Juvenile Pallid Sturgeon in Laboratory Aquaria

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by

Jan Jeffrey Hoover, K. Jack Killgore *and* S. Reid Adams

U.S. Army Engineer Research and Development Center,
Waterways Experiment Station, 3909 Halls Ferry Rd., Vicksburg, MS 39180-6199

Acquiring a Rare and Endangered Species

Bizarre appearance, mysterious habits, and rarity make river sturgeons (*Scaphirhynchus* spp.) very interesting to native fish enthusiasts (Fig. 1). Young river sturgeons, in particular, are intriguing because they are not commonly displayed at public aquaria and because they are infrequently (if ever) captured by anglers or naturalists. Even professional ichthyologists have difficulty sampling the early life history stages of these enigmatic fishes. As a result, little is known about their biology and behavior.

We belong to a team of fish biologists at the U.S. Army Engineer Research and Development Center. Most of our field work consists of evaluating effects of Corps of Engineer projects on fish communities. We also conduct descriptive studies of threatened and endangered species, and several years ago began work with sturgeon. In autumn 1997, we learned that some small captive-bred pallid sturgeon (*Scaphirhynchus albus*), from the Missouri and Yellowstone Rivers, might be available for research. We contacted Gavins Point National Fish Hatchery in Yankton, South Dakota, one of the few facilities where this endangered species has been successfully bred.[1] Personnel there put us in touch with the Upper Midwest Environmental Sciences Center in LaCrosse, Wisconsin, where there existed a surplus of the Gavins Point fish (originally intended for use in toxicology experiments). Because our team is conducting habitat studies of sturgeons in the lower Mississippi River, we already had a permit from the United States Fish and Wildlife Service to capture and tag pallid sturgeon in the field. This permit was amended to allow us to receive and maintain the Gavins Point sturgeon for study in the laboratory.

Living Conditions and Daily Care

In early December 1997, we received 89 five-month old pallid sturgeon. They were sent to us, doublebagged in 11 styrofoam shipping boxes: seven boxes with seven fish each, four boxes with 10 fish each. Water was 12°C when fish were packed in LaCrosse. A day later, when fish arrived in Vicksburg, temperature had warmed only a few degrees. All fish were active and alert at time of arrival, with little evidence of handling-related stress.

The sturgeon were immediately transferred to two types of flowing, closed system aquaria: commercially manufactured Living Streams Model LS-510 (Frigid Units, Toledo, Ohio; Fig. 2) and locally-constructed Ferguson flumes (Baker et al., 1994; Fig. 3). Living Streams are rectangular tanks, slightly trapezoidal in cross-section, made of green fiberglass. They measure 170 cm by 44 cm by 59 cm and are filled with water to a depth of 40 cm. Water circulates slowly in a vertically elliptical pattern. A chiller/circulator unit mounted at one end of the tank behind a screen draws water up through an opening in the false bottom of the tank, discharges it

[1] Blind Pony State Fish Hatchery in Missouri was the first hatchery to successfully spawn pallid sturgeon in 1992. The Natchitoches National Fish Hatchery in Louisiana was the most recent in 1998.
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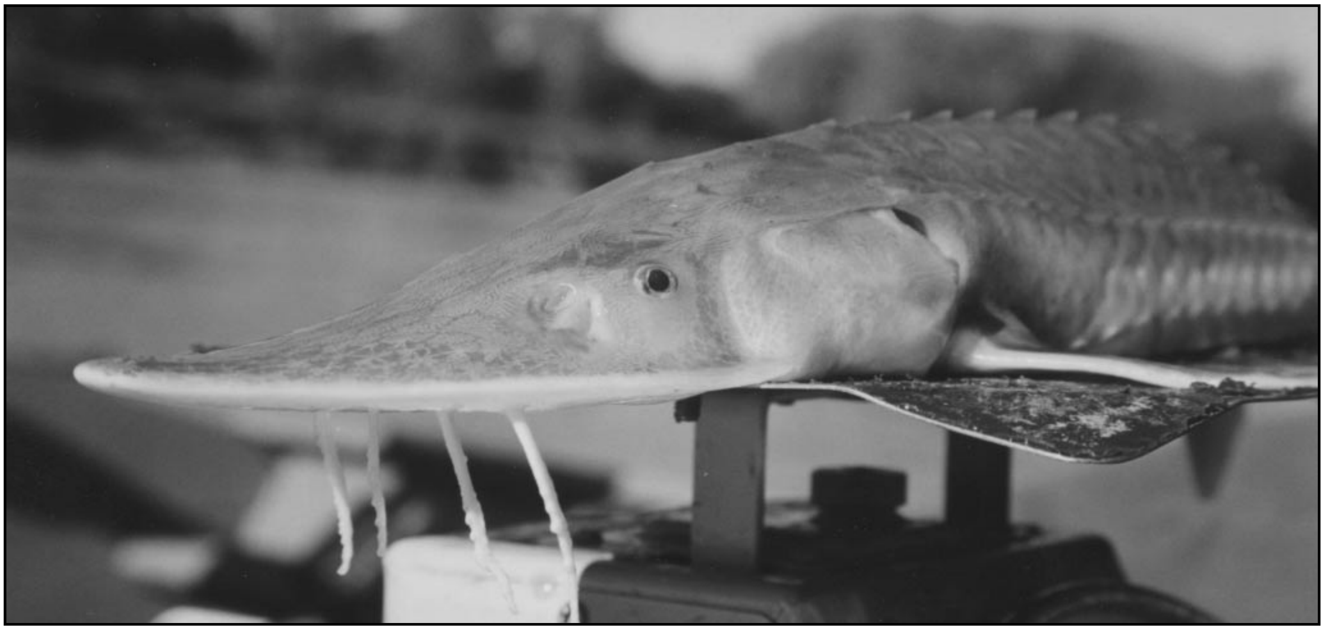

Fig. 1. Adult shovelnose sturgeon (*Scaphirhynchus platorynchus*) collected from the White River near Newport, Arkansas. Photograph by Jan Hoover.

along the length of the tank, through two fiberglass inserts of foam and carbon at the opposite end of the tank, and under the false bottom. Water volume is nearly 300 liters, of which 163 liters are available as living space for the fish. Cost of a Living Stream setup (tank, tank legs, and chiller/circulator) is approximately $3200 (Marcy Palmer, pers. comm.).

Ferguson flumes are rectangular tanks made of 12 mm thick clear Plexiglas. They measure 240 cm by 115 cm by 60 cm and are filled to a depth of 47 cm. A 150 cm Plexiglas partition divides the tank into two channels. Water is pumped through an opening into one corner of the tank by a Little Giant Pump Model 3/E1/2/N-R (Little Giant Pump Company, Oklahoma City, Oklahoma). Circulation within the flume is accelerated by a variable speed trolling motor mounted on a wooden frame over the flume. Water travels in a horizontally elliptical pattern, with higher velocities (20-60 cm/s) generated in upstream portions of the channel containing the motor, weaker velocities in the opposite channel (0-20 cm/s). Eddies form in the corners of the flume and along the partition, and water velocities form a mosaic-like gradient in both channels. At the completion of the circuit, water is drawn from the surface through an opening in the tank, falls through a self-assembled porous cylindrical filtration unit (i.e., a large pickle bucket, with holes drilled in the bottom, filled with foam, floss, and carbon). Water collects in a reservoir tank (cattle trough) beneath the flume in which it is circulated and chilled with a Remcor Liquid Circulator model CFF 500 (Remcor, Franklin Park, Illinois). Total water volume is approximately 1485 liters of which 1184 are available as living space for fish. Total water volume circulates through the filter approximately once every hour. Cost of materials for a Ferguson flume (exclusive of chiller, pumps, and pickle bucket) is approximately $2500.

Tank bottoms of Living Streams and Ferguson flumes were bare to prevent injury to the sturgeons' barbels and mouths (Fig. 4). Fish density was 10-12 fish/m^2. Temperature initially ranged from 17-20°C. Mean dissolved oxygen was 7.8 mg/l and pH 8.12. Fish were fed three times daily with Number 4 size Silver Cup Salmon Crumbles (Nelson and Sons, Murray, Utah). Swimming endurance and behavior were evaluated for individual sturgeon in a 100-liter Blazka-type Plexiglas swim tunnel (Beamish, 1978). Working section of tunnel is 39 cm long, 15 cm diameter. Swimming trials did not exceed eight hours, and most fish were tested only once. After swimming trials were completed, sturgeon were transferred to flumes that fluctuated with room temperature, i.e., 20-25°C. Our experiments did not harm the sturgeon and so, like retired racehorses, they were put out to pasture, allowing us to observe their behavior and development over the following year.

Fig. 2. Living Streams closed system aquaria. Photograph by Jan Hoover.

18 Months in an Aquarium

Juvenile pallid sturgeon are somewhat sluggish and lack the apparent complex behaviors of sunfishes and darters. In the continuous, linear flow of the swim tunnel, they swim in an undulating, serpentine manner, occasionally in midwater but more frequently skimming along the tunnel bottom; they cannot swim for extended periods in water velocities >40 cm/s (Adams et al., 1999). Pallid sturgeon, however, are capable of a distinctive stationholding behavior. Hunkering, or substrate appression, allows sturgeon to remain stationary in flowing water when they press themselves to the container bottom, arch their backs upwards, and turn their pectoral fins up and back to increase drag. Similar behavior is exhibited by adult shovelnose sturgeon (*Scaphirhynchus platorynchus*) and by some darters (Matthews et al., 1985; Adams et al., 1997).

In circulating flow of the Ferguson flumes, pallid sturgeon rest on the tank bottom most of the time, usually in groups of 3-5 fish. Their typically sedentary nature is reflected by their mode of breathing. Unlike paddlefish (*Polyodon spathula*) which must swim continuously to breathe, river sturgeon do not have to take water in through their mouths. Instead, they pump water in and out of their gill chamber, with their mouths closed; water enters through notches in the upper operculum and is expelled ventrally (Bemis et al., 1997). Sturgeon can creep about by walking on their pectoral fins, but more frequently swim slowly about by undulating their long tails, gliding over and around each other, staying close to the bottom. Individuals may stay in close proximity to each other, but move away when they touch their neighbors. When at rest, it is not uncommon to see individuals simultaneously raise their head and tails up and off the bottom in a curious arching posture. Occasionally, a fish surfaces and extends its rostrum up out of the water, a behavior similar to billing in paddlefish. Paddlefish will surface like this when crowded or stressed. Captive juvenile Gulf sturgeon (*Acipenser oxyrhynchus desotoi*) we

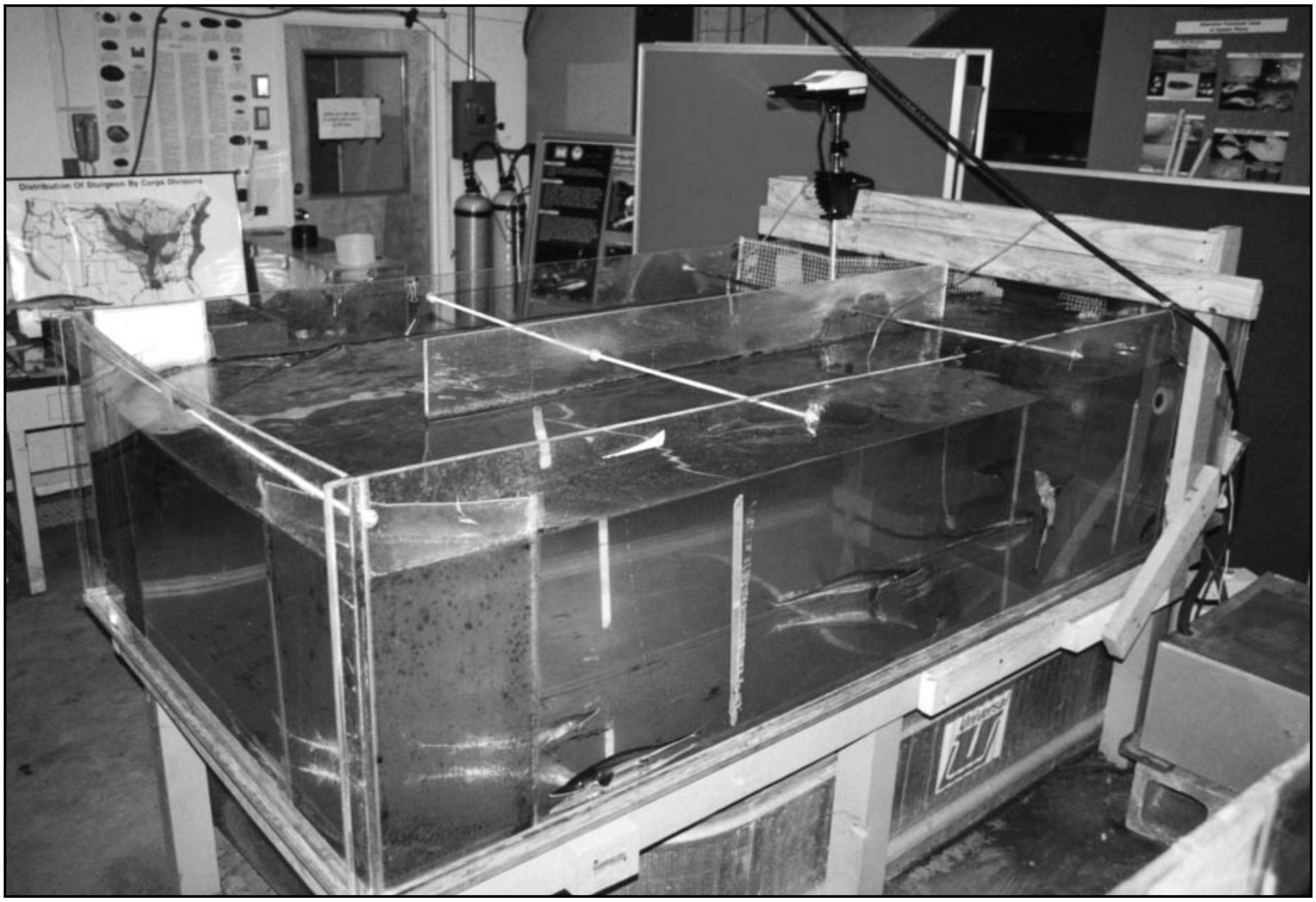

Fig. 3. Ferguson flume containing juvenile pallid sturgeon. Photograph by Jan Hoover.

maintained briefly did it as a conditioned response to being fed. Our pallid sturgeon, however, are neither stressed nor do they do it as a conditioned response. They are not easily startled, but when the flume is rapidly approached by an observer, or is bumped from the outside, the sturgeon will dart through the water at mid-depth or close to the surface. These sporadic bursts of intense activity render them ill-suited for small containers.

Growth of the pallid sturgeon was comparable to growth estimated for fish in nature. Fish were hatched at Gavins Point in July 1997 (Herb Bollig, pers. comm.). In January 1998, at age 6 months, fish ranged from 130-205 mm FL (length measured from tip of the snout to inner curve of caudal fin). Smaller fish, averaging 152 mm FL, weighed 11 g; larger fish, averaging 184 mm FL, weighed 20 g. In May 1998, at age 10 months, a sample of 12 fish ranged from 210-300 mm FL, averaging 265 mm FL and 70 g. In May 1999, at age 22 months, fish remaining in our care are approximately 300 mm FL, but one individual is over 400 mm FL. In nature, one year-old pallid sturgeon are believed to be 251-312 mm FL and weigh 30-83 g; two-year old fish, 320-437 mm FL, and 74-275 g (Carlander, 1969; Kallemeyn, 1983). Our fish approximated those sizes, especially during the first year, indicating that early growth in captivity was not restricted by tank size. Rapid growth and increasing requirements for larger aquaria, however, made it impossible for us to maintain all of the fish. With permission from the United States Fish and Wildlife Service, we were allowed to make the sturgeon available to other agencies. Our fish were subsequently transferred to University of Mississippi and Northeast Louisiana University for research, and to Mississippi Museum of Natural Science and Tennessee Aquarium for public display. Sturgeon adoption by the Tennessee Aquarium was arranged through the NANFA E-mail list.

We retained six specimens which we now keep in a Ferguson flume with five comparably-sized shovelnose sturgeon (also bred at Gavins Point). Fish are maintained on a light-dark cycle that approximates corresponding

Fig. 4. Juvenile pallid sturgeon, hatchery-reared, in a Ferguson flume. Photograph by Jan Hoover.

natural diel cycles. The trolling motor is used during daylight hours to provide supplemental flow and to keep fish conditioned to rapidly flowing water. Sturgeon occasionally occupy the faster water (25-40 cm/s), but only for short periods. Most of their time is spent resting in slack areas of the flume. Food is provided mid-morning and again at late afternoon or early evening. Our sturgeon eat in a leisurely manner but will finish at night any food not eaten during their afternoon feeding. Food is detected primarily by chemoreception. They often ignore pellets drifting within their apparent field of vision, but when their barbels touch a pellet, the mouth opens and closes until the pellet is inhaled. Live crayfish (Cambaridae), shrimp (*Palaemonetes* sp.), prawns (*Macrobrachium* sp.), golden shiners (*Notemigonus crysoleucas*), and river shiners (*Notropis blennius*) were put in the flume on several occasions but were not eaten, presumably because life in captivity has trained the fish to accept only artificial foods. The fish are thriving, however, and in 18 months, we have had no instance of disease and only a few accidental deaths. At night, fish occasionally jumped out of their tanks or wriggled their way through the fence surrounding the trolling motor propellor, usually with fatal results. We now keep tanks covered, block the bottom edge of the propellor's cage, and turn the motor off at night.

One minor difficulty was encountered with the sturgeon: maintaining water clarity. Apparently as a result of small uneaten food particles, and possibly due to excess slime generated by the fish, the water became turbid and yellow. This problem was negligible when fish were small but worsened as they grew. Eventually, fish were clearly visible only when less than 30 cm from the sides of the flume. There were no other changes in water quality; ammonia was undetectable and nitrates negligible. Last October, we began chilling the water to a constant 18°C and reduced the amount of food given at a single time. Cooler water, and more judicious feeding, had the desired result and water clarity is now much improved. Fish are clearly visible throughout the length of the tank, a distance of 2.5 m. Reduced temperature and feeding may also have contributed to the reduction in growth observed during the second year in our laboratory.

We plan to maintain these specimens indefinitely, and hope to see them one day attain their adult size (>500 mm FL) and characteristic coloration (Fig. 5). Eventually, however, their size will dictate larger quarters and probable donation to another facility. These sturgeon can never be released locally for a variety of reasons familiar to most NANFA members, foremost of which, their probable demographic and genetic distinctions from their brethren in the lower Mississippi River basin. The imperiled status of river sturgeons is well-known, even if the details of their biology are not (but see Kallemeyn, 1983; Keenlyne, 1997). Several comprehensive studies on sturgeon

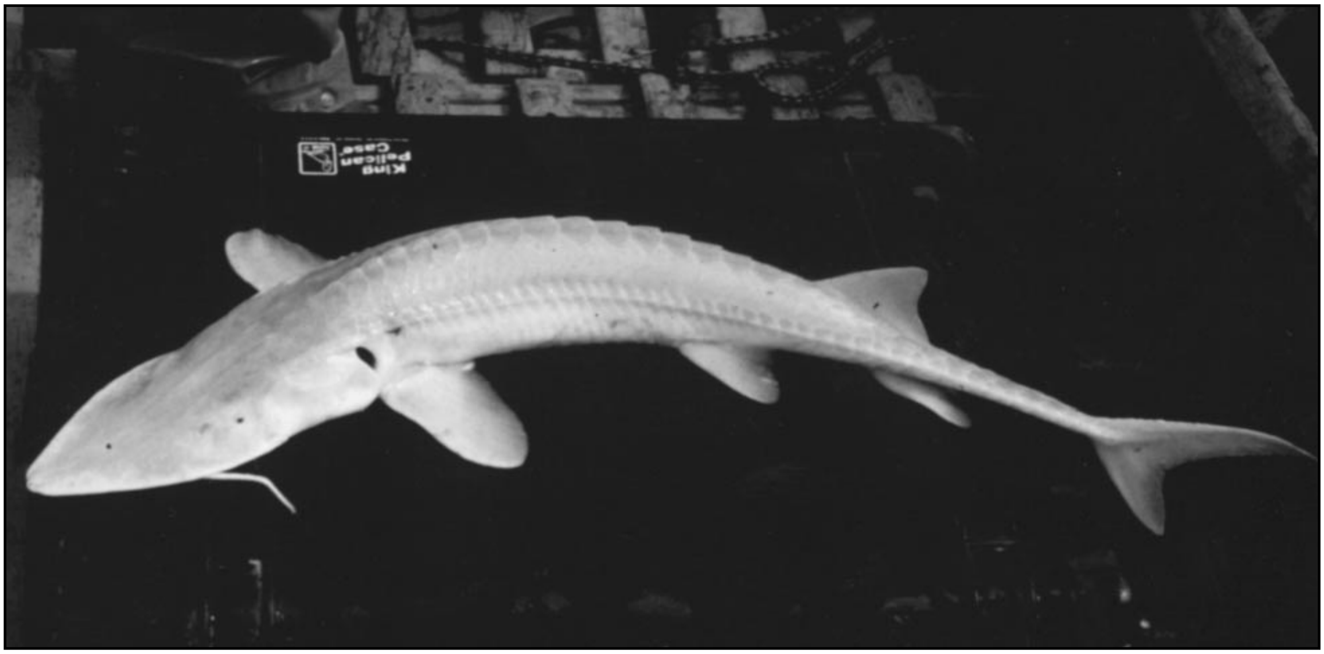

Fig. 5. Adult pallid sturgeon collected from the lower Mississippi River near Rosedale, MS. Photograph by Steven

population ecology, genetics, and systematics are ongoing, but until more is known about this group, they are perhaps best appreciated vicariously.

Acknowledgments

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