** Cedar River facility was shutdown in June of 2006 and no fish were available in 2008					

2. SIGNIFICANT CHANGES TO THE WORK PERFORMED IN COMPARISON TO THE ORIGINAL PROPOSED PLAN OF WORK AND HOW CHANGES AFFECTED ABILITY TO ACHIEVE THE INTENDED OUTCOMES

The SRFs have generally been in operation since 2006 with the following exceptions. 1) the Manitowoc River SRF did not start operation until 2007, was idle in 2008, and was moved to the Kewaunee River starting in 2009. This delay and move was because of permitting and water quality issues on the Manitowoc that complicated site selection and preparation. The Kewaunee River SRF has operated annually since 2009. 2) The Cedar River trailer was shut down in June 2006 due to failed gamete collection efforts on the Menominee River but both Whitefish River and the Milwaukee River SRFs produced lake sturgeon for stocking in 2006. 3) In 2008, efforts to collect gametes for the Michigan SRF's failed so no fish were stocked into those rivers in 2008. These delays early in the program will simply delay the final 25 year plan by 1-2 years for some facilities.

Although the annual average number of fish stocked from each trailer has ranged widely from 64 to 1,007, rearing techniques have been refined over time. These improvements have increased the success in recent years and from 2009-2011 resulted in increased consistency and numbers with 4,888, 3,653 and 2,828 fingerling lake sturgeon produced respectively.

OUTCOMES

3. TO WHAT EXTENT AND HOW DID THIS RESEARCH PROJECT ADVANCE SCIENTIFIC KNOWLEDGE OF THE ISSUE?

For a full discussion of the results of this project, refer to the full technical Final Report titled *Lake Sturgeon Rehabilitation Using Streamside Rearing Facilities Project Number: 2005.671* submitted to the GLFT on 12/19/2012.

The main goal for this project was to design, build, deploy and use streamside rearing facilities and to demonstrate that streamside rearing facilities were a viable option for the restoration of Lake Sturgeon

into Lake Michigan. This main goal has been reached and surpassed as additional trailers have been installed at the Kalamazoo and Ontonagon Rivers as a direct result of the success of this project. The full list of accomplishments from this project are listed below and more thoroughly detailed in the discussion section below.

1. Four new SRFs were constructed during the fall and winter of 2005 and delivered in April 2006. They were deployed on the Whitefish River and Cedar River in Michigan and the Milwaukee River in Wisconsin. The fourth trailer was to be deployed on the Manitowoc River, WI but WDNR did not have the site prepared for the trailer and could not raise fish at this site in 2006.
2. These trailers have been used since 2006 to produce large fingerling lake sturgeon for rehabilitation in selected Lake Michigan streams. From 2006-2011, over 13,500 lake sturgeon were raised and stocked using SRF's (Table 3).
3. Growth and condition varied by facility and year, but in all cases were comparable to what was observed in traditional hatcheries.
4. Two movement studies were conducted as part of this grant. In Wisconsin's study, the hydrophone receivers recorded movement at night, indicating that fingerling lake sturgeon must move almost exclusively during night time hours. Secondly, the Wisconsin study showed that these fish, in general, moved rapidly down the river and into the harbor or lower estuary of each river after about 30 days. The LRBOI study shows that the movement patterns between SRF-reared and wild lake sturgeon were very similar; average weekly distances traveled by SRF fish ranged from 0.05–2.28 km (of 46 km surveyed) while wild fish traveled 0.04–2.81 km (Mann et al. 2011).
5. Genetically, the goals of these efforts focus on two-parts. First, the restored population is ideally a genetically diverse, healthy, and sustainable population capable of adapting to all ecological stressors that the population encounters. Second, the introduction of propagated fish into the larger Lake Michigan and Great Lakes basin is done in such a way as to minimize the threat to native, remnant lake sturgeon populations representing the remaining genetic reservoir of Lake Michigan (and other Great Lakes) lake sturgeon. Based on the results during this project, additional larval rearing tanks were added to each facility beginning in 2012 so that up to 8 female families could be reared separately through the period of early development when most of the mortality of reared larvae occurs including that mortality that might be variable between female families. After this period of elevated mortality and as reared larvae

outgrow these 8 separate larval rearing tanks, progeny from 2 female families can be combined in equal numbers into the 4 larger rearing tanks for the remainder of the rearing season when mortality is low and less likely to be female specific.

4. TO WHAT EXTENT AND HOW DID THIS PROJECT CONTRIBUTE TO THE EDUCATION AND ADVANCEMENT OF GRADUATE OR UNDERGRADUATE STUDENTS FOCUSED ON GREAT LAKES FISHERY ISSUES?

The majority of work completed for this project was done by agency staff from WDNR, MDNR, LRBOI, and Riveredge Nature Center, with support assistance from the U.S. Fish and Wildlife service. As such, the opportunities for extensive education of graduate or undergraduate students were limited. However, UW-Stevens Point led the genetic evaluation component of this project that involved several students and completion of a graduate student project, and education of staff and volunteers at each facility did involve students who were pursuing graduate and undergraduate degrees. Specific contributions are listed below.

- UW-Stevens Point graduate student worked exclusively on the genetic component of this project. His Master's Degree titled "Propagation Practices and Genetic Resources in Lake Sturgeon Rehabilitation" was integral for the success of the project.

- Wisconsin DNR partnered with Riveredge Nature Center, a diverse 370 acre "learning laboratory" on the Milwaukee River, the educational opportunities are vast. Riveredge offers curriculum development to schools, continuing education for teachers, an urban and rural outreach program, and a wide range of educational enrichment programs for the general public. This Lake Sturgeon Project is becoming fully integrated into the continuing education courses offered at Riveredge, providing a way to reach thousands of students and the public.

- In addition to permanent staff working at each facility, WDNR, MDNR and LRBOI hired numerous seasonal or limited term employees to assist with spring field work and daily trailer operations. Many of these employees were in college or recent graduates. Working on this project gave them great field experience in a variety of fisheries areas that will benefit them in the long-term to secure permanent employment. Three LRBOI seasonal employees went on to Graduate Projects which focused on Great Lakes research.

- Implementation of this project led directly to the development and funding of a related project conducted by Michigan State University and Funded by the GLFT to evaluate lake sturgeon

stream-side culture methods and develop operating procedures tailored specifically for each river-based facility to enhance survival and rearing success

- Presentations of project development and implementation were given at Great Lakes Coordination meetings, at National, State, and University level Chapter meetings of the American Fisheries Society, and at Midwest Fish and Wildlife Conferences, all of which are attended by many students.

5. TO WHAT EXTENT AND HOW DID THIS WORK HELP YOU OR OTHERS ON YOUR TEAM BUILD NEW RELATIONSHIPS WITH OTHERS IN THE RESEARCH OR MANAGEMENT COMMUNITIES?

Although this project did not result in significant new relationships, existing relationships among the agencies and scientists involved in the project were broadened and strengthened. In particular, the commitment to lake sturgeon restoration in the Great Lakes has been strengthened and frequent communication among the project participants continues. Recaptures of fish released from the streamside rearing trailers is increasing and data sharing among agencies and project participants continues to expand our collective knowledge of lake sturgeon in Lake Michigan.

6. TO WHAT EXTENT AND HOW DO THE FINDINGS HAVE ACTION IMPLICATIONS FOR FISHERY MANAGERS? DO YOU HAVE ANY KNOWLEDGE OF USE OF THE FINDINGS BY MANAGERS? TO WHAT EXTENT DID THE RESEARCH ADVANCE THE PROCESS OF IDENTIFYING MANAGEMENT RESPONSES TO CRITICAL ISSUES?

Findings from this project have confirmed that lake sturgeon rearing in relatively small streamside rearing facilities can be successfully carried out. As a result, management agencies committed to lake sturgeon restoration in Great Lakes tributaries agree that lake sturgeon stocked in Great Lakes tributaries should be raised in streamside facilities. In Michigan and Wisconsin, all lake sturgeon being stocked into Great Lakes tributaries with direct access to the lake are being raised in streamside facilities.

7. CONSIDERING THE ABOVE OR OTHER FACTORS NOT LISTED, WHAT DO YOU CONSIDER TO BE THE MOST IMPORTANT BENEFITS OR OUTCOMES OF THE PROJECT?

The most important benefit of this project (and in consideration of other data on lake sturgeon) is the long-term maintenance of lake sturgeon biological and genetic diversity as lake sturgeon restoration proceeds.

RELATED EFFORTS

8. WAS THIS PROJECT A STAND-ALONE EFFORT, OR WAS THERE A BROADER EFFORT BEYOND THE PART FUNDED BY THE GLFT? HAVE OTHER FUNDERS BEEN INVOLVED, EITHER DURING THE TIME OF YOUR GLFT GRANT OR SUBSEQUENTLY?

This project was a direct result from an initial grant from the Great Lakes Fishery Trust to the Little River Band of Ottawa Indians to design, build and operate the first streamside rearing facility on the Great Lakes for Lake Sturgeon on the Big Manistee River. This project then built off the success of that initial project by building and deploying four more trailers for the Whitefish River and Cedar River in Michigan and the Milwaukee and Kewaunee Rivers in Wisconsin.

As a direct result from these initial grants, money was made available either from internal agency sources or from other granting agencies to continue the streamside rearing facilities beyond the first three years of operation. These additional sources are listed below.

Table 2. Other financial support for the streamside rearing facilities, non-permanent salaries.

Funding Source	Amount	Time frame	Agency	Purpose
Great Lakes Fish and Wildlife Restoration Act	$40,000	2006 – 2009	Wisconsin DNR	Lake Sturgeon Marking
Wisconsin DNR	~$4,000	2006 – present	Wisconsin DNR	Streamside rearing facility support
Michigan DNR	$21,000	2006 – present	Michigan DNR	Streamside rearing facility support
Little River Band of Ottawa Indians	~$100,000	2004 – present	Little River Band of Ottawa Indians	Streamside rearing facility support
US Fish and Wildlife Service	$170,000	2012-2014	Wisconsin DNR Michigan DNR Little River Band of Ottawa Indians	Facility upgrades and operation support
Great Lakes Fish and Wildlife Restoration Act	$330,000	2012 – 2014	Wisconsin DNR Michigan DNR Little River Band of Ottawa Indians	Streamside rearing facility support
Great Lakes Restoration Initiative – Bureau of Indian Affairs	~$30,000	2012-Present	Little River Band of Ottawa Indians	

As a direct result from the success of this project, two additional streamside rearing facilities have been designed, built and operated for the Ontonagon River on Lake Superior and the Kalamazoo River on Lake

Michigan. Upon completion of this GLFT funded project, this project team successfully proposed and secured funding from the Great Lakes Fish and Wildlife Restoration Act and from the US Fish and Wildlife Service for continued operation through 2014 of the 5 rearing facilities funded by this GLFT project and the operation of 3 additional facilities operating on the Kalamazoo River (Lake Michigan tributary), the Black River (Lake Huron tributary), and the Ontonagon River (Lake Superior tributary). This additional funding also provided for expansion and upgrading of facilities including increased separate family rearing capacity (from 4 to 8), additional filtration facilities to improve water quality, improved pumps to stabilize flow delivery and reduce filtration needs, and additional backup facilities to reduce risk of system failures. The LRBOI also successfully secured funding through the Great Lakes Restoration Initiative through the Bureau of Indian affairs to contribute towards continued operation of the Big Manistee River facilitated and collection of eggs and larvae.

9. HAS THERE BEEN ANY SPIN-OFF WORK OR FOLLOW-UP WORK RELATED TO THIS PROJECT? DID THIS WORK INSPIRE SUBSEQUENT, RELATED RESEARCH INVOLVING YOU OR OTHERS?

As a result of this GLFT funded project, research has been conducted at the Black River Sturgeon Facility operated jointly by Michigan DNR and Michigan State University including the GLFT funded project "Scribner/Baker project "Enhancing the success of Great Lakes lake sturgeon restoration through development of standard operating procedures for stream-side hatcheries" that stemmed directly from results of this initial GLFT funded Lake Sturgeon Streamside Rearing project. These research items were inspired by issues at these streamside rearing facilities that have and will aid in the annual production of Lake Sturgeon. Some of the results include best practices to collect and fertilize gametes, feeding rates, type of feed, rearing conditions among others. Because of the effectiveness of the streamside rearing facilities (and support by funders, such as the GLFT) new applications are being implemented. The Little River Band of Ottawa Indians will be using their facility to protect and hold wild captured lake sturgeon during sea lamprey treatments performed on the Big Manistee River and Muskegon River. This application may greatly increase survival of lake sturgeon during sea lamprey treatment years.

COMMUNICATIONS / PUBLICATIONS OF FINDINGS

10. LIST PUBLICATIONS, PRESENTATIONS, WEBSITES, AND OTHER FORMS OF FORMAL DISSEMINATION OF THE PROJECT DELIVERABLES, TOOLS, OR RESULTS, INCLUDING THOSE THAT ARE PLANNED OR IN PROCESS.

Baumgartner, M. 2012. Kewaunee River Streamside Rearing Facility, Coolwater Fish Culture Conference, Iowa

Baker, E. and B. Eggold. 2008. Lake Sturgeon Restoration Using Streamside Rearing Facilities on Four Lake Michigan Tributaries. 2008 Great Lakes Lake Sturgeon Coordination Meeting, Sault Saint Marie, MI.

Clapp, D.F., R.F. Elliott, S.J. Lenart, and R.M. Claramunt. 2012. Inshore and benthivore fish communities. In The state of Lake Michigan in 2011. Edited by D.B. Bunnell. Great Lakes Fish. Comm. Spec. Pub. 12-01.

Elliott, R.F. 2008. Status and trends of lake sturgeon. In The state of Lake Michigan in 2005. Edited by D.F. Clapp and W. Horns. Great Lakes Fish. Comm. Spec. Pub. 08-02. pp. 41-47.

Holtgren, M. 2007. Use and evaluation of streamside rearing techniques. Great Lakes Fishery Commission Lake Committee Meetings, March 21-22, 2007. Ypsilanti, MI.

Holtgren, M. 2008. Operation and evaluation of a streamside rearing facility for lake sturgeon in the Manistee River, MI. 2008 Great Lakes Lake Sturgeon Coordination Meeting, Sault Saint Marie, MI.

Roffler, L.S., B.L. Sloss, B. Eggold, T. Burzynski, R. Burch, and E. Baker. 2008. Genetic resources in lake sturgeon restoration using stream-side rearing facilities. 69th Annual Midwest Fish and Wildlife Conference. Columbus, OH.

Roffler, L.S. and B.L. Sloss. 2008. Genetic diversity implications of lake sturgeon stream-side rearing. 138th Annual meeting of the American Fisheries Society. Ottawa, Ontario, CA.

Roffler, L.S., B.L. Sloss, B. Eggold, T. Burzynski, and R. Bruch. 2007. Maintenance of genetic diversity in Lake Sturgeon restoration stocking. Wisconsin Chapter of the American Fisheries Society Annual Meeting. Wausau, WI. (Best Student Presentation Award)

Roffler, L.S., B.L. Sloss, B. Eggold, T. Burzynski, and R. Bruch. 2007. Genetic diversity and stream-side rearing facilities in lake sturgeon conservation. The 2007 Midwest Fish and Wildlife Conference, Madison, WI.

White, M. 2008. Use of volunteers in the daily operation of a lake sturgeon streamside rearing facility on the Milwaukee River, WI. 2008 Great Lakes Lake Sturgeon Coordination Meeting, Sault Saint Marie, MI.

11. PLEASE CHARACTERIZE YOUR EFFORTS TO SHARE THE FINDINGS OF THIS RESEARCH WITH STATE, FEDERAL, TRIBAL, AND INTERJURISDICTIONAL (E.G., GREAT LAKES FISHERY COMMISSION) AGENCIES CHARGED WITH MANAGEMENT RESPONSIBILITIES FOR THE GREAT LAKES FISHERY.

The project team has created formal presentations, posters, and reports based on this project which are listed above. In addition to these, the project team has presented updates and findings from the streamside rearing project to a variety of fisheries agencies including the Wisconsin DNR, Michigan DNR, Little River Band of Ottawa Indians, US Fish and Wildlife Service, Lake Michigan Technical Committee, Lake Michigan Committee, Great Lakes Fishery Commission and Lake Sturgeon Coordination Meetings. During these meetings, project team members updated staff on the progress of the project including status of the trailer operations, gamete collections, fry and fingerling numbers, stocking numbers, problems and issues, budgets and overall project status. In addition, project team members held regular conference calls to discuss the project averaging about 4 to 6 calls per rearing season.

Project team members are also members of the Lake Michigan Technical Committee (Eggold and Holtgren) and Lake Michigan Committee (Eggold) and related Lake Sturgeon Task Group and Benthivore Work Group (Elliott, Baker, Holtgren, Eggold) and have provided these committees with numerous updates over the course of this project. They have received positive feedback from these updates and have relayed those to the rest of the team. Both Committees have been fully supportive of the project and have appreciated the constant updates provided by team members.

12. PLEASE IDENTIFY TECHNICAL REPORTS AND MATERIALS ATTACHED TO THIS REPORT BY NAME AND INDICATE FOR EACH WHETHER YOU ARE REQUESTING THAT GLFT RESTRICT ACCESS TO THE MATERIALS WHILE YOU SEEK PUBLICATION.

Full Technical report titled *Lake Sturgeon Rehabilitation Using Streamside Rearing Facilities Project Number: 2005.671* with attached MS Thesis, *PROPAGATION PRACTICES AND GENETIC RESOURCES IN LAKE STURGEON REHABILITATION* **was submitted to the GLFT on 12/19/2012**.
No further restriction of access to these materials is requested.

13. MANUSCRIPTS. GRANTEES SUBMITTING ONE OR MORE PUBLICATIONS OR PENDING PUBLICATIONS IN LIEU OF A STAND-ALONE TECHNICAL REPORT MUST SUBMIT A COVER MEMO THAT CONFIRMS THAT ALL ASPECTS OF THE FUNDED RESEARCH ARE INCORPORATED IN THE PUBLISHED WORK, AND IN CASES OF MULTIPLE PUBLICATIONS, IDENTIFIES OR CROSSWALKS THE GRANT-FUNDED OBJECTIVES TO THE PUBLISHED ARTICLE CONTAINING RESULTS.

None attached.

14. COMPILATION REPORTS. GRANTEES WORKING ON SEVERAL RELATED SUB-PROJECTS UNDER A SINGLE GRANT MAY SUBMIT A SERIES OF SUB-PROJECT REPORTS RATHER THAN A SINGLE, INTEGRATED REPORT. HOWEVER, GRANTEES MUST SUBMIT A COVER SHEET OR INTRODUCTION THAT OUTLINES AND CROSSWALKS GRANT OBJECTIVES WITH THE LOCATION OF THE RESULTS IN THE COMPILATION DOCUMENT.

None attached.

DISCUSSION

For a full discussion of the results of this project, refer to the full technical Final Report titled *Lake Sturgeon Rehabilitation Using Streamside Rearing Facilities Project Number: 2005.671* submitted to the GLFT on 12/19/2012.

As the project team developed the objectives for the project, we intentionally wanted to create a set of objectives that would focus on the design and building of streamside rearing facilities that would be able to rear and stock Lake Sturgeon on an annual basis. These specific goals and results are outlined below:

1. Design and build streamside rearing facilities on the Milwaukee and Manitowoc Rivers, Wisconsin and Cedar and Whitefish Rivers, Michigan.

    - Four new SRFs were constructed during the fall and winter of 2005 and delivered in April 2006. They were deployed on the Whitefish River and Cedar River in Michigan and the Milwaukee River in Wisconsin. The fourth trailer was to be deployed on the Manitowoc River, WI but WDNR did not have the site prepared for the trailer and could not raise fish at this site in 2006.

2. Use streamside rearing facilities to annually rear and stock lake sturgeon in each river.

    - These trailers have been used since 2006 to produce large fingerling lake sturgeon for rehabilitation in selected Lake Michigan streams. From 2006-2011, over 13,500 lake sturgeon were raised and stocked using SRF's (Table 3).

3. Compare growth and condition factors of SRF lake sturgeon to hatchery reared and wild lake sturgeon.

    - Growth and condition varied by facility and year, but in all cases were comparable to what was observed in traditional hatcheries. Variation across SRF's was likely influenced by the combination of water temperature/quality, length of growing season, density of fish in rearing facility tanks, and feeding regimes. In most years, Manistee, Milwaukee, and Kewaunee SRF reared fish maintained a larger size during the growing season and reached a larger mean size at release than Whitefish River and Cedar River SRF fish. Sturgeon released from the Big Manistee River streamside rearing facility were similar in total length, weight and condition factor to their wild cohorts and in general, growth and condition of SRF reared fish was similar to that observed in wild Lake Michigan populations.

4. Assess short-term movement patterns and river retention of stocked lake sturgeon.

    - Two movement studies were conducted as part of this grant. Wisconsin investigated the movement patterns of recently stocked lake sturgeon fingerlings in the Milwaukee and Kewaunee Rivers from egg donor populations while LRBOI investigated the movement patterns of wild and SRF-reared lake sturgeon in the Big Manistee River. In Wisconsin's study, the hydrophone receivers recorded movement at night, indicating that fingerling lake sturgeon must move almost exclusively during night time hours. Secondly, the Wisconsin study showed that these fish, in general, moved rapidly down the river and into the harbor or lower estuary of each river after about 30 days. This pattern of downstream dispersal of age 0 lake sturgeon, predominantly at night, during summer to early fall has also been documented in wild populations (Holtgren and Auer 2001, Auer and Baker 2002, Benson et al 2005, Caroffino et al. 2009). Because these fish appear to be acting similar to wild fish and they were raised and imprinted on local river water there are minimal concerns about these SRF reared fish straying from home streams to spawn with established populations when they become sexually mature.

    - The LRBOI study shows that the movement patterns between SRF-reared and wild lake sturgeon were very similar; average weekly distances traveled by SRF fish ranged from

0.05–2.28 km (of 46 km surveyed) while wild fish traveled 0.04–2.81 km (Mann et al. 2011). Indications from this research suggest that by September of each year the SRF-reared age-0 lake sturgeon attained a size similar to that of their wild cohorts and exhibited similar movement patterns and substrate association

5. Collect, analyze and archive tissue samples from adult broodstock and representative progeny to determine a) genetic diversity of stocked fish, b) genetic diversity of returning adults in future years, and c) straying rates in future years.

    - The targets and suggestions that follow are, in many cases, based on best principles and based, in part, on the guidance of Welsh et al. (2010). The SRFs are a work in progress in terms of their overall impact and strategic implementation to rehabilitative and restoration efforts. Genetically, the goals of these efforts focus on two-parts. First, the restored population is ideally a genetically diverse, healthy, and sustainable population capable of adapting to all ecological stressors that the population encounters. Second, the introduction of propagated fish into the larger Lake Michigan and Great Lakes basin is done in such a way as to minimize the threat to native, remnant lake sturgeon populations representing the remaining genetic reservoir of Lake Michigan (and other Great Lakes) lake sturgeon.

      Throughout the pilot implementation of the SRFs, attempts were made to adhere to all genetic recommendations of Welsh et al. (2010). These specific guidelines included: (i) targeting an $N_b \geq 20$ over 25 years (for a targeted $N_e \geq 500$) with a minimal N_b target of $\geq$ 8/year over a 25 year period (minimal $N_e \geq 200$); (ii) Sampling broodfish over the entirety of the spawning period and at multiple spawning locations; (iii) Spawning 5 males to each female without re-using males. Rear female/male families separately to ensure equalized family contributions; (iv) Mark and genotype all broodstock to minimize re-use in the propagation program and to establish a baseline for future evaluation.

      With four tanks the SRFs are designed to rear 4 separate lots of fish. During this project we focused on trying to rear 4 female families in each SRF, one per tank. Based on the table of Welsh et al. (2010) this use of 4 female families coupled with a target of 5 males

per female should result in an annual N_b = 13.3; less than the targeted 25 but greater than the minimum 8. Extrapolating across a 25 estimated generation time for lake sturgeon shows a predicted N_e using this strategy of 332.5. The increase in future SRF production to at least 5 females while adhering to a 5 male to 1 female strategy would result in a 25 year N_e = 500. However, this introduces concerns over mixing families and equalizing contributions.

The strategy of rearing females separately allows for control over female family contribution. As the genetic study of Roffler shows, male contribution, even with splitting female egg lots, is variable and not proportional at the end of each production year. However, space limitations preclude separate hatching and rearing of each female/male family in a facility like these. More than 4 females have been used successfully in the SRF at Milwaukee with a recognition that lower control over female family contribution occurs. Further research should be conducted to determine if an increased number of females (e.g., 2 per tank for a total of 8) can be reared in the SRFs without introducing biased survival greater than a random expectation. If so, efforts to use this higher number of females should be used for those facilities using a brood source where ample numbers of broodfish are available. The resulting N_b would be 26.7 with a 25 year N_e = 666.7. This suggests under the current design that no more than 8 females (crossed with 5 males each) should be used in any given year.

Using a flexible target of female families introduces a possibility that some tanks have single female families and others are a mix of more than one female. Until better data on the impacts of mixing female families are available, all reasonable efforts should be made to ensure densities are equal across tanks and females contribute approximately equal number of offspring to the ultimate stocked fish.

Based on these results, additional larval rearing tanks were added to each facility beginning in 2012 so that up to 8 female families could be reared separately through the period of early development when most of the mortality of reared larvae occurs including that mortality that might be variable between female families. After this period of elevated mortality and as reared larvae outgrow these 8 separate larval

rearing tanks, progeny from 2 female families can be combined in equal numbers into the 4 larger rearing tanks for the remainder of the rearing season when mortality is low and less likely to be female specific.

Table 3. Lake sturgeon Streamside Rearing Facility stocking summary data.

Year	SRF Location	Strain	# of Female Donors	# of Males Donors	# stocked	Mean Length (mm)	Mean Weight (gr)	Mark
2004	LRBOI-Manistee River	Manistee R (MI)	Larval Drift		3	154	14.7	PIT
TOTAL					**3**			
2005	LRBOI-Manistee River	Manistee R (MI)	Larval Drift		51	127, 168	8.7, 20.3	PIT
TOTAL					**51**			
2006	LRBOI-Manistee River	Manistee R (MI)	Larval Drift		92	205, 217, 245	37.6, 43.2, 59.7	PIT
2006	MI-Whitefish River	Menominee R (MI)	Larval Drift		25	137		LV+PIT
2006	WI-Milwaukee River	Wolf River (WI)	8	40	27	233	65.0	RV+PIT
TOTAL					**144**			
2007	LRBOI-Manistee River	Manistee R (MI)	Larval Drift		29	211-237	40-58	PIT
2007	MI-Cedar River	Menominee R (MI)	1	4	189	156		RV
2007	MI-Whitefish River	Menominee R (MI)	1	4	722	74		LV
2007	WI-Manitowoc River	Wolf River (WI)	4	20	64	202-220	38-54	LV+PIT
2007	WI-Milwaukee River	Wolf River (WI)	2	10	158	200-225	36-51	RV+PIT
TOTAL					**1162**			
2008	LRBOI-Manistee River	Manistee R (MI)	Larval Drift		47	184	28.5	PIT
2008	WI-Milwaukee River	Wolf River (WI)	4	20	767	131-183	9-27	RV+PIT
TOTAL					**814**			
2009	LRBOI-Manistee River	Manistee R (MI)	Larval Drift/Egg		34	172	22.2	PIT
2009	MI-Cedar River	Peshtigo R (WI)	4	18	75	94		RV
2009	MI-Whitefish River	Peshtigo R (WI)	3	12	198	70		LV
2009	WI-Kewaunee River	Wolf River (WI)	4	20	2543	90-196	6-30	LV+41%PIT

2009	WI-Milwaukee River	Wolf River (WI)	4	20	2038	73-162	2-17	RV+51%PIT
TOTAL					**4888**			
2010	LRBOI-Manistee River	Manistee R (MI)	Larval Drift		74	158-165	16-19	PIT
2010	MI-Cedar River	Peshtigo R (WI)	2	8	951*	79 , 124		RV+82%CWT+82%PIT
2010	MI-Whitefish River	Peshtigo R (WI)	2	8	1417*	71, 62		LV+64%PIT+64%CWT
2010	WI-Kewaunee River	Wolf River (WI)	4	20	19	202-232	32-51	LV+PIT
2010	WI-Milwaukee River	Wolf River (WI)	4	20	1192	132-208	11-37	RV+66%PIT
TOTAL					**3653**			
2011	LRBOI-Manistee River	Manistee R (MI)	Larval Drift		4	191	28.3	PIT
2011	MI-Cedar River	Peshtigo R (WI)	4	16	292	117		RV+PIT+CWT
2011	MI-Whitefish River	Peshtigo R (WI)	4	16	456	82		LV+CWT
2011	WI-Kewaunee River	Wolf River (WI)	6	30	460	151	14.4	LV+PIT
2011	WI-Milwaukee River	Wolf River (WI)	4	20	1616	87-184	3-31	RV+69%PIT
TOTAL					**2828**			

* = Several hundred larval fish also were stocked but not reported here. Survival expected to be very low.