2000

Predation of Juvenile Acipenser fulvescens by Micropterus punctulatus and Ictalurus punctatus

Mark Sandoval

Predation of Juvenile *Acipenser fulvescens* by *Micropterus punctulatus* and *Ictalurus punctatus*

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ABSTRACT

The predation of lake sturgeon, *Acipenser fulvescens*, by spotted bass, *Micropterus punctulatus*, and channel catfish, *Ictalurus punctatus*, was investigated under artificial conditions. Experiments were conducted in a 27,600-liter tank at the Southeast Aquatic Research Institute. Spotted bass were provided bluegill, *Lepomis macrochirus*, as a potential food source during the first four days of each experiment, and lake sturgeon were provided as a potential food source during the latter four days of each experiment. Channel catfish were given either chow or lake sturgeon separately or chow and lake sturgeon concurrently as food sources. Spotted bass consumed 85 bluegill ($\bar{x}$ = 6.87 cm) but consumed no large sturgeon ($\bar{x}$ = 11.8 cm) or small sturgeon ($\bar{x}$ = 7.01 cm), and channel catfish consumed 13 small sturgeon and 5 large sturgeon but consumed no bluegill. It was determined that channel catfish, but not spotted bass, were predators of juvenile lake sturgeon.

INTRODUCTION

Lake sturgeon, *Acipenser fulvescens*, is one of 25 sturgeon species worldwide[1] and is one of the United States' largest and longest-lived freshwater fish with total lengths approaching 2.44 meters[2] and ages exceeding 150 years[3]. The body is cartilaginous, torpedo-shaped, and is covered with five rows of bony plates[4]. A benthic feeder, the sturgeon consumes worms, insect larvae[5], snails, some fish, aquatic plants and benthic debris[6], and they are found in clear or slightly murky lake or river environments[2].

Spawning occurs from May to June over areas of clean, large rubble in rapid flowing water[3]. The females require 15-20 years or more to reach sexual maturity and only spawn every 4-6 years[7], while males require 9-18 years to mature[3].

Unfortunately, these fish have nearly disappeared in their environments. In the Coosa, Missouri, Ohio and Middle Mississippi drainages, the lake sturgeon is nearing extinction[7], and the situation is similar in the New York and Great Lakes regions[8]. This decline is the result of the destruction of juvenile habitat regions, construction of dams[9], pollution[10], and excessive harvesting[1]. The cost of caviar from related species is rising to $3.50 per gram and a kilogram of sturgeon meat can cost $220.00[11]. As a result, these fish have been steadily declining in number.

Staff at the Southeast Aquatic Research Institute (SARI) have hatched and released lake sturgeon as part of a study since 1997. Hundreds of juvenile sturgeon have been released into the French Broad River, but their progress after release has not been studied. Little information is known regarding the behavioral and ecological interactions of juvenile lake sturgeon; however, efforts have been made to determine possible predators of *A. fulvescens*. The purpose of this study was to determine if spotted bass and channel catfish are predators of juvenile lake sturgeon under artificial conditions.

MATERIALS AND METHODS

Study System and Fish Maintenance

The study was conducted from September through December 2000 at the Southeast Aquatic Research Institute in Cohutta, Georgia.

A 27,600-liter, spring-fed tank (Figure 1) was cleaned with typical pool equipment (pump, brushes, leaf catchers, etc.), and temperature and dissolved oxygen (DO) readings were taken one to four times per day for one week using a YSI 55 hand-held dissolved oxygen and temperature system.

Wild-caught spotted bass were acquired from a local fisherman and housed in a 1,900-liter, spring-fed tank and fed ground worms, goldfish (*Carassius auratus*) and bluegill.

Channel catfish, bluegill and goldfish were acquired from the Institute's ponds and were housed in separate 2,300-liter, spring-fed tanks, and each were fed Ziegler ¼ inch catfish chow. The Institute's current yearling lake sturgeon were housed in 750-liter, constant-flow raceways and were fed bloodworms, brine shrimp and Zeigler pelleted trout chow.

Each fish involved in the study was transferred from its holding tank to the study tank using a fishnet and 19-liter bucket. If the holding tank and the study tank temperatures differed > 1.5 °C, the fish, with the exception of bluegill, were acclimated at a rate ≤ 1.5 °C per hour in a 190-liter cooler. Acclimation was accomplished by adding variable amounts of the study tank's water to the 190-liter cooler, which was filled with the holding tank's water. The total length of each fish was measured using a Wildco model 118 measuring board, and the fish was placed by hand into the study tank. Throughout the study, intra- and inter-species interactions were noted, and predation was measured by subtracting the number of prey fish present at the end of each trial from the number of prey introduced.

Throughout the study, the total length of each fish was noted. Four spotted bass $\bar{x}$ = 28.0 cm (Figure 2), 5 channel catfish $\bar{x}$ = 41.9 cm (Figure 3), 22 large sturgeon $\bar{x}$ = 11.8 cm (Figure 4), 23 small sturgeon $\bar{x}$ = 7.01 cm and 108 bluegill $\bar{x}$ = 6.87 cm (Figure 5) were utilized throughout the study. Two days prior to introducing the spotted bass into the study tank, a test group of six goldfish were introduced for two days to confirm habitability and then removed.

Spotted Bass Trials

After four spotted bass were placed into the study tank, six bluegill were introduced as a food source for the bass. The study was started after it was determined that the bass were preying upon the bluegill. During the first four days of a trial, the bass were provided a constant supply of bluegill (Figure 6). One large juvenile lake sturgeon was introduced into the study

tank on day three, and five additional large sturgeon were introduced on day five. From day five to day nine, no bluegill were present in the study tank, and on day nine, the sturgeon were removed, and bluegill were introduced for the next three days. Six small sturgeon were introduced into the study tank on day 12, and the study ran from day 14 to day 19 with sturgeon as the only food source. On day 19, the sturgeon were removed, and the *M. punctulatus* study was concluded.

Channel Catfish Trials

Five channel catfish were introduced into the study tank and were provided chow for four days, and on day five, six small sturgeon were introduced (Figure 7). The catfish were then deprived of chow from day 5 to day 11. On day 12, the sturgeon were removed and the trial was concluded. The catfish were fed chow for three more days.

After the catfish were provided chow for three days, six large sturgeon were introduced into the study tank. From day 4 to day 18, the catfish were deprived of chow, and on day 14, six small sturgeon were introduced into the study tank along with the large sturgeon (Figure 8). On day 18, the remaining sturgeon were removed, and the trial was concluded.

Later the same day, five small and five large sturgeon were then introduced into the study tank, and chow was provided for three days. From day 4 to day 13, the catfish had large and small sturgeon, but no chow, to feed on (Figure 9). Following day 13, the sturgeon were removed, and the channel catfish trial was concluded.

RESULTS

Spotted Bass Trials

No large or small sturgeon were consumed by the bass during the study, however, 85 of 108 bluegill were consumed (Figure 10). Twenty-seven of the bluegill were consumed by the

bass on days 9 and 10, and an additional 13 bluegill were found dead in or around the study tank. Ten bluegill remained in the study tank at the conclusion of the trial. Temperature and DO readings averaged 19.6 °C and 10.5 mg/L respectively throughout the spotted bass trials.

Channel Catfish Trials

The catfish consumed 13 of 17 small sturgeon and 5 of 16 large sturgeon (Figure 11). When a group of small sturgeon or a group of large sturgeon were tested, the small sturgeon group showed a greater predation rate (Figure 12), as did a mixed (large and small sturgeon) population, however the mixed population had a greater rate of predation upon both the small and large sturgeon (Figure 13). When chow was made available, the predation rate upon a mixed population greatly declined (Figure 14). Throughout the duration of the channel catfish trial, the average temperature and D.O. readings were 12.0 °C and 10.4 mg/L respectively.

DISCUSSION

This study indicated that spotted bass are not predators of juvenile lake sturgeon under our artificial test conditions. The number of bluegill eaten on days 9 and 10 indicated that the bass were hungry by the end of the four-day period in which sturgeon was the only food source. These results imply that if a hungry spotted bass encountered a juvenile lake sturgeon in the wild, it might not attempt to eat it.

Breck and Hay-Chmielewski[12] showed that largemouth bass, *Micropterus salmoides*, would not voluntarily consume juvenile lake sturgeon. Their study suggested that sturgeon produce a chemical that deters largemouth bass from preying upon them. A similar mechanism might account for the lack of predation by spotted bass on lake sturgeon in this study.

Channel catfish, however, were predators of juvenile lake sturgeon under our artificial test conditions. Both channel catfish and lake sturgeon feed upon similar prey and occupy

similar niches in nature[13, 6]. Therefore, if lake sturgeon and channel catfish populations are sufficiently large, encounters between the two fish may occur. If the sturgeon is sufficiently small, it is likely to become prey to the catfish.

Two observations of attack upon a sturgeon were made. In the first instance, a catfish swam over a large sturgeon and touched it with its barbels and then it stopped and struck at the sturgeon from the side. Although it tried several times to swallow the sturgeon, it was unable to, because the sturgeon was too long and would not bend enough to fit into its mouth. After a few seconds, the catfish released the sturgeon.

Several minutes later a small sturgeon swam from behind and below a catfish and emerged beneath the catfish's mouth. Again, after a short delay, the catfish struck at the sturgeon, but did not consume it. The sturgeon was stunned and floated upside down for a second until a second catfish came and ate it. Unlike the first observation, the sturgeon was sufficiently small to be consumed by the catfish.

A negative relationship may exist between increased sturgeon size and successful predation by the channel catfish (Figure 15). When available to predation, a small sturgeon was consumed an average of 1 every 1.8 days ($\bar{x}$ = 6.1 days since last feeding), whereas a large sturgeon was consumed an average of 1 every 6.5 days ($\bar{x}$ = 9.5 days since last feeding). Also, sturgeon were consumed by the catfish regardless of the availability of chow.

We have shown that spotted bass are not predators of juvenile lake sturgeon, but we have shown that channel catfish are predators of lake sturgeon under artificial conditions, and that there is a relationship between the size of juvenile sturgeon and predation. As sturgeon grow, the chance that they will be preyed upon decreases.

ACKNOWLEDGMENTS

I thank Dr. George Benz for his direction and guidance in the development and execution of this study and for his editorial assistance; Natalie Fisher and Sabrina Novak for their help in data collection and system maintenance; Dr. Ann Foster for her editorial assistance; and my wife, LeEtta, for her willingness to relinquish time with me so I could conduct this research. This research was funded in part by the Southeast Aquatic Research Institute and the Tennessee Aquarium.

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Figure 1. Study tank. A 27,600-liter tank was used for both bass and catfish predator studies.

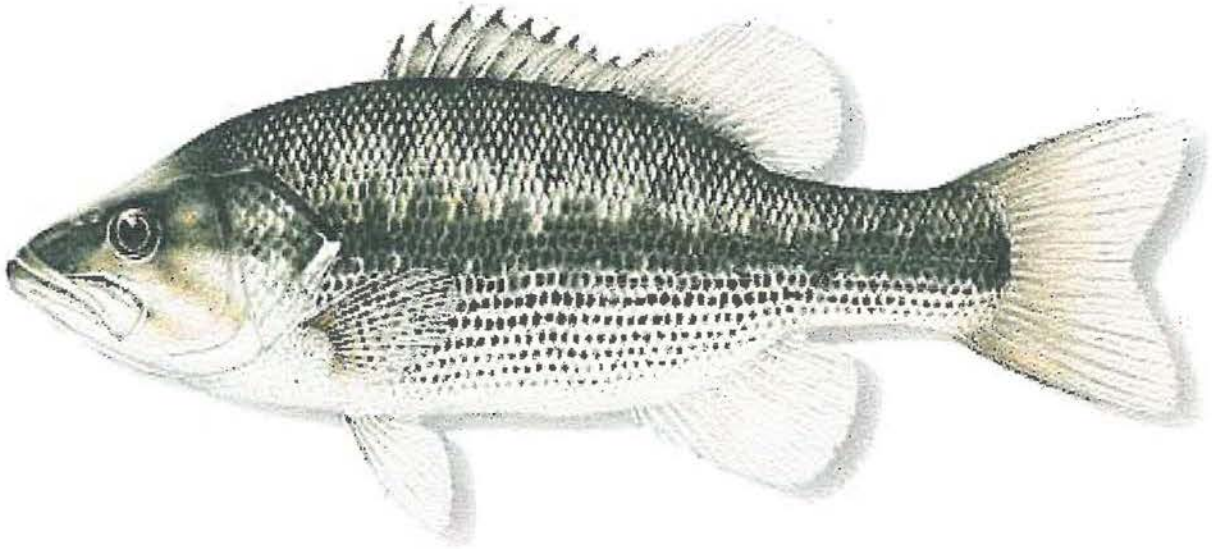

Figure 2. *Micropterus punctulatus.* An illustration of a spotted bass made by Joseph Tomelleri. The Native Fish Conservancy [Internet] http://www.nativefish.org/Store/JT.html.

Figure 3. *Ictalurus punctatus.* This is a drawing of an adult channel catfish. New York Department of Conservation [Internet] http://www.sarep.cornell.edu/Sarep/fish/fish.html.

Figure 4. Juvenile *Acipenser fulvescens.* This is one of the large sturgeon used in one of the studies.

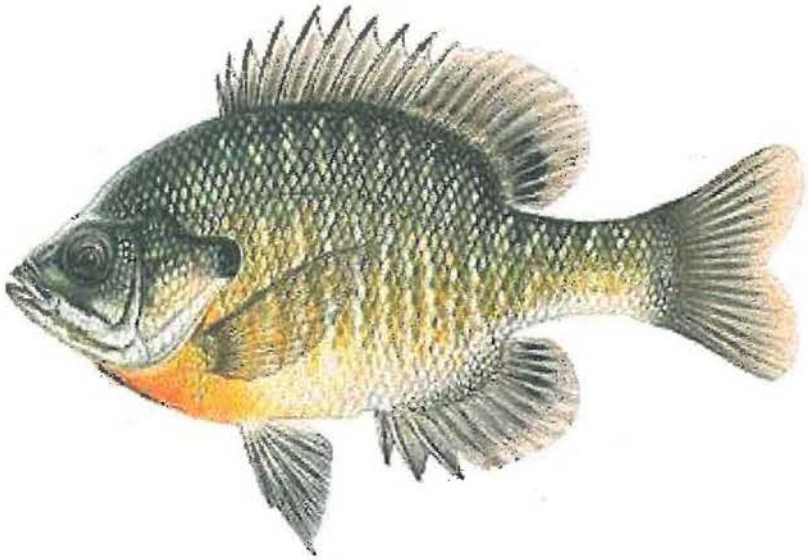

Figure 5. *Lepomis macrochirus.* A drawing of a bluegill made by Joseph Tomelleri. The Native Fish Conservancy. [Internet] http://www.nativefish.org/Store/JT.html.

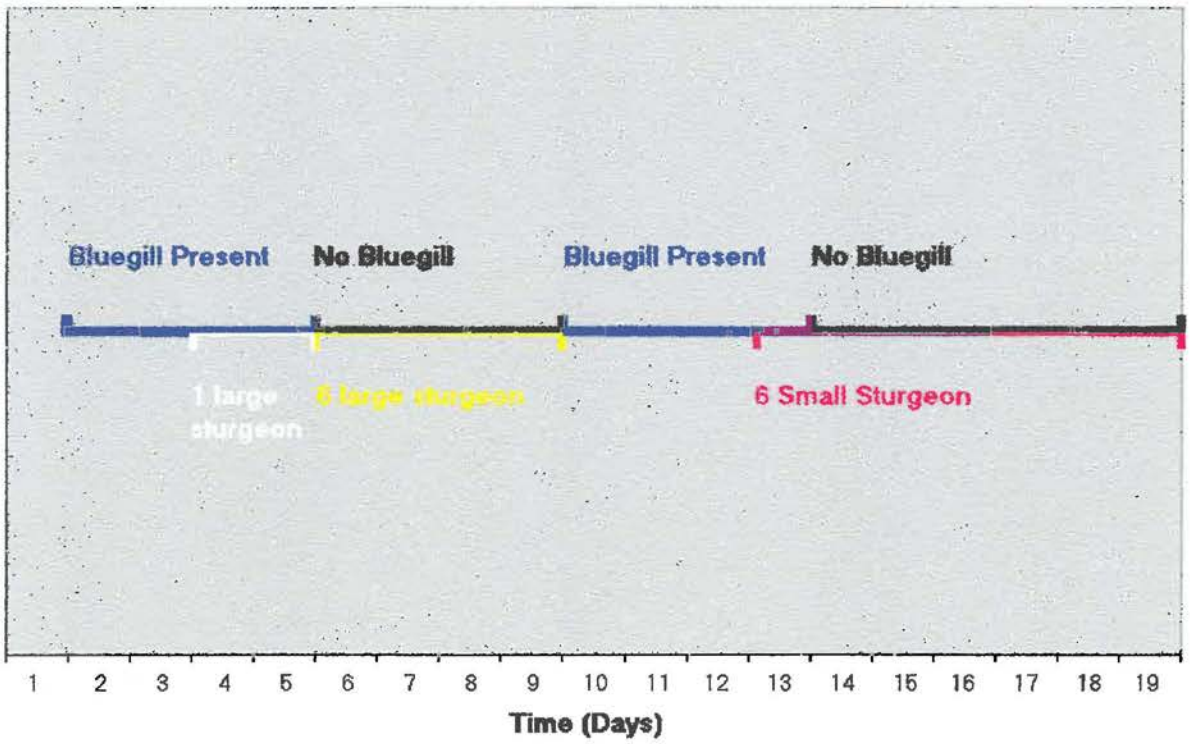

Figure 6. Spotted bass trial. Timeline showing the presence of prey fish throughout the trial.

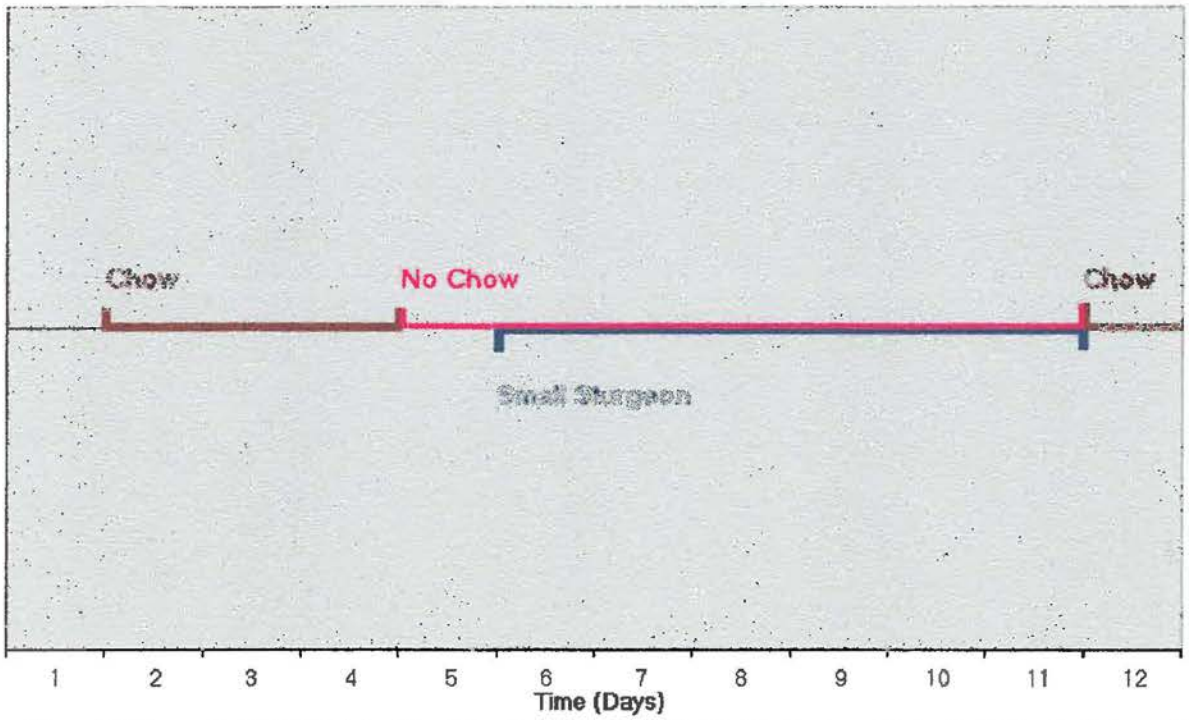

Figure 7. Channel catfish trial 1. Timeline showing the available food sources throughout the first channel catfish trial.

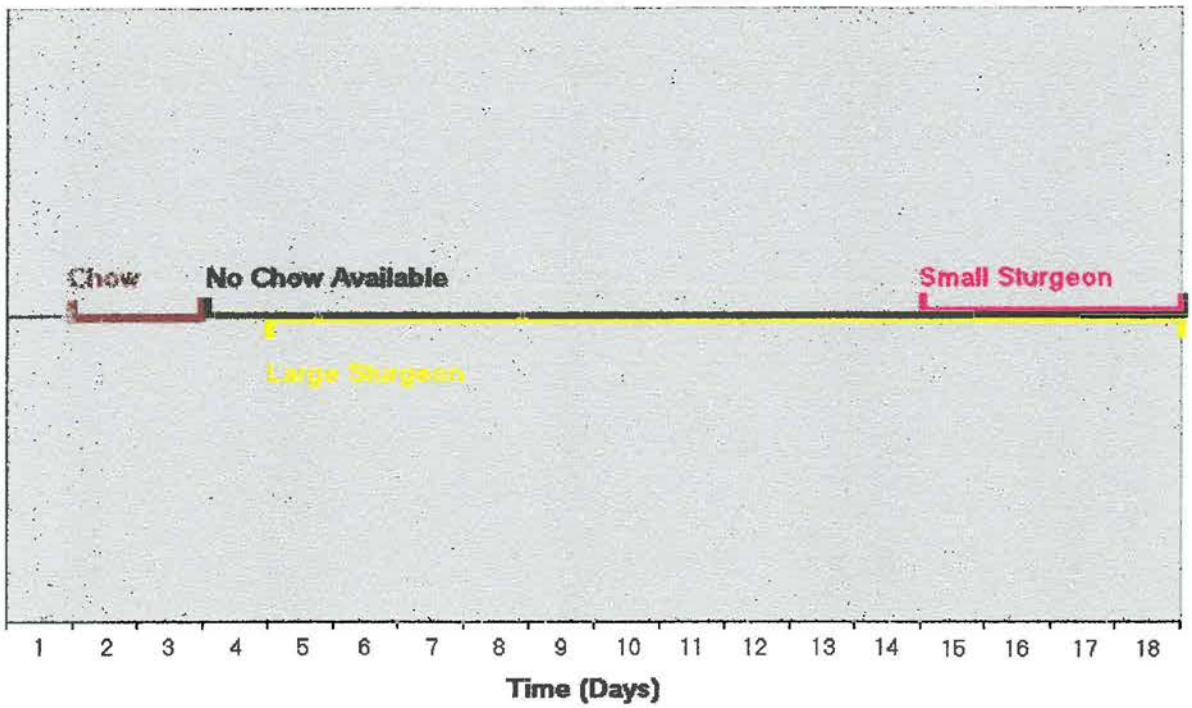

Figure 8. Channel catfish trial 2. Timeline showing the food sources available throughout the second channel catfish trial.

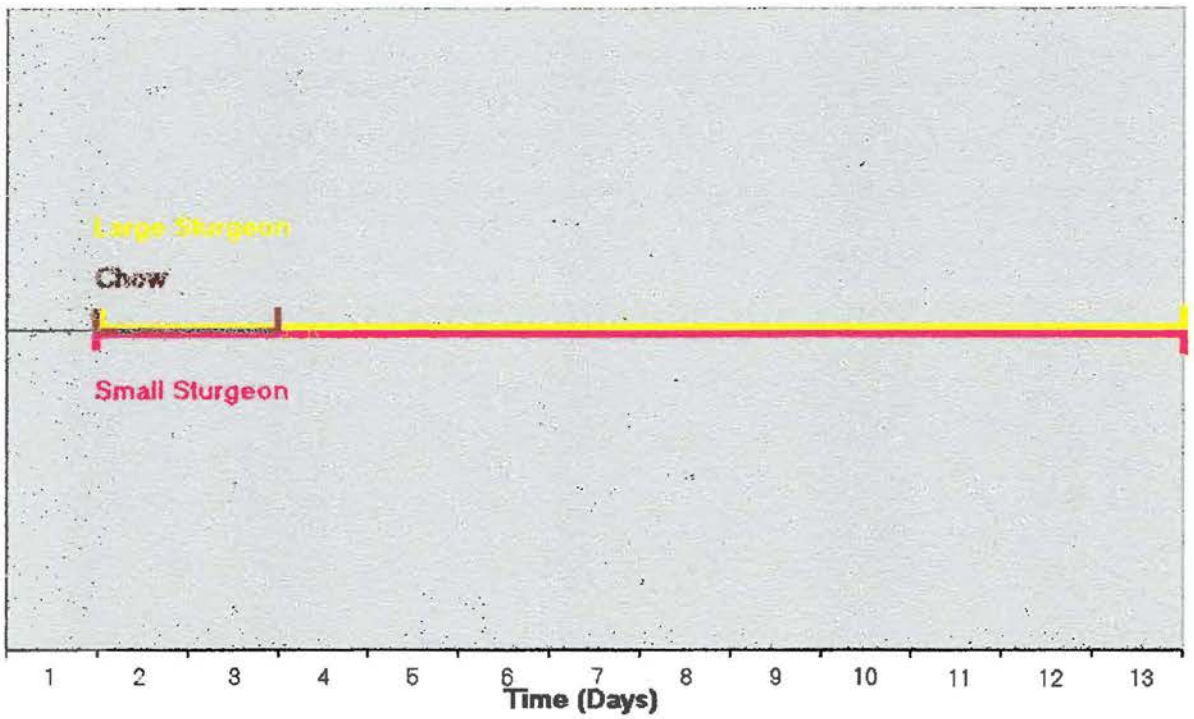

Figure 9. Channel catfish trial 3. Timeline showing the food sources available throughout the third channel catfish study.

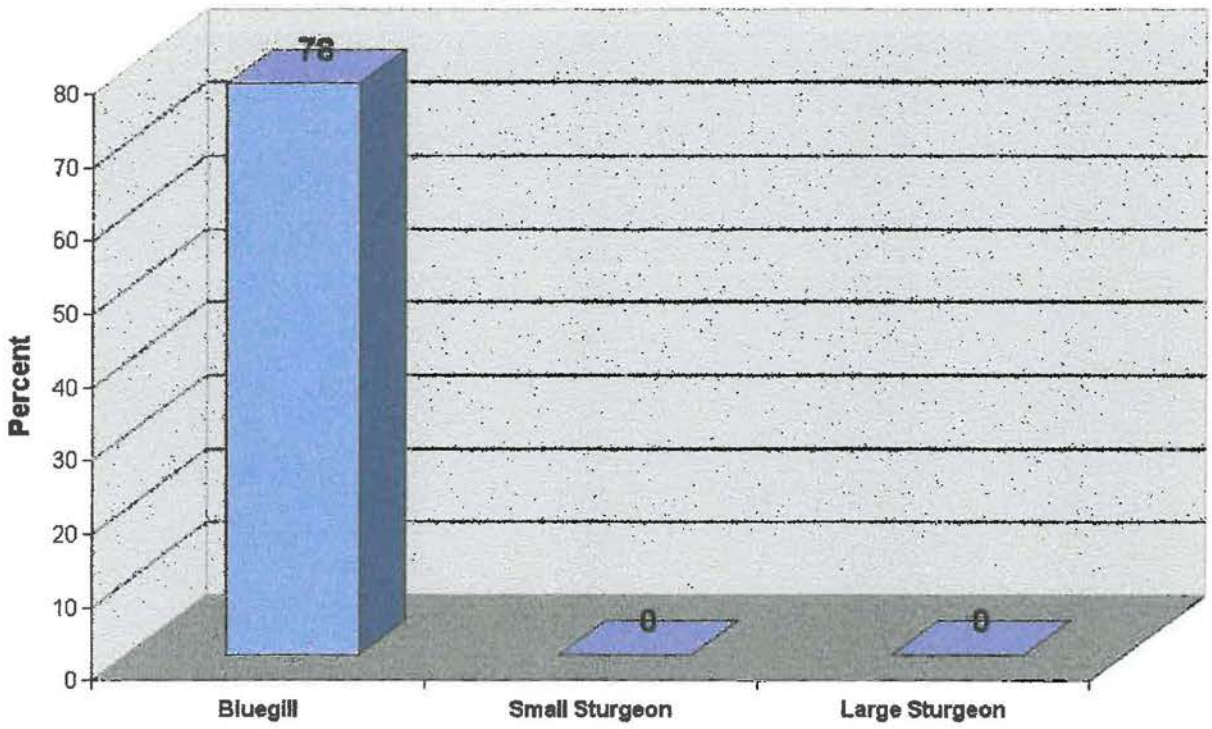

Figure10. Percent consumption of prey items throughout the spotted bass trial.

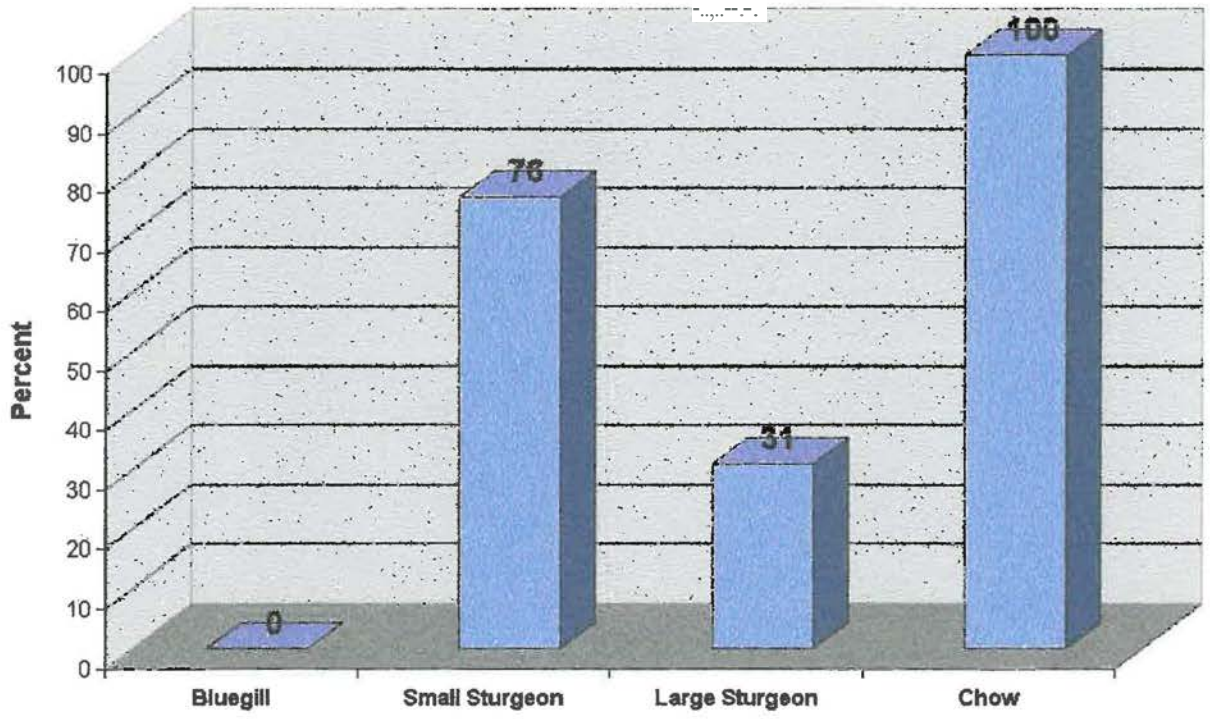

Figure 11. Percent consumption of food items throughout the channel catfish trials. The chow was given an arbitrary value of 100%.

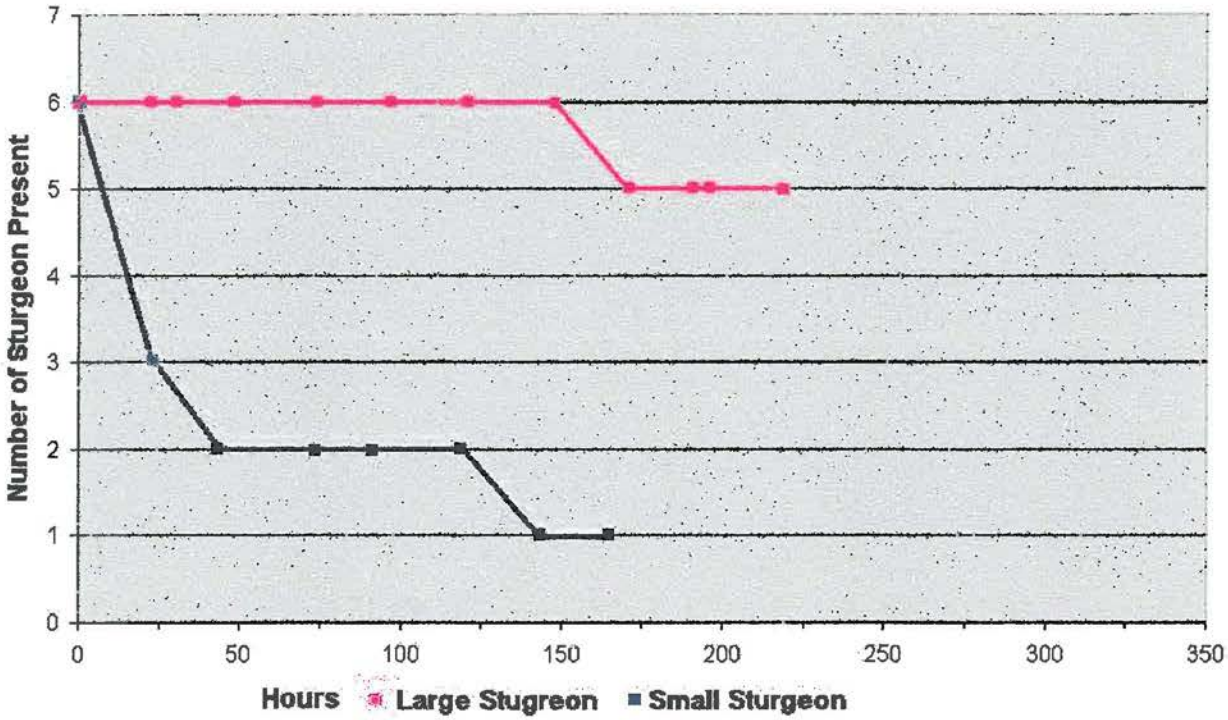

Figure 12. Rate of sturgeon predation by channel catfish. A group of small sturgeon was studied and then a group of large sturgeon was studied, and the predation rate upon each group independently was recorded.

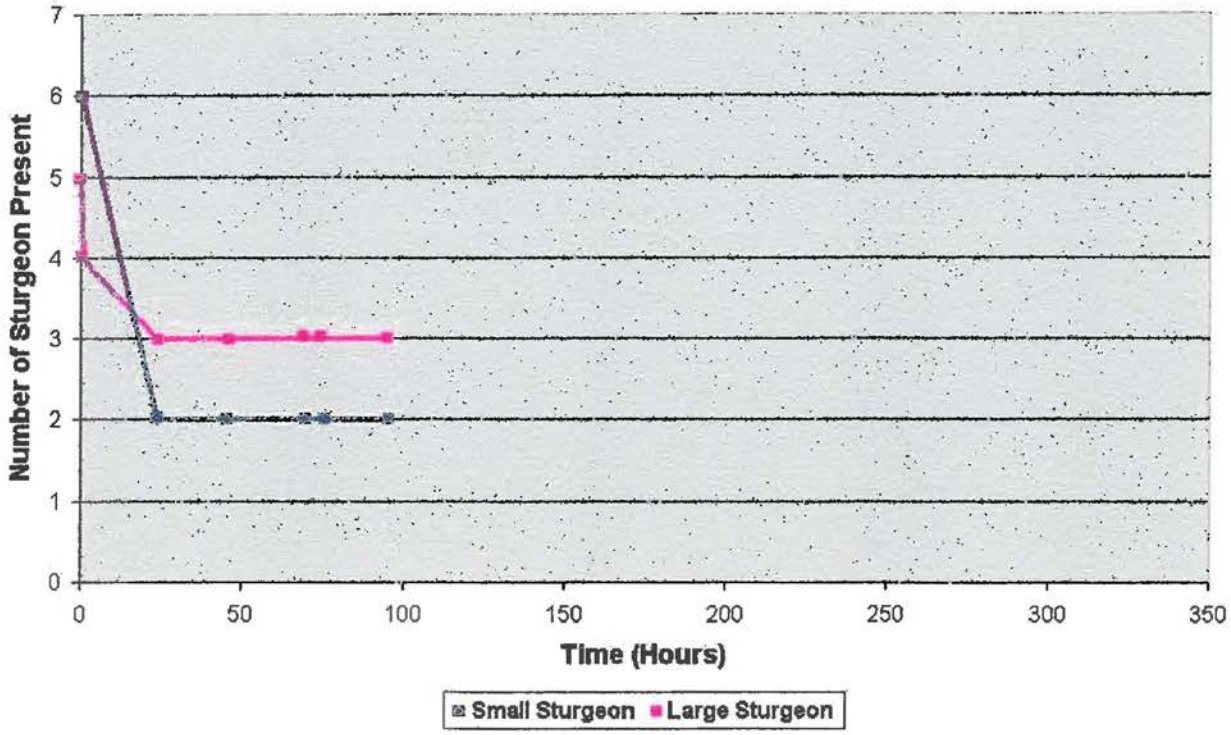

Figure 13. Rate of sturgeon predation by channel catfish. Both a group of small and a group of large sturgeon were studied concurrently, and the predation rate was recorded for each group.

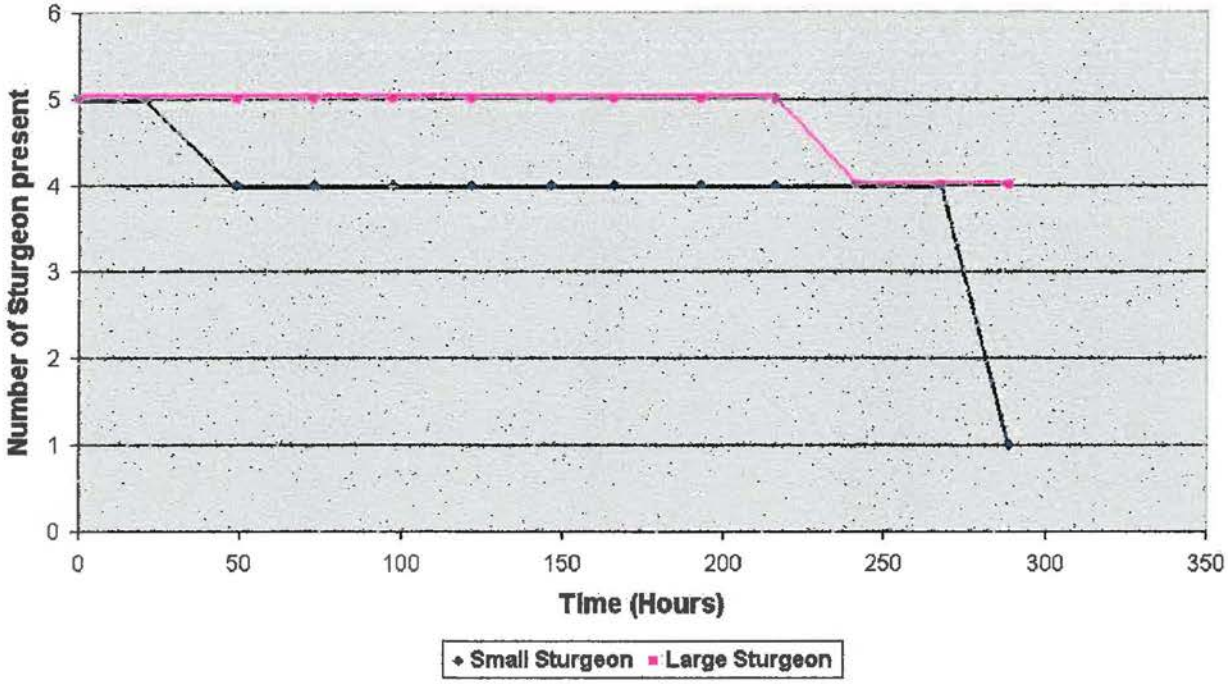

Figure 14. Rate of lake sturgeon predation by channel catfish. Large and small sturgeon groups were studied concurrently with chow to discover the effects an alternative food source (chow) has on predation.

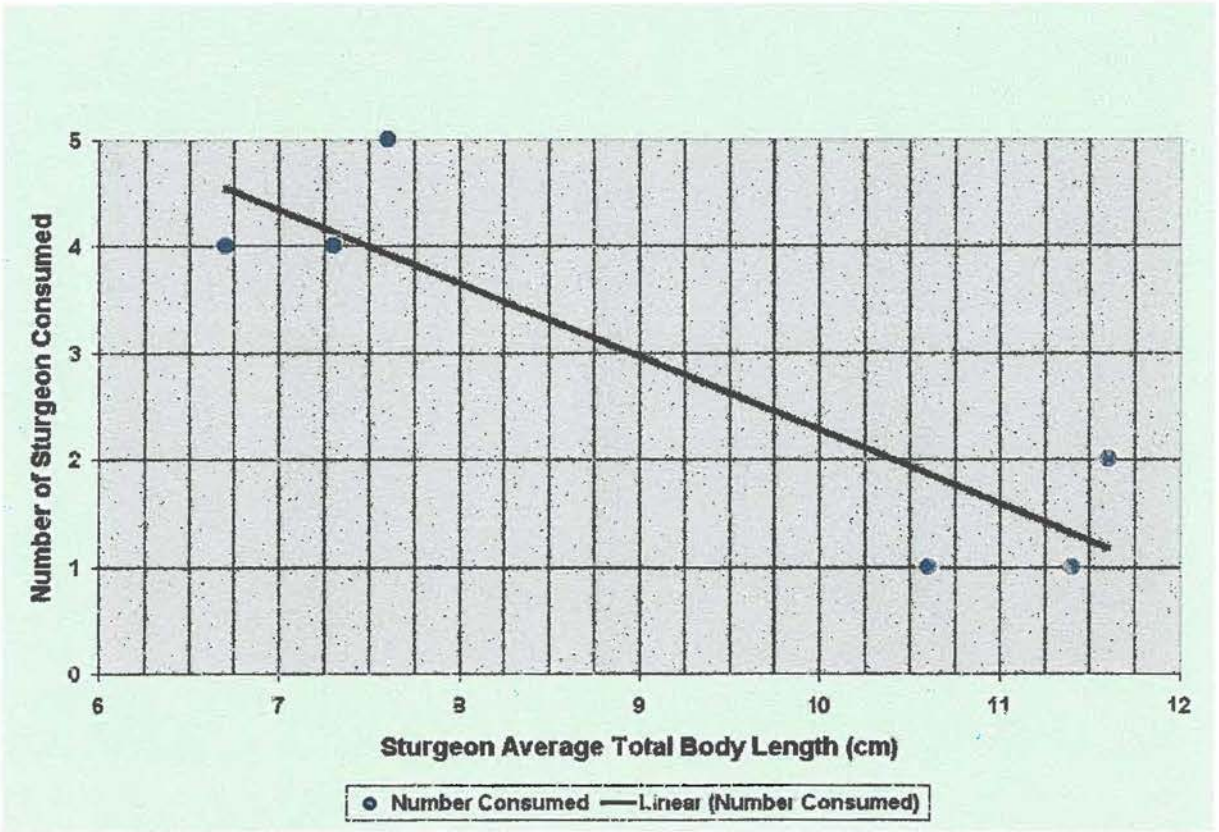

Figure 15. A simple linear regression which indicated a negative relationship between increased sturgeon size and successful predation by channel catfish.

SOUTHERN SCHOLARS SENIOR PROJECT

Name: Mark Sandoval Date: 6/28/00 Major: Biology

SENIOR PROJECT

A significant scholarly project, involving research, writing, or special performance, appropriate to the major in question, is ordinarily completed the senior year. The project is expected to be of sufficiently high quality to warrant a grade of A and to justify public presentation.

Under the guidance of a faculty advisor, the Senior Project should be an original work, should use primary sources when applicable, should have a table of contents and works cited page, should give convincing evidence to support a strong thesis, and should use the methods and writing style appropriate to the discipline.

The completed project, to be turned in in duplicate, must be approved by the Honors Committee in consultation with the student's supervising professor three weeks prior to graduation. Please include the advisor's name on the title page. The 2-3 hours of credit for this project is done as directed study or in a research class.

Keeping in mind the above senior project description, please describe in as much detail as you can the project you will undertake. You may attach a separate sheet if you wish:

I am working under the direction of Dr. George Benz at the Southeast Aquatic Research Institute (SARI) in Cohutta Georgia. The project is a predator behavior study of largemouth bass and channel catfish on <1yr. Lake Sturgeon. We are attempting to discover if largemouth bass and/or Channel Catfish are predators of young lake sturgeon. A controlled setting is being prepared where both predator and prey will be in the same environment and observations will be noted as to behavior and consumption. Conclusions will be drawn after several trials.

Signature of faculty advisor K Snyder (okay) Expected date of completion 12/00

Approval to be signed by faculty advisor when completed:

This project has been completed as planned: yes

This in an "A" project: yes!

This project is worth 2-3 hours of credit: 2

Advisor's Final Signature Linda Anne Foster

Chair, Honors Committee _____ Date Approved: _____

Dear Advisor, please write your final evaluation on the project on the reverse side of this page. Comment on the characteristics that make this "A" quality work.

(Over)

Goal To determine if largemouth bass and/or channel catfish are predators of YOY lake sturgeon.

Materials and Methods

Materials

1. Deep, thin mesh, long poled net (cleaning bottom of large tank).
2. Water pump/hose/head (suction cleaning apparatus).
3. Four cinder blocks.
4. Two branches.
5. Two oxygen saturation monitors.
6. Two thermometers.
7. Seine net for catfish/bass/sunfish?
8. Fishing gear for catfish/bass/sunfish?
9. Electric shock for bass?
10. Person/persons to help with seine net.
11. Equipment to prepare raceway in hatchery for acclimation to warm/cold water?
12. Food for sturgeon.
13. Large bucket for bass/catfish transport.
14. Small bucket for sturgeon transport.
15. Observation deck for large tank.
16. Long poled net to catch sturgeon in large tank.
17. Chest waders to use with seine net/cleaning tank.
18. Scale.
19. Measuring board.
20. Feed for sturgeon.
21. Data sheets.

Methods

A. Experiment A
   1. Clean large tank
   2. Place four cinder blocks and 2 branches in bottom of tank for cover
   3. Measure oxygen in large tank every____ hours/days/times per day?
   4. Measure temperature in large tank every____ hours/days/times per day?
   5. Obtain four 7-10 inch largemouth bass/channel catfish, measure & introduce to large tank
   6. Obtain eight sunfish of edible size and introduce to large tank
   7. Maintain presence of >5 sunfish in large tank
   8. Prepare raceway in hatchery for temperature acclimation of YOY sturgeon.
   9. Measure oxygen in raceway every____ hours/days/times per day?
   10. Measure temperature in raceway every____ hours/days/times per day?
   11. Select 6 of largest 2000 sturgeon, measure and transfer to hatchery
   12. Feed sturgeon____ times/day
   13. Introduce sturgeon to large tank two days after bass/catfish start eating sunfish and after sturgeon acclimate to necessary conditions?
   14. Allow sturgeon to remain in large tank for 48 hours
   15. Observe every____ hours to discover if/how many sturgeon were consumed.

B. After Experiment A: All Sturgeon Remaining after 48 Hours
   1. Repeat A 8-10
   2. Catch Sturgeon and place in hatchery
   3. Feed sturgeon____ times/day.
   4. Return sturgeon to home tank after acclimated to necessary conditions?
   5. Select six of smallest 2000 sturgeon, measure and put in hatchery.
   6. Repeat A 8-10, 12-15

C. After Experiment B: All Sturgeon Remain
   1. Repeat A 8-10

2. Repeat B 2,3
3. Obtain four >10 inch largemouth bass/channel catfish, measure & introduce to large tank
4. Repeat A 3,4,7,13-15

D. After Experiment C: All Sturgeon Remain
   1. Repeat B 2-4
   2. Catch bass/catfish in large tank and release
   3. Conclude bass/catfish is not predator of YOY lake sturgeon

E. After Experiment A: Some/All Sturgeon Missing
   1. Repeat B 1-3
   2. Select____ # of large 2000 sturgeon and introduce into hatchery with Exp. A sturgeon to total six sturgeon; measure
   3. Catch bass/catfish in large tank and release.
   4. Repeat A 3-5,7,13-15

F. After Experiment E: All Sturgeon Remain
   1. Repeat E 1-3
   2. Obtain four >10 inch largemouth bass/channel catfish, measure & introduce to large tank
   3. Repeat A 3,4,7,13-15

G. After Experiment F: All Sturgeon Remain
   1. Repeat D 1,2
   2. Conclude factor other than bass/catfish involved in missing sturgeon in Exp. A and bass/catfish not predator of YOY lake sturgeon

H After Experiment E: Some/All Sturgeon Missing
   1. Repeat D 1,2
   2. Conclude bass/catfish is predator of YOY lake sturgeon

Project Timeline

1.	Discussion and preparation:	8/8/00-9/3/00
2.	First Bass Experiment:	9/4/00-9/10/00
3.	Second Bass Experiment:	9/11/00-9/17/00
4.	Third Bass Experiment:	9/18/00-9/24/00
5.	Fourth Bass Experiment:	9/25/00-10/1/00
6.	First Catfish Experiment:	10/2/00-10/8/00
7.	Second Catfish Experiment:	10/9/00-10/15/00
8.	Third Catfish Experiment:	10/16/00-10/22/00
9.	Fourth Catfish Experiment:	10/23/00-10/29/00

Project Data Sheet

1. Large tank: bass/catfish length & weight, O2, temp, weather conditions, # sunfish present, sturgeon time in/out, # sturgeon present, comments
2. Hatchery: Sturgeon length & weight, O2, temp, feeding time/amount, comments