STUDY PERFORMANCE REPORT

State: Michigan **Project No.:** F-80-R-1

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

Period Covered: October 1, 1999 to September 30, 2000

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: This year we monitored growth of surviving age-0 lake sturgeon from last year's pond experiment, began new pond experiments to evaluate the effect of crayfish on lake sturgeon survival, and conducted laboratory predation experiments using age-0 lake sturgeon as prey. Two ponds were stocked in July 1999, with age-0 lake sturgeon (mean weight: 0.48 g; mean total length±1 SD: 51.3±5.7 mm). These ponds were drained in October 1999, and a total of ten survivors were recovered (5.0% survival). These ten survivors were measured, photographed, and released the same day into Pond 9 (average weight: 26.5±6.5 g; average length: 193±26 mm, including six fish with caudal fin damage). This pond was drained in April 2000, when three lake sturgeon were recovered (30% survival), and again in July 2000, when two were recovered. Using photographs from October, April, and July, we were able to individually identify the survivors, based on natural individual variation in spots and patches of color on the head, back, and fins. Over winter, from October to April, the fish doubled in mass, gaining an average of 30±8 g in mass and 29±7 mm in length. From April to July the two survivors increased more than three times in mass and gained an average of 138±10 mm in length. After almost exactly one year of growth in Saline ponds, the two surviving age-1 lake sturgeon had reached 161 and 249 g in mass and 323 and 376 mm in length. On August 2, 2000, we obtained 1000 age-0 lake sturgeon from Wolf Lake State Fish Hatchery; eggs had come from the Sturgeon River in Michigan's Upper Peninsula. Each of four ponds was stocked with 100 age-0 lake sturgeon. To evaluate the effect of crayfish density on lake sturgeon survival, crayfish were trapped daily in two ponds but not trapped in the other two ponds. To evaluate the effect of lake sturgeon density on growth and survival, two additional ponds were each stocked with 200 fish, and crayfish were trapped daily. As of September 30, 2000, 11,969 crayfish had been trapped and removed from the four low-crayfish ponds. Another experiment was conducted to evaluate growth of largemouth bass fed bluegills or lake sturgeon. In this 14-day experiment, four juvenile largemouth bass were force-fed one bluegill per day, and four other largemouth bass were force-fed age-0 lake sturgeon each day. Of 56 feedings with bluegill, only one bluegill was regurgitated, and it was digested after being re-fed to the largemouth bass. Of 56 lake sturgeon feedings, 21 resulted in regurgitation; on several additional occasions, the largemouth bass behaved as if they were attempting to regurgitate the lake sturgeon, but were not successful. Because the purpose was to evaluate predator growth on the two diets, regurgitated lake sturgeon were re-fed up to two times to a predator. Largemouth bass force-fed bluegill gained 4.52±0.40 g (mean±1 SD; initial weight: 28.18±2.71 g), an average weight gain of 1.1%/d, whereas those force-fed lake sturgeon lost 0.21±0.68 g (initial weight: 29.78±4.91 g), an average change of -0.1%/d. Both groups were given similar total amounts of food over the 14 days (16.9±0.1 g

bluegill; 17.5±1.1 g lake sturgeon); fish fed bluegill retained all the food, but the fish that were fed lake sturgeon only retained 12.9±2.1 g due to regurgitation.

Job 1. Title: Stock ponds.

Findings: In spring 2000, Wolf Lake Hatchery obtained fertilized lake sturgeon eggs from fish captured in the Sturgeon River of Michigan's Upper Peninsula. The eggs had first been sent to a hatchery in Wisconsin. Fry were first reared on live brine shrimp, and later reared on frozen black fly larvae and midge larvae (bloodworms). On August 2, 2000, we transported 1000 age-0 lake sturgeon from Wolf Lake Hatchery to the Saline Fisheries Research Station. Average weight of these fish at the hatchery was 2.1 g, and the fish appeared to be in good condition. Sixty-one fish (6.1%) died during transport, including fifty-three that swam into and lodged themselves in the draining hose attached to the side of the transport tank. These 53 fish were 80±10 mm in total length (mean±SD), and 2.04±0.71 g in weight.

Six ponds were stocked with age-0 lake sturgeon on August 2, 2000, immediately after arriving at the Saline Fisheries Research Station. To evaluate the effect of crayfish density on lake sturgeon survival, 100 lake sturgeon were stocked into each of four ponds. Crayfish were trapped daily in two ponds (Pond 7 and Pond 8), but not trapped in two other ponds (Pond 10 and Pond 16). We are also evaluating the effect on growth and survival of doubling lake sturgeon density from 100 to 200 per pond; two additional ponds (Pond 6 and Pond 9) were each stocked with 200 fish, and crayfish were trapped daily. As of September 30, 2000, 11,969 crayfish had been trapped and removed from the four low-crayfish ponds.

Because of concern about other fish species entering lake sturgeon ponds from the water supply reservoir and becoming predators, a net was positioned to strain inflow water, as was done last year. 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: Monitor growth of lake sturgeon.

Findings: As reported last year, two ponds were stocked on July 21, 1999, with age-0 lake sturgeon (mean weight: 0.48 g; mean total length±1 SD: 51.3±5.7 mm). These ponds were drained on October 12, 1999, and a total of ten survivors were recovered (5.0% survival). These ten survivors were measured, photographed, and released the same day into Pond 9 (average weight: 26.5±6.5 g; average length: 193±26 mm TL, including six fish with caudal fin damage). Within five minutes, adult crayfish (Orconectes virilis) had grabbed the caudal fin or peduncle of three of the fish that had been resting on the pond substrate; we helped one lake sturgeon escape. This pond was drained on April 13, 2000, and three lake sturgeon were recovered (30% survival). These individuals were measured, photographed, and released back into Pond 9. Using the photographs from October and April, we were able to individually identify the three survivors from the ten stocked in April, based on the natural individual variation in spots and patches of color on the head, back, and fins. Over winter, from October to April, they had doubled in mass, gaining an average of 30±8 g in mass and 29±7 mm in length. This pond was drained again in July 2000, and two lake sturgeon were recovered. Based on photographs we were again able to identify which individuals survived. From April to July these two fish increased more than three times in mass and gained an average of 138±10 mm in length. After almost exactly one year of growth in Saline ponds, these two age-1 lake sturgeon had reached 161 and 249 g in mass and 323 and 376 mm in length.

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

Findings: Ponds 7 and 8 were drained on October 12, 1999. 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). 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 lake sturgeon into Pond 9, and drained this pond in April 2000, and July 2000. The results are described under Job 2.

The ponds stocked in August 2000, will be drained in December 2000, to evaluate the effects of reducing crayfish density and the effects of stocking density on growth and survival of age-0 lake sturgeon.

Job 4. Title: <u>Evaluate vulnerability to predators.</u>

Findings: Given our direct observation in October, 1999, of crayfish attack on 190-mm age-0 lake sturgeon, crayfish predation on lake sturgeon fry seems most likely to have been the major factor causing the failed survival in 1998 and 1999. Crayfish were abundant in all of the experimental ponds and the raceway in both years. We are conducting a pond experiment in 2000 to further evaluate the potential for predation by crayfish on age-0 lake sturgeon.

Some brief observations of crayfish-lake sturgeon interactions were made on August 3, 2000. Two adult female crayfish (52.6 and 45.6 mm carapace length) and two age-0 lake sturgeon (77 and 83 mm) were placed in a gray tub (ca. 41 x 54 cm) filled with water to a depth of about 8 cm. During a 15-minute observation period, the crayfish did not attack the fish, even when the crayfish walked over the top of the resting lake sturgeon. In a second 20-minute observation period with a single large male crayfish (49.1 mm carapace length), the two lake sturgeon were not attacked, although the crayfish touched the fish with its antennae. When the two lake sturgeon were placed with these three crayfish into a 161-liter aquarium (slate bottom, 43.5 cm wide, 90 cm long, filled to 41 cm deep), both species seemed to ignore each other until frozen midge larvae were introduced into the tank as food. Within a few minutes one lake sturgeon and the large male crayfish moved toward the same aggregation of midge larvae that had sunk to the bottom of the tank. Both individuals started ingesting midge larvae. When a lake sturgeon swam close to the crayfish, the crayfish grabbed it with its two large claws, and then slowly ate the fish over the next 60 minutes. The capture and ingestion was filmed on videotape. This further demonstrates that adult crayfish are capable of capturing and eating age-0 lake sturgeon.

Laboratory experiments were conducted using largemouth bass as predators and age-0 lake sturgeon as potential prey. In a prey-choice experiment, juvenile largemouth bass in individual aquaria were presented with equal numbers of juvenile bluegill and age-0 lake sturgeon. On each successive day, the number of surviving prey was noted and dead or ingested prey were replaced. For six largemouth bass followed for three days, almost all the bluegill prey were ingested or dead by the next day, but no age-0 lake sturgeon died and none were ever ingested.

Another experiment was conducted to evaluate growth of largemouth bass fed bluegills or lake sturgeon. In this 14-day experiment, four juvenile largemouth bass were force-fed one bluegill per day, and four other largemouth bass were force-fed age-0 lake sturgeon each day. Of the 56 feedings with bluegill, only one bluegill was regurgitated, and it was digested after being re-fed to the largemouth bass. Of the 56 lake sturgeon feedings, 21 resulted in regurgitation; on several additional occasions, the largemouth bass behaved as if they were attempting to regurgitate the lake sturgeon, but were not successful. Because the purpose was to evaluate predator growth, regurgitated lake sturgeon were re-fed up to two times to a predator unless regurgitation occurred during the night. Largemouth bass force-fed bluegill gained 4.52±0.40 g (mean±1 SD; initial weight: 28.18±2.71 g), an average weight gain of 1.1%/d, whereas those force-fed lake sturgeon lost 0.21±0.68 g (initial weight: 29.78±4.91 g), an average change of -0.1%/d. Both groups were given similar total amounts of food over the 14 days (16.9±0.1 g bluegill; 17.5±1.1 g lake sturgeon). Fish fed bluegill retained all the food (in one case after one re-feeding), but despite the re-feeding, fish that were fed lake sturgeon only retained 12.9±2.1 g due to regurgitation.

We conducted additional experiments to explore causes of the regurgitation observed in the growth experiment. One possible cause of regurgitation is physical irritation of the predator's mouth or throat by the sharp scutes of juvenile lake sturgeon as the food item is inserted into the stomach. Another possible cause is presence of an irritating chemical in the skin or meat of juvenile lake sturgeon. To evaluate these hypotheses we conducted three experiments in which we force-fed juvenile largemouth bass with 10-mg gelatin capsules (ca. 25 mm in length) containing either bluegill or lake sturgeon. These capsules fit easily into the fish's stomach. The following precautions were taken to reduce the chance of transferring a potentially irritating chemical from lake sturgeon skin to other capsules. Capsules containing bluegill were prepared on a wooden board, then scalpel and forceps were washed with soap and water and rinsed thoroughly before preparing capsules containing lake sturgeon on a separate board. Capsules containing lake sturgeon "meat" (carcass excluding skin and head) were prepared on one half of the board, and capsules containing skin were prepared on the other half. In the first gelatin-capsule experiment, capsules contained either (1) pieces of bluegill, (2) lake sturgeon skin including scutes, (3) lake sturgeon meat, or (4) lake sturgeon skin trimmed to exclude scutes. In this experiment, we used the same eight largemouth bass from the growth experiment. The largemouth bass were grouped in pairs, with one fish that had been force-fed bluegill paired with one that had been force-fed lake sturgeon. Each type of capsule was given to each pair of fish for two consecutive days, for a total of eight days. The results of this experiment differed according to previous feeding history of the largemouth bass. During the first two days, the four largemouth bass previously force-fed lake sturgeon regurgitated none of the food from the capsules, whereas the largemouth bass previously force-fed bluegill regurgitated neither of the two bluegill capsules but at least some of the contents of all six lake sturgeon capsules (i.e., both capsules of all three types). Over the entire 8-d experiment, largemouth bass previously force-fed lake sturgeon regurgitated only three capsules (one containing bluegill, one containing lake sturgeon skin with scutes, one containing lake sturgeon skin without scutes), whereas largemouth bass previously force-fed bluegill regurgitated 18 capsules (six capsules of lake sturgeon skin without scutes, and four capsules each of the other three types). Results show that regurgitation behavior depends on recent feeding experience, that regurgitation can occur in the absence of scutes, and that initial experience with lake sturgeon as food is likely to produce regurgitation behavior.

In a second feeding-capsule experiment, we used eight other juvenile largemouth bass from the Saline ponds (41.0±6.5 g, 151±6 mm). As in the previous experiment, capsules contained either (1) pieces of bluegill, (2) lake sturgeon skin including scutes, (3) lake sturgeon meat, or (4) lake sturgeon skin trimmed to exclude scutes. Individual bass received the same food for four consecutive days. Regurgitation occurred in only 5 of 32 capsule feedings: one with bluegill, two with lake sturgeon skin with scutes, two with lake sturgeon skin without scutes, none with lake sturgeon meat.

In a third feeding-capsule experiment, we used eight additional juvenile largemouth bass from the Saline ponds. We modified the treatments, replacing capsules containing lake sturgeon skin including scutes with a new control: capsules containing only water. In this 4-d experiment, regurgitation occurred in only 6 of 32 capsule feedings: 6 with lake sturgeon skin without scutes, none with water capsules, none with bluegill, none with lake sturgeon meat.

The results of these laboratory experiments suggest that some chemical in lake sturgeon skin, and not the presence of scutes, causes largemouth bass to occasionally regurgitate ingested lake sturgeon. This chemical may also be the reason that largemouth did not voluntarily ingest live age-0 lake sturgeon in laboratory choice experiments.

Job 5. Title: Write progress report.

Findings: This progress report has been prepared.

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Date: September 30, 1999