# FISH SURVEY REPORT

## Lake Lemon
**November 17, 2009**

**Prepared for:**
**Lake Lemon Conservancy District**
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## INTRODUCTION

A survey of the fish community and other physical, biological, and chemical factors directly affecting the fish community was completed at Lake Lemon on October 7 & 8, 2009. The primary 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 and previous surveys completed on Lake Lemon
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 community 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. A detailed fish collection table is presented in Appendix B.

## RESULTS AND DISCUSSION

### WATER CHEMISTRY

Water quality parameters were measured at three stations (Table 1). Water temperatures ranged from 64.0 degrees Fahrenheit at the surface of Station 1 to 60.9 degrees at the bottom of the Station 3. Dissolved oxygen ranged from 10.61 parts per million (ppm) at the surface of the Station 2 to 3.21 ppm at a depth of 24 feet at Station 1. A desirable oxygen level for sustaining healthy, stress free fish was present to a depth of 21 feet at Station 1, and to the lake bottom at Stations 2 & 3 (Figure 1). These numbers indicate Lake Lemon was destratified at the time of the survey. Alkalinity is the capacity of solutes in an aqueous solution to neutralize acid. The alkalinity level was 85.5 ppm as calcium carbonate ($CaCO_3$) at the surface and bottom of all three stations. Water hardness is a measure of the amount of calcium and magnesium salts in water. The hardness level was 85.5 ppm at the surface and bottom of all three stations. The pH was 7.6 at the surface of Station 1 and 7.8 at Stations 2 & 3. The pH ranged from 7.2 to 7.6 at the bottom, which is normal for lakes in this area. The nitrate-nitrogen level was below detection limits at the surface for all three stations. Levels of nitrate-nitrogen on the bottom were 0.10 ppm at the Stations 1 & 3, and non-detectable at Station 2. The ortho-phosphate (phosphorus available for immediate uptake by plants) levels ranged from a high of 0.04 ppm at Station 1 to a low of 0.02 ppm at Station 2. Ortho-phosphate levels were substantially higher at the upper end of the lake. Microscopic algae and 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 3-feet at Stations 1 & 2, and 2.5-feet at Station 3. 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 community.

## Table 1. Water quality data from Lake Lemon, October 7, 2009.

**Station 1**

| Sample Depth (ft.) | Temp. (F) | DISSOLVED OXYGEN (ppm) | pH (standard units) | TOTAL ALKALINITY (ppm) | TOTAL HARDNESS (ppm) | NITRATE NITROGEN (ppm) | ORTHO PHOSPHATE (ppm) |
|---|---|---|---|---|---|---|---|
| Surface | 64.0 | 8.65 | 7.6 | 85.5 | 85.5 | 0.00 | 0.04 |
| 3 | 63.4 | 7.41 | - | - | - | - | - |
| 6 | 63.2 | 7.47 | - | - | - | - | - |
| 9 | 63.1 | 7.62 | - | - | - | - | - |
| 12 | 63.0 | 7.39 | - | - | - | - | - |
| 15 | 62.9 | 7.35 | - | - | - | - | - |
| 18 | 62.6 | 7.02 | - | - | - | - | - |
| 21 | 62.5 | 7.05 | - | - | - | - | - |
| 24 | 62.5 | 3.21 | 7.6 | 85.5 | 85.5 | 0.10 | 0.02 |

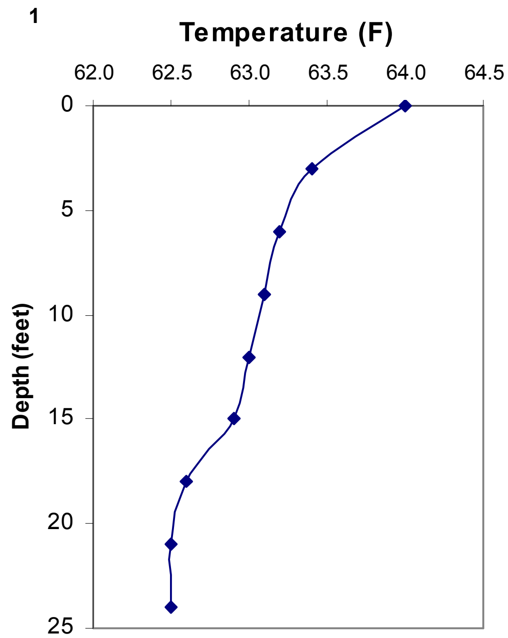
**Station 2**

| Sample Depth (ft.) | Temp. (F) | DISSOLVED OXYGEN (ppm) | pH (standard units) | TOTAL ALKALINITY (ppm) | TOTAL HARDNESS (ppm) | NITRATE NITROGEN (ppm) | ORTHO PHOSPHATE (ppm) |
|---|---|---|---|---|---|---|---|
| Surface | 61.4 | 10.61 | 7.8 | 85.5 | 85.5 | 0.00 | 0.02 |
| 3 | 61.7 | 10.51 | - | - | - | - | - |
| 6 | 62.0 | 10.37 | - | - | - | - | - |
| 9 | 62.1 | 10.23 | - | - | - | - | - |
| 11 | 61.7 | 9.17 | 7.6 | 85.5 | 85.5 | 0.00 | 0.04 |

**Station 3**

| Sample Depth (ft.) | Temp. (F) | DISSOLVED OXYGEN (ppm) | pH (standard units) | TOTAL ALKALINITY (ppm) | TOTAL HARDNESS (ppm) | NITRATE NITROGEN (ppm) | ORTHO PHOSPHATE (ppm) |
|---|---|---|---|---|---|---|---|
| Surface | 60.4 | 10.42 | 7.8 | 85.5 | 85.5 | 0.00 | 0.03 |
| 3 | 60.7 | 10.29 | - | - | - | - | - |
| 6 | 60.9 | 10.20 | - | - | - | - | - |
| 9 | 60.9 | 8.33 | 7.2 | 85.5 | 85.5 | 0.10 | 0.02 |

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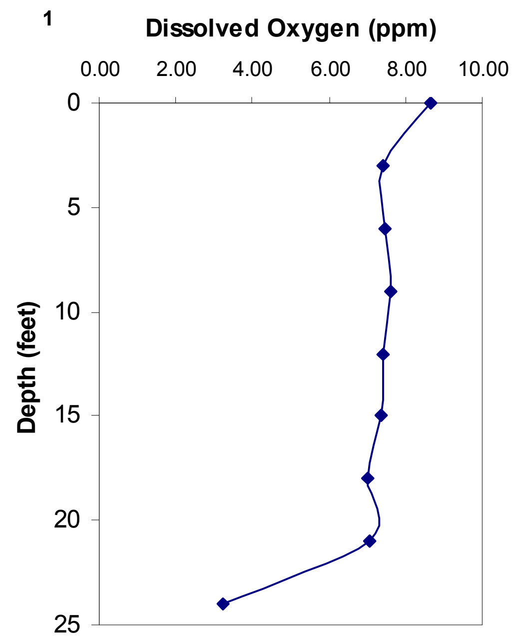
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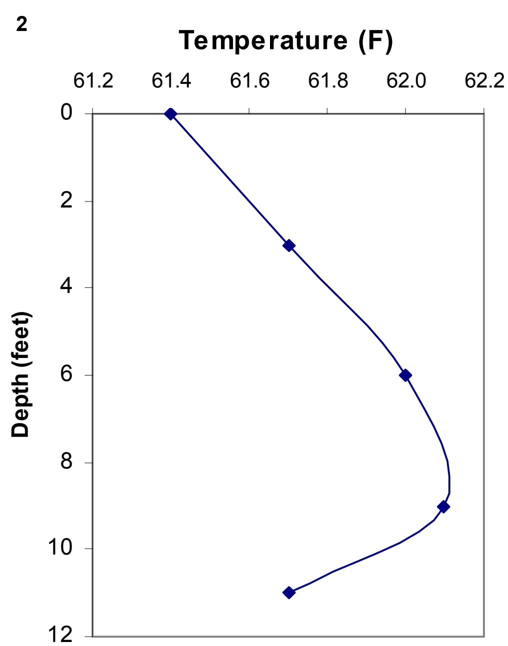
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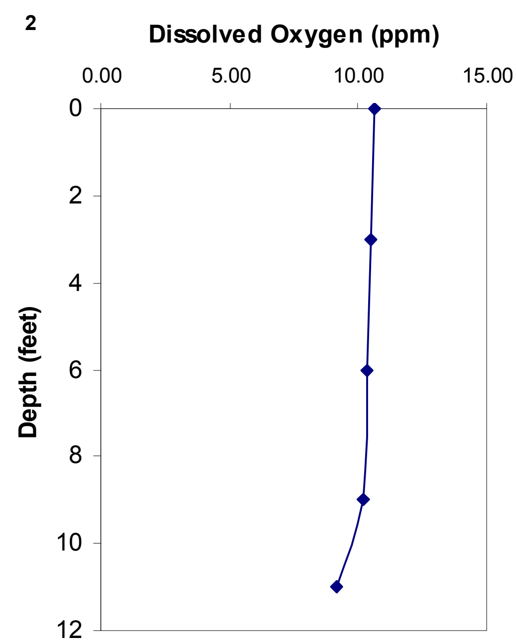
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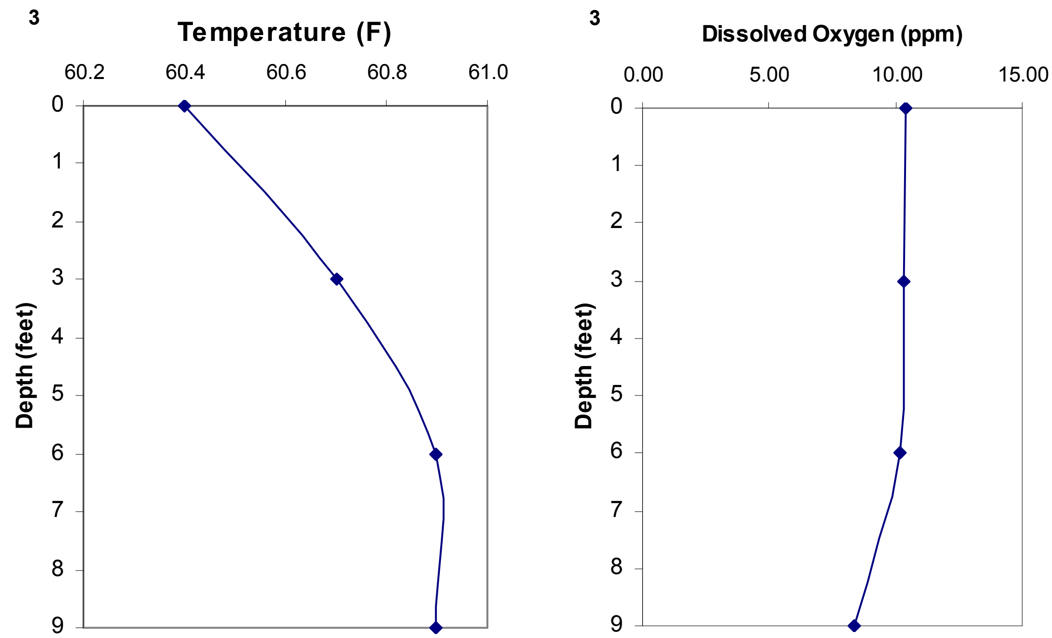


**Figure 1. Dissolved oxygen and temperature profiles for 3 stations at Lake Lemon October 7, 2009.**
***Station location is denoted by number at upper left hand corner of figure.**

## FISH COLLECTION

Electrofishing was the only fish sampling method used in 2009 (gill netting was part of the 2000 survey, but yielded little additional data despite the added effort). Electrofishing took place for two nights. The same zones sampled in 2000 were again used in 2009 (Figure 2). Electrofishing zones were established by dividing the shoreline 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. Three rip-rap sites, 4 undeveloped sites, 11 developed, and 6 emergent vegetation sites were sampled. Total electrofishing effort was 4.27 hours.

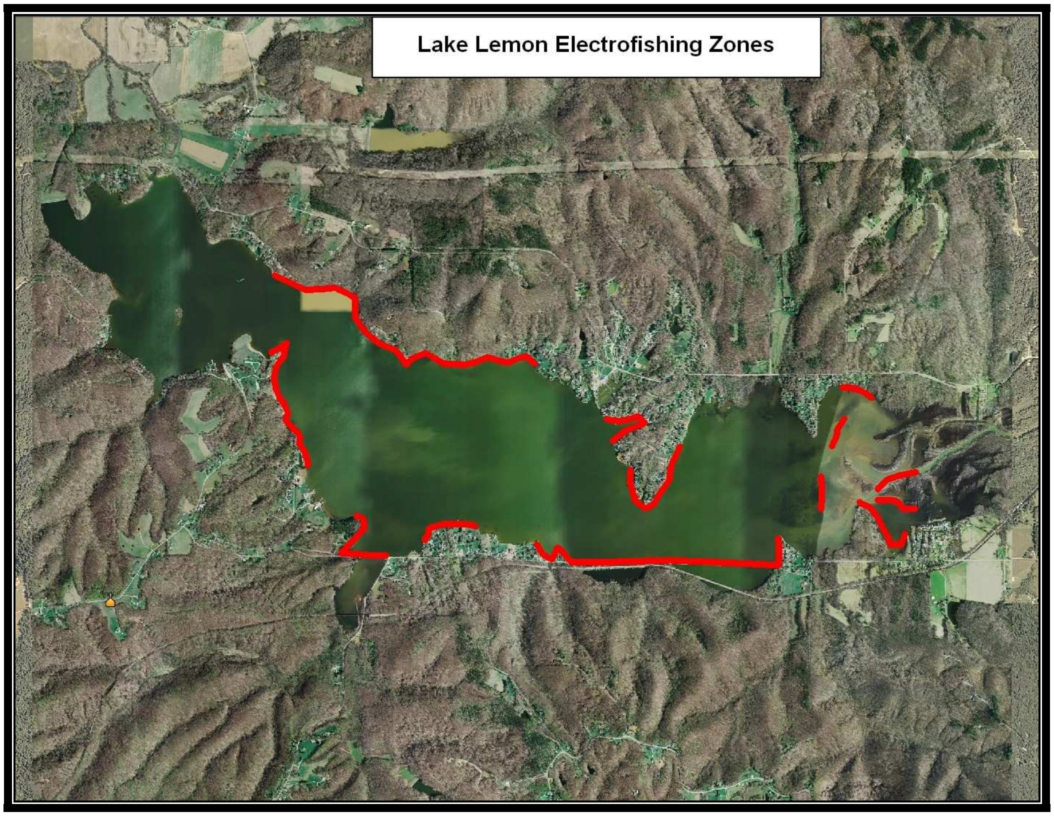


**Figure 2. Lake Lemon electrofishing areas.**

A total of 2555 fish weighing 782.62 pounds and representing twenty-eight species was collected from Lake Lemon (Table 2). Bluegill *(Lepomis macrochirus)* was the most abundant species comprising 36.75% of the fish collected. Gizzard shad *(Dorosoma cepedianum)* was the second most abundant species (22.19%), followed by largemouth bass *(Micropterus salmoides)* (11.15%), yellow bass *(Morone mississippiensis)* (6.85%), white crappie *(Pomoxis annularis)* (4.34%), and longear sunfish *(Lepomis megalotis)* (4.31%). Spotted sucker *(Minytrema melanops)*, golden redhorse *(Moxostoma erythrurum)*, redear sunfish *(Lepomis microlophus)*, green sunfish *(Lepomis cyanellus)*, common carp *(Cyprinus carpio)*, black redhorse *(Moxostoma duquesnei)*, spotted bass *(Micropterus punctulatus)*, flathead catfish *(Pylodictus olivaris)*, black crappie *(Pomoxis nigromaculatis)*, warmouth *(Lepomis gulosis)*, bowfin *(Amia calva)*, spotfin shiner *(Cyprinella spiloptera)*, yellow perch *(Perca flavescens)*, bluntnose minnow *(Pimephales notatus)*, logperch *(Percina caprodes)*, northern hogsucker *(Hypentelium nigricans)*, yellow bullhead *(Ameiurus natalis)*, grass pickerel *(Esox americanus vermiculatus)*, silver lamprey *(Icthyomyzon unicuspis)*, chestnut lamprey *(Icthyomyzon castaneus)*, and hybrid sunfish *(Lepomis spp. X Lepomis spp.)* comprised the remaining 14.40% of the sample.

**Table 2. Species collected from Lake Lemon, October 7, 2009.**

| Species | N | % N | Size Range (in) | Total Weight (lbs.) | % Wt | N/hr. |
|---|---|---|---|---|---|---|
| Bluegill | 939 | 36.75 | <3.0-7.5 | 93.67 | 11.97% | 220 |
| Gizzard shad | 567 | 22.19 | 3.0-13.0 | 93.23 | 11.91% | 133 |
| Largemouth bass | 285 | 11.15 | 3.0-20.5 | 224.46 | 28.68% | 67 |
| Yellow bass | 175 | 6.85 | 3.0-9.0 | 18.76 | 2.40% | 41 |
| White crappie | 111 | 4.34 | 6.0-10.0 | 24.83 | 3.17% | 26 |
| Longear sunfish | 110 | 4.31 | <3.0-6.0 | 9.06 | 1.16% | 26 |
| Spotted sucker | 84 | 3.29 | 4.5-20.0 | 26.66 | 3.41% | 20 |
| Golden redhorse | 60 | 2.35 | 6.5-17.0 | 49.92 | 6.38% | 14 |
| Redear sunfish | 48 | 1.88 | 5.0-10.0 | 21.65 | 2.77% | 11 |
| Green sunfish | 45 | 1.76 | <3.0-7.0 | 5.91 | 0.76% | 11 |
| Common carp | 18 | 0.70 | 10.5-28.5 | 116.27 | 14.86% | 4 |
| Golden shiner | 18 | 0.70 | <3.0-8.5 | 0.78 | 0.10% | 4 |
| Black redhorse | 17 | 0.67 | 8.5-15.0 | 9.54 | 1.22% | 4 |
| Spotted bass | 16 | 0.63 | 3.0-15.0 | 10.82 | 1.38% | 4 |
| Flathead catfish | 12 | 0.47 | 6.0-20.5 | 11.14 | 1.42% | 3 |
| Black crappie | 10 | 0.39 | 4.0-8.5 | 1.71 | 0.22% | 2 |
| Warmouth | 9 | 0.35 | <3.0-6.5 | 1.31 | 0.17% | 2 |
| Bowfin | 9 | 0.35 | 23.0-30.5 | 61.41 | 7.85% | 2 |
| Spotfin shiner | 8 | 0.31 | <3.0 | 0.08 | 0.01% | 2 |
| Yellow perch | 4 | 0.16 | 7.0-9.0 | 0.54 | 0.07% | 1 |
| Bluntnose minnow | 3 | 0.12 | <3.0 | 0.03 | 0.00% | 1 |
| Logperch | 1 | 0.04 | 5.5 | 0.06 | 0.01% | 0 |
| Northern hogsucker | 1 | 0.04 | 7.5 | 0.16 | 0.02% | 0 |
| Yellow bullhead | 1 | 0.04 | 10.0 | 0.45 | 0.06% | 0 |
| Grass pickerel | 1 | 0.04 | 7.0 | 0.08 | 0.01% | 0 |
| Silver lamprey | 1 | 0.04 | 9.5 | 0.05 | 0.01% | 0 |
| Chestnut lamprey | 1 | 0.04 | 5.0 | 0.01 | 0.00% | 0 |
| Hybrid sunfish | 1 | 0.04 | 3.0 | 0.03 | 0.00% | 0 |
| Total | 2555 | 100.00 | | 782.62 | 100.00% | |

N = number of individuals
%N = percent number of a species as compared to the total number of fish collected
%Wt = percent weight of a species as compared to the total weight of all fish collected
N/hr. = catch rate of species (number of fish of a species collected per hour of electrofishing effort)

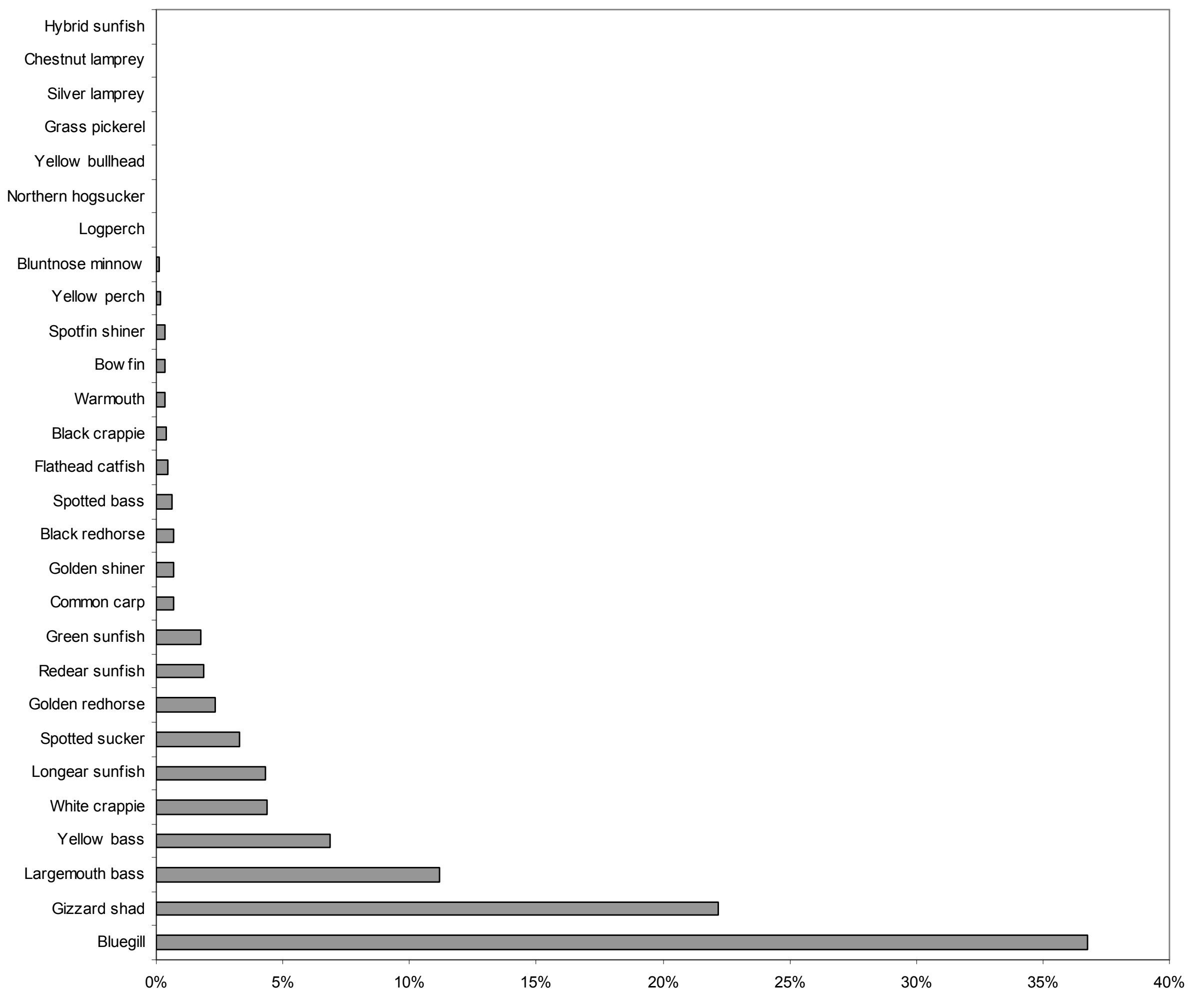


**Figure 3. Relative abundances of species collected from Lake Lemon, October 7, 2009.**

*Bluegill*

Bluegill was the most abundant species collected (36.75%) and ranked third by weight (11.97%). Bluegill ranged in size from less than 3.0 to 7.5 inches (Figure 3). Bluegill size structure has remained relatively unchanged over the past nine years, except there was a 2% increase in the frequency of individuals 7.0 inches and larger in length, thus possibly explaining the slight increase in proportional stock density (proportion of quality fish within a population) (Figures 5 & 6). The overall bluegill catch rate has increased 13% since 2000. Proportional stock density for bluegill was 43, compared to 38 in the 2000 survey. This is slightly above the ideal bluegill PSD range of 20 to 40 indicative of a balanced, exploited population (Appendix A). Condition factors (measurement of overall plumpness) were good for most size ranges. While the population exhibits a relatively balanced PSD, it continues to display a low percentage of individuals greater than 7.0 inches in length. **Please note that Figures 5 and 6 cannot be used to compare catch rates due to non standard sampling effort between surveys.*


**Figure 4. Bluegill *(Lepomis macrochirus)*.**

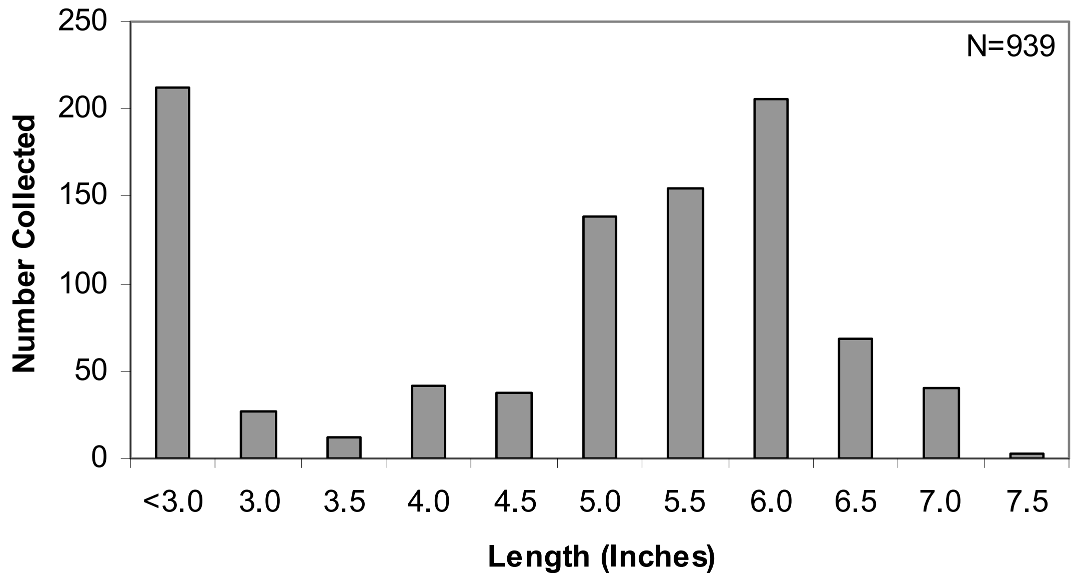


**Figure 5. Length frequency distribution of bluegill collected from Lake Lemon, October 7, 2009.**

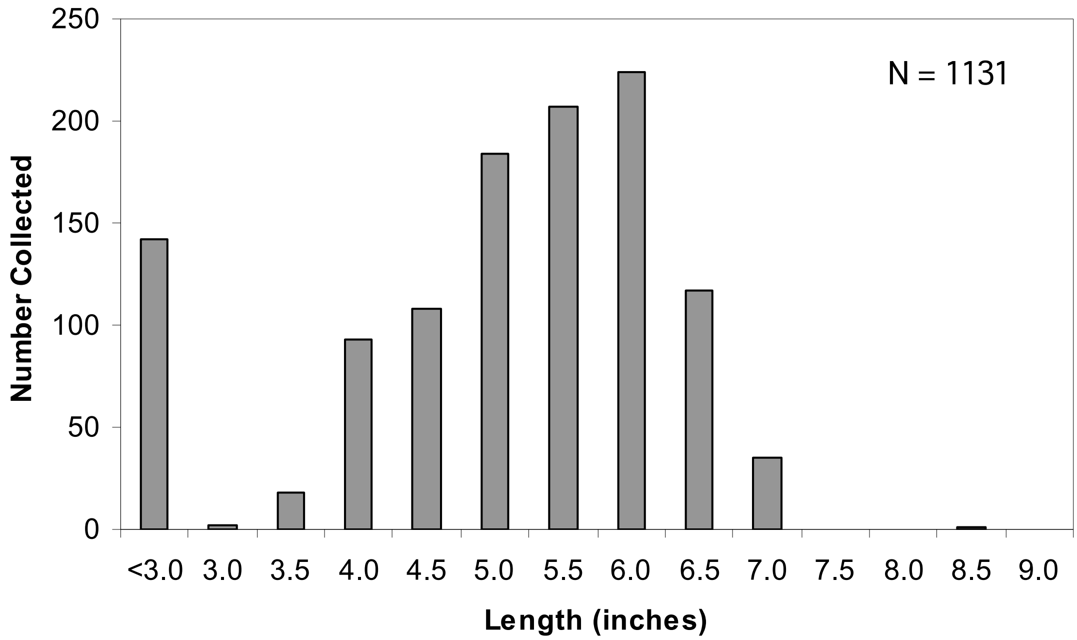


**Figure 6. Length frequency distribution of bluegill collected from Lake Lemon, September, 2000.**

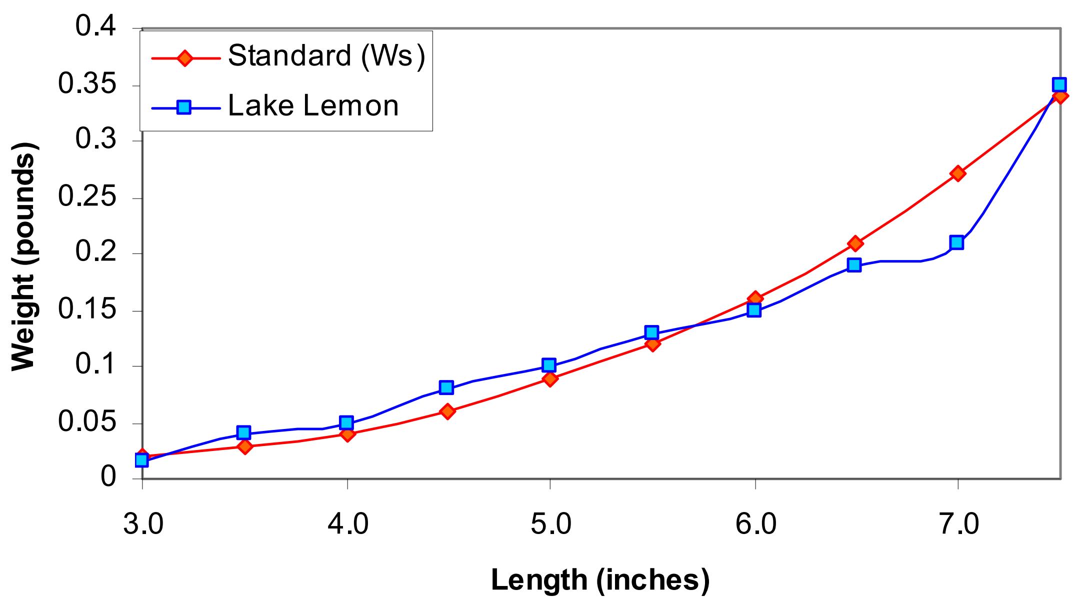


**Figure 7. Comparison of Lake Lemon bluegill weights to standard bluegill weights.**

*Gizzard shad*

Gizzard shad was the second most abundant species collected (22.19%) and ranked fourth by weight (11.91%). Comparatively, in the 2000 survey gizzard shad was the third most abundant species collected (13.25%) and ranked seventh by weight (6.00%). Individuals ranged in size from 3.0 to 13.0 inches in length (Figure 9). The current catch rate is 133 fish per hour and the 2000 catch rate was 77 fish per hour. This 72% increase in gizzard shad relative abundance may be attributed to the cyclic nature of their species or to other factors such as a change in available forage due to changes in water quality. In 2000 relatively few fish were larger than 7.0 inches and the population was exhibiting a slow growth rate. Presently, 65% of gizzard shad are 7.0 inches or greater in length. An increase in suspended nutrients from outside sources (fertilizer runoff) over the past 9 years may have lead to increased gizzard shad growth rates and thus the attainment of larger size classes (Figures 9 & 10). Juvenile gizzard shad are expected to be highly abundant in eutrophic water bodies (DiCenzo et. al. 1996). However, our data show that this is not the case in Lake Lemon where juvenile shad are not highly abundant. This is likely due to over winter mortality from lake drawdown activity coupled with the severe freeze in the winter of 2008/2009. Lowering water levels increases the severity of winter ice over effects on gizzard shad. Young-of-the-year gizzard shad have a decreasing chance of survival with increasing duration of ice cover during winter. A study on two South Dakota lakes found that zero young-of-the-year gizzard shad were collected in spring samples following winters that had at least 103 days of ice cover (Walburg 1964). It is advised to continue winter drawdown activity to increase gizzard shad winter kill.

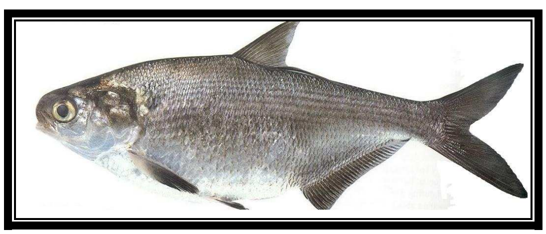

**Figure 8. Gizzard shad *(Dorosoma cepedianum)*.**

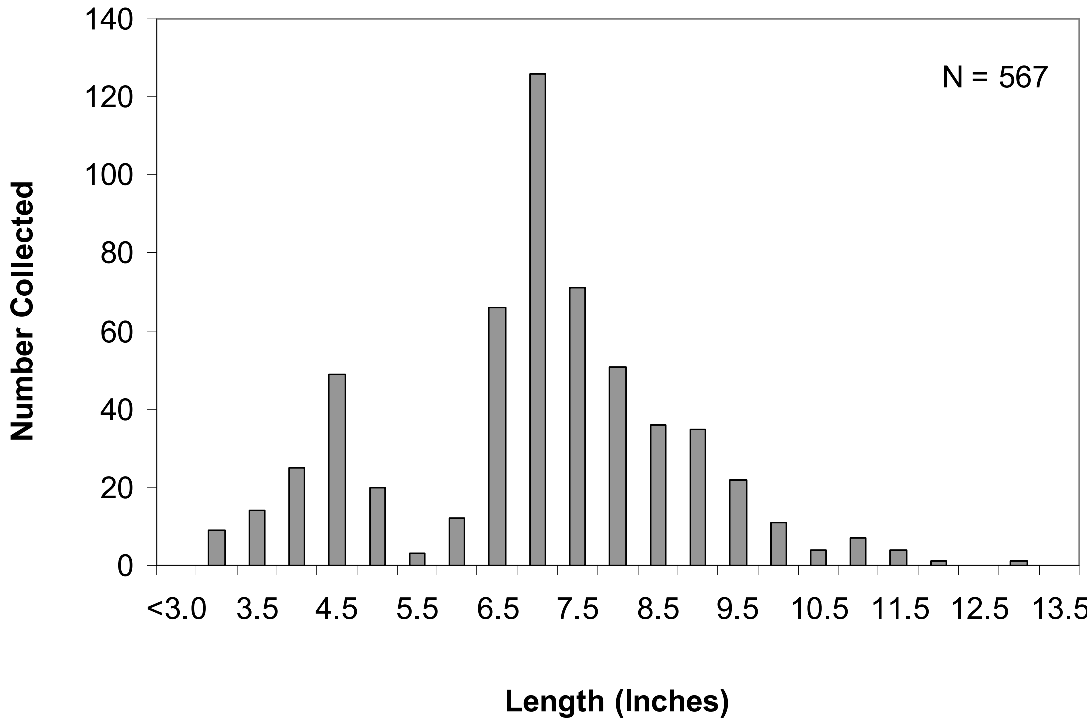


**Figure 9. Length frequency distributions of gizzard shad from Lake Lemon, October, 2009.**

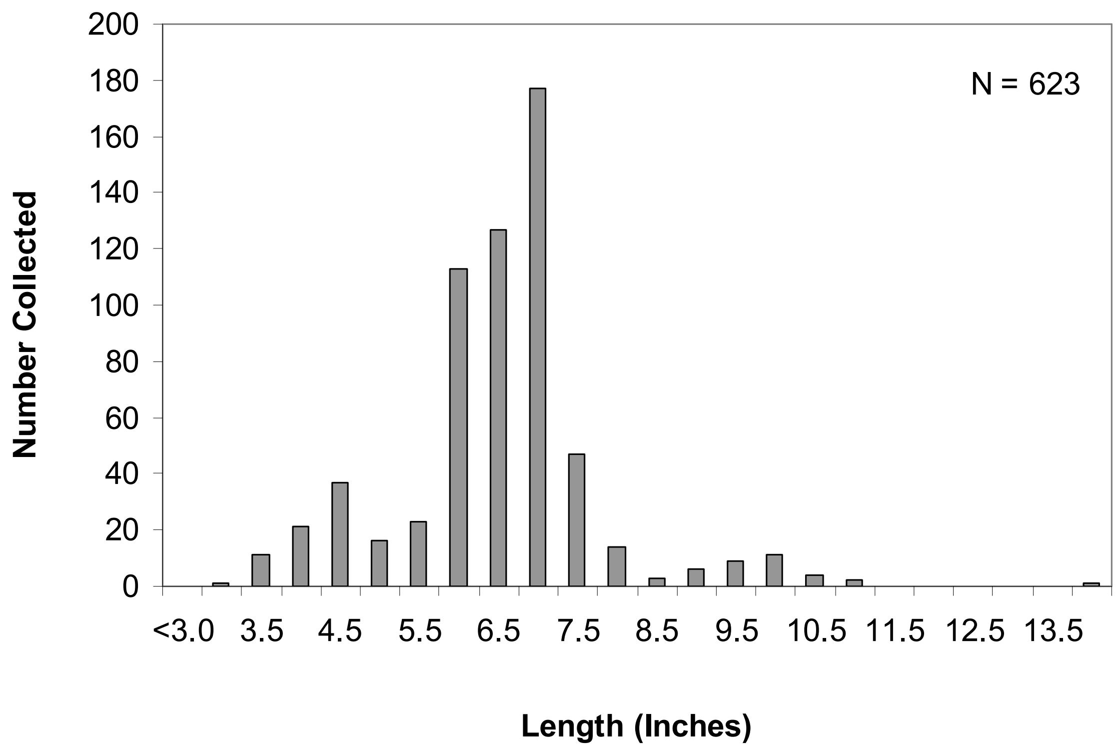


**Figure 10. Length frequency distribution of gizzard shad from Lake Lemon, September, 2000.**

*Largemouth bass*

Largemouth bass was the third most abundant species collected (11.15%) and ranked first by weight (28.68%). In 2000, largemouth bass was the fifth most abundant species collected (6%) and ranked first by weight (28.38%). Largemouth bass collected from Lake Lemon ranged in size from 3.0 to 20.5 inches (Figure 12). The total catch rate on largemouth bass increased from 45 fish per hour in 2000 to 67 fish per hour in 2009, an overall increase of 48%. The catch rate for stock size (≥ 8 inches) has increased by 68% since 2000 (Figure 14). The catch rates for quality (≥ 12 inches), preferred (≥ 15 inches), and memorable (≥ 20 inches) size classes have decreased slightly since 2000 (Figure 14). Proportional stock density for largemouth bass was 43, a slight decrease from 52 in the 2000 survey. Despite this 17% decrease, PSD remains in the ideal range of 40-60 for a balanced, exploited population. Largemouth bass average weights were very similar in comparison to standard weights (Figure 13). Relative weights for most size classes were very good, indicating that largemouth bass are finding adequate forage.

**Figure 11. Largemouth bass *(Micropterus salmoides)*.**

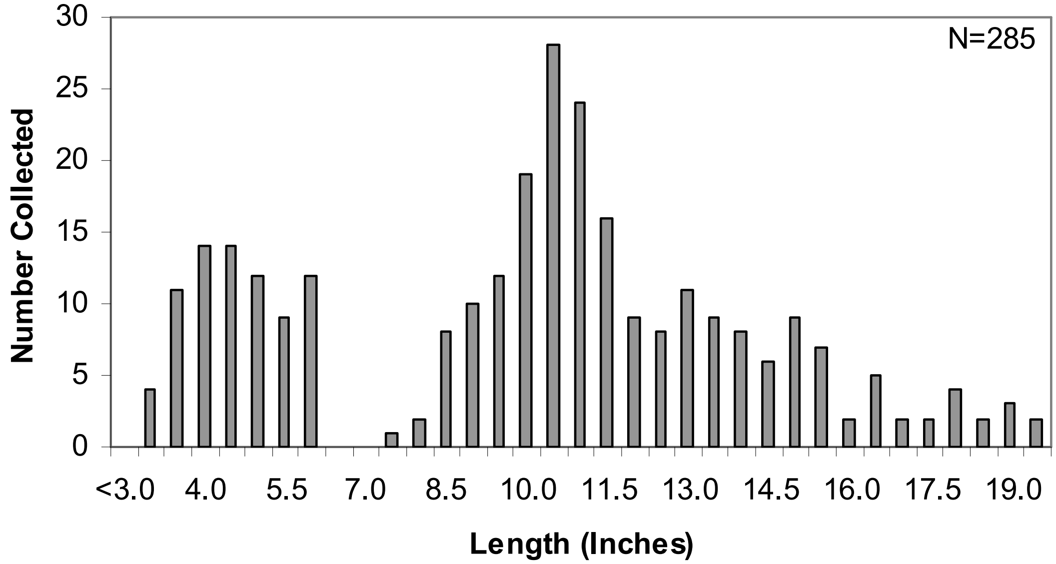


**Figure 12. Length frequency distribution of largemouth bass collected from Lake Lemon, October 7, 2009.**

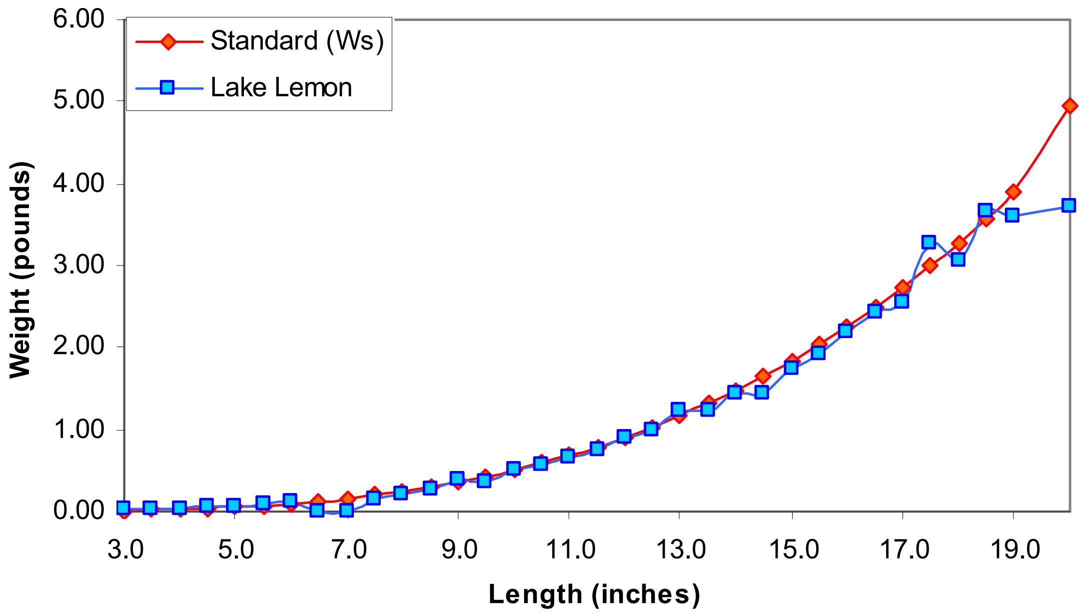


**Figure 13. Comparison of Lake Lemon largemouth bass weights to standard largemouth bass weights.**

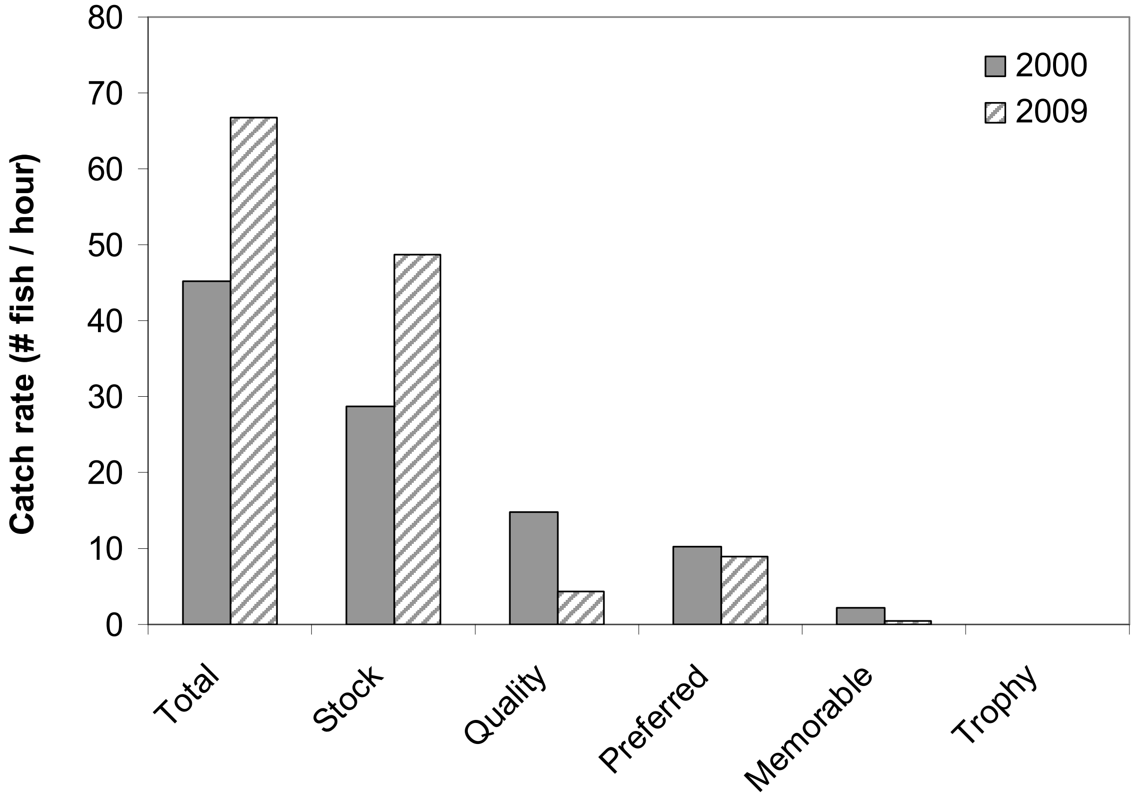


**Figure 14. Comparison of Lake Lemon largemouth bass catch rates by size class between 2000 and 2009. Total equals catch rate for all largemouth bass collected. Other categories are as follows: stock(≥8"), quality (≥12"), preferable (≥15"), memorable (≥20"), and trophy (≥25")**

*Spotted bass*

The catch rate of spotted bass has decreased drastically since 2000. Total catch rate for spotted bass was 13 fish per hour in 2000 and has dropped by roughly 70% to 4 fish per hour in 2009. Spotted bass ranged in size from 3.0 to 15.0 inches in length. Very few young-of-the-year spotted bass were collected, indicating poor reproduction in 2009. Despite decreased abundance, spotted bass may add an additional angling opportunity in Lake Lemon.

**Figure 15. Spotted bass *(Micropterus punctulatus)*.**

*Yellow bass*

Yellow bass was the fourth most abundant species collected (6.85%) and ranked tenth by weight (2.40%). In 2000, yellow bass ranked second in abundance (18.65%). Yellow bass relative abundance (catch rate) has decreased by 63% since 2000. Liberal harvest regulations and increased predation upon young-of-the-year yellow bass may have caused this reduction in relative abundance.

**Figure 16. Yellow bass *(Morone mississippiensis)*.**

*White crappie*

White crappie was the fifth most abundant species collected (4.34%) and ranked eighth by weight (3.17%) They ranged in size from 6.0 to 10.0 inches in length. Relative abundance of white crappie is comparable to 2000 data, with only an 8% increase. Crappie inhabit deeper water and typically do not sample well with electrofishing equipment. Young-of-the-year fish accounted for nearly 20% of the sample in 2000. Comparatively, no young-of-the-year white crappie were collected in this survey. This could be due to a poor recruitment year in 2009 or excessive predation, or a combination of both. The population is dominated by larger individuals that will provide another angling opportunity for sport fishermen.

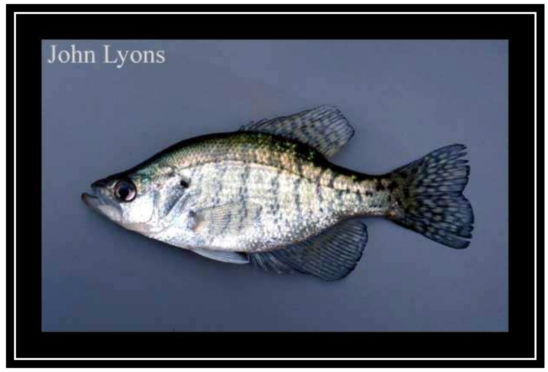


**Figure 17. White crappie *(Pomoxis annularis)*.**

*Yellow perch*

Yellow perch comprised only 1% of the species collected in the 2000 survey and only four individuals were collected in 2009. Yellow perch ranged from 7.0 to 9.0 inches. Yellow perch may provide a limited angling opportunity, but will provide additional forage for predatory fish.


**Figure 18. Yellow perch *(Perca flavescens)*.**

*Common Carp*

Common carp only accounted for 0.70% of fish collected in the survey, but ranked second by weight (14.86%). The relative abundance (catch rate) of common carp has remained very similar since the 2000 survey. In 2000, 5 fish per hour were collected compared to 4 fish per hour in 2009. A total of 18 carp ranging in size from 10.5 to 28.5 inches was collected. This population is dominated by large individuals. Preserving a healthy predator population, such as largemouth bass, will help keep common carp recruitment low and therefore keep population numbers under control. Common carp are not desirable in Lake Lemon's fish community. They reduce water clarity by feeding on the bottom, disturb desirable fish nests, and consume sport fish eggs. All common carp caught should be removed. Fishermen using live bait should be encouraged not to dump excess live bait into Lake Lemon from their bait wells. This will minimize chances of introducing more undesirable species into the lake.


**Figure 19. Common carp *(Cyprinus carpio)*.**

*Redear sunfish*

A total of 48 redear sunfish was collected during this survey. Redear sunfish ranged from 5.0 to 10.0 inches. Relative abundance (catch rate) of redear sunfish has increased by 120% since 2000 with 11 fish per hour being collected in 2009 compared to 5 fish per hour in 2000. As in 2000, no young-of-the-year redear were collected, indicating poor reproduction in 2009. Proportional stock density was 77, indicating that the majority of redear in Lake Lemon are still quality fish. Redear are not prolific spawners like bluegill and feed primarily on tiny insects and snails.

**Figure 20. Redear sunfish *(Lepomis microlophus)*.**

*Flathead catfish*

A total of 12 flathead catfish was collected during sampling. Individuals ranged in size from 6.0 to 20.5 inches. Flathead catfish relative abundance (catch rate) has increased by 50% from 2 fish per hour in 2000 to 3 fish per hour in 2009. Data indicate that flathead catfish are reproducing, and will help prey upon undesirable species. Flathead catfish, unlike most of their relatives, are strictly piscivorous (eat only fish) once they attain sizes greater than 10.0 inches in length and can have devastating effects on small impoundment ecosystems. This population should be monitored to ensure that the fish community of Lake Lemon is not being negatively impacted by their presence. Channel catfish were collected in the 2000 survey, but were absent in 2009. Catfish species are typically underrepresented by electrofishing, due to their ability to detect electrical currents at much greater distances than scaled fish and thus avoid capture. It is reasonable to assume that channel catfish are still present in Lake Lemon.

**Figure 21. Flathead catfish *(Pylodictis olivaris)*.**

*Other species*

There were eighteen other species collected during the survey. These species comprised 14.88% of fish sampled and included: longear sunfish, spotted sucker, golden redhorse, green sunfish, golden shiner, black redhorse, black crappie, warmouth, bowfin, spotfin shiner, bluntnose minnow, logperch, northern hogsucker, yellow bullhead, grass pickerel, silver lamprey, chestnut lamprey, and hybrid sunfish. The majority of these species pose no significant threats to the fishery of Lake Lemon. Silver and chestnut lampreys are native parasitic eel-like fish that feed on adult fish. Native lampreys rarely kill their host fish and do not present a threat to the fishery, unlike their non native relative the sea lamprey.

**Figure 22. Longear sunfish *(Lepomis megalotis).***


**Figure 23. Spotted sucker *(Minytrema melanops).***


**Figure 24. Golden redhorse *(Moxostoma erythrurum).***

**Figure 25. Green sunfish *(Lepomis cyanellus).***

**Figure 26. Golden shiner *(Notemigonus crysoleucas).***


**Figure 27. Black redhorse *(Moxostoma Duquesnei).***


**Figure 28. Black crappie *(Pomoxis nigromaculatis).***

**Figure 29. Warmouth *(Lepomis gulosus).***


**Figure 30. Bowfin *(Amia calva).***


**Figure 31. Spotfin shiner *(Cyprinella spiloptera).***


**Figure 32. Bluntnose minnow *(Pimephales notatus).***


**Figure 33. Logperch *(Percina caprodes).***


**Figure 34. Northern hogsucker *(Hypentelium nigricans).***

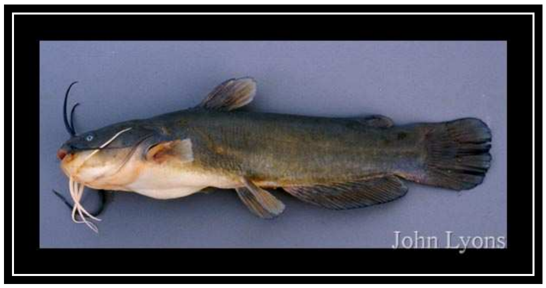


**Figure 35. Yellow bullhead *(Ameiurus natalis).***


**Figure 36. Grass pickerel *(Esox americanus vermiculatus).***


**Figure 37. Silver lamprey *(Icthyomyzon unicuspis).***


**Figure 38. Chestnut lamprey *(Icthyomyzon castaneus).***

**Figure 39. Hybrid sunfish *(Lepomis spp. X Lepomis spp.).***

## SUMMARY AND RECOMMENDATIONS

Lake Lemon continues to support a productive and relatively balanced fish community that should offer many different angling opportunities. Management strategies implemented following the 2000 survey may be having a positive impact on the fishery. For example, largemouth bass catch increased by 48% since the 2000 survey, while the population remained balanced with a good proportion of small and large individuals. In addition, the large, slow growing yellow bass population that was seen in the 2000 survey has decreased, the abundance of young gizzard shad has also declined, while redear sunfish catch rates have more than doubled. More restrictive bass tournament rules, reduction of dense milfoil coverage, along with bag limit restrictions may be a factor in these improvements.

Despite the overall improvements there still are areas of concern within the Lake Lemon fish community. Bluegill continue to grow slow with few individuals growing larger than 6.5 inches. There are still good numbers of fish in the 6.0 to 6.5 inch length ranges that provide angling opportunities. Bluegill harvest should continue to be encouraged in order to reduce competition and facilitate faster growth. Gizzard shad catch rates have increased on Lake Lemon when compared to 2000 (most of the increase was seen in larger individuals). The reduction in smaller shad may have been a result of the drawdown combined with the increased abundance of predators such as largemouth bass. It still appears that the shad population is under control. Additional predators shouldn't be needed at this time to help keep the shad population down, but future surveys should be conducted to monitor the effects gizzard shad are having on the fish community. Common carp continue to comprise a large percentage of the overall biomass of the fish community. Maintenance of a strong predator population should help keep this population from becoming more abundant. In addition, anglers using live bait should be encouraged not to dump excess live bait into Lake Lemon from their bait wells. This will decrease chances of introducing more undesirable species into the lake.

Overall water quality in Lake Lemon remains a concern. Lake Lemon is a shallow nutrient rich lake that is prone to microscopic algae blooms during the summer months. These algae blooms can lead to fluctuations in dissolved oxygen levels that can increase stress on fish populations that could eventually lead to fish kills or decreased fish growth. Installation of sewer systems, improvements in septic tanks, use of phosphorus free fertilizers, and allowing buffer zones to grow between lawns and the lake edge are just a few practices that can be implemented that may help improve Lake Lemon's water quality.

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

1. Maintain a 14.0 inch minimum length limit on largemouth bass along with limits on bass tournament sizes and timing that were established following the 2000 survey.
2. Maintain maximum harvest of bluegill and yellow bass in order to reduce overall numbers allowing for increased growth rates.
3. Encourage best management practices by homeowners and work with residents in the watershed in an effort to reduce siltation and nutrient inputs into the lake.
4. Complete another standard survey in 2012. The need for surveys is increased due to the abundance of gizzard shad. If shad numbers continue to increase, additional management strategies will be needed to combat this problem.

Once shad become overpopulated they can be detrimental to a fish community and virtually impossible to control.

5. Continue selective herbicide control of Eurasian watermilfoil and continue with winter drawdowns. The combination of these two management strategies has effectively controlled milfoil in the past. In addition, the drawdown may be having positive impacts on the fish community by reducing the shad population. Native vegetation control should be limited to high use areas only.
6. Require anglers and tournament fishermen to fill out creel survey sheets.
7. Continue addition of fish structure (artificial and/or natural) along shore and in deeper water. In addition, residents should be encouraged to allow emergent vegetation to grow along lake margins. This habitat is an important nursery area for a variety of fish and wildlife, will help filter water as it enters the lake, and discourage geese from grazing in yards.

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# 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 warm 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 32.0 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 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 YSI oxygen-temperature meter with 50 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 largemouth 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) | N | %N | AVERAGE WEIGHT (lbs) | TOTAL WEIGHT(lbs.) | CONDITION FACTOR | WS | RELATIVE WEIGHT |
|---|---|---|---|---|---|---|---|
| **BLUEGILL** | | | | | | | |
| <3.0 | 212 | 22.58% | 0.01 | 2.12 | - | - | - |
| 3.0 | 27 | 2.88% | 0.02 | 0.54 | 7.41 | 0.02 | 123 |
| 3.5 | 12 | 1.28% | 0.04 | 0.46 | 8.86 | 0.03 | 140 |
| 4.0 | 42 | 4.47% | 0.05 | 2.27 | 8.44 | 0.04 | 128 |
| 4.5 | 37 | 3.94% | 0.08 | 2.81 | 8.34 | 0.06 | 122 |
| 5.0 | 138 | 14.70% | 0.10 | 13.52 | 7.84 | 0.09 | 111 |
| 5.5 | 155 | 16.51% | 0.13 | 19.84 | 7.69 | 0.12 | 105 |
| 6.0 | 205 | 21.83% | 0.15 | 29.93 | 6.76 | 0.16 | 90 |
| 6.5 | 68 | 7.24% | 0.19 | 12.65 | 6.77 | 0.21 | 88 |
| 7.0 | 40 | 4.26% | 0.21 | 8.48 | 6.18 | 0.27 | 79 |
| 7.5 | 3 | 0.32% | 0.35 | 1.05 | 8.30 | 0.34 | 103 |
| TOTAL | 939 | 53.04% | | 93.67 | | | |
| **LARGEMOUTH BASS** | | | | | | | |
| <3.0 | 0 | 0.00% | 0.01 | - | - | - | - |
| 3.0 | 4 | 1.40% | 0.02 | 0.07 | 6.48 | 0.01 | - |
| 3.5 | 11 | 3.86% | 0.03 | 0.31 | 6.53 | 0.02 | - |
| 4.0 | 14 | 4.91% | 0.04 | 0.53 | 5.94 | 0.03 | - |
| 4.5 | 14 | 4.91% | 0.06 | 0.78 | 6.15 | 0.04 | - |
| 5.0 | 12 | 4.21% | 0.06 | 0.77 | 5.12 | 0.06 | - |
| 5.5 | 9 | 3.16% | 0.08 | 0.74 | 4.93 | 0.07 | - |
| 6.0 | 12 | 4.21% | 0.11 | 1.30 | 5.00 | 0.10 | - |
| 6.5 | 0 | 0.00% | 0.00 | 0.00 | 0.00 | 0.13 | - |
| 7.0 | 0 | 0.00% | 0.00 | 0.00 | 0.00 | 0.16 | - |
| 7.5 | 1 | 0.35% | 0.16 | 0.16 | 3.79 | 0.20 | 80 |
| 8.0 | 2 | 0.70% | 0.21 | 0.42 | 4.10 | 0.25 | 85 |
| 8.5 | 8 | 2.81% | 0.26 | 2.11 | 4.30 | 0.30 | 88 |
| 9.0 | 10 | 3.51% | 0.39 | 3.94 | 5.40 | 0.36 | 110 |
| 9.5 | 12 | 4.21% | 0.37 | 4.39 | 4.27 | 0.43 | 86 |
| 10.0 | 19 | 6.67% | 0.50 | 9.42 | 4.96 | 0.50 | 99 |
| 10.5 | 28 | 9.82% | 0.57 | 16.07 | 4.96 | 0.59 | 98 |
| 11.0 | 24 | 8.42% | 0.65 | 15.60 | 4.88 | 0.68 | 95 |
| 11.5 | 16 | 5.61% | 0.76 | 12.16 | 5.00 | 0.78 | 97 |
| 12.0 | 9 | 3.16% | 0.90 | 8.10 | 5.21 | 0.90 | 100 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 12.5 | 8 | 2.81% | 0.98 | 7.81 | 5.00 | 1.02 | 95 |
| 13.0 | 11 | 3.86% | 1.22 | 13.38 | 5.53 | 1.16 | 105 |
| 13.5 | 9 | 3.16% | 1.23 | 11.05 | 4.99 | 1.31 | 94 |
| 14.0 | 8 | 2.81% | 1.45 | 11.57 | 5.27 | 1.47 | 98 |
| 14.5 | 6 | 2.11% | 1.45 | 8.71 | 4.76 | 1.64 | 88 |
| 15.0 | 9 | 3.16% | 1.75 | 15.77 | 5.19 | 1.83 | 96 |
| 15.5 | 7 | 2.46% | 1.91 | 13.34 | 5.12 | 2.03 | 94 |
| 16.0 | 2 | 0.70% | 2.18 | 4.35 | 5.31 | 2.25 | 97 |
| 16.5 | 5 | 1.75% | 2.43 | 12.16 | 5.41 | 2.48 | 98 |
| 17.0 | 2 | 0.70% | 2.55 | 5.10 | 5.19 | 2.73 | 93 |
| 17.5 | 2 | 0.70% | 3.28 | 6.55 | 6.11 | 3.00 | 109 |
| 18.0 | 4 | 1.40% | 3.07 | 12.28 | 5.26 | 3.28 | 94 |
| 18.5 | 2 | 0.70% | 3.66 | 7.31 | 5.77 | 3.58 | 102 |
| 19.0 | 3 | 1.05% | 3.59 | 10.77 | 5.23 | 3.89 | 92 |
| 20.5 | 2 | 0.70% | 3.72 | 7.44 | 4.32 | 4.96 | 75 |
| TOTAL | 285 | | | 224.46 | | | |

**GIZZARD SHAD**

| | | | | |
|---|---|---|---|---|
| 3.0 | 9 | 1.59% | 0.02 | 0.18 |
| 3.5 | 14 | 2.47% | 0.02 | 0.28 |
| 4.0 | 25 | 4.41% | 0.03 | 0.70 |
| 4.5 | 49 | 8.64% | 0.04 | 1.76 |
| 5.0 | 20 | 3.53% | 0.04 | 0.76 |
| 5.5 | 3 | 0.53% | 0.07 | 0.22 |
| 6.0 | 12 | 2.12% | 0.08 | 0.91 |
| 6.5 | 66 | 11.64% | 0.14 | 9.24 |
| 7.0 | 126 | 22.22% | 0.13 | 15.88 |
| 7.5 | 71 | 12.52% | 0.16 | 11.08 |
| 8.0 | 51 | 8.99% | 0.21 | 10.91 |
| 8.5 | 36 | 6.35% | 0.29 | 10.30 |
| 9.0 | 35 | 6.17% | 0.29 | 10.22 |
| 9.5 | 22 | 3.88% | 0.31 | 6.91 |
| 10.0 | 11 | 1.94% | 0.37 | 4.09 |
| 10.5 | 4 | 0.71% | 0.43 | 1.71 |
| 11.0 | 7 | 1.23% | 0.56 | 3.90 |
| 11.5 | 4 | 0.71% | 0.67 | 2.66 |
| 12.0 | 1 | 0.18% | 0.69 | 0.69 |
| 13.0 | 1 | 0.18% | 0.84 | 0.84 |
| TOTAL | 567 | | | 93.23 |

**YELLOW BASS**

| | | | | |
|---|---|---|---|---|
| 3.0 | 1 | 0.57% | 0.02 | 0.02 |
| 3.5 | 22 | 12.57% | 0.04 | 0.97 |
| 4.0 | 70 | 40.00% | 0.05 | 3.36 |
| 4.5 | 6 | 3.43% | 0.04 | 0.24 |

| | | | | |
|---|---|---|---|---|
| 5.5 | 4 | 2.29% | 0.08 | 0.32 |
| 6.0 | 9 | 5.14% | 0.11 | 0.99 |
| 6.5 | 5 | 2.86% | 0.11 | 0.57 |
| 7.0 | 13 | 7.43% | 0.17 | 2.24 |
| 7.5 | 14 | 8.00% | 0.18 | 2.46 |
| 8.0 | 20 | 11.43% | 0.22 | 4.36 |
| 8.5 | 9 | 5.14% | 0.29 | 2.65 |
| 9.0 | 2 | 1.14% | 0.30 | 0.59 |
| TOTAL | 175 | | | 18.76 |

**GOLDEN REDHORSE**

| | | | | |
|---|---|---|---|---|
| 6.5 | 1 | 1.67% | 0.11 | 0.11 |
| 8.0 | 1 | 1.67% | 0.28 | 0.28 |
| 8.5 | 1 | 1.67% | 0.19 | 0.19 |
| 9.0 | 1 | 1.67% | 0.30 | 0.30 |
| 9.5 | 1 | 1.67% | 0.29 | 0.29 |
| 10.0 | 9 | 15.00% | 0.46 | 4.18 |
| 11.0 | 5 | 8.33% | 0.54 | 2.68 |
| 11.5 | 5 | 8.33% | 0.63 | 3.14 |
| 12.0 | 8 | 13.33% | 0.76 | 6.06 |
| 12.5 | 4 | 6.67% | 0.82 | 3.29 |
| 13.0 | 8 | 13.33% | 1.05 | 8.40 |
| 13.5 | 3 | 5.00% | 1.06 | 3.18 |
| 14.0 | 4 | 6.67% | 1.26 | 5.05 |
| 14.5 | 4 | 6.67% | 1.33 | 5.30 |
| 15.0 | 3 | 5.00% | 1.36 | 4.07 |
| 15.5 | 1 | 1.67% | 1.25 | 1.25 |
| 17.0 | 1 | 1.67% | 2.15 | 2.15 |
| TOTAL | 60 | | | 49.92 |

**BLACK REDHORSE**

| | | | | |
|---|---|---|---|---|
| 8.5 | 1 | 5.88% | 0.23 | 0.23 |
| 9.0 | 3 | 17.65% | 0.31 | 0.92 |
| 9.5 | 1 | 5.88% | 0.32 | 0.32 |
| 10.0 | 2 | 11.76% | 0.41 | 0.81 |
| 10.5 | 5 | 29.41% | 0.48 | 2.42 |
| 11.0 | 1 | 5.88% | 0.70 | 0.70 |
| 12.0 | 1 | 5.88% | 0.76 | 0.76 |
| 14.0 | 2 | 11.76% | 1.05 | 2.09 |
| 15.0 | 1 | 5.88% | 1.29 | 1.29 |
| TOTAL | 17 | | | 9.54 |

**WHITE
CRAPPIE**

| | | | | |
|---|---|---|---|---|
| 6.0 | 5 | 4.50% | 0.09 | 0.43 |

| | | | | |
|---|---|---|---|---|
| 6.5 | 10 | 9.01% | 0.13 | 1.26 |
| 7.0 | 14 | 12.61% | 0.16 | 2.18 |
| 7.5 | 7 | 6.31% | 0.20 | 1.39 |
| 8.0 | 34 | 30.63% | 0.22 | 7.48 |
| 8.5 | 23 | 20.72% | 0.25 | 5.84 |
| 9.0 | 12 | 10.81% | 0.33 | 4.01 |
| 9.5 | 4 | 3.60% | 0.34 | 1.36 |
| 10.0 | 2 | 1.80% | 0.44 | 0.88 |
| TOTAL | 111 | | | 24.83 |

**LONGEAR SUNFISH**

| | | | | |
|---|---|---|---|---|
| <3.0 | 8 | 7.27% | 0.01 | 0.08 |
| 3.0 | 5 | 4.55% | 0.03 | 0.17 |
| 3.5 | 8 | 7.27% | 0.03 | 0.24 |
| 4.0 | 18 | 16.36% | 0.06 | 1.12 |
| 4.5 | 14 | 12.73% | 0.08 | 1.06 |
| 5.0 | 40 | 36.36% | 0.11 | 4.40 |
| 5.5 | 14 | 12.73% | 0.11 | 1.54 |
| 6.0 | 3 | 2.73% | 0.15 | 0.45 |
| TOTAL | 110 | | | 9.06 |

**GREEN SUNFISH**

| | | | | |
|---|---|---|---|---|
| <3.0 | 1 | 2.22% | 0.01 | 0.01 |
| 3.0 | 1 | 2.22% | 0.03 | 0.03 |
| 3.5 | 1 | 2.22% | 0.07 | 0.07 |
| 4.0 | 8 | 17.78% | 0.06 | 0.45 |
| 4.5 | 2 | 4.44% | 0.07 | 0.14 |
| 5.0 | 11 | 24.44% | 0.10 | 1.14 |
| 5.5 | 2 | 4.44% | 0.17 | 0.33 |
| 6.0 | 7 | 15.56% | 0.19 | 1.36 |
| 6.5 | 9 | 20.00% | 0.18 | 1.66 |
| 7.0 | 3 | 6.67% | 0.24 | 0.72 |
| TOTAL | 45 | | | 5.91 |

**SPOTTED SUCKER**

| | | | | |
|---|---|---|---|---|
| 4.5 | 1 | 1.19% | 0.03 | 0.03 |
| 5.0 | 12 | 14.29% | 0.06 | 0.67 |
| 5.5 | 29 | 34.52% | 0.07 | 2.09 |
| 6.0 | 22 | 26.19% | 0.09 | 2.02 |
| 6.5 | 6 | 7.14% | 0.12 | 0.70 |
| 11.0 | 1 | 1.19% | 0.58 | 0.58 |
| 13.0 | 4 | 4.76% | 0.98 | 3.90 |
| 13.5 | 1 | 1.19% | 1.05 | 1.05 |
| 14.0 | 1 | 1.19% | 1.19 | 1.19 |

| | | | | |
|---|---|---|---|---|
| 14.5 | 2 | 2.38% | 1.40 | 2.79 |
| 15.5 | 2 | 2.38% | 1.82 | 3.64 |
| 16.0 | 1 | 1.19% | 1.95 | 1.95 |
| 17.0 | 1 | 1.19% | 2.35 | 2.35 |
| 20.0 | 1 | 1.19% | 3.70 | 3.70 |
| TOTAL | 84 | | | 26.66 |

**SPOTTED BASS**

| | | | | |
|---|---|---|---|---|
| 3.0 | 2 | 12.50% | 0.02 | 0.04 |
| 3.5 | 1 | 6.25% | 0.02 | 0.02 |
| 4.0 | 1 | 6.25% | 0.14 | 0.14 |
| 6.0 | 1 | 6.25% | 0.12 | 0.12 |
| 6.5 | 1 | 6.25% | 0.12 | 0.12 |
| 7.0 | 1 | 6.25% | 0.20 | 0.20 |
| 7.5 | 1 | 6.25% | 0.23 | 0.23 |
| 9.5 | 1 | 6.25% | 0.55 | 0.55 |
| 10.0 | 1 | 6.25% | 0.44 | 0.44 |
| 13.0 | 1 | 6.25% | 1.30 | 1.30 |
| 13.5 | 2 | 12.50% | 1.41 | 2.81 |
| 14.0 | 1 | 6.25% | 1.50 | 1.50 |
| 14.5 | 1 | 6.25% | 1.65 | 1.65 |
| 15.0 | 1 | 6.25% | 1.70 | 1.70 |
| TOTAL | 16 | | | 10.82 |

**COMMON CARP**

| | | | | |
|---|---|---|---|---|
| 10.5 | 1 | 5.56% | 0.75 | 0.75 |
| 18.5 | 1 | 5.56% | 3.20 | 3.20 |
| 20.0 | 2 | 11.11% | 4.42 | 8.83 |
| 21.0 | 1 | 5.56% | 5.25 | 5.25 |
| 21.5 | 1 | 5.56% | 4.50 | 4.50 |
| 22.0 | 2 | 11.11% | 6.13 | 12.25 |
| 22.5 | 1 | 5.56% | 6.00 | 6.00 |
| 23.0 | 1 | 5.56% | 6.50 | 6.50 |
| 24.0 | 2 | 11.11% | 7.94 | 15.87 |
| 24.5 | 1 | 5.56% | 7.00 | 7.00 |
| 25.0 | 3 | 16.67% | 7.83 | 23.49 |
| 26.0 | 1 | 5.56% | 9.31 | 9.31 |
| 28.5 | 1 | 5.56% | 13.31 | 13.31 |
| TOTAL | 18 | | | 116.27 |

**FLATHEAD CATFISH**

| | | | | |
|---|---|---|---|---|
| 6.0 | 1 | 8.33% | 0.11 | 0.11 |
| 9.0 | 1 | 8.33% | 0.21 | 0.21 |
| 9.5 | 1 | 8.33% | 0.29 | 0.29 |

| | | | | |
|---|---|---|---|---|
| 10.0 | 3 | 25.00% | 0.40 | 1.19 |
| 10.5 | 1 | 8.33% | 0.26 | 0.26 |
| 11.0 | 2 | 16.67% | 0.61 | 1.21 |
| 14.0 | 1 | 8.33% | 1.15 | 1.15 |
| 15.5 | 1 | 8.33% | 1.35 | 1.35 |
| 20.5 | 1 | 8.33% | 5.38 | 5.38 |
| TOTAL | 12 | | | 11.14 |

**WARMOUTH**

| | | | | |
|---|---|---|---|---|
| <3.0 | 1 | 11.11% | 0.01 | 0.00 |
| 4.0 | 2 | 22.22% | 0.07 | 0.13 |
| 4.5 | 1 | 11.11% | 0.17 | 0.17 |
| 5.5 | 1 | 11.11% | 0.15 | 0.15 |
| 6.5 | 4 | 44.44% | 0.22 | 0.86 |
| TOTAL | 9 | | | 1.31 |

**BLACK CRAPPIE**

| | | | | |
|---|---|---|---|---|
| 4.0 | 1 | 10.00% | 0.03 | 0.03 |
| 6.0 | 1 | 10.00% | 0.11 | 0.11 |
| 7.0 | 4 | 40.00% | 0.15 | 0.58 |
| 7.5 | 1 | 10.00% | 0.21 | 0.21 |
| 8.0 | 1 | 10.00% | 0.26 | 0.26 |
| 8.5 | 2 | 20.00% | 0.26 | 0.52 |
| TOTAL | 10 | | | 1.71 |

**BOWFIN**

| | | | | |
|---|---|---|---|---|
| 23.0 | 1 | 11.11% | 4.00 | 4.00 |
| 24.0 | 2 | 22.22% | 4.78 | 9.55 |
| 26.0 | 1 | 11.11% | 7.00 | 7.00 |
| 27.0 | 1 | 11.11% | 6.30 | 6.30 |
| 28.5 | 1 | 11.11% | 7.00 | 7.00 |
| 29.5 | 1 | 11.11% | 9.00 | 9.00 |
| 30.0 | 1 | 11.11% | 10.25 | 10.25 |
| 30.5 | 1 | 11.11% | 8.31 | 8.31 |
| TOTAL | 9 | | | 61.41 |

**REDEAR SUNFISH**

| | | | | |
|---|---|---|---|---|
| 5.0 | 6 | 12.50% | 0.11 | 0.11 |
| 5.5 | 2 | 4.17% | 0.13 | 0.25 |
| 6.0 | 2 | 4.17% | 0.19 | 0.37 |
| 6.5 | 1 | 2.08% | 0.16 | 0.16 |
| 7.0 | 2 | 4.17% | 0.39 | 0.77 |

| | | | | |
|---|---|---|---|---|
| 8.0 | 6 | 12.50% | 0.40 | 2.40 |
| 8.5 | 14 | 29.17% | 0.53 | 7.48 |
| 9.0 | 10 | 20.83% | 0.66 | 6.56 |
| 9.5 | 4 | 8.33% | 0.68 | 2.73 |
| 10.0 | 1 | 2.08% | 0.82 | 0.82 |
| TOTAL | 48 | | | 21.65 |

**YELLOW PERCH**

| | | | | |
|---|---|---|---|---|
| 7.0 | 2 | 50.00% | 0.13 | 0.13 |
| 8.0 | 1 | 25.00% | 0.20 | 0.20 |
| 9.0 | 1 | 25.00% | 0.21 | 0.21 |
| TOTAL | 4 | | | 0.54 |

**LOGPERCH**

| | | | | |
|---|---|---|---|---|
| 5.5 | 1 | 100.00% | 0.06 | 0.06 |
| TOTAL | 1 | | | 0.06 |

**NORTHERN HOGSUCKER**

| | | | | |
|---|---|---|---|---|
| 7.5 | 1 | 100.00% | 0.16 | 0.16 |
| TOTAL | 1 | | | 0.16 |

**BLUNTNOSE MINNOW**

| | | | | |
|---|---|---|---|---|
| <3.0 | 3 | 100.00% | 0.01 | 0.03 |
| TOTAL | 3 | | | 0.03 |

**YELLOW BULLHEAD**

| | | | | |
|---|---|---|---|---|
| 10.0 | 1 | 100.00% | 0.45 | 0.45 |
| TOTAL | 1 | | | 0.45 |

**GRASS PICKEREL**

| | | | | |
|---|---|---|---|---|
| 7.0 | 1 | 100.00% | 0.08 | 0.08 |
| TOTAL | 1 | | | 0.08 |

**SPOTFIN SHINER**

| | | | | |
|---|---|---|---|---|
| <3.0 | 8 | 100.00% | 0.01 | 0.08 |
| TOTAL | 8 | | | 0.08 |

**GOLDEN SHINER**

| | | | | |
|---|---|---|---|---|
| <3.0 | 8 | 44.44% | 0.01 | 0.08 |
| 3.0 | 1 | 5.56% | 0.02 | 0.02 |
| 6.5 | 2 | 11.11% | 0.10 | 0.10 |
| 7.5 | 5 | 27.78% | 0.16 | 0.16 |
| 8.0 | 1 | 5.56% | 0.18 | 0.18 |
| 8.5 | 1 | 5.56% | 0.24 | 0.24 |
| TOTAL | 18 | | | 0.78 |

**SILVER LAMPREY**

| | | | | |
|---|---|---|---|---|
| 9.5 | 1 | 100.00% | 0.05 | 0.05 |
| TOTAL | 1 | | | 0.05 |

**CHESTNUT LAMPREY**

| | | | | |
|---|---|---|---|---|
| 5.0 | 1 | 100.00% | 0.01 | 0.01 |
| TOTAL | 1 | | | 0.01 |

**HYBRID SUNFISH**

| | | | | |
|---|---|---|---|---|
| 3.0 | 1 | 100.00% | 0.03 | 0.03 |
| TOTAL | 1 | | | 0.03 |

# Appendix C
## Creel Survey Sample Sheet

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 | _____ ______ | _____ ______ | _____ ______ |
| Channel Catfish | _____ ______ | _____ ______ | _____ ______ |
| Crappie | _____ ______ | _____ ______ | _____ ______ |
| Other_____________ | _____ ______ | _____ ______ | _____ ______ |

Comments: