STUDY PERFORMANCE REPORT

State: Michigan **Project No.:** F-35-R-24

Study No.: 682 **Title:** Pond rearing of juvenile lake sturgeon

Period Covered: April 1, 1998 to September 30, 1999

Study Objective: To determine the relationship between initial size, rearing density, and growth rate and survival of age-0 lake sturgeon in rearing ponds, and to measure size-dependent vulnerability to piscivores such as walleye.

Summary: In spring 1998, age-0 lake sturgeon were stocked into two ponds. Tube traps were deployed to capture juveniles and monitor growth, but no fish were caught. The ponds were surveyed once by divers; no sturgeon were seen. The ponds were drained in fall 1998. No juvenile lake sturgeon were recovered. It was suspected at the time that high July water temperatures in the ponds might have caused complete mortality of the juvenile sturgeon. A second experiment was done in summer 1999. On July 21, 1999, two ponds and one outdoor raceway were stocked with age-0 sturgeon (mean weight: 0.48 g; mean total length±1 SD: 51.3±5.7 mm). It was predicted that survival would be better in the raceway because water temperatures are cooler than in the adjacent ponds. Temperature recorders showed that average daily water temperatures in the raceway were 9.6°C cooler than in an adjacent pond. The raceway was drained on September 28, 1999; no juvenile lake sturgeon were recovered, but crayfish (*Orconectes virilis*) were abundant. The two ponds were drained on October 12, 1999. Of 40 sturgeon fry stocked into Pond 8, three sturgeon were recovered (7.5% survival; average weight: 28.9±6.2 g; average length: 208±19 mm TL, including two fish with caudal fin damage); however, about a dozen sturgeon had been sighted the day prior to pond draining. Of 160 sturgeon fry stocked into Pond 7, seven sturgeon were recovered (4.4% survival; average weight: 25.5±6.9 g; average length: 186±27 mm, including four with caudal fin damage). We released the ten surviving sturgeon into another pond, and within five minutes, adult crayfish had grabbed the caudal fin or peduncle of three of the sturgeon that had been resting on the substrate. Crayfish are abundant in these ponds and in the outdoor raceways. Predation by crayfish could explain the poor survival of age-0 lake sturgeon in our experiments. During July 24 to August 2, 1999, mean daily water temperature in Pond 5 exceeded 28.0°C, reaching 31.1°C on July 31, and yet 10 sturgeon survived in the ponds. Over the same period the mean daily temperature in the raceway did not exceed 22.0°C, but none of the 97 sturgeon in the raceway survived. High temperature now seems less likely, and crayfish predation seems more likely, to be the major cause of sturgeon fry mortality. Further experiments are planned for next year.

Job 1. Title: Stock ponds.

Findings: Michigan requested 30,000 eyed lake sturgeon eggs from Wisconsin's Menominee River egg take to be used at Wolf Lake Hatchery and the Saline Fisheries Research Station in 1998. But Wisconsin had some problems obtaining enough eggs in 1998, and consequently, fewer than anticipated eggs were received at the Wolf Lake Hatchery. No eggs from this source were available for use at the Saline ponds.

Also in 1998, eggs and milt were collected from lake sturgeon captured in the north channel of the St. Clair River, in the delta at the north end of Lake St. Clair. Some of the fertilized eggs were reared in aquaria at room temperature at the Mt. Clemens Fisheries Station on Lake St. Clair. Most of the eggs were reared at about 14°C in circular tanks at the Great Lakes Science Center of the U.S. Geological Survey, Biological Resources Division (USGS/BRD), in Ann Arbor. On June 12, 1998, lake sturgeon fry (*N* = 76, about 35 mm TL) in very good condition were obtained from Bob Haas (Mt. Clemens Fisheries Station) and stocked into Pond 6 at Saline. On July 24, 1998, additional lake sturgeon fry (*N* = 458) in very poor condition were obtained from Jerrie Nichols (USGS/BRD Great Lakes Science Center) and stocked into Pond 5 at Saline. This second group of age-0 sturgeon was from the same lot of eggs as the first group, but due to the cold rearing temperature and lack of food, they were smaller in size on July 24 than their siblings stocked on June 12.

In July 1998, we deployed a recording digital thermometer in Pond 5 because of concern about high water temperatures in the ponds (Table 1). In 1999, recording digital thermometers were deployed in the outdoor raceway (Table 2), Pond 5 (Table 3), and in two additional ponds (these data have not yet been analyzed).

In spring 1999, Wolf Lake Hatchery obtained fertilized lake sturgeon eggs from fish captured in the St. Clair River. Fry were reared at 78°F (25.6°C), and fed live brine shrimp. On July 21, 1999, we transported 300 age-0 lake sturgeon from Wolf Lake Hatchery to the Saline Fisheries Research Station. Average weight at the hatchery was 0.48 g, average length was 51.3 mm (SD = 5.7 mm, *N* = 20), and the fish appeared to be in good condition. Three fish (1%) died during transport. Pond 7 received 160 sturgeon and Pond 8 received 40 fish. Because of concern about high water temperatures in the ponds, we put 97 sturgeon into one of the six outdoor raceways (Number 1 North). The raceways are typically several degrees cooler than the ponds. During July 24 to August 2, 1999, the mean daily water temperature in the raceway did not exceed 22.0°C (Table 2). Over the same 10-d period, the mean daily temperature in Pond 5 exceeded 28.0°C, reaching a high of 31.1°C on July 31 (Table 3).

In 1999, because of concern about other fish species entering the sturgeon ponds from the water supply reservoir and becoming predators, a net was positioned to strain inflow water. A wooden frame supported a plastic five-gallon bucket with the bottom removed, and a nylon net with 2-mm mesh hung within the bucket. All inflow water passed through this net, and nets were checked every day or two. Small numbers of fish and crayfish were caught in these nets and removed.

Job 2. Title: <u>Monitor growth of lake sturgeon.</u>

Findings: In 1998 we unsuccessfully attempted to monitor the growth of juvenile lake sturgeon by capturing them with tube traps. These traps were cut from corrugated, flexible plastic tile into tubes 30-40 cm long, about 10 cm in diameter. The traps were open at one end, with 2-mm nylon mesh covering the other end. A cord attached to a float was tied to a hole near the open end, and the tube was sunk to the pond bottom using a large carriage bolt. It was hoped that juvenile lake sturgeon would seek refuge in these tubes, especially on sunny days, and that they could be captured by rapidly lifting the tube off the bottom. Although these traps did catch some crayfish, no sturgeon were captured.

One attempt was made in October 1998, by personnel from the USGS/BRD Great Lakes Science Center, to capture juvenile sturgeon in the ponds using a diver-operated seine. In addition, two SCUBA divers made a visual search of the pond. No sturgeon were caught or seen.

On September 28, 1999, the outdoor raceway was drained with the intention of measuring the growth of the sturgeon and transferring the survivors to a pond. However, none of the 97 stocked sturgeon were recovered.

Job 3. Title: <u>Drain ponds.</u>

Findings: Pond 6 was drained on October 13, 1998. No juvenile lake sturgeon were recovered. Pond 5 was drained on November 20, 1998. No juvenile lake sturgeon were recovered. However, we found 213 age-0 largemouth bass, with a mean length of 160 mm (range: 112-233 mm TL). It is not known how these fish got into the pond. The presence of these bass stimulated us to deploy nets to strain the pond inflow water in subsequent experiments.

At the end of the 1998 experiment we thought that the failed survival of the age-0 lake sturgeon may have been due to high water temperatures. Data from a recording digital thermometer (Ryan TempMentor, S/N 902686, deployment 13) indicated that water temperature in Pond 5 reached a maximum hourly value of 29.2°C on July 17, 1998, and that the average daily temperature ranged from 27.1°C to 28.0°C during July 17-23 (Table 1). The temperature was probably very similar in Pond 6. In Pond 5, the condition of the sturgeon fry at stocking was very poor, and they had been raised in cold water, so the high pond water temperatures in mid-July may have caused mortality. In Pond 5, it is possible that any sturgeon fry surviving the warm temperatures could have been eaten by the largemouth bass or crayfish.

In 1999, the outdoor raceway was drained on September 28, in order to transfer any surviving sturgeon fry to a pond. However, no sturgeon fry were recovered. Present in the raceway were significant numbers of adult crayfish (few juveniles were seen), two juvenile white suckers, two mottled sculpins, three central mudminnows, twenty five brook sticklebacks, and one fathead minnow.

Ponds 7 and 8 were drained on October 12, 1999. On October 11, as the water level was being lowered, about twelve lake sturgeon were sighted in Pond 8. Of 40 sturgeon fry stocked into Pond 8, only three sturgeon were recovered (7.5% survival; average weight: 28.9±6.2 g; average length: 208±19 mm TL, including two fish with caudal fin damage). We observed feces and tracks of a single great blue heron that had walked a distance of about 15 m through the pond (without meandering) as the water level was being lowered for draining. This heron may have captured some sturgeon. Of 160 sturgeon fry stocked into Pond 7, seven sturgeon were recovered (4.4% survival; average weight: 25.5±6.9 g; average length: 186±27 mm, including four with caudal fin damage). Adult crayfish were present in both ponds.

We released the ten surviving sturgeon into Pond 9, and within five minutes, adult crayfish had grabbed the caudal fin or peduncle of three of the sturgeon that had been resting on the substrate. All three sturgeon struggled to escape. We lifted one attacked sturgeon from the water and the crayfish came, too, holding on to the fish's caudal fin. The crayfish was removed and the sturgeon was tossed into deeper water. Crayfish are abundant in these ponds and in the outdoor raceways. Predation by crayfish could explain the poor survival of age-0 lake sturgeon in our experiments.

Job 4. Title: Evaluate vulnerability to predators.

Findings: No experiments have yet been conducted on vulnerability to predators. Because only a limited number of age-0 lake sturgeon were available, lab studies on vulnerability to predators were postponed until larger numbers could be obtained.

It is possible that predation by largemouth bass contributed to the failed survival of age-0 lake sturgeon in Pond 5 in 1998. However, no piscivores were present in Pond 6 and still no survivors were found. Tracks and feces of a great blue heron were observed only in Pond 8, and this heron might have captured some sturgeon just before pond draining. But given our direct observation of crayfish attack on large age-0 lake sturgeon, crayfish predation on lake sturgeon fry seems most likely to have been the major factor causing the failed survival. Crayfish were present in all of the experimental ponds and the raceway in both 1998 and 1999. We hope to conduct lab experiments in 2000 to further evaluate the potential for predation by crayfish on age-0 lake sturgeon.

Job 5. Title: Write progress report.

Findings: This progress report has been prepared.

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Date: September 30, 1999

Table 1.–Daily mean water temperatures in 1998, with monthly summaries, for Pond 5, Saline Fisheries Research Station. The monthly summaries are based on hourly values recorded with a digital thermometer (TempMentor S/N 902686, deployment 013).

Day	Jul	Aug	Sep	Oct	Nov
1		23.6	23.5	19.5	13.2
2		23.9	23.1	17.7	12.7
3		23.8	22.5	16.5	11.1
4		23.3	22.6	15.5	9.4
5		22.3	22.7	15.7	8.2
6		22.2	23.5	16.7	7.4
7		23.3	23.8	17.7	7.5
8		24.5	21.8	16.8	7.9
9		25.6	20.4	16.2	8.0
10		26.0	20.3	15.8	8.8
11		25.8	20.9	15.9	8.1
12		25.2	21.4	16.3	7.1
13		24.8	22.5	16.2	7.2
14		24.6	22.6	14.5	7.2
15		24.5	22.6	14.4	7.6
16		24.6	22.7	14.6	7.6
17	28.0	24.9	23.0	15.6	
18	27.3	25.3	22.7	16.0	
19	27.1	23.9	22.7	15.3	
20	27.7	23.4	23.2	14.5	
21	27.7	24.1	23.7	12.9	
22	27.5	25.1	22.6	11.7	
23	27.4	26.0	20.6	11.6	
24	26.2	26.5	19.0	12.0	
25	25.0	26.4	19.1	12.3	
26	24.3	25.9	20.4	12.6	
27	24.5	25.6	21.6	12.6	
28	25.0	24.8	21.4	13.2	
29	25.5	24.7	20.4	12.9	
30	24.5	24.6	20.6	13.0	
31	23.5	24.1		13.0	
Monthly average	26.1	24.6	21.9	14.8	8.7
Monthly minimum	22.6	21.7	18.0	10.7	6.6
Monthly maximum	29.2	27.5	24.7	20.6	13.4
Average daily range	2.2	1.8	1.9	1.3	1.1
Cum. degree days	391.1	763.1	658.0	459.3	138.9
Number of days	15	31	30	31	16

Table 2.–Daily mean water temperatures in 1999, with monthly summaries, for Raceway 1 North, Saline Fisheries Research Station. The monthly summaries are based on hourly values recorded with a digital thermometer (TempMentor S/N 901893, deployment 013).

Day	Jul	Aug	Sep
1		19.2	15.1
2		18.0	15.6
3		17.0	15.9
4		16.8	15.6
5		17.4	16.1
6		16.7	17.0
7		16.3	17.3
8		17.2	16.4
9		15.9	16.3
10		15.6	13.9
11		16.8	14.3
12		16.2	14.9
13		17.5	16.0
14		17.2	13.7
15		15.9	12.6
16		16.4	13.1
17		17.8	13.1
18		16.4	12.9
19		15.0	13.4
20		15.6	14.1
21		16.0	13.0
22		16.1	11.4
23		14.7	12.2
24	22.0	15.4	13.9
25	21.3	17.1	12.6
26	18.7	16.7	13.4
27	19.2	17.3	14.3
28	19.5	17.7	
29	19.8	16.7	
30	20.2	15.2	
31	19.5	15.3	
Monthly average	20.0	16.6	14.4
Monthly minimum	15.9	12.4	8.6
Monthly maximum	25.5	23.2	20.4
Average daily range	6.7	5.6	5.2
Cum. degree days	160.3	513.2	388.3
Number of days	8	31	27

Table 3.–Daily mean water temperatures in 1999, with monthly summaries, for Pond 5, Saline Fisheries Research Station. The monthly summaries are based on hourly values recorded with a digital thermometer (TempMentor S/N 904340, deployment 010).

Day	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1		3.7	12.8	17.0	23.3	25.1	30.1	24.1
2		3.7	13.3	18.0	23.7	25.0	28.8	24.6
3		3.6	14.3	19.0	22.5	26.3	27.3	25.2
4		2.8	14.7	19.8	22.7	28.4	26.9	25.2
5		3.3	13.4	20.1	23.4	30.3	26.5	25.5
6		1.7	13.2	20.0	25.2	30.7	25.8	26.3
7		1.4	12.5	19.6	27.2	29.3	25.3	26.2
8		3.0	14.3	18.9	28.1	28.5	25.2	
9		3.6	13.3	18.7	28.3	28.0	24.2	
10		3.8	11.7	19.2	28.7	26.7	24.2	
11		4.2	11.1	19.7	29.7	26.1	23.7	
12		4.5	10.8	19.7	29.9	26.5	24.5	
13		4.4	12.1	17.7	28.6	26.7	25.1	
14		4.7	12.9	17.0	27.3	27.0	24.7	
15		5.0	13.5	18.9	24.8	27.5	23.8	
16		5.7	12.2	20.0	23.3	28.1	24.3	
17		6.8	11.8	21.3	22.5	28.6	26.0	
18		6.4	11.7	21.9	21.9	27.7	25.4	
19	3.9	5.8	12.1	21.2	22.7	27.5	24.1	
20	3.9	6.8	12.8	21.6	23.0	27.2	23.3	
21	3.9	6.8	13.4	22.2	24.3	27.1	23.9	
22	3.8	5.6	12.9	22.3	25.1	27.5	24.5	
23	3.8	6.1	11.7	21.0	26.1	28.1	24.2	
24	3.8	7.1	11.2	19.1	27.3	28.4	23.5	
25	3.9	6.9	12.4	16.3	28.0	29.0	23.5	
26	4.1	6.7	14.1	16.7	28.3	28.6	23.8	
27	4.0	7.6	15.2	18.7	28.4	28.2	24.2	
28	4.0	8.7	14.7	19.7	28.4	28.9	25.4	
29		10.3	14.8	21.7	27.8	29.6	25.6	
30		10.7	15.9	23.4	26.3	30.4	24.2	
31		11.9		23.9		31.1	24.0	
Monthly average	3.9	5.6	13.0	19.8	25.9	28.0	25.0	25.3
Monthly minimum	3.5	0.0	9.0	14.7	20.7	24.0	22.0	22.8
Monthly maximum	4.8	14.1	18.0	24.6	30.9	32.7	31.6	28.1
Average daily range	0.6	1.9	2.1	2.4	2.2	1.9	1.9	2.6
Cum. degree days	39.1	173.1	391.0	614.3	776.9	868.2	775.9	177.1
Number of days	10	31	30	31	30	31	31	7