SHOVELNOSE STURGEON POPULATION MONITORING, BROODSTOCK COLLECTION, AND RESEARCH EXTENSION PROJECTS, WABASH RIVER, INDIANA

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Progress Report 2005 - 2007

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EXECUTIVE SUMMARY

- This report summarizes population, broodstock, and research extension data for shovelnose sturgeon (*Scaphirhynchus platorynchus*) from 2005 to 2007.
- As of February 2, 2007, commercial and recreational anglers can only possess shovelnose sturgeon (SNS) ≥ 25 in fork-length (FL); additionally commercial anglers can only posses SNS from October 1 through May 31.
- The objectives of this study were to: 1.) sample index stations (RM 298.8 to 316.4) to analyze trends of SNS abundance and growth; 2.) assist the Ohio Department of Natural Resources (ODNR) and the West Virginia Division of Natural Resources (WVDNR) in collection of SNS broodstock for their reintroduction programs; and 3.) aid regional researchers in collection of tissue samples to determine SNS spawning readiness (US Geological Survey) and detect SNS sonic communication to identify spawning behavior and locations (US Army Corps of Engineers).
- Shovelnose sturgeon were processed by Indiana DNR (IDNR) personnel in 2005 (N = 865), 2006 (N = 291), and 2007 (N = 536) in the upper Wabash River.
- Cumulative length-frequency data from index stations indicate that median FL values for SNS were 27.2 (2004), 26.4 (2005), and 27.1 in (2007).
- The ODNR successfully raised and stocked 709 (2005) and 4,000 (2007) fingerling SNS in the Scioto River; the WVDNR was unsuccessful raising SNS fry in 2005 and has yet to report on 2006 and 2007 broodstock cultures.
- IDNR personnel collected tissue (blood plasma and eggs) samples from gravid female SNS (N = 33) for USGS researchers in 2007.
- IDNR personnel assisted USACE researchers in locating probable SNS spawning riffles near Heron Island and Mascouten Park; however, SNS sonic communication signals were not detected even though SNS were observed.
- It is recommended that IDNR biologists continue to: 1.) closely monitor changes in SNS population abundance and growth; 2.) assist the ODNR and WVDNR collect broodstock for their reintroduction programs; and 3.) collaborate on research extension projects with USGS and USACE scientists to gain collective insights on SNS reproduction that could not be accomplished by any one agency alone.

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INTRODUCTION

The shovelnose sturgeon (*Scaphirhynchus platorynchus*) is one of nine species of sturgeon of the order Acipensiformes native to North America. Also in the genus *Scaphirhynchus*, the pallid sturgeon (*S. albus*) and the Alabama sturgeon (*S. suttkusi*) are the closest relatives of the shovelnose sturgeon (SNS) and exhibit similar morphological characteristics (i.e., three rows of bony scutes, a shovel-like snout, a protrusible mouth, and a long filament on the caudal fin). Sturgeon populations world-wide have been largely threatened by two forms of anthropogenic activity: habitat alteration and over-harvest. Most of the large rivers in the United States have been modified (i.e., dams, channel dredging, bank stabilization) for the purposes of flood control, navigation, and hydropower. The Wabash River is one exception, and as the twelfth longest river in the United States it has the longest free-flowing stretch of river (411 mi) east of the Mississippi River. This relatively unaltered system is the eastern most stronghold of SNS. Consequently, there is a substantial commercial caviar and recreational sport fishery for this species.

Shovelnose sturgeon take many years to reach sexual maturity (7 to 9 years), have received increasing fishing pressure over the last decade (international caviar trade), and are vulnerable to over-harvest (Colombo et al. 2007). Subsequently, the Indiana DNR implemented more restrictive harvest regulations as of February 2, 2007. Commercial and recreational anglers can only possess SNS ≥ 25 inches fork-length (FL). In addition, commercial anglers can only posses SNS from October 1 through May 31. Due to the unique life history of SNS, Kennedy (2005) recommended the 25 in minimum length limit (recently implemented) for SNS in the Wabash River, and suggested that a long-term program designed to monitor population changes should be considered. Thus, we have taken measures to act on these recommendations and have attempted to build upon previous work by sampling index stations originally proposed by Kennedy (2005) with the intention to collect long-term data that will allow us to monitor SNS population trends in the Wabash River.

Restoration programs for SNS have been initiated by the Ohio Department of Natural Resources (ODNR) and the West Virginia Division of Natural Resources (WVDNR) as of 2005. Both agencies have acquired sexually mature SNS from the Wabash River with the aid of the Indiana Department of Natural Resources (IDNR) and Purdue University (PU) annually from 2005 through 2007. The goals of these programs are to create self-reproducing SNS populations

in the Scioto River (Ohio) and the Kanawha River (West Virginia) through the stocking of post-spawn adults and cultured fingerlings derived from the Wabash River.

The Indiana DNR has also been part of several research extension projects with federal agencies interested in SNS reproduction. The US Geological Survey (USGS) has asked for assistance to collect blood plasma and egg samples from gravid female SNS. Plasma obtained allows for biomarkers (i.e., reproductive steroids) to be quantified so that reproductive status and health can be evaluated. Egg collection allows for a polarization index (PI) to be determined and indicates SNS spawning readiness. The USGS anticipates that these data can be used as a surrogate for the federally endangered pallid sturgeon for which data is exceptionally difficult to acquire. In addition, the US Army Corps of Engineer (USACE) is using cutting-edge technology designed to locate SNS via acoustic communications. The objective is to identify the origin of sound waves produced by SNS and use this information to determine relationships between spawning behavior and habitat. Since the upper Wabash River hosts a concentrated population of SNS during the spawning season, the USACE found these circumstances offered an ideal opportunity to test their equipment in May 2007. Many of the complexities associated with SNS reproduction remain to be discovered, and the technical expertise other regional biologists can offer will greatly increase our understanding of SNS life history characteristics in the Wabash River.

The objectives of our research are threefold: 1.) sample fixed index stations to analyze long-term trends of SNS abundance and growth; 2.) assist the Ohio DNR and the West Virginia DNR collect SNS broodstock for their reintroduction programs; and 3.) aid regional researchers in collecting tissue samples (USGS) and sonic communication signals (USACE) to determine SNS spawning readiness and behavior.

METHODS

Study Area

The upper Wabash River (Figure 1) was the primary area of investigation for this study as Purdue University researchers (Kennedy 2005) identified probable SNS spawning areas near Lafayette, Indiana. From its origin near the town of St. Henry, Ohio, the Wabash River meanders 276 mi across northern and western Indiana before it forms the 200 mi border between Indiana and Illinois prior to its confluence with the Ohio River near Uniontown, Kentucky. The

Wabash River drains 73 counties in Indiana and a total land area of 32,821 mi^2, ranking as the second largest sub-basin of the Ohio River valley (Tennessee River sub-basin = 40,893 mi^2). The headwater elevation of the Wabash River is 876 ft from which the river descends 2.3 ft/mi to Logansport, Indiana and 0.6 ft/mi thereafter to its mouth. J. Edward Rousch Lake (formerly Huntington Reservoir) is the only impoundment along the entire stretch of the Wabash River near Huntington, Indiana.

Population Monitoring

Our population monitoring protocol was to electroshock (i.e., boom-mount pulsed-DC electrofishing boats) four index stations twice each spring on the upper Wabash River, with each index station being sampled three times (i.e., 1/4, 1/2, and 3/4-stream width) for 20 min each in the downstream direction and included Heron Island (HI; Figure 2), Mascouten Park (MP; Figure 3), Goose Island (GI; Figure 4), and Collier's Island (CI; Figure 5). All SNS collected were assigned a serial number and measured (± 0.1 in) from the tip of the rostrum to the fork of the caudal fin (fork length; FL). Wet weight was measured with a toploading mechanical dial scale (Douglas Homs Corporation, Belmont, California) for fish up to 2.2 lbs (± 0.1 oz). A linear spring scale (Pesola ©, Barr, Switzerland) was used to measure the wet weight of SNS up to 11 lbs (± 2 oz). All SNS were fitted with a T-bar anchor tag (Floy Tag Inc., Seattle, Washington) in the musculature at the base of the left pectoral fin. The left pectoral ray was clipped from all sturgeon, stored in scale envelopes, and archived in the laboratory for historical record of population age structure. If the sturgeon was a recapture, the Floy-tag number was recorded and the right pectoral fin ray was clipped. The number of males was determined by the presence of milt after pressure was applied to the ventral surface. Gravid females were identified in 2007 with a 10-gauge spice injector (Delux Marinade Injector, New Iberta, LA) used to puncture suspect females (i.e., swollen abdomens). All other stages of maturity (i.e., immature females, immature males, mature non-gravid females, mature non-gravid males, mature non-functional females, mature non-function males, inter-sex fish, and unverified mature gravid females in 2005 and 2006) were not verified because this would have required invasive surgical techniques. Before sturgeon were released downstream of the index station collected, they were also examined for egg-check marks. Catch-per-unit-effort (CPUE) was summarized as the number of fish captured per-hour of electroshocking. Length-weight

regressions were derived for SNS by logarithmic (log_{10}) transformation of the data. Cumulative length-frequency distributions were analyzed annually with Kolmogorov-Smirnov tests.

Broodstock Collection

All broodstock were collected from the Wabash River near HI and MP in proximity to Lafayette, Indiana. The agencies (i.e., IDNR, ODNR, and WVDNR), and universities (PU) involved met at the MP ramp (RM 313.2) from early- to mid-May of each year to coordinate sampling effort. Typically, several runs (varying in duration from 5 to 25 min of effort) were conducted by boom-mount pulsed-DC electrofishing boats. Sturgeon captured were hauled to the MP ramp where roughly half of the crew monitored two collection cages and segregated fish (i.e., by sex) while remaining crew members continued to collect SNS. Females were typically rotund with an obvious blue band running the entire anterior-posterior length of the ventral surface. Males were relatively slender and could be verified by the presence of milt or spawning tubercles. After several gravid females and males were identified, they were placed into ODNR (PI: Dr. Richard Zweifel) and WVDNR (PI: Chris O'Bara) hatchery-transport trucks and shipped to Logan Hollow (IL), Palestine (WV), and Kincaid (OH) fish hatcheries. Remaining SNS were placed into separate collection cages where the IDNR recorded a variety of biological data including fork length (in), wet weight (lbs), sex (male, female , unknown), egg-check mark (Y/N), and Floy® tag number before releasing the fish.

Research Extension Projects

Indiana DNR personnel collaborated with USGS (PI: Dr. Diana M. Papoulias) in 2007 to collect blood plasma and egg samples from gravid female SNS. The USGS supplied an instructional DVD, field centrifuge, dry ice cooler, data sheets, large storage container including small field and laboratory supplies, and dry ice shipping containers. Blood and egg samples were taken from gravid female SNS in 2007 after they were identified from population monintoring and broodstock collection (i.e., gravid females not taken by ODNR or WVDNR). Sturgeons were held at the rostrum upside down while an 18-gauge needle was inserted between the anal and caudal fin to make an entry point between the scutes. A 20-gauge needle was used to draw a small volume of heparin (i.e., clot preventative) into the syringe to coat the length of the cylinder. Then the remaining heparin was expelled back into the heparin vial and stored on

ice for reuse. The 20-gauge needle was then slowly inserted straight through the hole made by the 18-gauge needle until the backbone was identified. The needle was carefully pulled one millimeter from the backbone while gently pulling on the plunger until the syringe was filled with 4 mL of blood. The blood was transferred from the syringe to a labeled vaccutainer and put on ice to limit clotting and the degradation of proteins. Pressure was then applied to the needle entry point to stop the bleeding. After all blood samples were collected, the vaccutainers were placed in the field centrifuge at 3500 RMPs for 10 min. The resulting plasma was removed with a disposable pipet and evenly distributed with 1 mL of plasma among four labeled cryovials. The labeled cryovials were placed in a cryo-box and put on dry ice until shipment. USGS extracted steroids from plasma samples and use radioimmunoassay (RIA) to determine hormone (estradiol, 11-ketotestosterone, and testosterone) levels and evaluate reproductive state.

A 10-gauge spice injector (Delux Marinade Injector, New Iberta, LA) was used to collect eggs from gravid female SNS in 2007. The abdominal surface of gravid female SNS was punctured with the spice injector midway between the edge of the ventral scutes and the midline approximately one third of the way from the pelvic fins to obtain a sample of 10 to 20 eggs. The eggs were immediately placed into labeled bottles containing 10% neutral buffered formalin and shipped to USGS at room temperature in a box separate from the plasma. The eggs were measured by USGS for polarization index (PI) values. Using a razor blade the eggs were cut down the animal-vegetal axis through the nucleus or germinal vesicle (GV). A microscope and eyepiece micrometer were used to measure the total length of the egg (i.e., along the long axis) as well as the distance from edge of the vegetal pole of the oocyte to the beginning edge of the GV (i.e., generally the shortest distance). Oocytes with a GV to cell membrane length and total length ratio 0.07 or lower were considered ready to spawn.

The IDNR also collaborated with the USACE (PI: Tom Keevin) on May 9, 2007 to aid in the identification of SNS sonic communication signals. This work is related to pallid sturgeon restoration because both shovelnose and pallid sturgeon have been shown to communicate via acoustic signals during the breeding season. Because large congregations of SNS spawn in the Wabash River near Lafayette, Indiana, this stretch of river provided an ideal location to hear SNS "talking" in the field. The ultimate goal of the USACE is to identify spawning locations of pallid sturgeon based on sound. It has been hypothesized by USACE researchers that male SNS may use low frequency sound transmissions to aggregate and may have other calls to entice

female SNS once they are near the spawning habitat. The goal of the IDNR was to direct the USACE to known SNS concentrations where a hydrophone and laptop computer were used to record SNS sonic transmissions.

RESULTS

Population Monitoring

Shovelnose sturgeon were captured at index stations in 2005 (N = 313), 2006 (N = 60) and 2007 (N = 176). Index stations were sampled to meet protocol in 2005 (i.e., effort = 8.0 hours), but due to personnel and time constraints effort declined in 2006 (0.5 hours) and 2007 (2.0 hours), respectfully. More SNS were captured among mid-channel transects (47%) within index stations than either left (32%) or right (21%) descending transects. Mean CPUE among all years and index stations was 52 fish/hr and was highest at HI in 2006 (120 fish/hr) and lowest at CI in 2005 (20 fish/hr). Of the 549 fish captured, 1% (N = 5) were IDNR recaptures and 4% (N = 20) were PU recaptures, while the remaining 95% (N = 524) were tagged with a new IDNR Floy-tag and released. One percent (N = 6) of the SNS collected were observed with egg-check marks. Fork-length (Mean ± SD) and weight (Median, IQR) of SNS among all years and index sites was 26.8 ± 1.9 in and 2.9, 2.3 to 4.6 lbs (Table 1). Length-weight relationships were similar among years (Figure 6). Cumulative length frequency distributions from 2004 and 2007 were significantly different from 2005 (Figure 7; D = 0.22, df = 289, P < 0.001; D = 0.19, df = 176, P < 0.001, respectively), but were not statistically different from each other (D = 0.06, df = 176, P = 0.80). Median FL values for 2004, 2005, and 2007 were 27.2, 26.4, and 27.1 in, respectively. For 88% (N = 488) of the SNS collected, sex could not be verified; eight percent (N = 41) were mature gravid males and 4% (N = 20) were mature gravid females (Table 2). For all data combined in 2007 (i.e., index stations, broodstock collection, research extension), the minimum FL value for gravid females was 25.4 in (Figure 8).

Broodstock Collection

Overall, 1087 SNS were sampled during broodstock collection from 2005 through 2007 (Table 3). Mean CPUE during broodstock collection was 143 fish/hr and was highest on May 10, 2005 (229 fish/hr) and lowest on May 10, 2006 (96 fish/hr). Definitive gravid male, female, and unknown SNS represented 18% (N = 197), 3% (N = 37), and 79% (N =567) of the sample,

respectively. Three percent (*N* = 28) of the SNS were recaptures (PU = 13 Floy; IDNR = 12 Floy; ILDNR = 2 PIT; USFWS= 1 Floy). Less than 1% of the SNS collected displayed egg-check marks.

On May 10, 2005, 229 SNS were sampled with 1.0 hours of effort by IDNR, PU, ODNR, and WVDNR. Wabash River stage was 3.7 ft and water temperatures ranged from 64 °F at 0700 hours to 70 °F at 1900 hours. At 0900 hours ODNR left the MP ramp with what was believed to be 16 male and 21 gravid female SNS. However, all fish turned out to be male except for one gravid female that released ~16,000 eggs. At 1000 hours WVDNR left the MP ramp with what was believed to be 15 male and 25 female SNS. Again, most fish turned out to be males and only three were gravid females. One female spawned during transport and released ~10,000 eggs. By 1300 hours the INDNR and PU processed, tagged, and released 152 fish for which sex was not determined. Seven (3%) SNS were recaptures (PU = 2 Floy; IDNR = 2 Floy; ILDNR = 2 PIT; USFWS = 1 Floy). None of the SNS collected displayed egg-check marks.

On May 16, 2005, 323 SNS were sampled with 1.6 hours of effort by IDNR, ODNR, and WVDNR. The Wabash River stage was 4.7 ft and water temperature was 62 °F at 1900 hours. At 1200 hours ODNR left the MP ramp with nine female and five male SNS. By 1400 hours the WVDNR left the MP ramp with six female, five possible female, and 30 male SNS. By 1700 hours the INDNR processed, tagged, and released 268 fish (i.e., 32 gravid male, 236 sex unknown). Sixteen (5%) SNS were recaptures (PU = 8 Floy; IDNR = 8 Floy). None of the SNS collected displayed egg-check marks.

On May 10, 2006, 231 SNS were sampled with 2.4 hours of effort by IDNR, and WVDNR. The Wabash River stage was 4.0 ft and water temperature was 66 °F at 1600 hours. The WVDNR placed 231 SNS in their transport truck, and dropped-off 28 brood fish to the ODNR Kincaid hatchery, Ohio. The remaining 203 brood SNS were taken to Palestine hatchery, West Virginia. None of the SNS collected were recaptures or displayed egg-check marks.

On May 9, 2007, 304 SNS were sampled with 2.6 hours of effort by IDNR, ODNR, and WVDNR. The Wabash River stage was 5.1 ft and water temperature was 70 °F at 1200 hours. The ODNR transported 16 males and 14 females to Kincaid State Fish Hatchery, Ohio. The WVDNR transported 97 SNS to Palestine Fish Hatchery, West Virginia. The INDNR processed, tagged, and released 177 fish; four (2%) were gravid female, 68 (38%) were gravid male, and sex was undermined for the remaining 105 (60%) fish. Five (3%) SNS were recaptures (PU = 3

Floy; IDNR = 2 Floy). Two (1%) of the fish collected displayed egg-check marks. The ODNR successfully reared SNS fry at Kincaid fish hatchery (Figure 9) and stocked 4,000 SNS fingerlings into the Scioto River in September 2007 (Figure 10).

Research Extension Projects

Gravid female SNS (*N* = 33) were collected for USGS in early May 2007 and included blood plasma and egg tissue samples. No gravid females were collected on May 2, 2007 (i.e., exploratory sampling for USGS); four were collected on May 9, 2007 (i.e., those not shipped for broodstock); nine where collected on May 10, 2007 (i.e., a specific excursion targeting gravid females for USGS); and 20 where collected on May 16, 2007 (i.e., index station sampling). Blood plasma samples were successfully taken from 30 of the gravid females collected, and egg samples were successfully taken from 32 of the gravid females collected (Figure 11; Table 4). The samples were shipped to USGS on May 22, 2007.

The USACE researchers met IDNR personnel at the MP ramp on May 9, 2007 and directed them to *listen* for SNS near the ramp riffle because many SNS had been sampled there earlier that day (i.e., for broodstock collection). Although, USACE researchers heard many sonic transmissions, they were unsuccessful in locating SNS. The USACE researchers later invited IDNR personnel to listen to what they had been hearing with the hydrophone and headphones. One could hear a variety of sounds that USACE researchers suspected where from fish (i.e., possibly drum or redhorse) but not SNS. IDNR personnel then drove USACE researchers to the HI riffle and electrofished the site to verify that SNS where in the area. Many SNS (~30) came up while electroshocking the area, yet no sonic signals from SNS where detected. Because SNS in these areas had been heavily sampled on May 9, 2007 (i.e., broodstock collections), USACE researchers attempted to use their sonic equipment on the morning of May 10, 2007. Again, no sonic transmissions from SNS were detected. As of January 2008, we are waiting for an update from the USACE as to whether they want to conduct further tests using their sonic equipment on the Wabash River for SNS this coming spring (i.e., 2008).

DISCUSSION

Population Monitoring

The results of this study have provided evidence that abundance of SNS in the Wabash River warrants further investigation. Within index stations, we captured similar percentages of SNS (32, 47, 21%) during each downstream pass (left, middle, right) as reported by Purdue University (28, 48, 24%; Kennedy 2005). Overall CPUE in our 2005 sample was lower (39 fish/hour) than reported in 2004 by Purdue University (73 fish/hour; Kennedy 2005). However, our 2006 and 2007 samples were higher (120 and 88 fish/hour, respectively) than previous records. Although these estimates were from the same time periods (i.e., early May), it remains challenging to draw definitive conclusions based on these data for several reasons. First, index stations were only sampled to protocol once (IDNR, 2005). For example, the 2004 dataset (Purdue University) includes only one of two complete pass of all index stations; while datasets from IDNR in 2006 and 2007 were incomplete due to personnel changes and time constraints. Second, it was not explicitly recorded when one or two dippers were utilized, again complicating CPUE comparisons. If the IDNR considers monitoring long-term changes in SNS abundance a future priority, it is imperative that the original protocol be followed. Should the study design be modified, it should resolve the above discrepancies so that statistical comparability can recommence. Because it has proven difficult to meet protocol, the IDNR may find it beneficial to abandon the left and right descending runs within transects and only sample mid-channel transects. Such measures would maximize efficiency of data collection and allow variability (i.e., multiple samples) among transects to be estimated. Such measures will facilitate meaningful comparison and interpretation of long-term trends in SNS abundance.

Analysis of size distributions for SNS in the Wabash River indicates that the minimum FL (≥ 25 in) harvest limit for SNS may be an insufficient regulation to protect this fishery from recruitment over-fishing. Of the 33 gravid female SNS collected in 2007, all were greater than 25 in FL (minimum = 25.4 in FL). Similarly, 87% of the 68 gravid male SNS collected in 2007 were greater than 25 in FL. Our data indicates that SNS ≤ 25 in were (to some extent) documented in the sample. Yet, none (0%) of the gravid females, few (13%) of the gravid males, and 20% (59/295) of unknown sex would have been protected by the current minimum 25 in FL regulation. In addition, median FL values of gravid female and gravid male SNS collected in 2007 were 27.3 and 27.2 in, respectively. Thus, if a 27 in minimum FL limit were to replace

the current minimum harvest regulation of 25 in FL, 36 and 54% of all gravid female and male SNS would be protected, respectfully. Similarly, Colombo et al. (2007) argued that a 27 in minimum length limit provided the necessary protection to curtail growth and recruitment over-fishing of SNS in the middle Mississippi River. If the IDNR agrees that some degree of protection for mature SNS is a governing dynamic of long-term SNS sustainability in the Wabash River, a larger minimum FL limit should be considered.

Identification of sex ratios and maturity phases has remained a challenging aspect of SNS management in the Wabash River. Definitive gravid female SNS represented 3 and 4% of our broodstock and index site collections, respectively. Definitive gravid male SNS represented 18 and 8% of our broodstock and index station collections, respectively. All other SNS were classified as *unknown*, which included immature females, immature males, mature non-gravid females, mature non-gravid males, mature non-functional females, mature non-function males, and inter-sex fish. To determine mean values and annual variation of sex ratios and maturity phases, the IDNR is advised to develop a study design were a predetermined number of fish are sacrificed annually (i.e., $N = 100$) *and* in proportion to the size distribution represented by the sample. Then mean sex ratios and maturity phases would provide the information necessary to make sound management recommendations regarding minimum length limits that offer long-term protection of gravid SNS and a sustainable fishery.

Broodstock Collection

Through collaborative accomplishments, the IDNR has aided the ODNR and WVDNR in their attempt to restore extirpated populations of SNS. Because of the interjuristdictional nature of this species, professional partnerships with other agencies are often the difference between successful or unsuccessful management practices. In addition, the lack of information pertaining to the culture of SNS merits further research. Such collaboration should remain a priority of the IDNR. The following information summarizes hatchery results from broodstock collections and because the IDNR was not an active participant in the rearing of fry and fingerling SNS, it will be discussed herein (Dr. Richard Zwiefel, Ohio Division of Natural Resources, and Chris O'Bara, West Virginia Department of Natural Resources, personal communication).

Ohio DNR.—Misidentification of females on the first collection trip (May 10, 2005) resulted in a single female that released ~16,000 eggs. Although identification of females on the

second collection trip (May 16, 2005) resulted in a higher proportion (64%) of brood females, they were collected too late in the spawning period and as a result induced ovulation was unsuccessful and sperm motility from the males was poor relative to the previous week. Of the ~16,000 eggs collected, ~10,000 hatched on May 17, 2005. About 9,000 were feeding by May 24, 2005, yet mortality was high and by June 16, 2005 only 1,500 fry remained. On October 25, 2005, 709 fingerling shovelnose sturgeon (mean FL = 6.5 in) were stocked in the Scioto River near Circleville, Ohio. Although ~90,000 eggs were collected on May 11, 2006 and ~76,000 fry hatched by May 13, 2006, a period of cold weather decreased water inflow temperatures at the hatchery to below 60 °F resulting in a total loss of fry by May 24, 2006. Brood adults were fitted with a coded wire tag and released into the Scioto River near Circleville, Ohio on June 1, 2006. In 2007, six of the 14 brood females released ~200,000 eggs on May 11, 2007. Thirteen percent (25,000) of the eggs hatched as fry by May 15, 2007 and by June 15, 2007, 6,900 fry remained. On July 3, 2007, brood adults were stocked into the Scioto River near Circleville, Ohio after being marked with coded-wire tags. Roughly 4,000 fingerling sturgeon (range: 2 to 6.3 in) were stocked in the Scioto River near Circleville, Ohio on September 27, 2007.

West Virginia DNR.—On the first collection trip (May 10, 2005) brood adults were transported to Logan Hollow Fish Hatchery, Illinois. None of these fish were successfully spawned. On the second collection trip (May 16, 2005) brood adults were transported to Palestine State Fish Hatchery, West Virginia and successfully spawned. However, within the week after hatching all the fry died. All spent brood adults were stocked in the Kanawha River, West Virginia. As of January 2008 we are waiting for information regarding the number of eggs collected, hatching success, fry survival, and stocking of fingerlings in 2006 and 2007 from the West Virginia DNR.

Research Extension Projects

With the aid of USGS and USACE researchers, IDNR biologists are just beginning to understand SNS spawning preparedness in the Wabash River. The lack of information pertaining to SNS reproduction merits further research, and these collaborative efforts should remain a priority of the IDNR. The following information summarizes blood plasma and egg results from USGS collections. We have yet to determine whether USACE researchers will be

interested in additional acoustic surveys. Because the IDNR was not an active participant in the quantification of blood plasma and egg measurement in the laboratory, their results will be discussed herein (Mandy Annis, USGS, personal communication).

On May 9, 2007 mean (± SD) PI values were 0.08 ± 0.06 (N = 4); on May 10, 2007 mean PI values 0.08 ± 0.02 (N = 9); and on May 16, 2007 mean PI values were 0.05 ± 0.03 (N = 19). Polarization index values suggest SNS were near spawning on May 9 or 10 and by May 16 SNS were at or below the hatchery spawning threshold of 0.07. Additional sampling time points are needed to validate these findings. Synchronized spawning, if it does occur with the Wabash SNS population, would differ from the mainstem Missouri River population. Fish of all stages of sexual maturity can be captured at the same location within the mainstem of the Missouri River, with black-egged female PI's varying greatly at a given location at a given time.

Blood plasma samples of SNS from the Wabash River were analyzed using radioimmunoassay (RIA) to determine steroid concentrations for 17 β-estradiol (E), 11-ketotestosterone (11-KT), and testosterone (T). The mean (± SD) steroid concentration for E was 845 ± 551 pg/mL; 11-KT concentration was 22,887 ± 12,799 pg/mL; and T concentration was 38,555 ± 24,707 pg/mL. Androgens (i.e., T and 11-KT) were elevated for female SNS in the Wabash River when compared to female SNS from the mainstem of the Missouri River. Mean (± SD) T levels in 2005 and 2006 from the Missouri River were 10,865 ± 7,961 pg/mL and 17,569 ± 7,999 pg/mL, respectively. Mean (± SD) concentrations for 11-KT from females of the Missouri River in 2005 and 2006 were 3,341 ± 3,262 pg/mL and 3,159 ± 2,877 pg/mL, respectively. Mean (± SD) E levels for SNS collected in 2005 and 2006 in the Missouri River were 3,679 ± 3,289 pg/mL and 11,515 ± 15,584 pg/mL. Additional evaluations between mainstem Missouri River and Wabash River females are needed. The USGS has indicated they are interested in working with the IDNR in 2008.

RECOMMENDATIONS

- Index stations should continue to be sampled on an annual basis to monitor changes in abundance, growth, sex and maturity status of shovelnose sturgeon.
- Broodstock collection should continue on an as-need basis to supply ODNR and WVDNR gravid shovelnose sturgeon for their reintroduction programs.
- Blood plasma, egg collection, and acoustic survey should continue to aid USGS and USACE researchers determine shovelnose sturgeon spawning preparedness in the Wabash River.

LITERATURE CITED

Colombo, R. E., J. E. Garvey, N. D. Jackson, R. Brooks, D. P. Herzog, R. A Hrabik, and T. W. Spier. 2007. Harvest of Mississippi River sturgeon drives abundance and reproductive success: a harbinger of collapse? Journal of Applied Ichthyology 23 (2007): 444-451.

Kennedy, A. G. 2005. Population characteristics, reproductive biology, and the effects of length limits on shovelnose sturgeon in the upper Wabash River, Indiana. Master's Thesis. Purdue University, West Lafayette, Indiana.

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Date: October 29, 2008

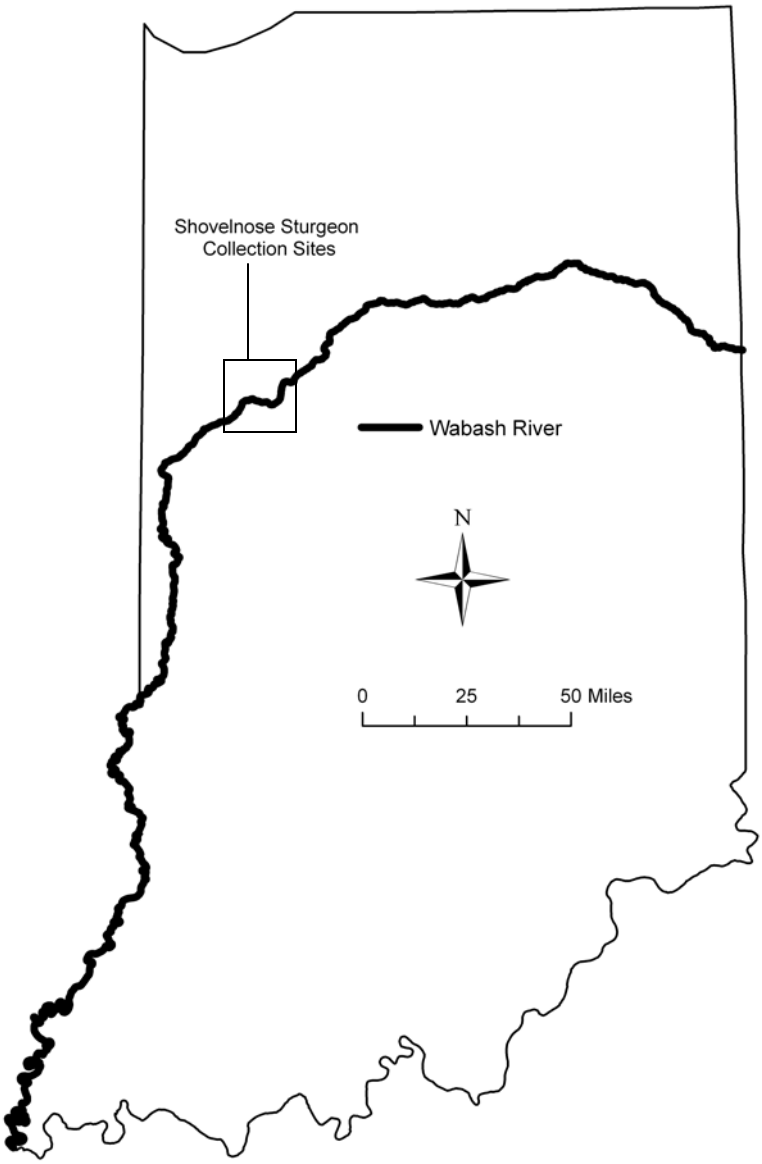

Figure 1. Shovelnose sturgeon population index stations, broodstock collection sites, and research extension locations on the Wabash River, Indiana.

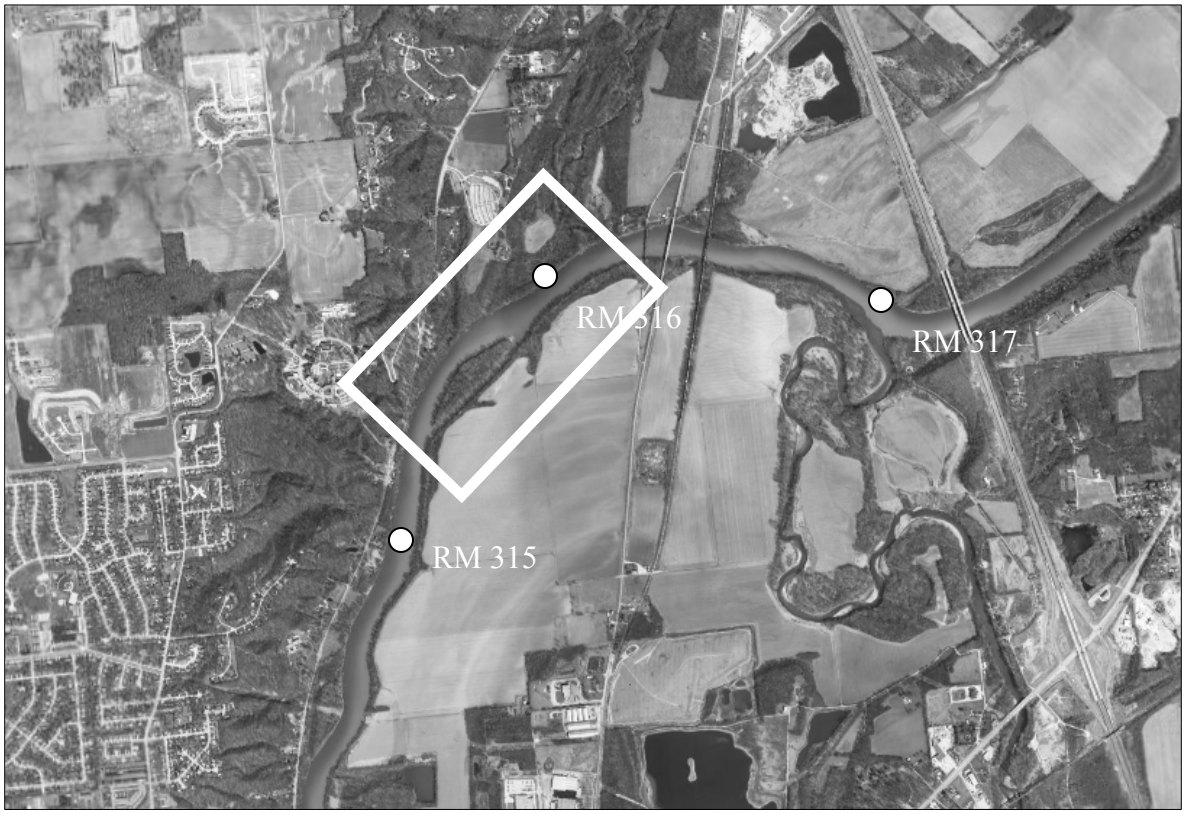

Figure 2. Heron Island electrofishing index station (RM 315.4 to 316.4) and broodstock collection sites for shovelnose sturgeon in the Wabash River, Indiana.

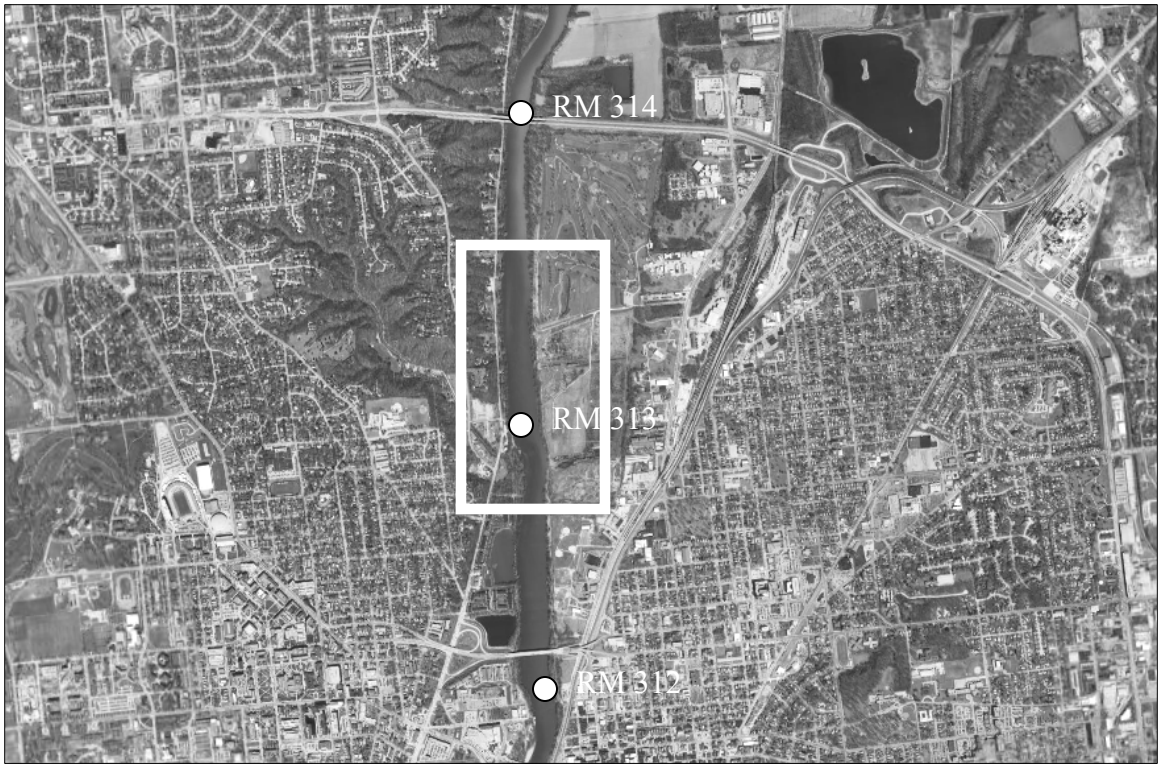

Figure 3. Mascouten Park electrofishing index station (RM 312.7 to 313.4) and broodstock collection sites for shovelnose sturgeon in the Wabash River, Indiana.

Figure 4. Goose Island electrofishing index station (RM 300.8 to 301.4) for shovelnose sturgeon in the Wabash River, Indiana.

Figure 5. Collier's Island electrofishing index station (RM 298.8 to 299.4) for shovelnose sturgeon in the Wabash River, Indiana.

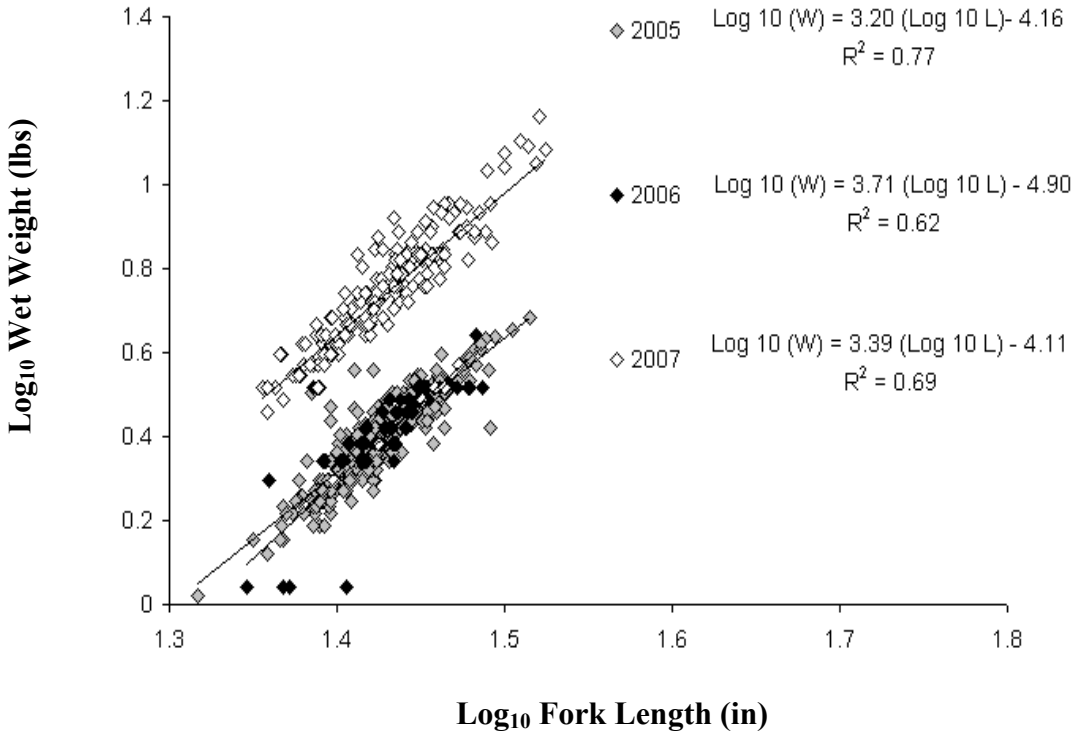

Figure 6. Length-weight regression results for shovelnose sturgeon collected in 2005, 2006, and 2007, Wabash River, Indiana.

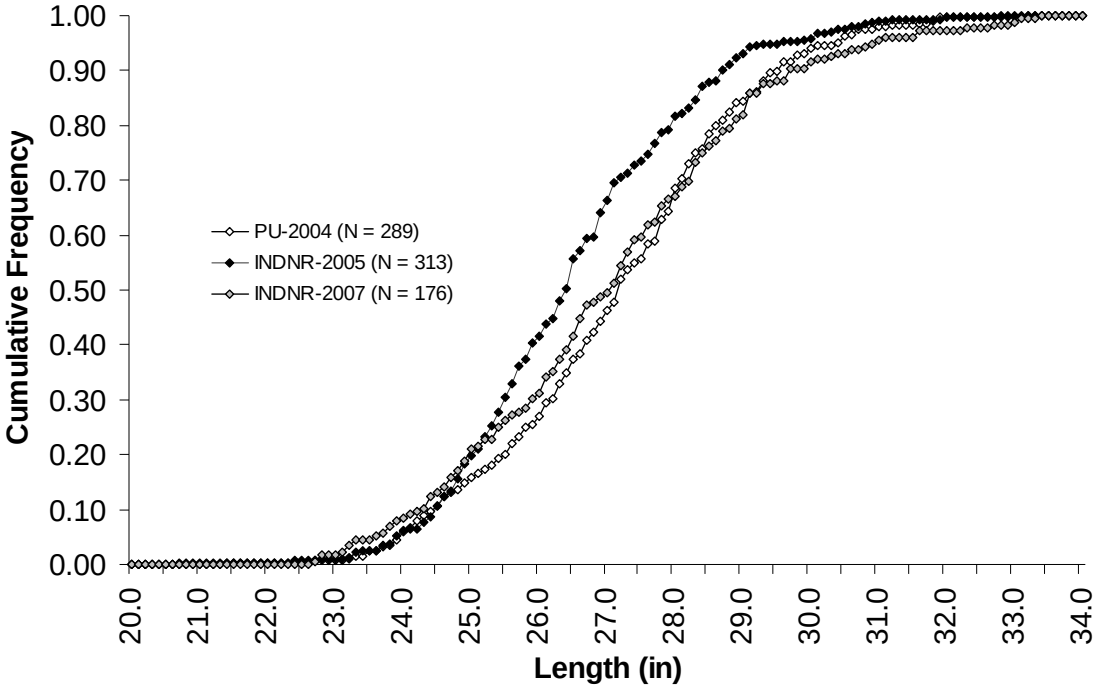

Figure 7. Cumulative frequency distribution per length group for shovelnose sturgeon collected in May 2004 (Purdue University), 2005 and 2007 (Indiana DNR) in the Wabash River, Indiana.

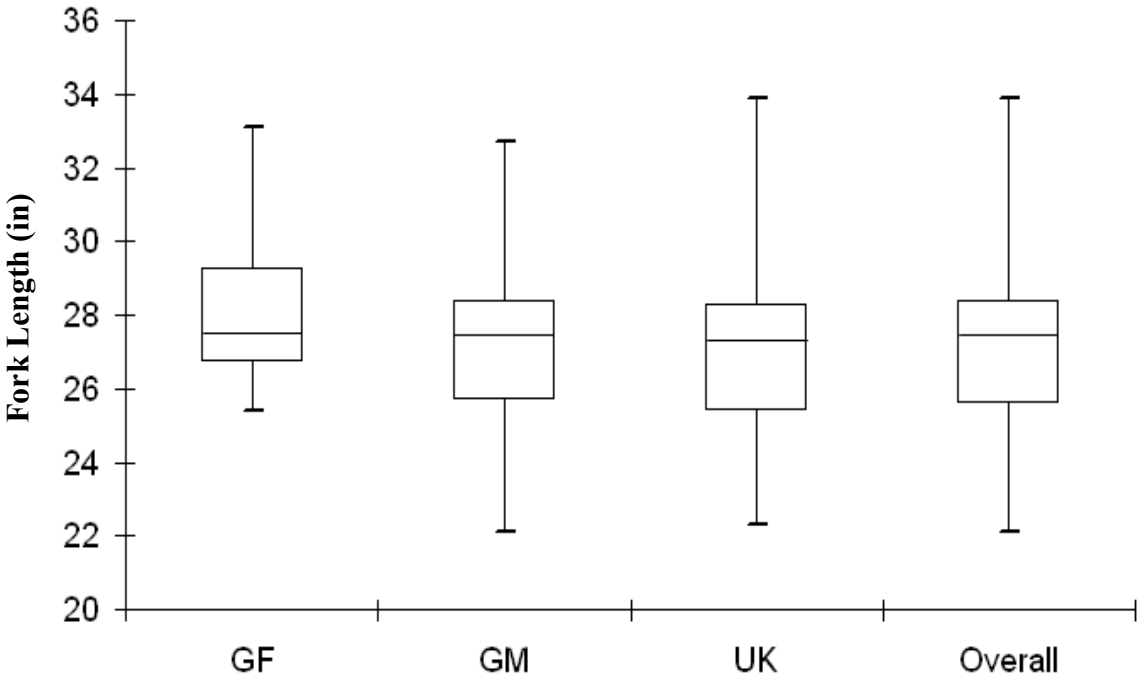

Figure 8. Box plots of fork length (FL) versus gravid female (GF; $N = 33$), gravid male (GM; $N = 68$), unknown (UK; $N = 295$), and overall ($N = 396$) categories for shovelnose sturgeon collected in the Wabash River, Indiana, 2007. The horizontal bar within each box represents median FL values; the upper and lower horizontal bars of the box represent 25% deviations from the median; and the whiskers represent the outermost 25% deviations from the median.

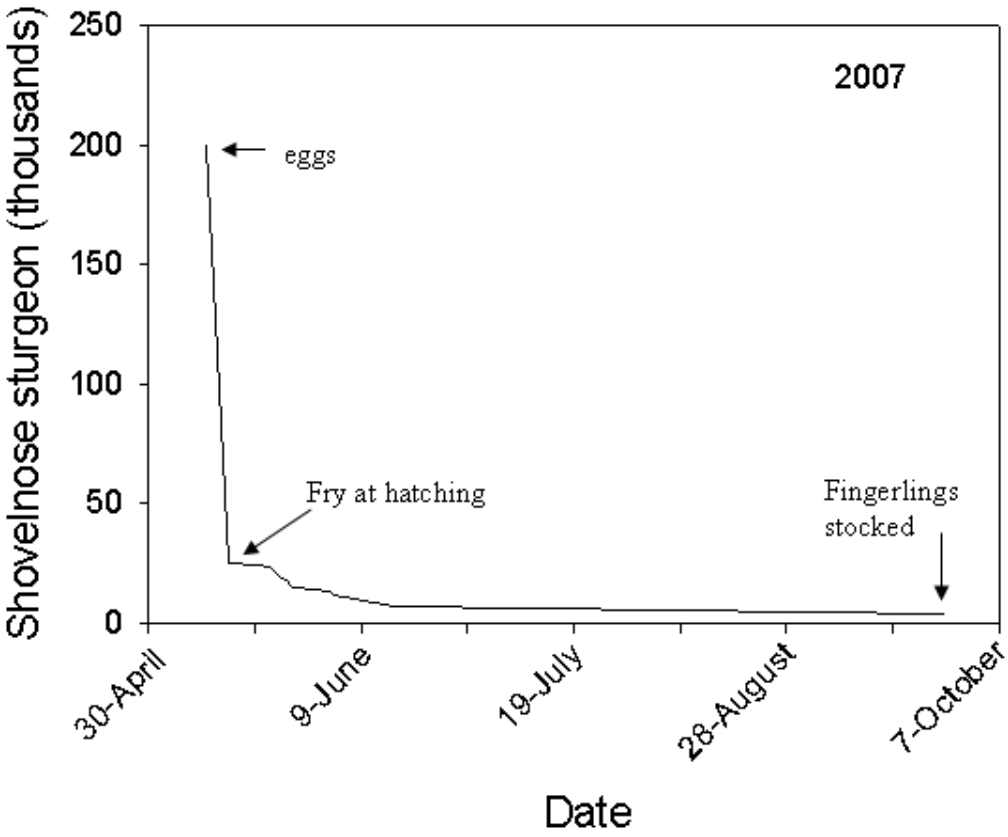

Figure 9. Survival of shovelnose sturgeon from eggs to fingerlings at the Kincaid State Fish Hatchery, 2007 (Dr. Richard Zweifel, Ohio Department of Natural Resources, personal communication).

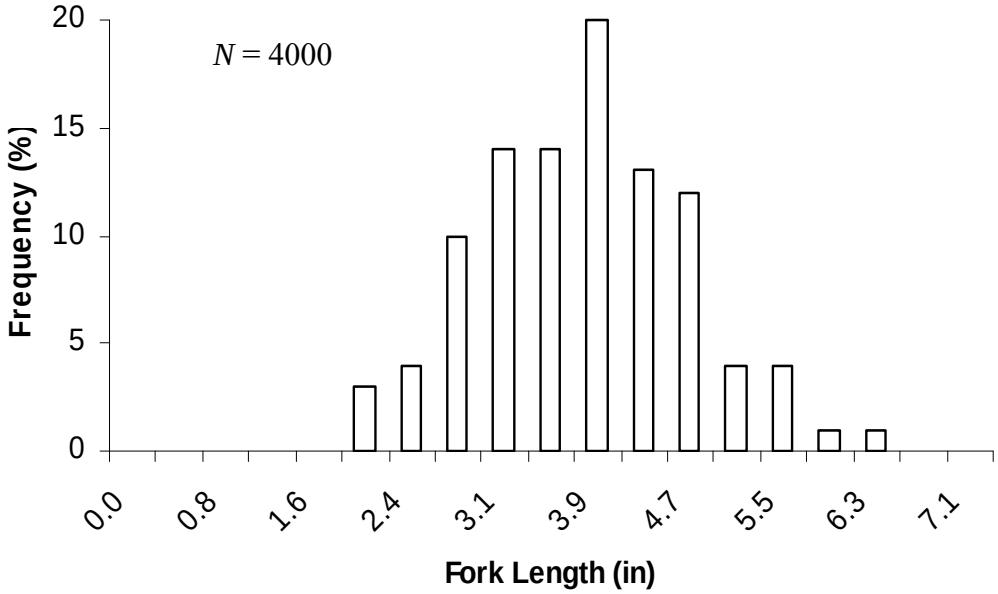

Figure 10. Fork length frequency distribution of fingerling shovelnose sturgeon stocked into the Scioto River on September 27, 2007 (Dr. Richard Zweifel, Ohio Department of Natural Resources, personal communication).

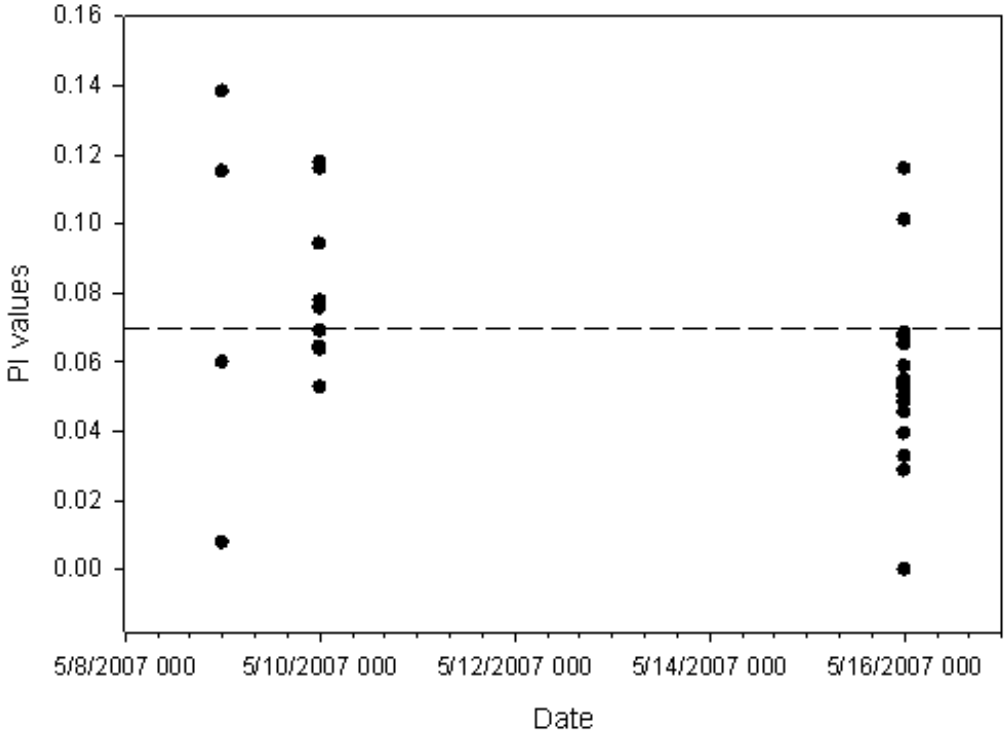

Figure 11. Polarization index (PI) of gravid female shovelnose sturgeon from the Wabash River by date. Dotted line denotes the PI value (0.07) at which maturational competence is estimated to occur (Mandy Annis, USGS, personal communication).

Table 1. Summary statistics of shovelnose sturgeon collected at Heron Island (HI), Mascouten Park (MP), Goose Island (GI), and Colliers Island (CI) index stations from the Wabash River, 2005, 2006, and 2007.

Statistic	HI	MP	GI	CI	Totals
Effort (hr)					
2005	2.0	2.0	2.0	2.0	8.0
2006	0.5	-	-	-	0.5
2007	1.0	1.0	-	-	2.0
Total	3.5	3.0	2.0	2.0	10.5
No. Collected					
2005	140	86	48	39	313
2006	60	-	-	-	60
2007	104	72	-	-	176
Total	304	158	48	39	549
CPUE (fish/hr)					
2005	70	43	24	20	39
2006	120	-	-	-	120
2007	104	72	-	-	88
Mean	87	53	24	20	52
IDNR Recaptures					
2005	0	3	0	1	4
2006	0	-	-	-	0
2007	0	1	-	-	1
Total	0	4	0	1	5
PU Recaptures					
2005	9	2	2	0	13
2006	5	-	-	-	5
2007	1	1	-	-	2
Total	15	3	2	0	20
No. Tagged					
2005	131	81	46	38	296
2006	55	-	-	-	55
2007	103	70	-	-	173
Total	289	151	46	38	524
Mean FL ± SD					
2005	26.8 ± 1.7	26.2 ± 1.7	27.2 ± 2.0	26.1 ± 1.5	26.6 ± 1.7
2006	27.1 ± 1.8	-	-	-	27.1 ± 1.8
2007	27.0 ± 2.0	27.3 ± 2.5	-	-	27.1 ± 2.2
Mean	26.9 ± 1.8	26.7 ± 2.2	27.2 ± 2.0	26.1 ± 1.5	26.8 ± 1.9

Table 2. Summary of shovelnose sturgeon sex and maturity status from fish collected at index stations (Heron Island (HI), Mascouten Park (MP), Goose Island (GI), and Colliers Island (CI)), broodstock, and USGS sites in the upper Wabash River, 2005, 2006, and 2007.

Date	Purpose	Location	No. Gravid ♀	No. Gravid ♂	No. Others/Unknown[1]
5/5/05	Index	HI, MP	-	-	140[2] (100)[3]
5/6/05	Index	GI, CI	-	-	50 (100)
5/10/05	Brood	MP	4 (2)	73 (32)	152 (66)
5/10/05	Index	GI, CI	-	13 (35)	24 (65)
5/11/05	Index	HI, MP	-	25 (29)	61 (71)
5/16/05	Brood	HI, MP	15 (6)	40 (25)	268 (69)
2005	Total	All	19 (2)	151 (18)	695 (80)
5/10/06	Index	HI	-	-	60 (100)
5/10/06	Brood	HI, MP	-	-	231 (100)
2006	Total	All	-	-	291 (100)
5/2/07	USGS	HI, MP	-	2 (14)	12 (86)
5/9/07	Brood	HI, MP	18 (6)	84 (28)	202 (66)
5/10/07	USGS	HI, MP	9 (21)	8 (19)	25 (61)
5/16/07	Index	HI, MP	20 (11)	3 (2)	153 (87)
2007	Total	All	47 (9)	97 (18)	392 (73)
05-07	Totals	All	66 (4)	248 (15)	1378 (81)

[1] Others/Unknown includes immature females, immature males, mature non-gravid females, mature non-gravid males, mature non-functional females, mature non-function males, inter-sex fish, and unverified mature gravid females.

[2] Value refers to the number of SNS collected.

[3] Value in parenthesis refers to the percentage of SNS collected.

Table 3. Shovelnose sturgeon sampling conditions and summary statistics from the upper Wabash River, 2005, 2006, and 2007.

Date	Purpose	Location[1]	Water Temp (ºF)	River Stage (ft)	Effort (hrs)	No. Collected	CPUE (fish/hr)	No. Tagged	No. Recap	No. Released	No. ODNR	No. WVDNR
5/5/05	Index	HI, MP	-	-	2.0	140	70	134	6	140	-	-
5/6/05	Index	GI, CI	-	-	2.0	50	25	48	2	50	-	-
5/10/05	Brood	MP	64	3.7	1.0	229	229	145	7	152	37	40
5/10/05	Index	GI, CI	-	-	2.0	37	19	36	1	37	-	-
5/11/05	Index	HI, MP	-	-	2.0	86	43	78	8	86	-	-
5/16/05	Brood	HI, MP	62	4.7	1.6	323	202	252	16	268	14	41
2005	Total	All	-	-	10.6	865	82	693	40	733	51	81
5/10/06	Index	HI	-	-	0.5	60	120	55	5	60	-	-
5/10/06	Brood	HI, MP	66	4.0	2.4	231	96	0	0	0	28	203
2006	Total	All	-	-	2.9	291	100	55	5	60	28	203
5/2/07	USGS	HI, MP	-	-	0.6	14	23	14	0	14	-	-
5/9/07	Brood	HI, MP	70	5.1	2.6	304	117	172	5	177	30	97
5/10/07	USGS	HI, MP	-	-	0.8	42	53	36	6	42	-	-
5/16/07	Index	HI, MP	-	-	2.0	176	88	173	3	176	-	-
2007	Total	All	-	-	6.0	536	89	395	14	409	30	97
05-07	Totals	All	-	-	19.5	1692	87	1143	59	1202	109	381

[1] Heron Island (HI); Mascouten Park (MP); Goose Island (GI); and Colliers Island (CI).

Table 4. Steroid concentrations (17-β estradiol, 11-ketotestosterone, and testosterone) and polarization index (PI) of gravid female shovelnose sturgeon from the Wabash River (Mandy Annis, USGS, personal communication).

Date	Fish ID	Floy	PI	17-β Estradiol (pg/mL)	11-Ketotestosterone (pg/mL)	Testosterone (pg/mL)
5/9/07	2	900	0.14	2,870	3,713	6,501
5/9/07	1	902	0.01	677	27,011	29,412
5/9/07	3	903	0.12	879	8,172	6,426
5/9/07	4	904	0.06	71	5,905	8,286
5/10/07	9	917	0.05	616	14,614	14,181
5/10/07	5	918	0.12	2,054	9,877	10,081
5/10/07	7	924	0.09	511	39,521	58,077
5/10/07	12	927	0.06	670	24,358	29,089
5/10/07	13	928	0.06	879	10,333	16,127
5/10/07	10	930	0.08	902	30,791	87,201
5/10/07	6	934	0.12	748	22,771	42,360
5/10/07	11	938	0.07	624	35,370	57,931
5/10/07	8	941	0.08	588	1,351	48,728
5/16/07	18	977	0.00	534	44,138	54,110
5/16/07	24	1031	0.03	558	23,827	9,288
5/16/07	22	1035	0.05	838	27,303	40,762
5/16/07	19	1037	0.00	730	45,391	74,487
5/16/07	21	1038	0.00	NA	NA	NA
5/16/07	17	1045	0.07	665	20,661	27,232
5/16/07	23	1052	0.05	537	18,975	31,283
5/16/07	15	1057	0.05	512	37,766	50,108
5/16/07	20	1058	0.07	791	10,717	58,244
5/16/07	16	1060	0.10	1,716	25,058	69,655
5/16/07	14	1065	0.05	625	27,366	57,156
5/16/07	27	1095	0.05	601	22,045	21,973
5/16/07	29	1096	0.12	1,838	54,341	25,946
5/16/07	25	1097	0.03	531	14,688	58,189
5/16/07	26	1098	0.06	NA	NA	NA
5/16/07	32	1107	0.04	647	16,431	14,509
5/16/07	30	1109	0.07	591	20,089	30,077
5/16/07	31	1110	0.05	268	23,305	23,286
5/16/07	28	1114	0.05	622	20,713	95,930
Median	-	-	0.06	625	22,045	36,023
Min	-	-	0.00	71	13,051	6,426
Max	-	-	0.12	2,054	54,341	95,930