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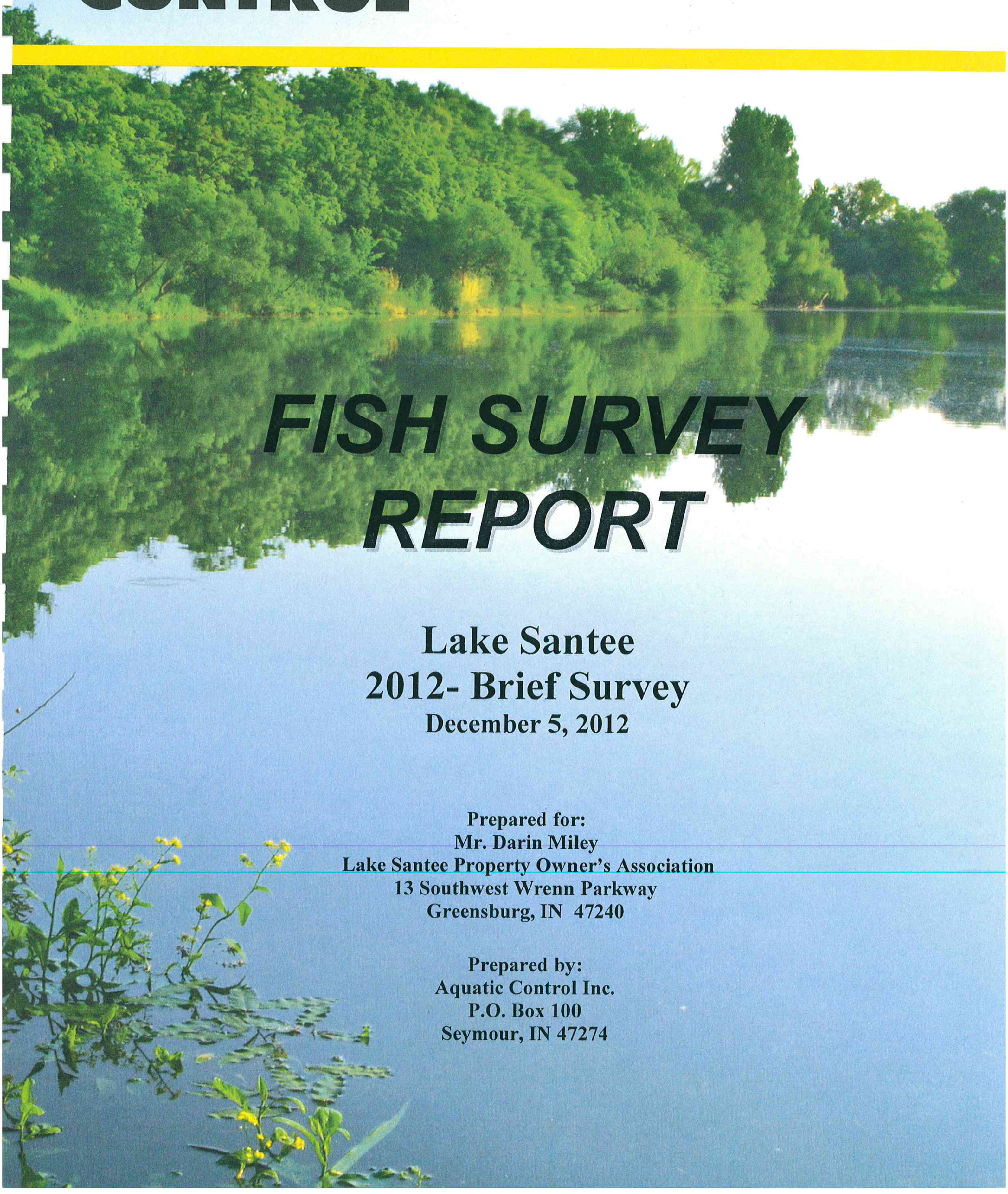

FISH SURVEY REPORT

Lake Santee
2012- Brief Survey

December 5, 2012

Prepared for:
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INTRODUCTION

A brief survey of the fish population and other physical, biological, and chemical factors directly affecting the fish population was completed at Lake Santee, October 17, 2012. All fish were measured, but only bluegill, largemouth bass, and gizzard shad were weighed.

The major objectives of this survey and report are:

1. To provide a current status report on the fish community of the lake
2. To compare the current characteristics of the fish community with established indices for Indiana lakes and to past fish surveys completed on Lake Santee
3. To provide recommendations for management strategies to enhance or sustain the sport fish community

The data collected are adequate for the intended uses; however, there will be unanswered questions regarding aspects of the fish population and other related factors of the biological community in the lake and a more detailed survey should be completed in the near future. All fish numbers used in the report are based on the samples collected and should not be interpreted to be absolute or estimated numbers of fish in the lake. General information regarding water chemistry, fish communities, and methods are described in Appendix A. A detailed fish collection table is presented in Appendix B.

RESULTS AND DISCUSSION

WATER CHEMISTRY

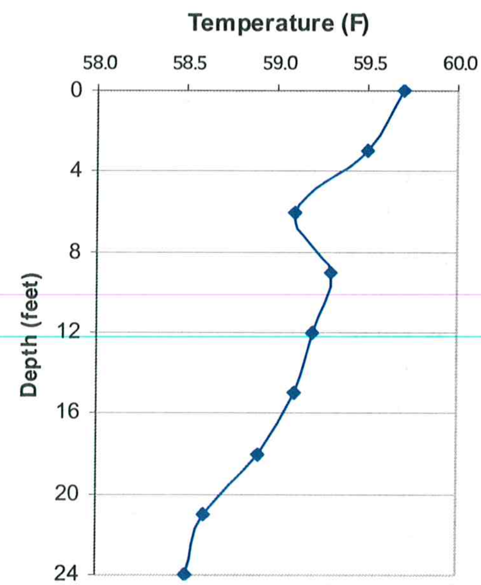
The results of selected physio-chemical parameters from Lake Santee are presented in Table 1. Water temperatures ranged from 59.7 degrees Fahrenheit at the surface to 58.5 degrees Fahrenheit at the bottom. Dissolved oxygen ranged from 9.10 parts per-million (ppm) at the surface to 7.40 ppm at the bottom (Figure 1). A desirable oxygen level for maintenance of healthy stress free fish was present throughout the water column. These numbers indicate Lake Santee was de-stratified at the time of the survey, which is typical for this time of year (see Appendix A for further details on lake stratification). The alkalinity level was 136.8 ppm and the hardness level was 136.8 ppm at the surface. The pH measured 8.59 at the surface. These numbers are normal for lakes in this area and indicate the lake is capable of good fish production. The Secchi disk depth was measured at 2.5 feet. Nitrate-nitrogen levels were 0.9 ppm and ortho-phosphate levels were 0.02

ppm at the surface. Lake Santee has water quality that is capable of supporting a relatively healthy fish population.

Table 1. Selected water quality parameters measured on Lake Santee, October 17, 2012.

Sample Depth (ft.)	Temp. (°F)	Dissolved Oxygen (ppm)	pH (standard units)	Total Alkalinity (ppm)	Total Hardness (ppm)	Nitrate/ Nitrogen (ppm)	Ortho phosphate (ppm)	Total phosphorus (ppm)
Surface	59.70	9.10	8.59	136.8	136.8	0.90	0.02	0.30
3	59.50	9.20	-	-	-	-	-	-
6	59.10	9.20	-	-	-	-	-	-
9	59.30	9.10	-	-	-	-	-	-
12	59.20	9.00	-	-	-	-	-	-
15	59.10	8.70	-	-	-	-	-	-
18	58.90	8.50	-	-	-	-	-	-
21	58.60	8.20	-	-	-	-	-	-
24	58.50	7.40	-	-	-	-	-	-

*Dashes indicate no sample was taken at selected depth for given parameter.



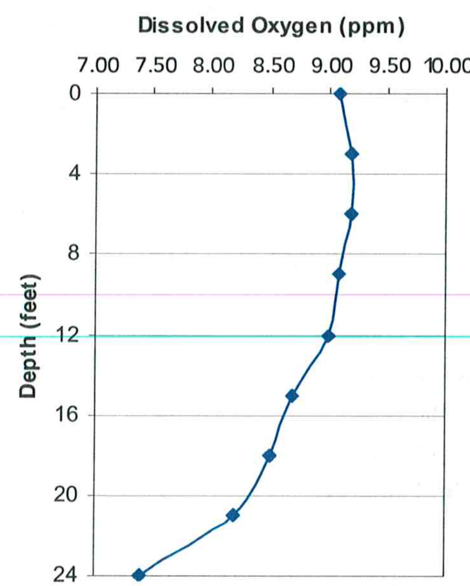


Figure 1. Dissolved oxygen and temperature profiles for Lake Santee, October 17, 2012.

FISH COLLECTION

A total of 1,739 fish representing 15 species was collected from Lake Santee (Table 2 and Figure 2). Bluegill *Lepomis macrochirus* was the most abundant species comprising 56.58% of the fish collected. Gizzard shad *Dorosoma cepedianum* was the second most abundant species (18.75%), followed by brown bullhead *Ameiurus nebulosus* (10.01%), largemouth bass *Micropterus salmoides* (5.35%), black crappie *Pomoxis nigromaculatus* (3.16%), green sunfish *Lepomis cyanellus* (1.96%), white crappie *Pomoxis annularis* (1.55%), hybrid striped bass *M. chrysops X M. saxatilis* (0.75%), bluntnose minnow *Pimephales notatus* (0.52%), redear sunfish *Lepomis microlophus* (0.52%), channel catfish *Ictalurus puncatus* (0.40%), spotfin shiner *Cyprinella spiloptera* (0.23%), common carp *Cyprinus carpio* (0.12%), hybrid sunfish *Lepomis spp. X Lepomis spp.* (0.06%), and golden shiner *Notemigonus crysoleucas* (0.06%). White sucker, yellow bullhead, smallmouth bass, and grass carp were collected in past surveys, but none were collected during the current survey. Figure 3 shows the relative abundance of bluegill, gizzard shad, and largemouth bass over the past five surveys.

Table 2. Species collected from Lake Santee, October 17, 2012.

Species	N	% N	Size Range (in)	Total Weight (lbs.)	% Wt	N/hr.
Bluegill	984	56.58	<3-8.0	115.74	36.06	491
Gizzard shad	326	18.75	4.0-15.0	123.72	38.54	163
Brown bullhead	174	10.01	<3-12.0			87
Largemouth bass	93	5.35	3.0-19.0	81.54	25.40	46
Black crappie	55	3.16	3.5-9.0			27
Green sunfish	34	1.96	<3.0-7.0			17
White crappie	27	1.55	6.0-8.5			13
Hybrid striped bass	13	0.75	8.0-26.5			6
Bluntnose minnow	9	0.52	3.0			4
Redear sunfish	9	0.52	4.5-9.0			4
Channel catfish	7	0.40	13.0-28.5			3
Spotfin shiner	4	0.23	<3.0			2
Common carp	2	0.12	31.0-35.0			1
Hybrid sunfish	1	0.06	6.0			0
Golden shiner	1	0.06	2.0			0
Total	1739	100.00		321.00	100.00	

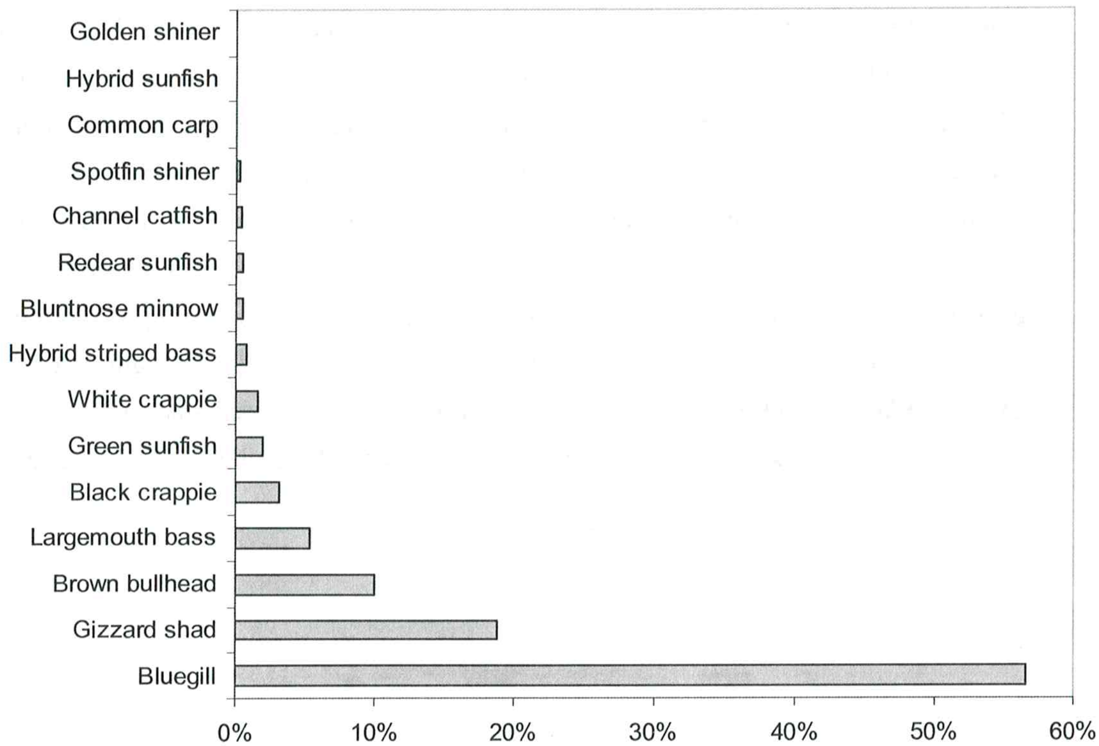


Figure 2. Relative abundance of species collected from Lake Santee, October 17, 2012.

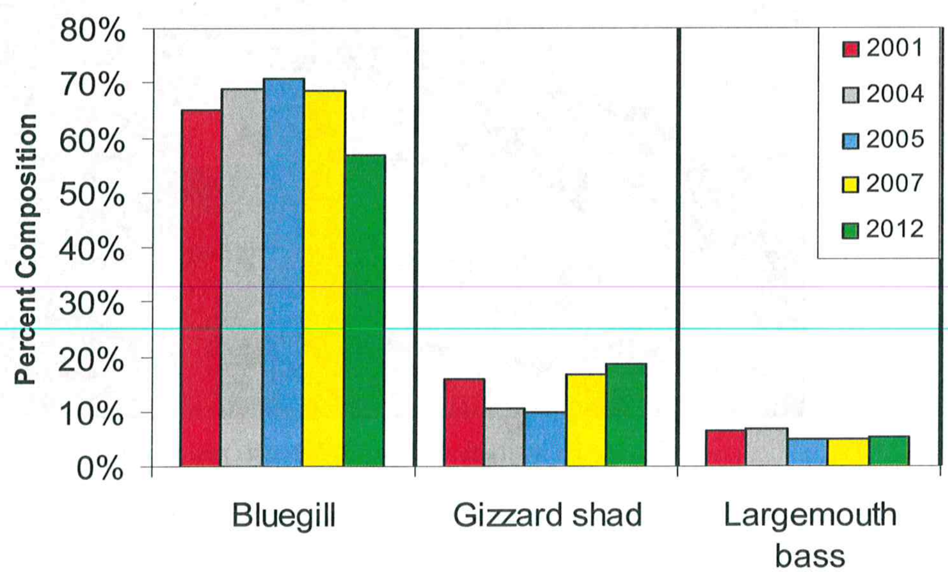


Figure 3. Comparison of selected species over past five surveys.

Bluegill

Bluegill (Figure 4) was the most abundant species collected (56.58%). Individuals ranged in size from less than 3.0 to 8.0 inches (Figure 5). Only 4.67% of bluegill collected were 3.5 inches or less, indicating reproduction was poor in 2012 . The catch-per-unit-effort (CPUE) was 491 and the proportional stock density (proportion of quality fish within a population) was 16, which is slightly below the desired range of 20-40 for bluegill, but closer to a balanced state than it was in 2007 (56). Relative weights for bluegill were good for fish up to 5.0 inches, but low for fish 5.5 to 8.0 inches. Bluegill weights were also below standard weights for most size ranges (Figure 6). The bluegill quality remains low in the lake, which is typical for lakes with prominent gizzard shad populations. Figure 7 shows a length frequency distribution comparison for bluegill over the past five surveys.

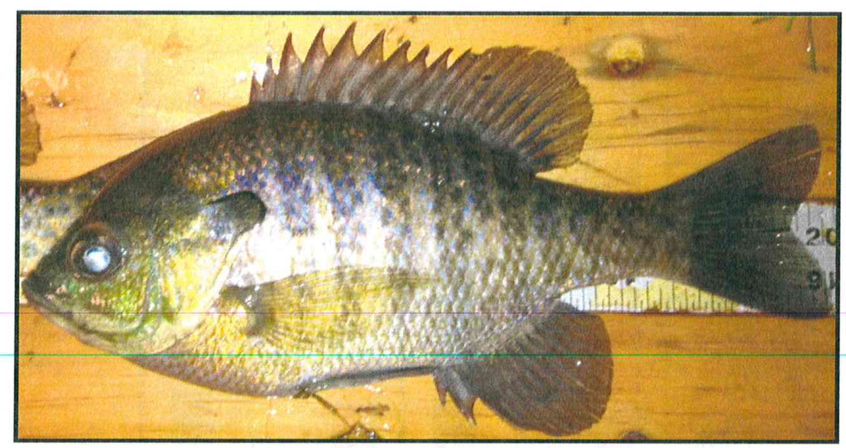


Figure 4. Photograph of bluegill, *Lepomis macrochirus*.

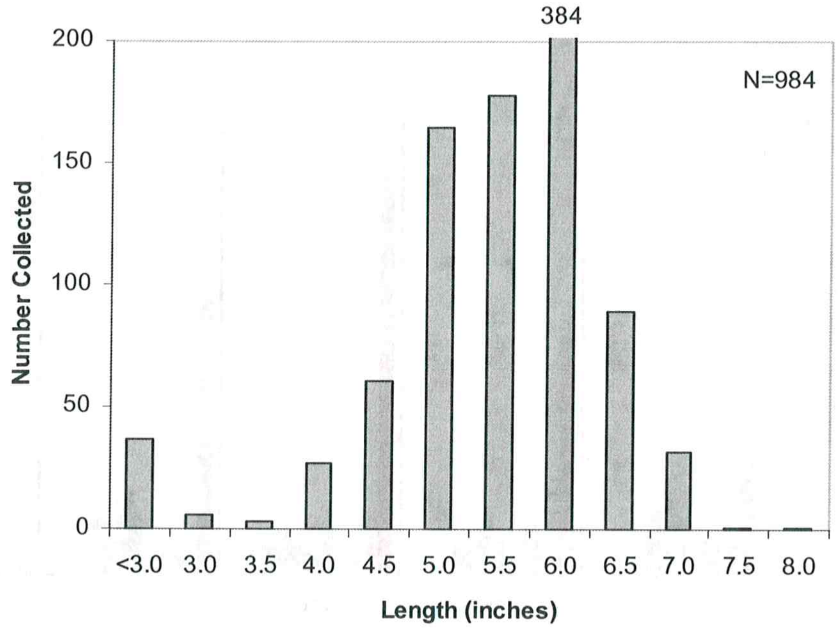


Figure 5. Length frequency distribution of bluegill collected from Lake Santee, October 17, 2012.

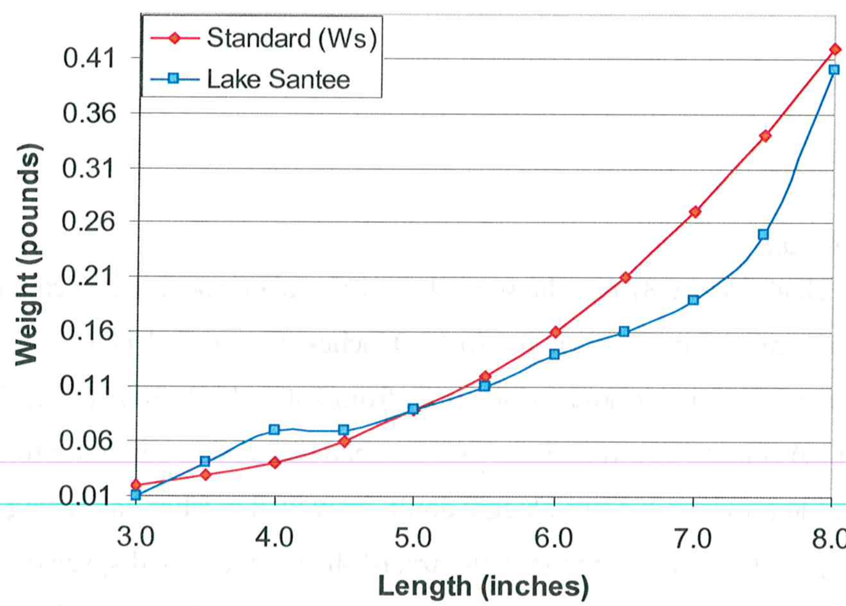


Figure 6. Comparison of Lake Santee bluegill weights to standard bluegill weights.

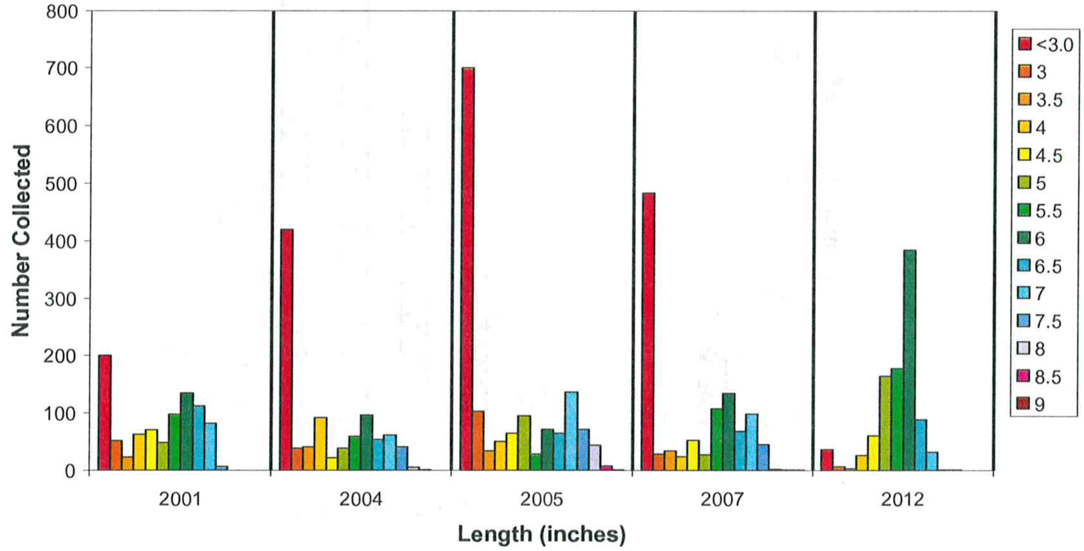


Figure 7. Length frequency comparison of bluegill over the past five surveys.

Gizzard shad

Gizzard shad (Figure 8) was the second most abundant species collected (18.75%). Individuals ranged in size from 4.0 to 15.0 inches (Figure 9). The CPUE for the 2012 survey was 163 fish per hour, which is up from 2007 (138), 2005 (102), 2004 (77), and 2001 (110) (Figure 10). It appears that the shad population continues to increase. As observed in previous surveys bluegill don't grow well in lakes containing this species. This may be due to competition with gizzard shad for food and space or largemouth bass switching to gizzard shad as their primary forage causing bluegill to become overabundant and slow growing. Figure 11 shows the percent composition of gizzard shad over the past five surveys.

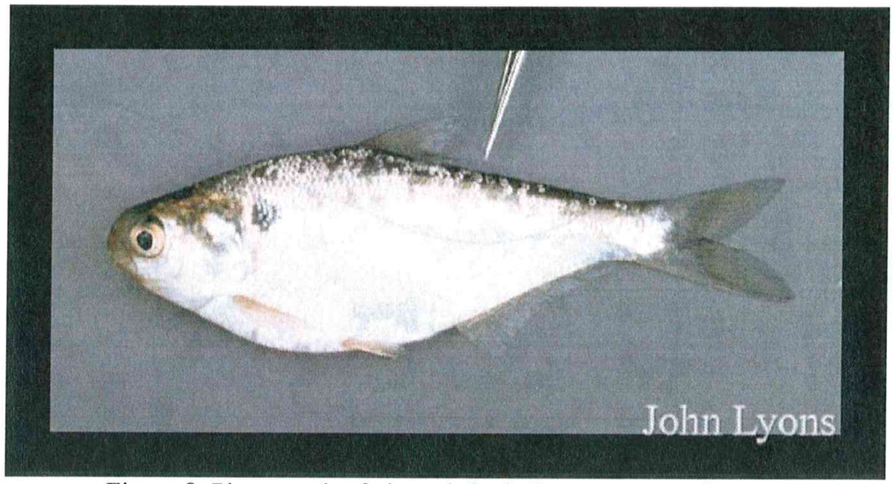


Figure 8. Photograph of gizzard shad, *Dorosoma cepedianum*.

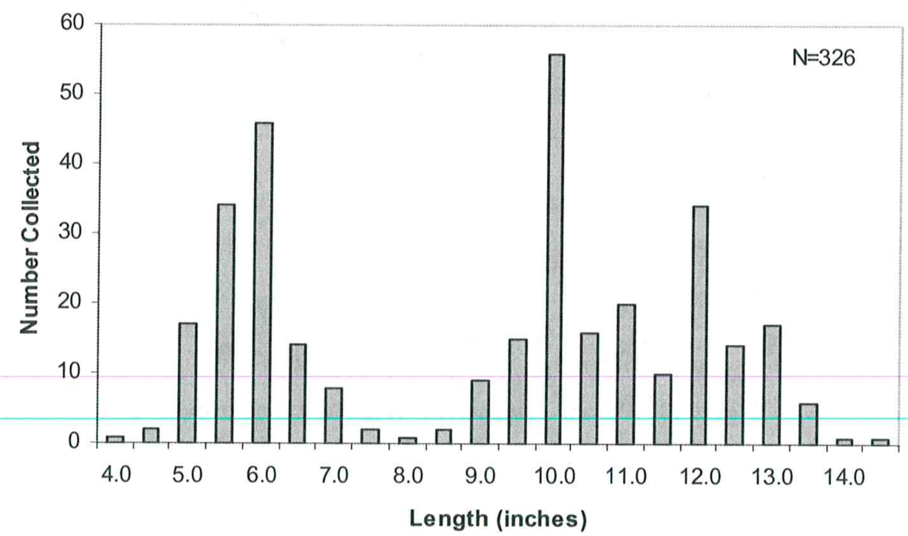


Figure 9. Length frequency distribution of gizzard shad collected from Lake Santee October 17, 2012.

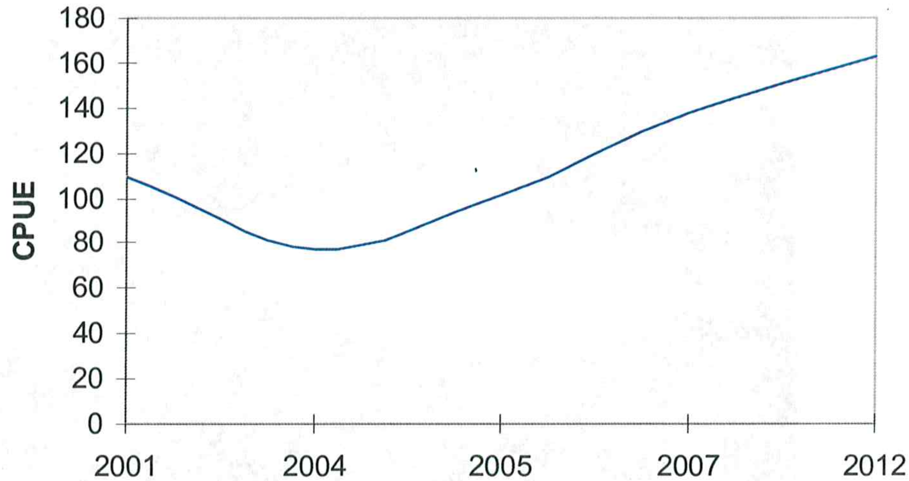


Figure 10. CPUE for gizzard shad over the past five surveys.

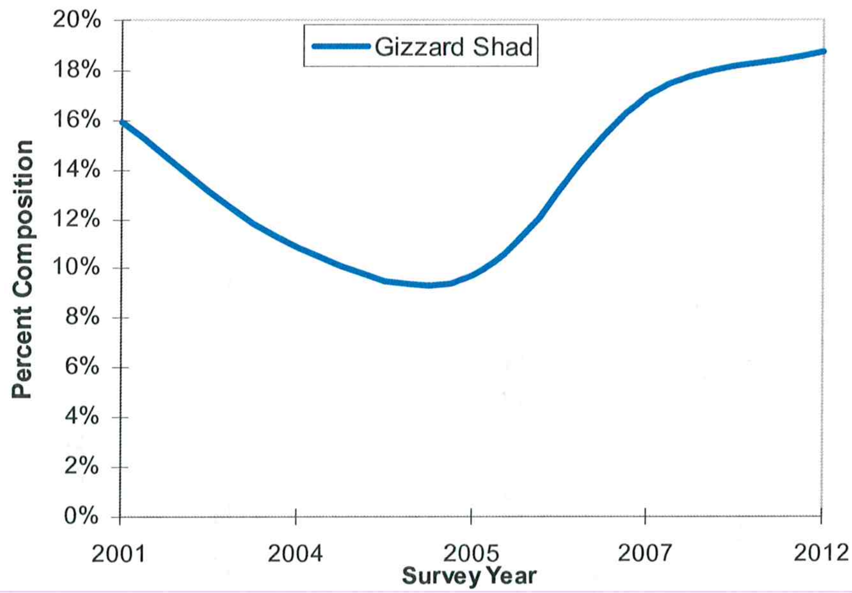


Figure 11. Percent composition of gizzard shad over the past five surveys.

Brown bullhead

Brown bullhead (Figure 12) was the third most abundant species collected (10.01%). Brown bullhead compete with desirable species for resources and aren't usually considered an important game fish. They don't reach sizes comparable to channel catfish, and most anglers don't find bullheads very palatable. This species should be removed when caught.

Figure 12. Photograph of brown bullhead, *Ameiurus nebulosus*.

Largemouth Bass

Largemouth bass (Figure 13) was the fourth most abundant species collected (5.35%). A total of 93 largemouth bass ranging in size from 3.0 to 19.0 inches was collected (Figure 14). Figure 15 shows the CPUE (catch per unit effort/catch rate) from the past five surveys. It appears that there has been a slight increase in the abundance of largemouth bass since the last survey. Condition factors (measurement of overall "plumpness") were good for most length ranges. Largemouth bass weights were good compared to standard weights for most size ranges (Figure 16).

Figure 13. Photograph of largemouth bass, *Micropterus salmoides*.

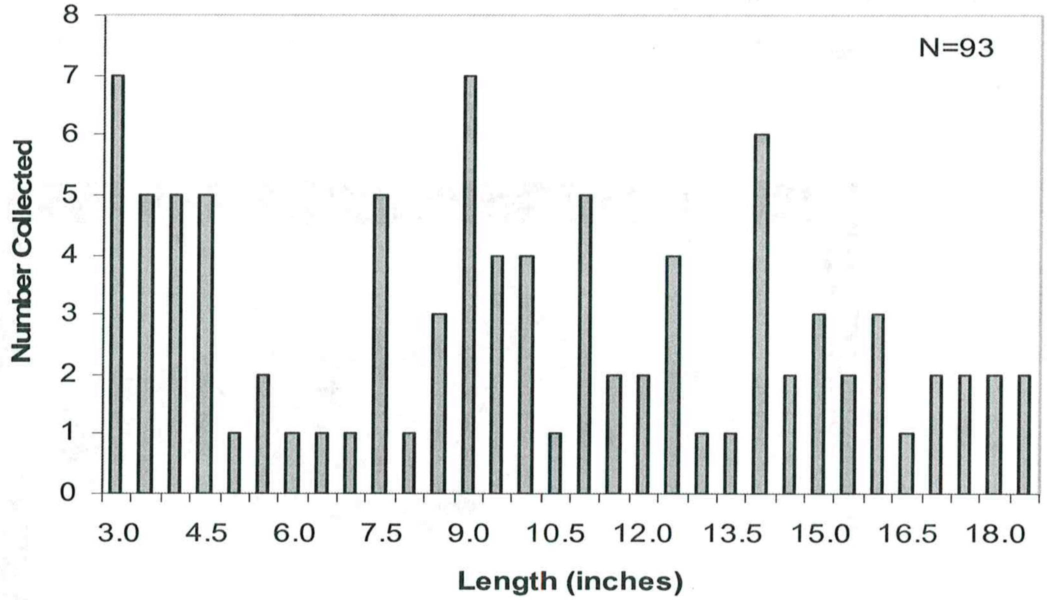


Figure 14. Length frequency distribution of largemouth bass collected from Lake Santee, October 17, 2012.

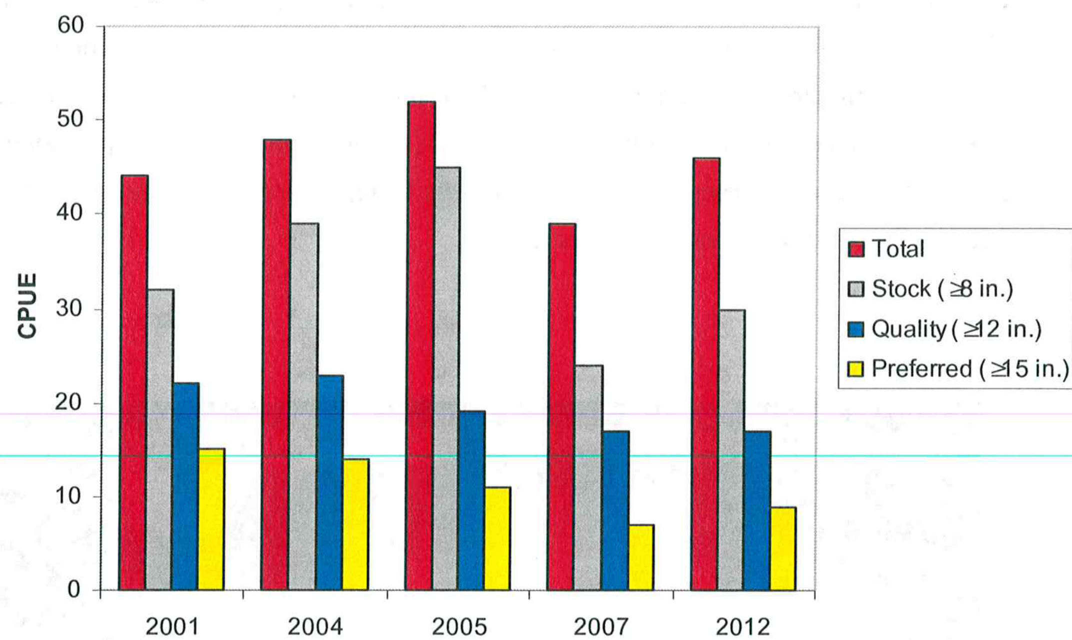


Figure 15. Largemouth bass CPUE comparison over past the past five surveys.

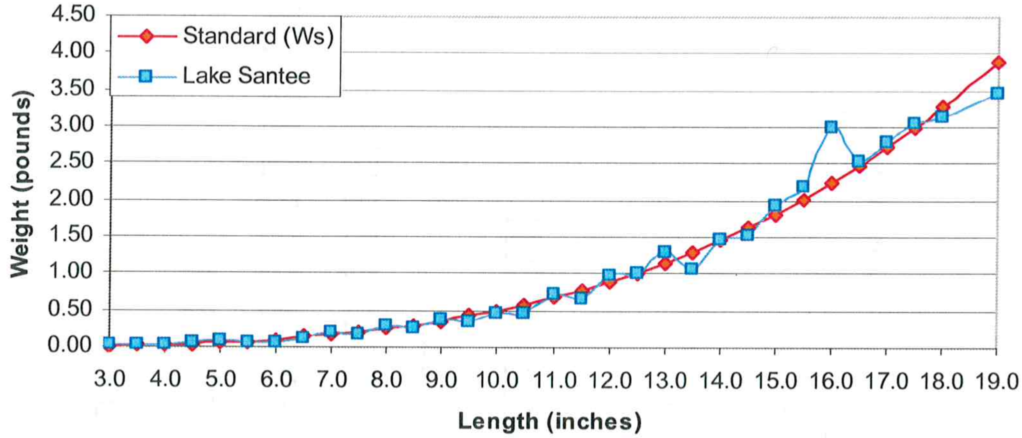


Figure 16. Comparison of Lake Santee largemouth bass weights to standard largemouth bass weights.

Black crappie

Black crappie (Figure 17) was the fifth most abundant species collected (3.16%). Individuals ranged in size from 3.5 to 9.0 inches (Figure 18). Almost 65% of black crappie were between 7.0 and 8.0 inches. The CPUE for black crappie was 27 fish per hour, which was a slight increase from the last survey. This species inhabits deeper water and is usually not well represented in electrofishing surveys. Crappie are predators and compete with largemouth bass for food. Crappie are very cyclic and difficult to manage.

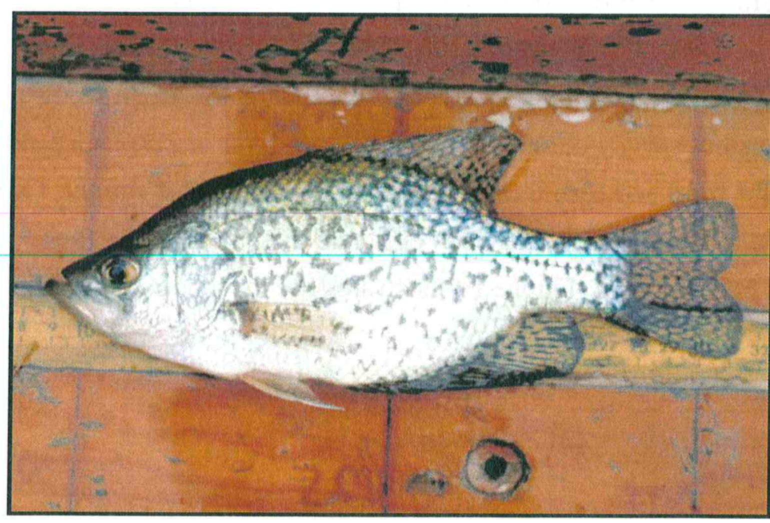


Figure 17. Photograph of black crappie, *Pomoxis nigromaculatus*.

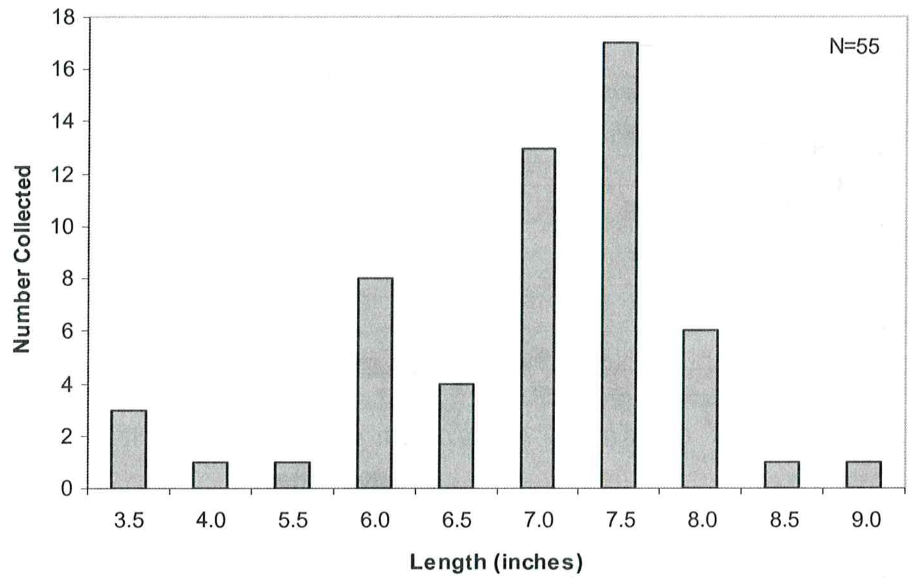


Figure 18. Length frequency distribution of black crappie collected from Lake Santee, October 17, 2012.

Green Sunfish

Green sunfish was the sixth most abundant species collected and ranged in size from less than 3.0 to 7.0 inches (Appendix B). Thirty-four green sunfish were collected comprising 1.96% of the survey sample (Table 2). The CPUE for green sunfish was 17 fish per hour for the current survey compared to 24 fish per hour in 2007. Green sunfish compete with bluegill for food and resources and should be removed if caught. Green sunfish look superficially like bluegill. They can easily be distinguished by their larger mouths and more rounded pectoral fins. Figure 19 illustrates the morphological differences between green sunfish and bluegill.

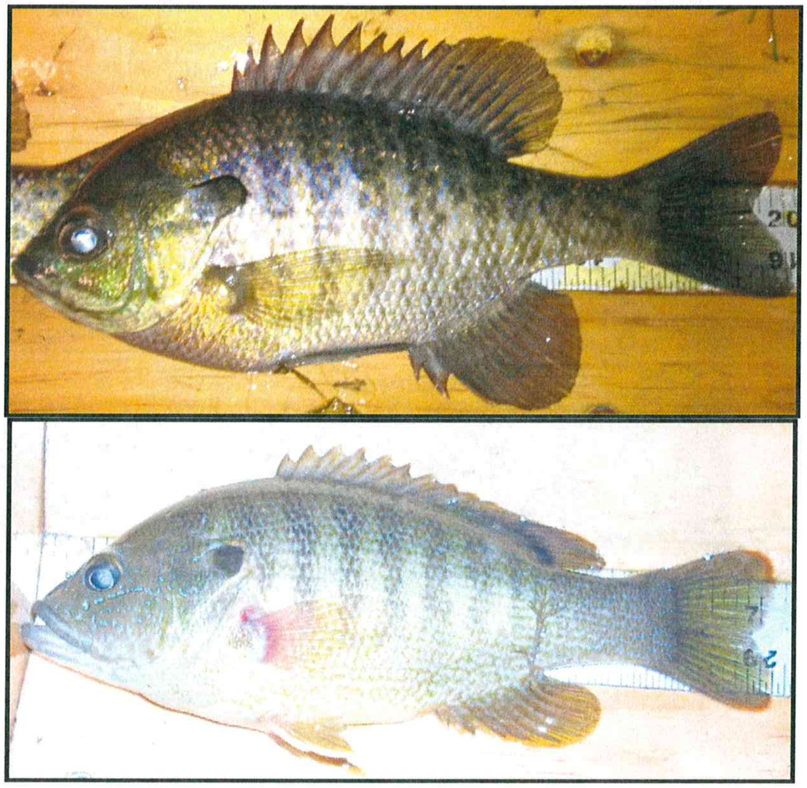


Figure 19. Photographic comparison of bluegill (top) and green (bottom) sunfish.

White crappie

White crappie (Figure 20) was the seventh most abundant species collected (1.55%) and ranged in size from 4.0 to 9.0 inches (Figure 21). Almost 50% of white crappie were 6.0 to 8.5 inches. The CPUE for white crappie was 13 fish per hour for the current survey, which is the same as the last survey. This species is very similar to black crappie. White and black crappie will offer additional angling opportunities, and at this time no harvest restrictions are necessary. Figure 22 illustrates the relative abundance of black and white crappie over the past five surveys.

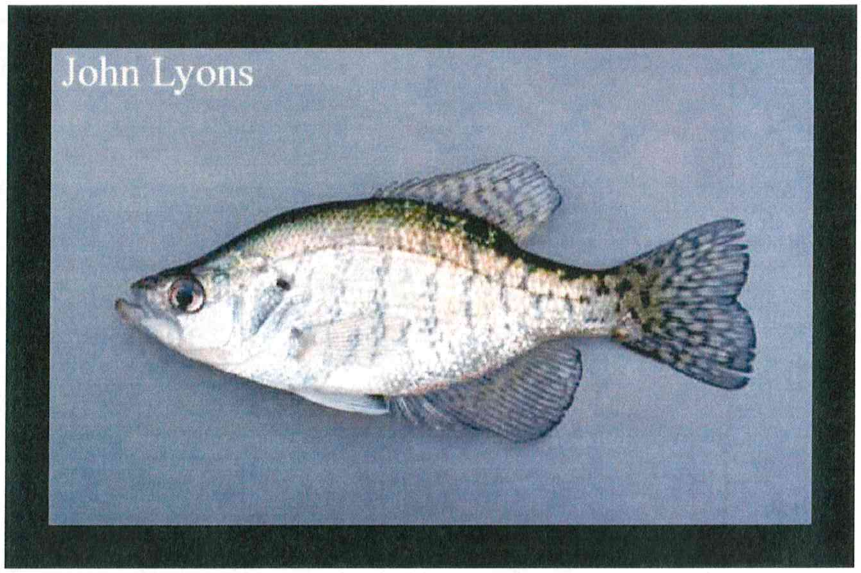


Figure 20. Photograph of white crappie, *Pomoxis annularis*.

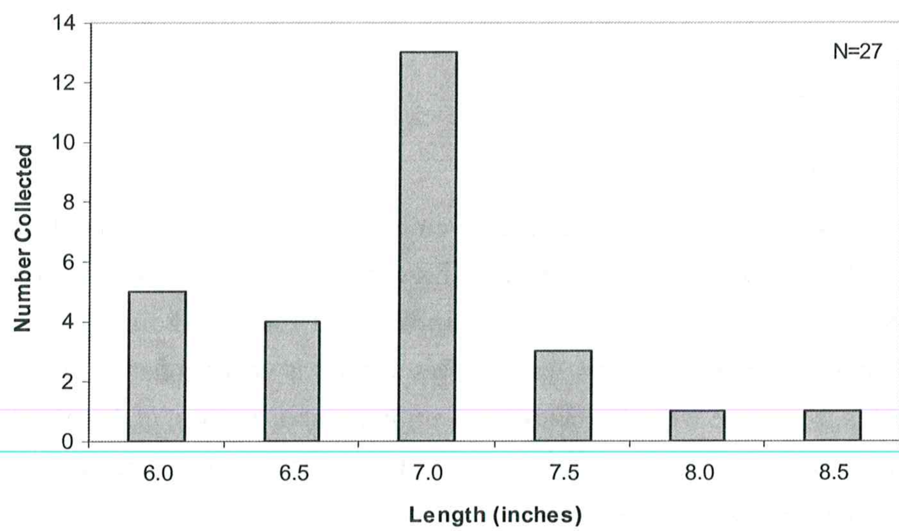


Figure 21. Length frequency distribution of white crappie collected from Lake Santee, October 17, 2012.

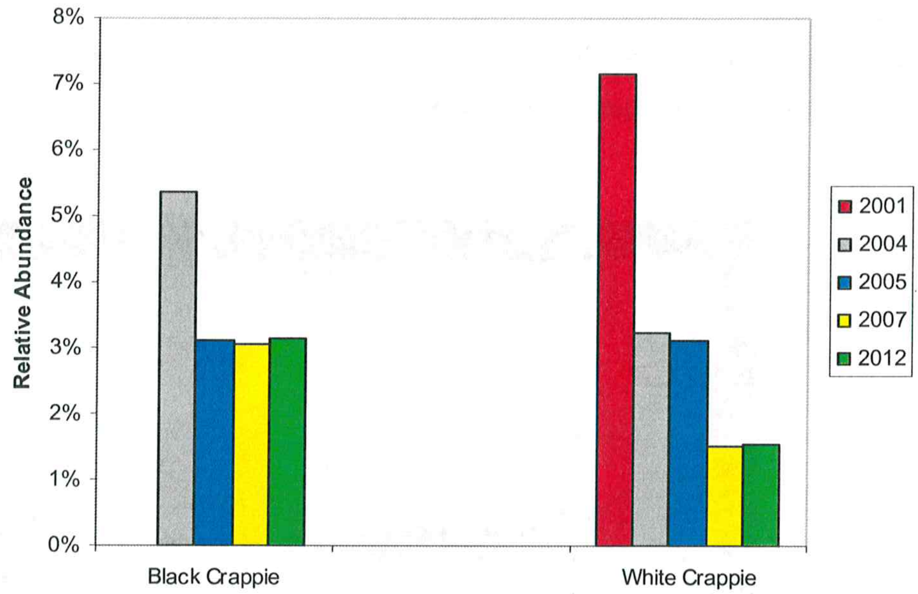


Figure 22. Black and white crappie sampling comparison over the past five surveys.

Hybrid striped bass

We collected thirteen hybrid striped bass during the survey. Hybrid striped bass (Figure 23) are an open water species and therefore electrofishing is not the best means to get an accurate representation of the population. Individuals ranged in size from 8.0 to 26.5 inches. Hybrid striped bass have low reproduction rates and will need to be restocked to keep a good population in the lake. Hybrid striped bass are voracious predators and help prey on gizzard shad.

Figure 23. Photograph of hybrid striped bass, *M. chrysops X M. saxatilis*.

Other Species

Nine bluntnose minnows (Figure 24) were collected during the sample. This species likely provides additional forage for predatory fish.

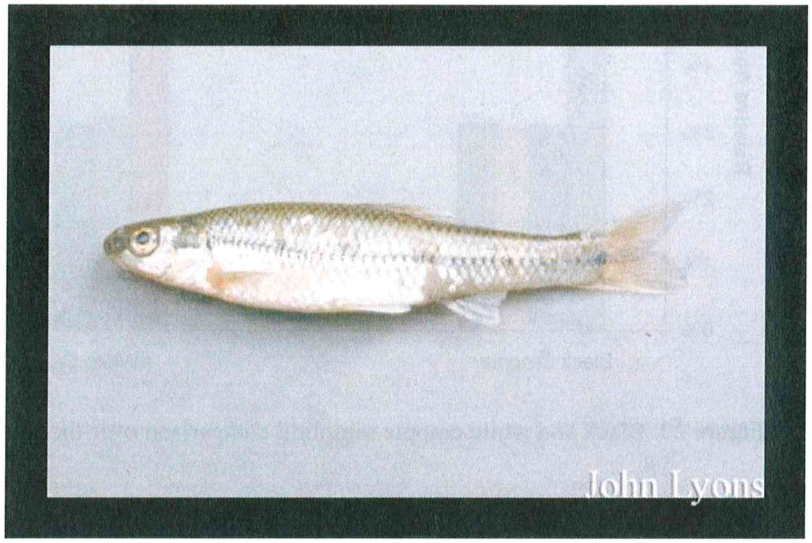


Figure 24. Photograph of bluntnose minnow, *Pimephales notatus*.

Nine redear sunfish (Figure 25) were collected during electrofishing. Redear sunfish inhabit deeper water than bluegill and feed primarily on insects and snails. They also tend to grow faster and obtain larger sizes than bluegill. This species should provide an additional angling opportunity in Lake Santee. Due to their slower reproductive potential and small population, this species should be protected with more restrictive bag limits.

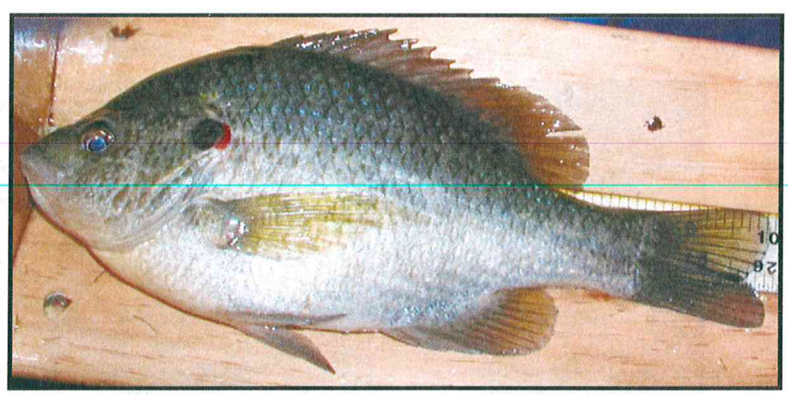


Figure 25. Photograph of redear sunfish, *Lepomis microlophus*.

Seven channel catfish (Figure 26) were collected during electrofishing (this species typically does not sample well with electrofishing equipment). One channel catfish was collected in the previous survey. Young-of-the-year channel catfish are typically eliminated by largemouth bass and other predators leading to little or no recruitment into the population. If this species is desired, stocking needs to take place periodically.

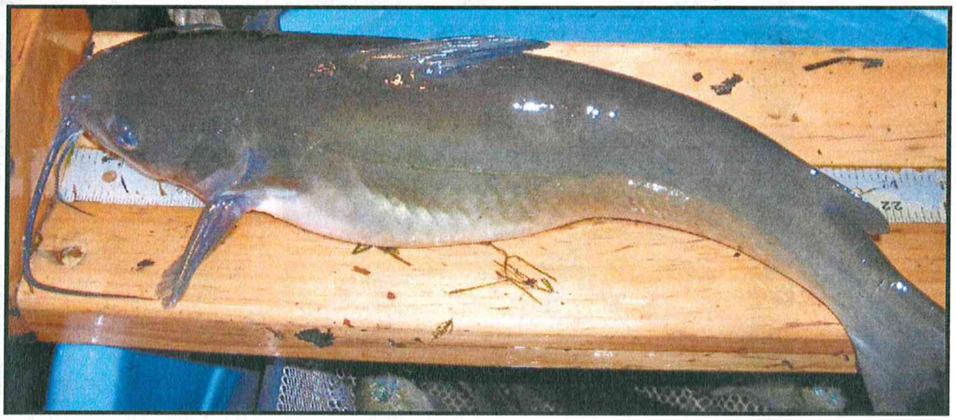


Figure 26. Photograph of channel catfish, *Ictalurus punctatus.*

Four spotfin shiners (Figure 27) were collected during the sample. This species, similar to bluntnose minnows, likely provides additional forage for predatory fish.

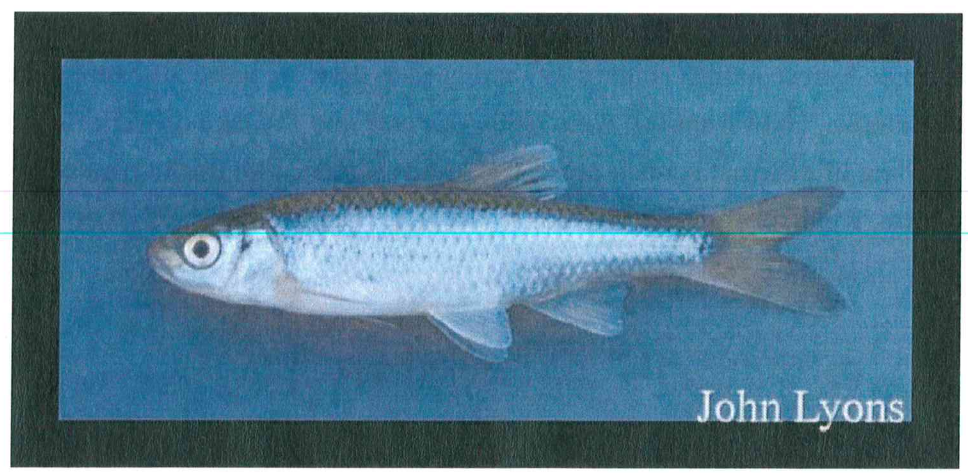


Figure 27. Photograph of spotfin shiner, *Cyprinella spiloptera.*

Two common carp (Figure 28) were collected ranging in size from 31.0 to 35.0 inches (Appendix B). Carp have the potential to disrupt a fishery by destroying bass and bluegill nests as well as increasing turbidity levels. This disruption is caused from their foraging habits. Currently this species is being controlled by predators and does not pose a serious threat to the fishery; however, all carp caught should be removed from the lake.

Figure 28. Photograph of common carp, *Cyprinus carpio.*

A single hybrid sunfish (Figure 29) and golden shiner (Figure 30) were collected during the sample. Hybrid sunfish were likely released into the lake or were the result of the breeding of different sunfish present. Golden shiners, like bluntnose minnows and spotfin shiners, will likely provide additional forage for predatory fish.

Figure 29. Photograph of hybrid sunfish, *Lepomis spp. X Lepomis spp.*

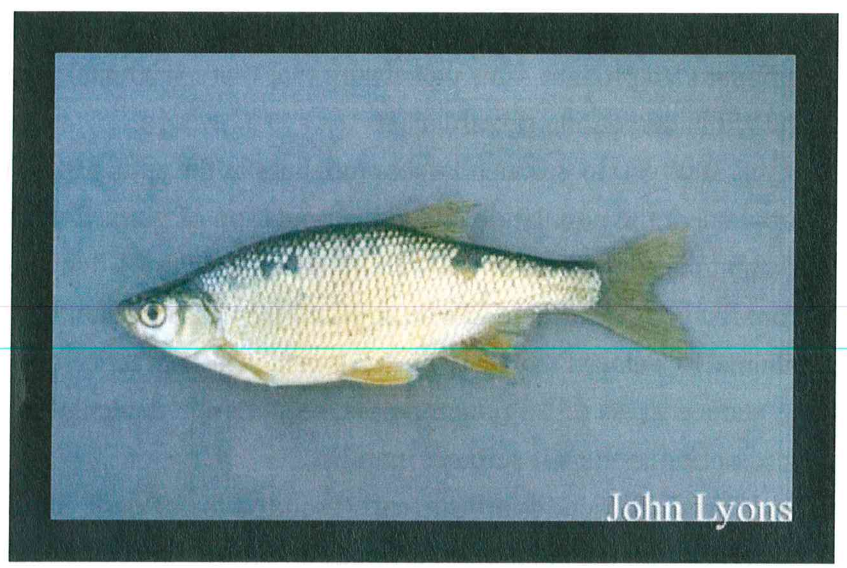


Figure 30. Photograph of golden shiner, *Notemigonus crysoleucas.*

SUMMARY AND RECOMMENDATION

The current survey was a brief survey, similar to the survey in 2007, intended to collect a limited amount of data that can be used to make recommendations for improving the fishery, while keeping the costs of the survey within the Association's budget. This survey has limitations due to a smaller sample size and use of only a single sampling technique, but data appears to indicate that largemouth bass are experiencing an increase in number while the bluegill population continues to decrease in quality. This phenomenon may be associated with a continual increase in gizzard shad numbers. Gizzard shad numbers are still nowhere near previous high levels, but the continual increase warrants attention and action.

Due to the fact that Lake Santee is a drinking water reservoir, the P.O.A. has limited options when dealing with a gizzard shad problem (fish toxicants aren't allowed). Steps taken in previous years appear to have stabilized gizzard shad expansion and a quality fishery still exists for a variety of species. Continued predator stocking will be needed to maintain this fishery. In addition, a winter lake drawdown should concentrate forage and increase gizzard shad winter kill. These recommendations should help preserve the fishery.

The following recommendations, **listed in order of importance**, will help protect and enhance the fishery in Lake Santee:

1. Continue stocking hybrid striped bass at a rate of 2,000 per year. Encourage anglers to report any catches of this species and institute a 1 fish per day, 21.0 inch minimum length limit. This will ensure that there is a healthy population in the lake and aid in decreasing gizzard shad.
2. Stock 3000 5.0 to 8.0 inch largemouth bass in the spring of 2013. This will help supplement the population and aid in predation of gizzard shad.
3. Maintain a trophy bass limit where only 1 bass over 21.0 inches can be removed from the lake. This limit can be adjusted for bass tournaments. There should be minimal or delayed mortality due to tournament's practice of "catch and release." To reduce stress on largemouth bass, reduction in the length of tournaments is a wise option in the hot summer months.
4. No harvest restrictions are currently required for bluegill. Harvest is encouraged.
5. Continue with the addition of artificial structure. Weed beds and natural structure are still lacking in Lake Santee. Poor light penetration continues to limit the amount of submerged vegetation. Artificial structure should be the means of

replacing this vegetation. Artificial structure should be placed in areas where it won't interfere with boat traffic, but cannot be placed so deep that it goes below the thermocline.

6. Conduct a Standard Fish Survey in 2015 in order to monitor the effects of the above recommendations and assess the need for additional management options. Include gill nets to monitor hybrid striped bass survival.
7. Continue to limit redear sunfish harvest to 15 per day.
8. Maintain the limit on crappie harvest to 25 per day.
9. Remove all brown bullhead, green sunfish and common carp. With the exception of brown bullhead, currently predators are adequately controlling these species.
10. If funds are available and if an increased channel catfish population is desired, then up to 2500 8.0-10.0 inch fish can be stocked.
11. Work with local landowners in the watershed and encourage the utilization of best land management practices concerning farming techniques. Examples of these practices are the creation of permanent wetlands, no-till farming, or the installation of filter strips.
12. Continue with nuisance bluegreen algae bloom control with targeted EPA algaecide applications. Applications to control problematic bluegreen algae blooms aid in increased water clarity as well as the reduction of extreme dissolved oxygen fluctuations that have been a persistent problem at Lake Santee in the past. Nuisance bluegreen algae blooms also affect juvenile fish. Juvenile fish feed on zooplankton. Bluegreen algae is not a preferred food item for these very beneficial zooplankton.

Prepared by: Aquatic Control Inc.
Jimmy Ferguson, Aquatic Biologist

APPENDIX A

GENERAL INFORMATION

In order to help understand our analysis and recommendations, basic principles of water chemistry and the physical attributes of water must be understood. Sources of dissolved oxygen (D.O.) in water include uptake from the atmosphere and photosynthesis. Decreases in D.O. are mostly attributed to the respiration of plants, animals, and aerobic bacteria that occur in a lake or pond. Large quantities of plants may produce oxygen depletion during the nighttime hours as plants stop photosynthesis and utilize oxygen for respiration. Dissolved oxygen levels below 5.0 are considered undesirable in ponds and lakes (Boyd, 1991). Lower levels of D.O. may stress fish and decrease the rate of decomposition of organic matter entering or produced within a lake or pond. If oxygen depletion is determined to be a problem in a lake or pond, solutions exist to help improve conditions. Vegetation control to reduce overly abundant vegetation may improve conditions. Aeration systems may also be used to increase oxygen levels and promote the breakdown of organic matter.

Water temperature of a lake or pond affects the activity of "cold-blooded" animals such as fish and invertebrates as well as the amount of D.O. that water is capable of holding. Deeper ponds and lakes may thermally stratify in the summer months and result in deeper waters becoming depleted of oxygen. Lake stratification is a result of the peculiar property of water density changes with temperature. The density of all liquid changes with changes in temperature, however, water behaves in a special way. As most liquids are cooled the density, or relative weight, of the liquid increases due to the compaction of the molecules in the liquid, and conversely, as liquids are heated the density decreases. Water, because of its unique characteristics, is at its maximum density at 4 degrees Centigrade, or approximately 39.2 degrees Fahrenheit. When water is either heated above this temperature or cooled below this temperature its density decreases. This is why ice floats, or forms on the surface of lakes and ponds. A normal cycle of stratification in lakes in our region of the country, in early spring after ice out is as follows: the lake water will all be nearly the same temperature shortly after ice out and wind action on the lake surface will induce circulation of the entire volume of water. As spring advances and the increased sunlight energy warms the surface waters, these become lighter and tend to separate from the deeper waters and essentially float on top of the cooler water. This continues until there is a very stable "layering" or stratification of water in the lake. There are three distinct layers of water in stratified lakes, as described by limnologists:

1. Epilimnion (upper warm layer) - this is, generally speaking, confined to the top 10 ft. to 15 ft. of the lake volume. This is a warm region, mixed thoroughly by wind to a more or less uniform temperature. It is also the zone of most photosynthetic production and is usually high in dissolved oxygen.
2. Thermocline or Metalimnion (middle layer of rapidly changing temperature) - this layer is the area in the lake where temperature decreases rapidly, usually about 1 degree centigrade or more per meter (or approximately 3 ft.). Oxygen depletion generally begins in this layer.

3. Hypolimnion (deep, cold layer) - this layer is relatively unaffected by wind mixing or motor boat activity, and is often devoid of oxygen. Oxygen is depleted by the decomposition of dead organic matter falling from the upper waters as well as external sources such as leaves and grass clippings that sink to the bottom of the lake.

Once this stratification is established (usually by early to mid-June, in our area) it is very stable and stays intact until the fall turnover, which is caused by decreasing surface water temperatures (causing increased density), and the mixing of the lake waters by the wind. The lake then circulates completely for a period of time, usually until ice cover forms, sealing off the surface of the lake from the atmosphere. A reverse stratification then sets in where the water just under the ice is just above 32 degrees Fahrenheit with increasing temperature with depth to a temperature of 39.2 degrees Fahrenheit. Decomposition continues in the bottom throughout the winter, resulting in oxygen depletion in the bottom waters. This progresses towards the surface throughout ice cover and can cause an oxygen depletion fish kill under the ice during severe winters. After the ice melts, the lake begins to circulate again, and the cycle has completed itself. This phenomenon has a profound affect on the biological and chemical components of the lake ecosystem.

Alkalinity is the ability of water to buffer against pH changes upon the addition of an acid or base. The alkalinity of a lake or pond is generally determined by the characteristics of the watershed or local geology. As a general guideline a well-buffered system has an alkalinity of 50 parts per million (ppm) or greater. Well-buffered systems have potential for moderate to high productivity. Alkalinity is important in determining algaecide dosages, particularly copper sulfate. The maximum safe dosage for fish of copper sulfate if total alkalinity is less than 50 ppm is 0.25 ppm or .68 pounds / acre-foot, 1.00 ppm or 2.7 pounds / acre-foot for a total alkalinity range of 50 to 200 ppm, and 1.5 ppm or 4.0 pounds / acre- foot for a total alkalinity greater than 200 ppm.

Hardness is a measure of the calcium and magnesium (and some other ions) concentrations in water. The concept of hardness comes from the field of domestic water supply. It is a measure of soap requirements for adequate lather formation and is an indicator of the rate of scale formation in hot water heaters. Hardness and alkalinity are sometimes used interchangeably; however, these parameters sometimes have very different values. Waters containing a hardness measure of greater than 75 ppm may be considered hard and are often clearer and weedier then soft waters (Walker et al., 1985).

Nitrogen can exist in several forms within a body of water, including: ammonia, nitrite, nitrate, and organic nitrogen (amino acids and proteins). Ammonia results from the biological decomposition of organic matter by bacteria. During the process of nitrification, nitrate (which is directly available for plant uptake) is formed from the complete biological oxidation of ammonia in which nitrite is an intermediate product. Nitrate is a major plant nutrient. The most important forms of nitrogen for the growth of algae include ammonia and nitrate. Total nitrogen levels above 1.9 ppm are generally indicative of nutrient enrichment or eutrophic conditions (Wetzel, 1983). Inorganic nitrogen (nitrite, nitrate, ammonia, and ammonium) levels greater than 0.30 ppm are indicative of eutrophic lakes and ponds (Sawyer, 1948). Nitrogen in surface waters cannot be controlled by any economical method. Blue-green algae can fix nitrogen directly from the atmosphere unlike other forms of plants.

Phosphorus is a major plant nutrient and is most often the limiting factor for algae and macrophyte (vascular plants) growth within an aquatic system. Total phosphorus levels in excess of 0.03 ppm indicate eutrophic conditions (Vollenwieder, 1968). Waters with excessive plant growth high nutrients and degraded water quality are typical of eutrophic lakes and ponds. Ortho-phosphorus is a measure of the dissolved inorganic phosphorus available for immediate plant uptake. Concentrations of ortho-phosphate above 0.045 ppm may be considered critical concentrations above which nuisance algae blooms could be expected (Sawyer, 1948). The remainder of the total phosphorus is most likely bound onto particulate material and although not immediately available for uptake, could become available through biochemical degradation. Dissolved phosphorus is absorbed from the water column primarily by phytoplankton. Phosphorus supply to aquatic macrophytes is primarily from the sediment rather than from the water column. Phosphorus is released from sediment under anaerobic conditions but is precipitated to the sediment under aerobic conditions. Phosphorus can be precipitated from the water column by use of alum (aluminum sulfate). Sediment phosphorus can be inactivated and made unavailable to macrophytes by heavy applications of alum to the sediment surface.

EQUIPMENT AND METHODS

Water quality analysis equipment used in this survey included a YSI ProODO dissolved oxygen/temperature meter with a 60 ft. remote sensing probe, a Hach field test kit, and a Wildco Alpha Water bottle sampler. The following water quality parameters were measured and recorded: dissolved oxygen, temperature, pH, total hardness, total alkalinity, nitrate-nitrogen, and orthophosphate. The parameters selected are the major water quality factors influencing the lakes productivity and fish health. Water quality testing to determine nutrient levels was completed in the lab using a Hach DR/2010 spectrophotometer.

Fish sampling was done with the use of an electrofishing boat. Electrofishing is simply the use of electricity to capture fish for the evaluation of population status. Various types of equipment are in use today, however, most fisheries biologists agree that pulsed DC current is more efficient and less harmful to the fish collected than AC current. Electrofishing with an experienced crew using proven equipment is probably the least selective method of sampling warm water fish species in the temperate waters of our area. Evaluation of electrofishing efficiencies have shown that night electrofishing is a reliable method for sampling populations of largemouth bass, bluegill, and redear sunfish, and generally detects the presence of green sunfish and other scaled fish species. The method is less efficient for sampling populations of channel catfish, bullheads, and crappie (Reynolds and Simpson, 1976). The largest bias in electrofishing is generally that of collecting more large fish of a given species than smaller individuals. This is due to the differential effect of the electric current on fish of different sizes, interference with collection from dense weed beds, if present, as well as the potential bias of the person dipping stunned fish (Nielsen & Johnson, 1983). Many years of experience by our personnel has reduced this bias to an acceptable level.

Electrofishing equipment used in this survey consisted of a 16 foot workboat equipped with a Smith-Root Type VI electrofisher powered by a 4000 watt portable generator and a boom mounted electrosphere designed by Coffelt Manufacturing. The electrosphere allows the use of higher voltages at lower amperage. This has proven to improve the efficiency of the electrofishing technique with lower damage to captured fish. The electrofisher was operated in the pulsed DC mode using an output level of 400 to 750 volts. The increased effectiveness of this electrofishing system makes fish of all species, including channel catfish, more vulnerable to capture. This results in a better sampling of all fish species with a higher capture rate of the more vulnerable species (bass, bluegill, redear, and green sunfish) in the samples taken. All fish collected were placed in water filled containers aboard the sampling boat for processing. A sub-sample of up to five specimens from each species was taken in each one-half inch group. The individual fish in these sub samples were weighed to the nearest hundredth pound for average weight determinations. Additional specimens were recorded by length group.

Field data was summarized and is presented in table and graph form. Condition factors and relative weight calculations (standard measurements of the relative plumpness) were calculated for important species using standard formulas (Anderson and Gutreuter, Carlander 1977, Hillman 1982, Wege and Anderson 1978). Relative weight is a comparison of fish weights at certain sizes to standard calculated weights at those sizes. Relative weights of 100 or greater are considered good. An important procedure used in our evaluation of the bass – bluegill populations, and other species to a lesser extent, is the Proportional Stock Density Index. This population index was developed by intensive research into dynamics of fish population structure, primarily in largemouth bass - bluegill dominated populations (Anderson 1976), and subsequent field testing by numerous fisheries research and management biologists in mid-western states. Bluegill samples are divided into three major groups: those less than 3.0 inches in length, those 3.0 inches and larger, and those 6.0 inches and larger. The group 3.0 inches and larger are called the "stock". The 6.0-inch and larger individuals are considered to be "quality" or harvestable size. Bluegill PSD is the percentage of bluegill "stock" that is in the harvestable size. Largemouth bass samples are separated into "stock size" (8.0 inches plus) and quality size (12.0 inches plus), for PSD calculations. Largemouth bass PSD is the percentage of bass "stock" that are of a "quality" or harvestable size.

This study, and subsequent studies and application of the techniques developed in those studies, have shown that fish populations that are producing, or are capable of producing, a sustained annual harvest of "quality" largemouth bass and bluegill have certain characteristics. These include the following:

1. Reasonably high numbers of bluegill smaller than 2.5 inches (young-of-the-year)
2. Proportional Stock Density index of 20 - 40 for bluegill.
3. Bluegill growth which results in a length of 6.0 inches by age III or IV, with low numbers of age V or older fish.
4. Proportional Stock Density index of 40 - 60 for largemouth bass.

5. A minimum of 20 adult bass per acre.
6. A maximum of 50% annual mortality (harvest) of bass in age II - V.
7. Growth rate that results in 8 inch bass reaching quality size (12 inch plus) in approximately 1 year.
8. No missing year classes in ages 0 - V.
9. A maximum of 10% of the lake bottom covered by dense weed beds.

These parameters, and other factors, are used in the evaluation and development of recommendations from Aquatic Control surveys.

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Appendix B
Fish Collection Table

SIZE GROUP (IN)	NUMBER	PERCENTAGE	AVERAGE WEIGHT (lbs.)	TOTAL WEIGHT (lbs.)	CONDITION FACTOR	WS	RELATIVE WEIGHT
BLUEGILL							
<3.0	37	3.76%	0.01	0.37	-	-	-
3.0	6	0.61%	0.01	0.08	5.19	0.02	86
3.5	3	0.30%	0.04	0.13	10.03	0.03	159
4.0	27	2.74%	0.07	1.96	11.33	0.04	172
4.5	61	6.20%	0.07	4.42	7.96	0.06	116
5.0	165	16.77%	0.09	15.18	7.36	0.09	104
5.5	178	18.09%	0.11	18.87	6.37	0.12	87
6.0	384	39.02%	0.14	53.76	6.48	0.16	86
6.5	89	9.04%	0.16	14.24	5.83	0.21	76
7.0	32	3.25%	0.19	6.08	5.54	0.27	70
7.5	1	0.10%	0.25	0.25	5.93	0.34	74
8.0	1	0.10%	0.40	0.40	7.81	0.42	95
TOTAL	984			115.74			
LARGEMOUTH BASS							
3.0	7	7.53%	0.02	0.15		0.01	
3.5	5	5.38%	0.03	0.15	7.00	0.02	-
4.0	5	5.38%	0.04	0.21	6.56	0.03	-
4.5	5	5.38%	0.06	0.28	6.15	0.04	-
5.0	1	1.08%	0.08	0.08	6.40	0.06	-
5.5	2	2.15%	0.07	0.13	3.91	0.07	87
6.0	1	1.08%	0.05	0.05	2.31	0.10	51
6.5	1	1.08%	0.12	0.12	4.37	0.13	94
7.0	1	1.08%	0.20	0.20	5.83	0.16	124
7.5	5	5.38%	0.18	0.90	4.27	0.20	90
8.0	1	1.08%	0.28	0.28	5.47	0.25	114
8.5	3	3.23%	0.25	0.75	4.07	0.30	84
9.0	7	7.53%	0.39	2.70	5.29	0.36	108
9.5	4	4.30%	0.34	1.36	3.97	0.43	80
10.0	4	4.30%	0.45	1.81	4.53	0.50	90
10.5	1	1.08%	0.46	0.46	3.97	0.59	78
11.0	5	5.38%	0.72	3.62	5.44	0.68	106
11.5	2	2.15%	0.67	1.34	4.41	0.78	85
12.0	2	2.15%	1.00	1.99	5.76	0.90	111
12.5	4	4.30%	1.02	4.09	5.24	1.02	100
13.0	1	1.08%	1.30	1.30	5.92	1.16	112
13.5	1	1.08%	1.06	1.06	4.31	1.31	81
14.0	6	6.45%	1.47	8.80	5.34	1.47	100
14.5	2	2.15%	1.52	3.03	4.97	1.64	92
15.0	3	3.23%	1.94	5.82	5.75	1.83	106
15.5	2	2.15%	2.20	4.40	5.91	2.03	108

16.0	3	3.23%	3.01	9.03	7.35	2.25	134
16.5	1	1.08%	2.54	2.54	5.65	2.48	102
17.0	2	2.15%	2.80	5.60	5.70	2.73	103
17.5	2	2.15%	3.05	6.09	5.68	3.00	102
18.0	2	2.15%	3.15	6.30	5.40	3.28	96
19.0	2	2.15%	3.45	6.90	5.03	3.89	89
TOTAL	93			81.54			

GIZZARD SHAD

4.0	1	0.31%	0.03	0.03
4.5	2	0.61%	0.04	0.08
5.0	17	5.21%	0.07	1.26
5.5	34	10.43%	0.06	2.11
6.0	46	14.11%	0.11	5.15
6.5	14	4.29%	0.11	1.54
7.0	8	2.45%	0.09	0.72
7.5	2	0.61%	0.15	0.29
8.0	1	0.31%	0.30	0.30
8.5	2	0.61%	0.32	0.63
9.0	9	2.76%	0.33	2.93
9.5	15	4.60%	0.36	5.40
10.0	56	17.18%	0.43	23.86
10.5	16	4.91%	0.43	6.82
11.0	20	6.13%	0.56	11.20
11.5	10	3.07%	0.54	5.40
12.0	34	10.43%	0.71	24.14
12.5	14	4.29%	0.81	11.37
13.0	17	5.21%	0.78	13.19
13.5	6	1.84%	0.86	5.16
14.0	1	0.31%	0.95	0.95
15.0	1	0.31%	1.20	1.20
TOTAL	326			123.72

BROWN BULLHEAD

<3.0	1	0.57%
5.0	1	0.57%
6.0	2	1.15%
7.0	10	5.75%
7.5	10	5.75%
8.0	53	30.46%
8.5	15	8.62%
9.0	28	16.09%
9.5	9	5.17%
10.0	34	19.54%
10.5	4	2.30%
11.0	5	2.87%
12.0	2	1.15%
TOTAL	174	

BLACK CRAPPIE

3.5	3	5.45%

4.0	1	1.82%
5.5	1	1.82%
6.0	8	14.55%
6.5	4	7.27%
7.0	13	23.64%
7.5	17	30.91%
8.0	6	10.91%
8.5	1	1.82%
9.0	1	1.82%
TOTAL	55	

GREEN SUNFISH

<3.0	4	11.76%
3.5	2	5.88%
4.0	7	20.59%
4.5	5	14.71%
5.0	11	32.35%
5.5	2	5.88%
6.0	1	2.94%
6.5	1	2.94%
7.0	1	2.94%
TOTAL	34	

WHITE CRAPPIE

6.0	5	18.52%
6.5	4	14.81%
7.0	13	48.15%
7.5	3	11.11%
8.0	1	3.70%
8.5	1	3.70%
TOTAL	27	

HYBRID STRIPED BASS

8.0	2	15.38%	0.23	0.45
8.5	7	53.85%	0.19	1.34
9.0	1	7.69%	0.30	0.30
9.5	1	7.69%	0.26	0.26
10.0	1	7.69%	0.25	0.25
26.5	1	7.69%	9.80	9.80
TOTAL	13			12.40

BLUNTNOSE MINNOW

3.0	9	100.00%
TOTAL	9	

REDEAR SUNFISH

4.5	1	11.11%
5.0	1	11.11%
6.0	5	55.56%
9.0	2	22.22%
TOTAL	9	

CHANNEL CATFISH

13.0	1	14.29%
13.5	2	28.57%
15.0	1	14.29%
19.0	1	14.29%
24.0	1	14.29%
28.5	1	14.29%
TOTAL	7	

SPOTFIN SHINER

1.0	3	75.00%
2.0	1	25.00%
TOTAL	4	

COMMON CARP

31.0	1	50.00%
35.0	1	50.00%
TOTAL	2	

HYBRID SUNFISH

6.0	1	100.00%
TOTAL	1	

GOLDEN SHINER

2.0	1	100.00%
TOTAL	1	

Appendix C-Creel Survey Form

Date:

Time you began fishing______
Time you finished fishing______

Fishing From: Bank__ Boat___

Location: Open Water__ Weeds__ Woody Structure___
Man-made structure___ Rock____ Other____

What species are you fishing for?____________________________

How many have you caught and released?_____________________________

How would you rate your fishing success today? Poor___ Fair____ Good____ Excellent____

Write down number and sizes of fish you have harvested

Species Harvested	Length__number__	Length__number__	Length__number__
Bluegill	_____ ______	_____ ______	_____ ______
Largemouth Bass	_____ ______	_____ ______	_____ ______
Redear Sunfish	_____ ______	_____ ______	_____ ______
Hybrid Striped Bass	_____ ______	_____ ______	_____ ______
Crappie	_____ ______	_____ ______	_____ ______
Other__________	_____ ______	_____ ______	_____ ______

Comments: