STUDY PERFORMANCE REPORT

State: Michigan **Project No.:** F-80-R-3

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

Period Covered: October 1, 2001 to September 30, 2002

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 started a pond experiment and completed two lab experiments. The goal of this pond experiment is to evaluate the effect of adult largemouth bass on lake sturgeon survival in ponds that contain crayfish. In July 2002, four ponds were each stocked with 100 age-0 lake sturgeon (mean weight: 2.0 g; mean total length: 81 mm). Two ponds had been stocked earlier with 50 adult largemouth bass. Our hypothesis is that direct and indirect effects of largemouth bass on crayfish will improve survival of age-0 lake sturgeon. The plan is to drain these four ponds in the spring of 2003 to measure sturgeon survival. Based on experiments and observations from previous years, we hypothesized that age-0 lake sturgeon might have a chemical defense that would cause fish predators to regurgitate them if they were ingested. An experiment was conducted in the laboratory to test whether largemouth bass would regurgitate gelatin capsules containing lake sturgeon more frequently than control capsules containing fathead minnows. The bass did not regurgitate capsules containing lake sturgeon more than capsules with fathead minnows. In an experiment that tested prey selection, twelve largemouth bass were held in individual aquaria, and two fathead minnows and two age-0 lake sturgeon were introduced into each aquarium. Any prey that were consumed or died were replaced each day for three days. For the twelve bass over three days, 63 fathead minnows were consumed, but no lake sturgeon were consumed. This experiment indicates that largemouth bass in aquaria do not voluntarily ingest age-0 lake sturgeon.

Findings: Jobs 1, 2, 3, 4, and 5 were scheduled for 2001-02, and progress is reported below.

Job 1. Title: <u>Stock ponds.</u>–We started a pond experiment on July 23, 2002, using age-0 lake sturgeon reared at Wolf Lake Hatchery. These age-0 lake sturgeon came from eggs and milt obtained from lake sturgeon captured in Michigan's Upper Peninsula. The eggs hatched at Wolf Lake Hatchery on June 5, 2002.

The experiment is intended to test whether presence of adult largemouth bass will improve survival of age-0 lake sturgeon in ponds containing crayfish. Results of previous experiments, as well as direct observations in the lab and in ponds, indicate that adult crayfish can be predators of age-0 lake sturgeon, reducing their survival. Adult largemouth bass reduce the number of crayfish through predation. Presence of largemouth bass is also likely to have an indirect effect on lake sturgeon survival by altering the behavior of crayfish. In ponds with predators such as adult largemouth bass, crayfish are expected to be less active and spend more time in burrows, further reducing the encounter rate between crayfish and lake sturgeon. Based on laboratory experiments conducted in summer 2000, and confirmed in the experiments from summer 2002, we would not expect largemouth bass to ingest many (if any) lake sturgeon.

Each of four ponds received 100 age-0 lake sturgeon (mean weight: 2.0 g; mean total length: 81 mm). Two ponds (Pond 6 and Pond 9) were previously stocked with 50 adult largemouth bass. The other two ponds (Pond 5 and Pond 7) are controls, with no other fish. Because of concern about other fish species entering lake sturgeon ponds from the water supply reservoir, a net was positioned to strain inflow water, as was done in previous years.

We set three crayfish traps in each pond on August 7, 2002, baited with fresh pieces of bluegill, to gain information about the effect of largemouth bass on crayfish density and behavior. We retrieved the traps the next day and measured carapace length and determined sex of crayfish in each trap. Control ponds averaged 38 and 26 crayfish per trap, with mean (±SD) carapace length of 40.3±4.2 mm and 43.4±9.2 mm for Pond 5 and Pond 7, respectively. (One trap failed in Pond 7; it came open in the pond.) Of ponds stocked with largemouth bass, Pond 6 had no crayfish in any of three traps. Pond 9 averaged 35.7 crayfish per trap, no different than control ponds, but mean (±SD) carapace length of 28.3±5.8 mm was much smaller than for control ponds. Bass may have had a dramatic effect on the density or behavior of crayfish in Pond 6; perhaps bass in Pond 9 are responsible for smaller sizes of crayfish observed there.

We plan to drain the ponds in spring 2003 and compare lake sturgeon survival in ponds with versus without largemouth bass. We expect much higher survival in ponds containing largemouth bass.

Job 2. Title: Monitor growth of lake sturgeon.–On one occasion, one of us snorkeled around one pond to look for lake sturgeon. None were observed. This pond had clear water, but aquatic macrophytes were abundant, so fish may have hidden in the plants. The other three ponds were sufficiently turbid that observation was considered impractical.

Job 3. Title: Drain ponds.–The current plan is to drain the four ponds in spring 2003 to evaluate lake sturgeon survival in ponds with versus without largemouth bass.

Job 4. Title: Evaluate vulnerability to predators.–Chemical defenses have been demonstrated not only in many species of terrestrial arthropods (Eisner 1970), but also in aquatic organisms (Hay 1996), including beetles (Gerhart et al. 1991), water mites (Kerfoot 1982), and fish (Tachibana et al. 1984). In fact, skin secretions toxic to fish have been reported in 60 species of fish from 18 different families (Kalmanzon et al. 1999). Based on experiments and observations from previous years, we hypothesized that age-0 lake sturgeon might have a chemical defense, possibly in the skin, that would cause fish predators to regurgitate them if they were ingested.

Juvenile lake sturgeon have sharp scutes that might mechanically irritate a predator's mouth, esophagus, or stomach, possibly causing a predator to eject this prey type. To reduce the possibility of mechanical irritation of the mouth or esophagus by scutes, pieces of juvenile lake sturgeon or fathead minnow were inserted into gelatin capsules, then the capsules were force-fed to largemouth bass. If juvenile lake sturgeon have a chemical defense, we expected that the chemical would induce regurgitation shortly after the gelatin capsule dissolved in the stomach.

Starting July 24, 2002, a 6-d experiment was conducted at the Saline Fisheries Research Station to test whether largemouth bass would regurgitate lake sturgeon more frequently than fathead minnows, consistent with chemical defense by juvenile sturgeon. To evaluate whether the presumed defensive chemical was in the skin or the rest of the body, we compared three types of feeding capsules: capsules containing lake sturgeon skin (with dorsal scutes removed), capsules containing the rest of the body (but not the head), and capsules containing pieces of fathead minnow, known to be a well-accepted prey item for largemouth bass. Each day for six days, four capsules of each type were prepared and one capsule was force-fed to each of twelve largemouth bass. Fathead minnow capsules were prepared first. Following rapid decapitation, a fish was cut into pieces that would fit into a 1-inch long, 0.25-inch diameter gelatin capsule (Fisher Scientific, gelatin capsules #00), and the capsule was immediately force-fed to a designated largemouth bass. After the four minnow capsules had been prepared and fed, we thoroughly washed the plastic cutting board, scissors, and scalpel in running tap water, changed latex gloves, and switched to a second set of instruments and cutting board. Following rapid decapitation of a lake sturgeon, the dorsal scutes were dissected out and the skin was separated from the rest of the carcass and placed in one capsule. The carcass (without the head) was placed in another capsule, and then capsules were immediately force-fed to designated largemouth bass. Starting on the second day of the experiment, at the conclusion of the force-feeding, one live fathead minnow was placed in each of the twelve aquaria to provide additional food for the bass. We recorded whether or not regurgitated food was observed in each tank in the 24 h after feeding.

The experiment used twelve largemouth bass (mean total length±SD: 214±27 mm; mean weight: 132±48 g) kept in individual 10-gallon aquaria. All bass were obtained from ponds at the Saline Fisheries Research Station. Six of the bass ("acclimated") had been held in their aquaria for at least six weeks. They appeared to be well acclimated to the holding conditions and readily fed on fathead minnows placed in their tanks. Six other bass ("unacclimated") were caught by angling 4-5 d before the start of the experiment. These were considered to be unacclimated to the lab conditions at the start of the experiment. Water temperature in each aquarium was measured daily with a digital thermometer; daily average temperature varied between 22.7°C and 24.9°C.

With three types of capsules (skin "S", carcass "C", and fathead "F"), there are six ways to give one of each type: SCF, SFC, FSC, FCS, CSF, or CFS. Each sequence was randomly assigned to one acclimated and one unacclimated bass in each 3-d period. Thus, each bass received two capsules of each type during the 6-d experiment. For the second 3-d period, each capsule was trimmed prior to filling so that the length was ¾ inch, rather than the original 1 inch.

Out of a total of 72 capsules fed to the bass, they regurgitated 11 capsules (15%): 5 fathead capsules, 4 carcass capsules, and 2 skin capsules. (A twelfth capsule, containing sturgeon skin, was regurgitated within 10 s of force-feeding. The capsule was still intact, and it was immediately re-fed to the bass. Because of the extremely short interval before regurgitation, because the capsule was intact, and because the re-fed capsule was not regurgitated, this event was not included in the total number of regurgitations.) The bass did not regurgitate capsules containing lake sturgeon more than capsules with fathead minnows. These results are not consistent with our hypothesis of a chemical defense by juvenile lake sturgeon.

Of the 11 regurgitations, 10 were by acclimated bass, 1 (a skin capsule) was by an unacclimated bass. The pattern of regurgitations was influenced more by the acclimation state of the bass than by the type of capsule. Perhaps unacclimated bass were more hungry and thus less likely to regurgitate items in their stomach.

It is conceivable that juvenile lake sturgeon have a chemical defense that acts only on the mouth or esophagus, and is less effective or rapidly deactivated in the stomach of fish predators. Perhaps a defensive chemical is associated with the dorsal scutes or the head, both of which were removed in our experiment. In such cases our experiment would not have detected a chemical defense. Although this experiment does not exclude the possibility of a chemical defense by juvenile lake sturgeon, it does not provide support for such a hypothesis.

A second experiment started on July 30, 2002, and evaluated prey selection by largemouth bass. The twelve largemouth bass used in the first experiment were held in the same individual aquaria. Two fathead minnows and two age-0 lake sturgeon were introduced into each aquarium. Prey that were consumed or found dead were replaced the next day for three days. The average length of the fathead minnows was 52±5 mm (N = 72). The average length of the lake sturgeon was 79±10 mm (N = 26). For each bass, the larger of the two sturgeon was 35-40% of the bass' length. Timmons and Pawaputanon (1980) found that largemouth bass could swallow bluegill, a deep-bodied, spiny-rayed fish, that were 40% of their length, so the bass would not be expected to have difficulty ingesting sturgeon of this relative size.

For the twelve bass over three days, 63 fathead minnows were consumed and 6 were found dead (presumably killed by the bass, based on apparent injuries). No lake sturgeon were consumed, but two were found dead in one tank (no injuries were obvious). Often, the fathead minnows were ingested within a few minutes of being placed in the tanks, and in such cases the only prey items available for the rest of the 24-h period were the two lake sturgeon. This experiment indicates that largemouth bass in aquaria do not voluntarily ingest age-0 lake sturgeon.

Because the largemouth bass did not voluntarily ingest juvenile lake sturgeon, we tried to trick the bass into ingesting them. We continued to hold the largemouth bass in individual tanks, and each day released 1-5 minnows one at a time by hand into each tank. After five days of such feeding, four bass were capturing each minnow within about 1 s after its entry into the tank. On the sixth day, we fed each of these bass a minnow, which was captured rapidly. Then we offered a sturgeon (74, 74, 77, 80 mm) to each of the four bass. Two of the four bass engulfed the sturgeon, but spit it out immediately; the other two bass did not ingest the sturgeon. All four sturgeon, including the two that had been captured by bass, were still alive 48 h later. The next day another sturgeon (67 mm) was offered to one of the four bass. The bass engulfed it very quickly and then spit it out very quickly. We then offered three minnows, which were promptly consumed, indicating that the bass was hungry. These observations are further evidence that largemouth bass do not prefer to ingest juvenile lake sturgeon. The reason for this behavior is not clear.

Job 5. Title: <u>Write progress report.</u>–This progress report has been prepared.

Literature Cited:

Eisner, T. 1970. Chemical defense against predation in arthropods. Pages 157-217 *in* E. Sondheimer and J. B. Simeone, editors. Chemical ecology. Academic Press, New York.

Gerhart, D. J., M. E. Bondura, and J. A. Commito. 1991. Inhibition of sunfish feeding by defensive steroids from aquatic beetles: structure-activity relationships. Journal of Chemical Ecology 17(7):1363-1370.

Hay, M. E. 1996. Marine chemical ecology: what's known and what's next? Journal of Experimental Marine Biology and Ecology 200:103-134.

Kalmanzon, E., E. Zlotkin, and R. Aknin-Herrmann. 1999. Protein-surfactant interactions in the defensive skin secretion of the Red Sea trunkfish *Ostracion cubicus*. Marine Biology 135:141-146.

Kerfoot, W. C. 1982. A question of taste: crypsis and warning coloration in freshwater communities. Ecology 63:538-554.

Tachibana, K., M. Sakaitani, and K. Nakanishi. 1984. Pavoninins: shark-repelling ichthyotoxins from the defense secretion of the Pacific sole. Science 226:703-705.

Timmons, T. J., and O. Pawaputanon. 1980. Relative size relationship in prey selection by largemouth bass in West Point Lake, Alabama-Georgia. Proceedings of the Annual Conference Southeastern Association of Fish and Wildlife Agencies 34(1980):248-252.

Prepared by: <u>James E. Breck and Elizabeth Hay-Chmielewski</u>
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