2015 ST. LOUIS RIVER LAKE STURGEON SURVEY SUMMARY
St. Louis County, Minnesota and Douglas County, Wisconsin
Wisconsin Waterbody ID Code (WBIC): 2843800

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Executive Summary

Led by Minnesota Department of Natural Resources (MDNR), Wisconsin DNR (DNR) and Fond du Lac Band of Lake Superior Chippewa (FDL) assisted with a survey of lake sturgeon *Acipenser fulvescens* in May 2015. The purpose of the survey was to gather basic population information and to increase the number of tagged lake sturgeon for future recapture information in the St. Louis River and Lake Superior. The survey was conducted during a non-contiguous six-day period using backpack electrofishing, boat electrofishing, and hand netting. A total of 196 fish were captured and released, with 114 positively identified males. Total length ranged from 774 mm (30 in) to 1,465 mm (58 in) and averaged 1,168 mm (46 in). Of the 196 fish, 14 were recaptured (11 with initial tagging information) from previous tagging surveys, whereas 182 fish were not previously tagged. Annual growth computed from years-at-large between capture events was inversely related with initial lengths at capture. Based on agency records, previously tagged fish were initially tagged throughout the St. Louis River and along Lake Superior's south shore from the City of Superior east to Chequamegon Bay and Michigan's Sleeping Bay, nearly 150 miles east of the St. Louis River. Fourteen lake sturgeon had curled fins, a trait typically associated with hatchery-reared fish. In addition to gathering lake sturgeon data, the survey exemplified the efficiency of using backpack electrofishing gear in a large river under relatively low-flow conditions.

Introduction

The St. Louis River is a border water of the states of Wisconsin and Minnesota, and lake sturgeon are jointly managed by the Minnesota and Wisconsin Departments of Natural Resources (MDNR, DNR) and the Fond du Lac Band of Lake Superior Chippewa (FDL). The river immediately downstream from Fond du Lac Dam is within the State of Minnesota, and this section contains the majority of lake sturgeon spawning grounds. As such, MDNR leads most sturgeon surveys. The organizations share the goal of rehabilitating the self-sustaining population that once existed prior to European settlement of the area.

Similar to surveys in recent years, DNR and FDL assisted Minnesota DNR in the 2015 survey. The surveys were and are conducted to better understand the population in the St. Louis River and Lake Superior through specific tasks: (1) implant tags in as many untagged fish as possible, and (2) gather common population index data such as length, weight, and sex of newly tagged and previously tagged fish. A retrospective outcome was an understanding of survey equipment needs and crew sizes in low river flow conditions.

Survey Area

As in previous surveys, the 2015 survey was conducted in the St. Louis River downstream from the Fond du Lac Dam (Figure 1). Located approximately 21 miles upstream from Lake Superior, the dam blocks any volitional upstream fish movement beyond the dam Predominant substrates in the survey area were large boulders and cobble, which included large boulders installed as part of a spawning habitat enhancement project in 2009. Much of the riverine and estuarine habitat consists of sand, silt, gravel, and cobble substrates and diverse submergent and emergent aquatic vegetation communities.

River flow approximated 1,100 cubic feet per second (cfs) during the first few days of the survey, and water temperature ranged from 14 to 16 degrees Celsius during that time (Figure 2). The wetted width in the backpack electrofishing and hand-netting area was approximately 350 feet, whereas that of the boat electrofishing area approximated 200 feet. Water depths averaged two feet and four feet in the backpack electrofishing and boat electrofishing areas, respectively. Water color was stained throughout the study reach, and water clarity was approximately two to three feet; generally good for stained water.

Methods

Overview

Adult lake sturgeon were collected using boat electrofishing, backpack electrofishing, and hand-netting during a non-contiguous six-day period in May 2015. For boat electrofishing, MDNR and FDL used boom electrofishing boat to capture, process, and release fish. For backpack electrofishing, the general procedure was for DNR crews to collect the fish with a backpack electrofishing unit and MDNR and FDL crews to process

and release the fish. Occasionally, the crews worked interchangeably to collect and process fish, particularly when hand-netting.

Water temperature data were taken from the U.S. Geological Survey gaging station 0404024000 at Scanlon, MN (http://waterdata.usgs.gov/mn/nwis/uv?site_no=04024000). River flow data at the dam were provided courtesy of Minnesota Power (N. Rosemore, Minnesota Power, personal communication).

Fish Collection

Boat electrofishing

Boat electrofishing was conducted from the base of the rapids at the cable barrier, just upstream from the Fond du Lac powerhouse, downstream to the campground and the Highway 23 bridge (Figure 1) near Chambers Grove. The electrofishing boat, owned and operated by MDNR, was operated in either a single or dual-boom, pulsed DC current configuration utilizing two dippers in addition to the operator (Figure 3).

Backpack electrofishing

Backpack electrofishing was conducted at the base of the Fond du Lac Dam spillway (Figure 4) using a DNR UW-ETS model APB-3 unit with pulsed DC current. The settings were approximately 300 Volts, approximately 1-2 Amps, 20% Duty Cycle, and 80 cycles-per-second Pulse Rate. DNR operated the backpack with short "burst" periods (6-8 seconds). A second crew member was staged a few feet downstream with a large dip net. If a stunned sturgeon surfaced during electrofishing, the sturgeon was guided into the larger dip net using the smaller dip net carried by the backpack operator or simply using the electrical field from the anode. All captured sturgeon were transferred to a holding tank (approximately 75-100 gallons) at the fish processing station on shore.

Hand-Netting

Hand-netting was employed at the base of the Fond du Lac Dam spillway in shallow water areas. As lake sturgeon were visually observed by dip-netters they were grasped at the caudal peduncle (i.e., "tailed"), then guided into a dip net. This was particularly effective on May 5, when dozens of fish were active in shallow water (Figure 5).

Fish Processing

Regardless of electrofishing method, all sturgeon were processed similarly. Total length (nearest millimeter), weight (nearest gram), and girth (nearest millimeter) were measured using a custom-built measuring board, a spring scale, and a tailor/soft tape measure, respectively (Figure 6). Sex was determined based on expelled milt or roe (i.e., gametes) during handling. A partial pectoral fin clip was taken for DNA analysis. Each fish was inspected for tags, such as PIT (passive integrated transponder) or Floy. A Biomark Model 601 PIT tag reader (Biomark, Inc., Boise, ID) was waved along the dorsal side of each fish approximately 8 to 12 inches from the posterior end of the head. If a tag was detected, its number was recorded. Otherwise, a new tag was implanted approximately 8 to 12 inches from the posterior end of the head (Figure 6).

Data Handling and Analysis

All data were entered into respective Wisconsin DNR and Minnesota DNR databases and summarized. DNR contacted agency personal to determine the locations at which the previously tagged fish were initially tagged. Length-frequency analysis, a two-sample t-test, and linear regression techniques were employed using the MS Excel Data Analysis ToolPak.

Results

A total of 196 lake sturgeon were handled during the survey, with 114 positively identified as males (Table 1). Eighty-one fish could not be accurately sexed, as gametes were not externally visible during processing. Total length ranged from 774 mm (30 in) to 1,455 mm (57 in) and averaged 1,168 mm (46 in) (Figure 7). Of the 196 fish, 14 were recaptured from previous tagging surveys (Table 2), whereas 182 fish were not previously tagged. Fourteen of the 196 fish had curled fins.

Twelve of the 14 recaptured lake sturgeon were traced to their initial tagging locations, although only 11 of the 12 had known initial tagging dates (Table 2). Of those traced to initial tagging, seven were initially tagged on the St. Louis River by MDNR, four were either Floy or PIT-tagged by WDNR (one at the mouth of Dutchman Creek, one at the mouth of the Amnicon River, and two in Chequamegon Bay), and one was Floy-tagged by Michigan DNR on a commercial fishing vessel in Sleeping Bay, nearly 150 miles east of the St. Louis River (Figure 8).

A positive relationship existed between total length (L) and total weight (W) (Figure 9), based on length-weight data pairs from 187 sturgeon, as follows:

$$\log_{10}(W) = 2.948(\log_{10}L) - 5.0913;\ r^2 = 0.8618;\ p < 0.0001$$

Total length measured in this survey (year 2015) and total length measured at initial tagging (variable years from 2000 through 2014) were used to infer annual growth rates for the 11 sturgeon with known initial tagging dates. Annual growth was correlated with the number of years-at-large ($r^2 = 0.3966$; $p = 0.04$) (Figure 10), and the average growth of these 11 fish was 19.1 ± 7.4 mm/year (0.75 ± 0.29 inches /year). Two individuals initially tagged during a 2014 survey grew 10 mm (0.4 in) and 24 mm (0.9 in) in one year. The two sturgeon initially tagged during a 2001 survey grew 383 mm (15.1 in) and 543 mm (21.4 in) during the 14-year period since first capture, which, if generalized over the period of 14 years, grew 27 mm (1.1 in) and 38 mm (1.5 in) per year.

Five of the 11 recaptured lake sturgeon were initially tagged along Lake Superior's south shore from 2000 through 2006, whereas the other six sturgeon were initially tagged exclusively in the St. Louis River from 2010 through 2015. Those fish tagged from 2000 through 2006 were significantly smaller at initial tagging (range: 579-1,036 mm; average=838 mm) than those fish initially tagged from 2010 through 2015 (range: 1,020-1,215 mm; average=1,139 mm) (two-sample t-test, $t = 2.5$, $P = 0.02$).

Discussion

Fishery

The 196 lake sturgeon captured and released during this survey was the highest of any previous targeted adult sturgeon survey in the St. Louis River to date (A. Varian, Minnesota DNR, personal communication). This was likely attributable to the resultant low water conditions from minimal snowpack and rainfall, which enabled use of backpack electrofishing units and a large fish collection crew size. However, a general increase in the number of returning fish from rehabilitation efforts cannot be discounted. The 185 newly tagged lake sturgeon are expected to increase the number of recaptures in future surveys and contribute greater knowledge from which to manage lake sturgeon. Further, other aspects of the data set offer some insight regarding hatchery fish, growth rates, individual fish movement, and distribution.

Hatchery Fish

Seven percent of the lake sturgeon captured, including at least one fish initially tagged in Chequamegon Bay, were likely of hatchery origin, based on the presence of curled fins (generally pectoral). This trait is common to sturgeon propagation (Hadley and Rotella 2009, Steffensen et al. 2010), and although considered a deformity with implications for sturgeon survival (Hadley and Rotella 2009), can serve as a unique mark of hatchery-reared fish. The potential for hatchery origin is also inferred from the length range of sturgeon (957 to 1,327 mm). This size group corresponds to an age range of 11 to 30 years according to surrogate length-at-age data for fish captured in Chequamegon Bay from 1988 through 2006 (Wisconsin DNR unpublished files). From 1983 to 2000, 14 sturgeon year classes were stocked, including 762,000 fry (annual mean ~ 76,000), 143,000 fingerlings (annual mean ~ 12,000), and 500 yearlings. Since not all stocked fish were marked, it is difficult to determine whether fish beyond the 7% were also of hatchery origin. Overall, however, this exemplifies the likelihood of hatchery-reared fish to recruit to spawning size and emigrate from and immigrate to the St. Louis River.

Growth

Of the 11 recaptured lake sturgeon with known initial tagging dates, the smaller (i.e., immature) fish were generally at-large for a longer period of time. Further, they grew more than the larger and presumably older (i.e., mature) individuals, which likely reflects greater somatic growth by immature fish compared to their mature counterparts that, instead, allocate energy to reproduction (Beamesderfer and Farr 1997, Peterson et al. 2007, Lyons 2012). Contrastingly, Smith and Baker (2005) did not find any correlations between growth and length at initial capture. The fish in their study were all of similar lengths and initially captured in two contiguous years (compared to the 15-year span of initial captures found in the current survey), which may have reduced the sensitivity to detect a relationship.

The larger fish were initially tagged and exclusively recaptured in the St. Louis River during the past five years through targeted tagging efforts of MDNR, FDL, and DNR during that time. Proportional with the numbers of larger recaptured fish was the

predominance of newly tagged fish greater than 1,000 mm (39 inches), which is within the range at which many male sturgeon are sexually mature (Probst and Cooper 1955, Golder and Associates 2011, IUCN Red List 2015) and recruit to a spawning population.

Migration

Lake sturgeon are known for their migratory behavior (Auer 1996, Wishingrad et al. 2014). In this survey, five recaptured sturgeon were initially tagged east of Superior and up to 150 miles east at Sleeping Bay, MI. These were primarily the smaller fish previously noted that were initially tagged in the early to mid-2000s. The other six sturgeon, were initially tagged in the St. Louis River from 2010 to 2014 as part of increased tagging efforts in St. Louis River during that time. The extent to which these fish migrated is not known.

Survey Conditions and Logistics

Ambient Conditions and Equipment

The lack of measureable snowpack and rainfall events created very favorable conditions to safely wade the river and operate a backpack electrofishing unit. In addition, the shallow water enabled crews to capture sturgeon solely by hand and with dip nets, which eliminated the need for additional equipment such as backpack electrofishing units and appurtenant supplies, as well as the need for specially trained personal to operate the units. Although the sole use of dip nets was new for capturing sturgeon in the St. Louis River spawning area, the method has been employed elsewhere. For example, Smith and Baker (2005) solely used dip nets to capture spawning lake sturgeon in the Upper Black River of Michigan and Wendel and Damman (2011) used dip nets in the Yellow River of northwest Wisconsin.

The ambient conditions of the 2015 survey prompted agency staff to recognize that low snow pack and low spring run-off conditions may be beneficial to capturing sturgeon using a large survey crew to optimize sturgeon collection in both reaches of the river. For surveys conducted in future years under conditions similar to the 2015 survey, agency staff should plan advance scheduling of additional crews to handle more individual sturgeon; this will maximize available labor to optimize sturgeon capture and handling. Also, advance planning for a boom-electrofishing boat crew and a dip net crew during optimal survey conditions would promote higher catches from which to increase the number of tagged sturgeon in this population. This will facilitate understanding the lake sturgeon population in the St. Louis River, as well as Lake Superior.

During a spawning walleye survey on May 4, 2015, a crew inadvertently observed 12 to 15 lake sturgeon below the Fond du Lac Dam spillway. At the time, the crew experimentally captured sturgeon using a backpack electrofishing unit and recognized the equipment's efficiency in low-water conditions. With a portable work-up kit, a four or five person crew could easily use a backpack shocker unit to capture sturgeon from the bottom of the rapids along each river bank up to the spillway. The crew also realized the potential efficiency of capturing sturgeon by hand and with dip nets, based on the shallow, placid water occupied by sturgeon.

Safety

The main safety issues with using backpack electrofishing gear were having electrofishing gear deployed in a larger river and dealing with moderate current over slippery, rock and boulder substrate. Cleats, studs, and/or felt soled wading boots would improve traction for staff capturing sturgeon, and wading depth should not exceed the waist level of the backpack operator. Communication between the backpack operator and other crew members is critical to ensure crew member awareness of when the electrofishing unit is operating and that all staff has secure footing prior to the commencement of electrofishing. Long-sleeved rubber (insulating) gloves, wading belts, and personal floatation devices should be required for all staff when conducting adult lake sturgeon surveys with backpack electrofishing gear.

Conclusions and Management Recommendations

1. Lake sturgeon that spawn in the St. Louis River can migrate relatively long distances along Lake Superior's south shore. Because of this migratory pattern, management decisions need to consider the large scope of habitat necessary for their life history.

2. Lake sturgeon growth is relatively slow based on recaptured fish, and in some years can be less than one inch. More detailed growth information from structures should be collected in future assessments.

3. Lake sturgeon can be effectively surveyed using backpack electrofishing equipment below the Fond du Lac Dam during low river flow and dam spill conditions.

4. Lake sturgeon surveys should be conducted annually during the next several years to increase the number of tagged sturgeon in the St. Louis River and western Lake Superior. The additional mark and recapture information from the surveys will inform resource managers of abundance and other population parameters. e information, population abundance and other parameters may be assessed.

5. This survey is a positive indicator that the lake sturgeon population is progressing toward rehabilitation. Rehabilitation was an objective of the most recent Lake Superior Management Plan (WDNR 1988).

Acknowledgements

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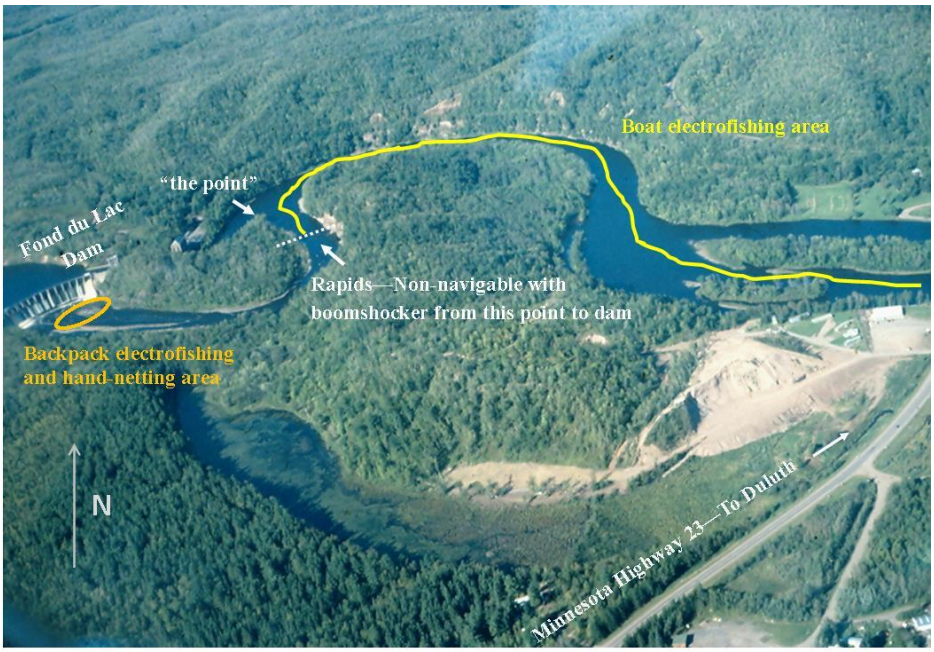

Figure 1. Aerial photograph of and survey locations in the St. Louis River from Fond du Lac Dam to Minnesota Highway 23, St. Louis County, MN and Douglas County, WI. Photo: Wisconsin DNR files; labels added.

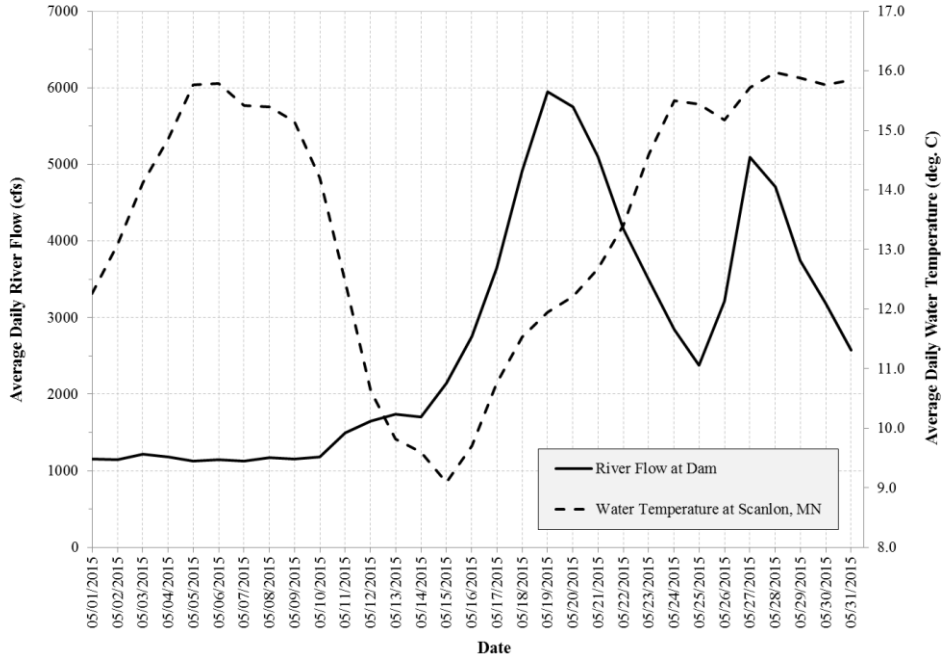

Figure 2. River flow at Fond du Lac Dam and water temperature of the St. Louis River at the USGS Scanlon Gage (No. 0402400), St. Louis County, MN, May 2015. River flow data courtesy of Minnesota Power.

Figure 3. Minnesota DNR electrofishing crew on the St. Louis River near "the point" and rapids, St. Louis County, MN and Douglas County, WI, May 2015. Photo by Paul Piszczek, Wisconsin DNR.

Figure 4. Wisconsin DNR (left) and Minnesota DNR (right) capture lake sturgeon below Fond du Lac Dam, St. Louis County, MN, May 2015. Photo by Paul Piszczek, Wisconsin DNR.

Figure 5. Spawning lake sturgeon below Fond du Lac Dam collectable by "tailing," St. Louis County, MN, May 2015. Photo by Paul Piszczek, Wisconsin DNR.

Figure 6. Minnesota DNR processes a St. Louis River lake sturgeon, St. Louis County, MN, May 2015. A: PIT tag reader scan, B: Length and girth measurement, C: Weight measurement, D: PIT tag implantation. Photos by Paul Piszczek, Wisconsin DNR.

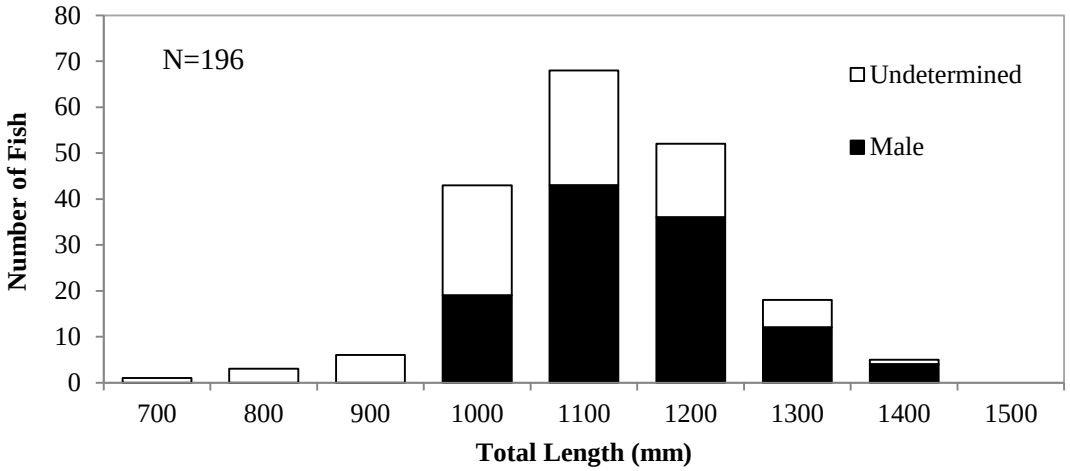

Figure 7. Length-frequency distribution of lake sturgeon captured and released in the St. Louis River, May 2015.

Figure 8. Location map showing initial tagging locations of lake sturgeon captured during a survey in the St. Louis River, May 2015.

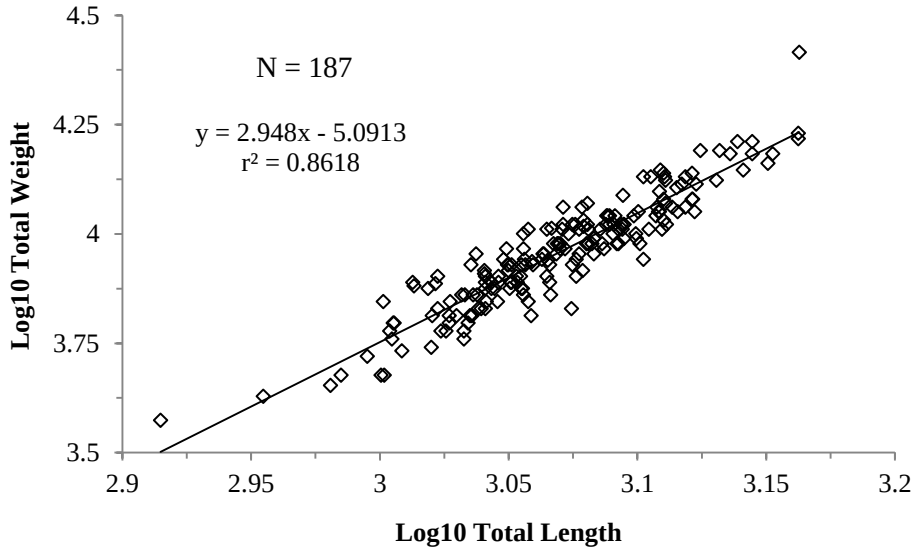

Figure 9. Log-linear length-weight regression for newly tagged and recaptured lake sturgeon in the St. Louis River, May 2015.

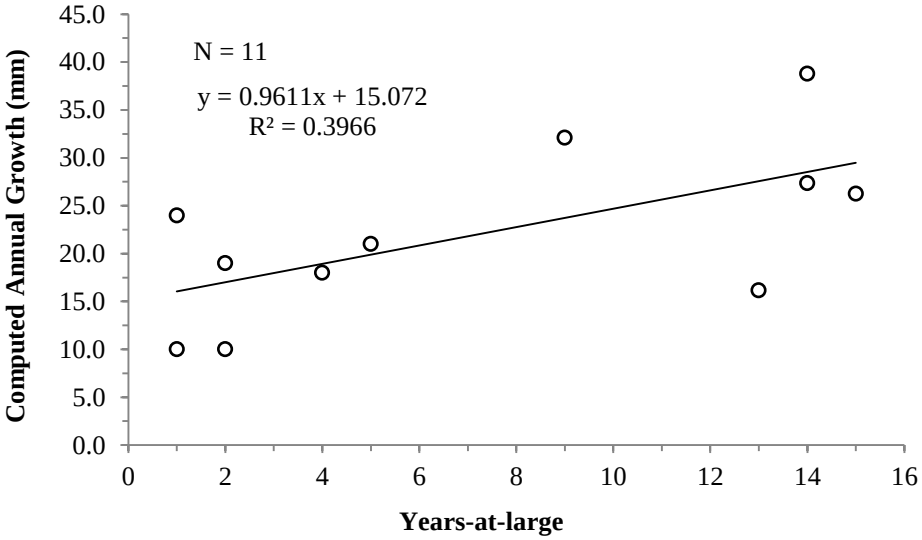

Figure 10. Relationship between years-at-large vs. computed annual growth for recaptured lake sturgeon in the St. Louis River, May 2015. Smaller fish were generally at-large longer than larger fish.

Table 1. Lake sturgeon summary for fish collected from the St. Louis River, St. Louis County, MN and Douglas County, WI, May 2015.

Description	Number
New sturgeon captured/handled	196
New PIT tags implanted	185
Recaptured sturgeon from previous surveys	14
Recaptured sturgeon with newly implanted PIT tagged fish from this survey	11
Sturgeon with curled fins	14
Females	0
Males	114
Unidentifiable sex	82

Table 2. Tag information, agency, and previous capture data for lake sturgeon with existing tags from the St. Louis River, May 2015.

Initial Tagging Date	Initial Length at Tagging (mm)	Length Measured in 2015 (mm)	Estimated Growth Since Initial Tagging (mm)	Initial Tagging Location	Sex	Agency	Tag Type	Tag Color, Number
05/22/2013	1128	1166	38	St. Louis R	M	MN DNR	PIT	900118000111621
05/19/2010	1138	1243	105	St. Louis R	M	MN DNR	PIT	985161000793790
05/22/2014	1209	1233	24	St. Louis R	U	MN DNR	PIT	982000180958849[4]
05/31/2013	1122	1142	20	St. Louis R	M	MN DNR	PIT	900118000111672
05/23/2014	1020	1030	10	St. Louis R	U	MN DNR	PIT	982000180958553
05/20/2011	1215	1287	72	St. Louis R	M	MN DNR	PIT	900118000111648
ni[1]	ni	1111	-	St. Louis R	M	MN DNR	PIT	982000180957560[4]
05/31/2000	983	1377	394	Chequamegon Bay, WI	M	WDNR	PIT	421E4D5D10
07/19/2001	579	1122	543	Mouth of Dutchman Cr, WI	M	WDNR	FLOY	Orange, F004655
06/20/2002	914	1124	210	Sleeping Bay, MI	U	MI DNR	FLOY	Yellow, 5603
07/19/2001	678	1061	383	Mouth of Amnicon R, WI	M	WDNR	FLOY	Orange, F004716
05/18/2006	1036	1325	289	Chequamegon Bay, WI	M	WDNR	FLOY; PIT	Orange, F009765; 4441473A3F[4]
ni	ni	1244	-	ni	M	unk[2]	PIT	4441361925N[4]
ni	ni	1064	-	ni	M	unk	Hole punch[3]	-

[1]ni = no information
[2]unk = unknown
[3]generally used for genetics analysis and not necessarily a tagging/marking attribute
[4]fish had curled fins (mainly pectoral)