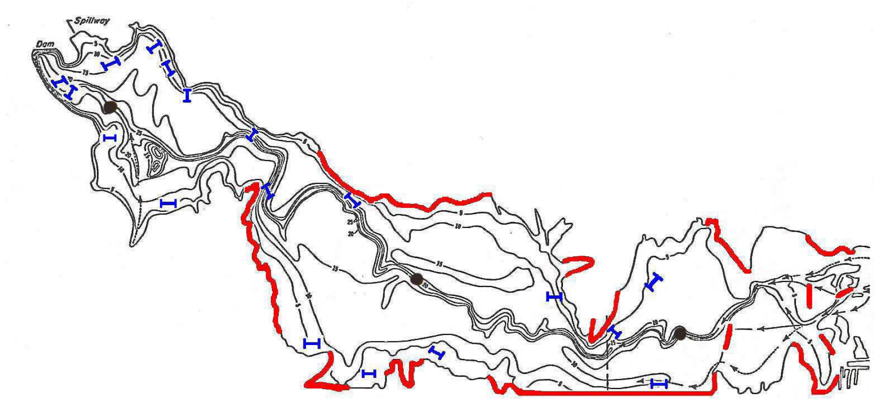
FISH MANAGEMENT REPORT



Lake Lemon
2000

PREPARED BY

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SEYMOUR, INDIANA

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INTRODUCTION

A survey of the fish populations and other physical, biological, and chemical factors directly affecting the fish populations was completed at Lake Lemon on September 26-29, 2000. 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 and averages for Indiana lakes
3. To provide recommendations for management strategies to enhance or sustain the sport fish community
4. To provide management recommendations designed specifically to optimize the largemouth bass sport fishery

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. 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. Tables and figures containing information collected in the survey are presented in Appendix B.

RESULTS AND DISCUSSION-Water Quality

The results of selected physio-chemical parameters from Lake Lemon are presented in Table 1. Water quality parameters were measured at three stations (Figure 1). Water temperatures ranged from 67.0 degrees Fahrenheit at the surface of the west station to 57.8 degrees at the bottom of the east station. Dissolved oxygen ranged from 10.5 parts per million (ppm) at the surface of the east station to 0.5 ppm at a depth of 19 feet at the middle station. A desirable oxygen level for maintenance of healthy stress free fish was present to a depth of 27 feet at the west station, 15 feet at the middle station, and to the bottom at the east station. These numbers indicate Lake Lemon was destratified at the time of the survey. Cooler water and higher oxygen levels at the east station are probably due to the proximity to Bean Blossom Creek. The alkalinity level was 102.6 ppm at the surface of all three stations. The alkalinity level was 119.7 at the bottom of the west and middle stations and 102.6 at the bottom of the east station; indicating a relatively high productivity level, typical for this region (Appendix A). The pH was 8.0 at the surface of all three stations and ranged from 8.0 to 7.0 at the bottom, which is in the normal range for lakes in this area. The nitrate-nitrogen level ranged from a high of 1.5

ppm at the surface of the west station to a low of 0.3 ppm at the bottom of the west station indicating high levels of nutrients within Lake Lemon. The ortho-phosphate level ranged from a high of .58 ppm at the east station to a low of .02 ppm at the west station. Ortho-phosphate levels were substantially higher at the upper end of the lake. Microscopic algae and the plant biomass may filter out the ortho-phosphate by the time it reaches the lower end of the lake. These levels should be monitored in the future. Secchi disk readings were two feet at all three stations. Based upon nutrient levels and secchi disk readings, Lake Lemon is classified as a eutrophic lake. Lake Lemon is currently capable of sustaining a healthy fish population.

RESULTS AND DISCUSSION-Fish Data

A total of 4,488 fish weighing 1,152 pounds and representing 27 species was collected from Lake Lemon (Table 2). Yellow bass was the most abundant species comprising 28% of the fish collected. Bluegill was the second most abundant species (25%) followed by gizzard shad (14%), white crappie (8%), largemouth bass (6%), brook silverside (5%), and longear sunfish (4%). Golden redhorse, spotted bass, spotted sucker, yellow perch, black redhorse, common carp, redear sunfish, golden shiner, flathead catfish, spotfin shiner, channel catfish, warmouth, bowfin, green sunfish, black crappie, northern hog sucker, logperch, bluntnose minnow, pumpkinseed, and chestnut lamprey comprised the remaining 10% of the sample catch.

Yellow bass was the most abundant species collected (28%) and ranked fourth by weight (9.2%). A total of 1,257 yellow bass were collected. Catch rates for yellow bass were 105 fish per hour for electrofishing and 15 fish per net hour for gillnetting (Table 3 & 4). They ranged in size from 3.0 to 8.5 inches (Table 5). Over 77% of yellow bass were between 5.5 and 7.5 inches (Figure 2). Growth of yellow bass was normal compared to District 5 averages in the first year of growth but below average in the following years (Figure 3). Yellow bass represented only 3% of fish collected in the 1982 survey compared to 28% of the total catch in this survey. This indicates an expansion in the population since 1982. It appears yellow bass are overpopulated and growing slowly within Lake Lemon.

Bluegill was the second most abundant by number (25%) and fifth by weight (8.7%). Catch rates for bluegill were 195 per hour of electrofishing and .09 per net hour for gillnets (Table 3 & 4). Bluegill collected from Lake Lemon ranged in size from less than 3.0 to 8.5 inches (Table 5). The number of young-of-the-year bluegill was lower than expected. About 54% ranged from 5.0 to 6.0 inches (Figure 4). Proportional stock density (proportion of quality fish within a population) for bluegill was 38 and is within the desired PSD range of 20 to 40 indicative of balanced fish communities (Appendix A). The length distribution chart for bluegill illustrates the relatively low number of bluegill greater than 6.5 inches collected (Figure 4). Average length and weight of bluegill by age were compared to the Department of Natural Resources data for the southern half of Indiana in Figure 5 and Figure 6 respectively. These comparisons indicate the growth of bluegill was normal for age 0 and age 1 fish, but much below normal for age 2 to 4 fish. Relative weight (a measurement of relative plumpness) for bluegill was below the preferred number of 100 for all but one size group (Figure 7 and Appendix A). The bluegill population appears to be balanced, but growing slower than normal.

Gizzard shad was the third most abundant fish by number (14%) and ranked seventh by weight (6%). This is a significant decrease from 1982 when gizzard shad comprised nearly half of all fish collected. Catch rates for gizzard shad were 77 fish per hour of electrofishing and 0.7 fish per hour of gill netting. Gizzard shad ranged in size from 3.0 to 14.0 inches (Table 5). Nearly 75% of gizzard shad were between 6.0 and 7.5 inches (Figure 8). Young-of-the-year gizzard shad accounted for only 13% of the population. The low abundance of small and young gizzard shad may be attributed to low reproduction for the year, high predation on the smaller gizzard shad, or a combination of both. Largemouth bass, yellow bass, and crappie all prey upon small gizzard shad. Compared to DNR District 5 data, gizzard shad appear to be growing slower than normal (Figure 9). Slow growth of gizzard shad allows them to remain vulnerable to predation for a longer period of time. Relative weights of gizzard shad are normal (Figure 10). Overall, the gizzard shad population currently appears to be benefiting large predators, but has the potential to compete for food and space with smaller fish.

White crappie was the fourth most abundant by number (8%) and tenth most abundant by weight (3%). Catch rates for white crappie were 24 fish per hour of electrofishing and 0.8 fish per hour of gillnetting (Table 3 and 4). They ranged in size from less than 3.0 to 13.5 inches (Table 5). Young-of-the-year white crappie accounted for nearly 20% of the fish sampled indicating successful reproduction in 2000. Proportional stock density was 5 indicating few quality white crappie were present in our sample. Seventy percent of white crappie ranged from 6.0 to 7.0 inches (Figure 11). Compared to District 5 age data, white crappie growth is normal at age 0 and 1 but below normal after age 1 (Figure 12). The population in Lake Lemon appears to be dominated by slow growing smaller individuals with very few quality fish.

Largemouth bass collected ranked fifth by number (6%) and first by weight (23%). The electrofishing catch rate for largemouth bass was 45 fish per hour (Table 3). The electrofishing catch rate is slightly lower than Indiana averages. This may be due to the lack of bass in the shallow upper end of the lake which was sampled heavily. Only one largemouth bass was collected in gill nets (Table 4). Largemouth bass collected from Lake Lemon ranged in size from 3.0 to 21.5 inches (Table 5). Proportional stock density for largemouth bass was 52. The desired level for largemouth bass PSD in a balanced fish community is 40 to 60. The length distribution of largemouth bass collected in the survey indicates a balanced population exists in Lake Lemon. Approximately 26% of largemouth bass collected were greater than 14.0 inches and nearly 11% were over 18.0 inches. This indicates that there are numerous quality largemouth bass present in Lake Lemon. Average length and weight compared to age were below southern Indiana averages from Department of Natural Resources' data (Figure 14 and Figure 15). Relative weights were below the desired level of 100 for most fish less than 12 inches and average to above average for largemouth bass greater than 12 inches (Figure 16). The status of the largemouth bass and bluegill populations in Lake Lemon, based upon PSD, is graphically depicted in Figure 17. Overall the largemouth bass population in Lake Lemon appears to be balanced. There are numerous quality largemouth bass in the population to provide excellent angling opportunities, and adequate numbers of smaller individuals to grow into quality fish. The slow growth of the smaller bass may be due to competition for food with numerous smaller predator species such as white crappie and yellow bass. Once largemouth bass reach 14 inches they are able to prey upon the numerous larger gizzard shad (6.5-7.0 inches) and growth rates and relative weights increase.

Spotted bass were not as common as largemouth bass in the sample. A total of 74 individuals and 41 pounds was collected. This is a slight increase compared to past surveys. Spotted bass ranged in size from less than 3.0 to 17.5 inches (Table 5). Spotted bass typically grow slower and do not grow as large as largemouth bass, but there was a good number of quality spotted bass (greater than 12 inches) present in the survey. The population in Lake Lemon is well developed compared to most Indiana lakes and reservoirs. This species may provide some additional fishing opportunities.

Yellow perch comprised 1% of the fish collected by number. They ranged from 4.0 to 8.0 inches (Table 5). Seventy-eight percent of yellow perch sampled ranged from 6.5 to 7.0 inches and were between 2 and 4 years old (Figure 19 and 20). The yellow perch in Lake Lemon are growing slower than yellow perch of other lakes in this area (Figure 18). Yellow perch may provide a limited angling opportunity.

A total of 28 carp were captured in this sample. Carp accounted for only 0.6% of the collection by number, but 17.1% of the total weight. Specimens ranging in length from 9.0 to 31.5 inches were collected. This species is not desirable in a lake population.

High population levels of carp can cause turbid water conditions because of its bottom feeding nature. In this population, carp is represented primarily by large individuals. Any carp captured should be removed from the population. This species does not appear to be having a great impact on the fish population of Lake Lemon at its current population level.

Twenty-seven redear sunfish were collected from Lake Lemon. They ranged in size from 6.0 to 9.5 inches (Table 5). Sixty-three percent of redear sunfish were between 7.5 to 8.0 inches (Figure 21). No young-of-the-year redear sunfish were collected indicating poor reproduction in 2000. The PSD of redear sunfish was 96 indicating the majority of redear sunfish are quality fish. Although the majority of redear sunfish in Lake Lemon are quality fish, they may be hard to catch due to their small population size.

A total of 15 flathead catfish and 10 channel catfish were collected in the survey. Flathead catfish were collected by electrofishing and gillnetting. Channel catfish were only collected in gill nets. Flathead catfish ranged in size from 8.5 to 19.0 inches. Channel catfish ranged in size from 10.0 to 21.5 inches (Table 5). Forty percent of channel catfish were 17.0 inches. The survey indicates reproduction is taking place in Lake Lemon. These two catfish species can provide excellent angling opportunities, and may help reduce the abundant prey fish present in Lake Lemon.

SUMMARY AND RECOMMENDATION

Overall, the fishery in Lake Lemon is in good condition and can provide angling opportunities for a wide variety of game fish. Largemouth bass should provide the best angling opportunity. However, some management strategies may be implemented to further improve the fishery.

The fish community within Lake Lemon has an overabundance of small slow growing yellow bass. Yellow bass are competing for food and space with each other and with other game fish (white crappie, bluegill, and largemouth bass). This may be contributing to slow growth observed in many game species. Yellow bass have few predators once they reach adult size. Young-of-the-year yellow bass provide a possible food source for larger predators, but many are surviving to reach adult size. Reducing the population of yellow bass will be a difficult task. Increasing angler harvest is one step that can be taken to reduce the population. There are numerous yellow bass in Lake Lemon that would provide an excellent angling opportunity. We recommend no limits be placed on yellow bass harvest. All yellow bass captured should be harvested. Harvest by anglers will not be enough to reduce the yellow bass population. Maintenance of an optimal weed community will allow largemouth bass and other predator fish, a better opportunity to prey upon young-of-the-year yellow bass. The optimal weed community for Lake Lemon is beyond the scope of this report. However, in general would include a minimal population of Eurasian water milfoil and no greater than 10-30% vegetation coverage of the littoral region.

Bluegill are also exhibiting slow growth with few individuals obtaining sizes larger than 6.5 inches. Bluegill harvest should also be encouraged with no limits placed on the population. There are numerous 6.0 and 6.5 inch bluegill, which could provide a good angling opportunity and excellent table fare. A reduced weed community will also be beneficial to the population by allowing largemouth bass a better opportunity to utilize abundant bluegill. These two steps will help reduce competition between bluegill and should result in better growth rates and overall larger fish.

The largemouth bass population in Lake Lemon is healthy and balanced. There are excellent numbers of quality largemouth bass present in Lake Lemon. However, largemouth bass are exhibiting slower than normal growth, especially fish less than 12.0 inches. This may be due to competition with smaller predator fish and/or the poor water clarity present in Lake Lemon. Largemouth bass primarily feed by sight, and poor water clarity may be effecting their ability to capture prey. Steps should be taken to increase the water clarity of Lake Lemon. Increasing the water clarity will be a major undertaking in a reservoir this size, but it would benefit the fish population and the overall aesthetic value of the lake. The current length limits on largemouth bass are working and should not be changed. Bass tournaments on Lake Lemon have been steadily increasing in the past few years, and provide a great deal of additional revenue to the conservancy district. At the current level, tournaments do not appear to be severely affecting the overall bass population. Kwak and Henry (1995) found that tournament mortality was minimal compared with other sources of mortality. However, Schramm et al. (1991) identified biological problems related to tournament fishing. Reduction of standing stocks, increased mortality, and relocation of fish were identified as the primary perceived biological problems associated with tournament fishing. The current regulations on tournaments appear to be adequate; however, increasing regulation on the number of tournaments can only have positive effects on the bass fishery. The current restrictions on tournaments in the months of July and August should remain in place. Many studies have shown that these months have the highest mortality rates due to the high water temperature and low oxygen levels present during the summer. Tournaments can become beneficial to managing the lake by informing managers of tournament catch results. This can help give managers a better idea of what is taking place with the bass population over time. The fishing club should turn in a short report, which includes the number of fish caught, total weight, and time spent fishing. Catch report sheets should also be distributed to all anglers who launch boats. These sheets could be filled out and turned in following the fishing trip. This information should include; species, number, and size of fish caught. Also, angler satisfaction and time-spent fishing should be reported. An example of a creel survey form is included in Appendix B. This information would be valuable in managing the fishery.

The most noticeable change in the fish population compared to the 1982 survey, was the dramatic decrease in the proportion of gizzard shad collected. In 1982, 48.5% of fish collected were gizzard shad, but in the 2000 survey gizzard shad comprised only 13.9% of fish collected. Gizzard shad populations can fluctuate substantially from year to year, so it is difficult to be sure if the population is under control or is just having a poor year. There was a great deal of time between the past surveys. A follow up survey would help better understand population fluctuations. Growth rates for gizzard shad are below normal in this survey and in the 1982 survey. Slow growing gizzard shad can be beneficial to a fish community by providing additional forage for various predator species. The slower gizzard shad grow, the longer they remain available as prey. It appears that currently gizzard shad are beneficial to the overall fish community, due to their slow growth and lower population. It is important to keep gizzard shad numbers under control. If gizzard shad become too numerous, they can have devastating affects on the overall fish community. Currently it appears large numbers of yellow bass, white crappie, and largemouth bass are keeping shad numbers low. Additional predators are not needed at this time to control the gizzard shad population. However, future surveys should be conducted to monitor the gizzard shad population and the potential for stocking a large predator species.

Interest has been shown in introducing a new species to Lake Lemon to help control gizzard shad and provide an additional sport fishery. Currently the predator species in Lake Lemon are adequately controlling the gizzard shad population. Many predator introductions (striped bass, hybrid striped bass, walleye, and musky) have had success in lakes with abundant forage. We believe Lake Lemon has the available forage to support an additional predator. Along with gizzard shad, there are numerous small bluegill, white crappie, brook silverside, and longear sunfish, which could provide forage for an introduced predator. Although there is abundant forage in Lake Lemon, many of the desirable game fish might not survive the summer months due to high temperatures and low oxygen levels that may be present in the lake. Musky and striped bass require water temperatures below 77 degrees with adequate oxygen levels (greater than 4.0 ppm). These conditions were present at the time of the survey, but it is unlikely that these conditions exist during the summer months. Adding an additional predator will likely have little effect on the overall population structure, but may provide desired angling opportunities. Hybrid striped bass may be the best option. Hybrid striped bass will be able to survive and grow quickly in Lake Lemon. Annual or biannual stocking would be needed to sustain this fishery. Currently, Lake Lemon has an excellent largemouth bass fishery with large numbers of smaller game fish. It is our belief that resources should be spent on maintaining and improving this fishery before an additional game fish is added. It is difficult at this time to recommend additional stocking due to the lack of information on the overall population trends in Lake Lemon. It is important to conduct a future survey before a large fish stocking is undertaken. This survey would be limited to 2 hours of electrofishing and no gillnetting. Gillnetting provided us with very little additional data and would not be needed in a future survey.

The following recommendations are designed to improve the fishery at Lake Lemon.

1. Encourage maximum harvest of bluegill and yellow bass to reduce intra-specific and inter-specific competition
2. Develop a plan to increase water clarity allowing largemouth bass and other predators to increase feeding efficiency
3. Continue control of Eurasian water milfoil and further develop weed management plan to produce optimal aquatic vegetation communities.
4. Maintain a 14 inch minimum length limit on largemouth bass
5. Allow only a limited number of tournaments with a limit on the number of boats (less than 15) which report total fish caught, weight, and time fished
6. Require anglers to fill out a creel census sheet which includes total fish caught, individual length estimates, total fish removed, time spent fishing, and overall fisherman satisfaction
7. Conduct a brief survey in 2001 and/or 2002 to assess the changes in this complex fish community and the need for additional regulations or stocking with additional complete surveys every 3-5 years
8. Continue addition of fish structure (artificial and/or natural) along shore and in deeper water

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APPENDIX A

GENERAL INFORMATION
&
METHODS

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 lead to oxygen depletion during the nighttime hours as plants stop photosynthesis and consume oxygen for respiration. Dissolved oxygen levels below 5.0 ppm 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 unique way that 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 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 an Otterbine oxygen-temperature meter with 25 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 photospectometer.

Fish sampling was done with the use of an electrofishing boat and gill nets. 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, green sunfish) in the samples taken. Electrofishing took place for three nights. The entire shoreline was separated into four habitat types: developed (docks, seawalls, etc.), undeveloped, rip-rap, and emergent vegetation (lotus and spatterdock). The four habitat types were then numbered separately on the map, and sites were selected based upon a stratified random sample by habitat type (Figure 1). Three rip-rap sites, 4 undeveloped sites, 11 developed, and 6 emergent vegetation sites were sampled. Total electrofishing effort was 5.77 hours.

Gill nets are passive entanglement capture devices. They are dependent upon the movement of the fish during the time of sampling, rather than active movement of the sampling device by man or machinery. Passive gear can be used to sample fish for many purposes and can yield reasonably accurate data on relative abundance for many species, particularly perch, pike, catfish, and crappie (Nielsen & Johnson, 1983). Experimental gill nets used in the survey were 125 ft. long by 6 ft. deep, and consisted of five 25 ft. panels of monofilament netting from 0.5 to 1.5 inch bar mesh. Six gill nets were fished overnight in selected locations for three consecutive nights for a total of 258 net hours.

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. Scale samples were collected from selected specimens for age determination of important species. Impressions of the scale samples were made in acetate microscope slides using a heated Carver hydraulic press. The slides were viewed using a Bausch and Lomb microprojector to determine age.

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

TABLES
&
FIGURES