# FISH SURVEY REPORT

# Christmas Lakes

**November 20, 2014**

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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 Christmas Lakes on November 3, 2014. 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.

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. A detailed fish collection table is presented in Appendix B.

## RESULTS AND DISCUSSION-Lake Holly

### WATER CHEMISTRY

The results of selected physio-chemical parameters from Lake Holly are presented in Table 1. Lake Holly was measured at 11.8 surface acres and had a maximum depth of 18.0 feet at the time of the survey. Water temperatures ranged from 56.6 degrees Fahrenheit at the surface to 54.4 degrees Fahrenheit at the bottom. Dissolved oxygen ranged from 8.61 parts per-million (ppm) at the surface to 5.14 ppm at the bottom (Figure 1). A desirable oxygen level for maintenance of healthy stress free fish was present throughout the water column. These numbers indicate Lake Holly was partially de-stratified at the time of the survey, which is typical for this time of year (See Appendix A for further details on lake stratification). The alkalinity level was 68.4 ppm at the surface and at the bottom. The hardness level was 68.4 ppm at the surface and at the bottom. The pH was 7.43 at the surface and 7.25 on the bottom. These pH levels are normal, but the hardness and alkalinity levels are uncommon for lakes in this area and indicate the lake is capable of moderate fish production. Lakes with soft water have low mineral contents, which leads to lower productivity. The Secchi disk depth was measured at 4.0 feet. Nitrate-nitrogen levels were 0.5 ppm at the surface and 0.7 ppm on the bottom. Ortho-phosphate levels were 0.01 ppm at the surface and 0.02 ppm on the bottom. Lake Holly appears to have water quality which is capable of supporting a healthy fish population.

**Table 1. Selected water quality parameters measured on Lake Holly, November 3, 2014.**

| Sample Depth (ft.) | Temp. (°F) | Dissolved Oxygen (ppm) | pH (standard units) | Total Alkalinity (ppm) | Total Hardness (ppm) | Nitrate/ Nitrogen (ppm) | Ortho phosphate (ppm) | Total phosphorus (ppm) |
|---|---|---|---|---|---|---|---|---|
| Surface | 56.60 | 8.61 | 7.43 | 68.4 | 68.4 | 0.50 | 0.01 | 0.40 |
| 3 | 56.50 | 8.51 | - | - | - | - | - | - |
| 6 | 55.90 | 8.30 | - | - | - | - | - | - |
| 9 | 55.20 | 7.91 | - | - | - | - | - | - |
| 12 | 55.00 | 7.58 | - | - | - | - | - | - |
| 15 | 54.60 | 7.14 | - | - | - | - | - | - |
| 18 | 54.40 | 5.14 | 7.25 | 68.4 | 68.4 | 0.70 | 0.02 | 1.24 |

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

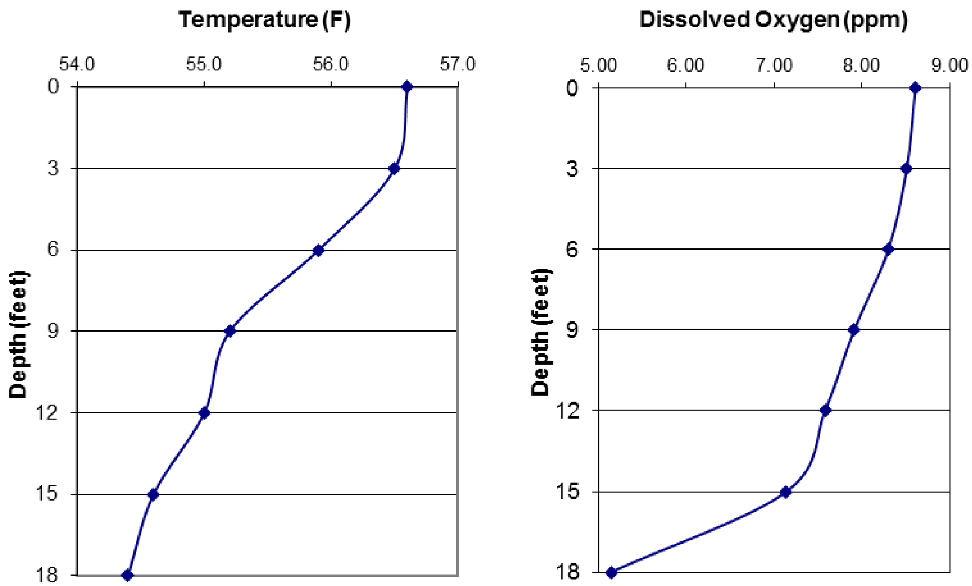


Figure 1. Temperature and dissolved oxygen profiles for Lake Holly, November 3, 2014.

FISH COLLECTION

A total of 231 fish weighing 55.48 pounds and representing five species was collected from Lake Holly (Table 2 & Figure 2). Bluegill *Lepomis macrochirus* was the most abundant species comprising 44.16% of the fish collected. Largemouth bass *Micropterus salmoides* was the second most abundant species (29.44%), followed by redear sunfish *Lepomis microlophus* (16.45%), warmouth *Lepomis gulosus* (9.52%), and black crappie *Pomoxis nigromaculatus* (0.43%). Channel catfish and white crappie were collected in past surveys, but were not represented in this survey. All of these species are desirable in a lake of this size with the exception of warmouth. This species was present at relatively low levels and likely has little negative impact on the fishery.

**Table 2. Species collected from Lake Holly, November 3, 2014.**

| Species | N | % N | Size Range (in) | Total Weight (lbs.) | % Wt | N/hr. |
|---|---|---|---|---|---|---|
| Bluegill | 102 | 44.16 | <3-9.0 | 7.72 | 13.91 | 179 |
| Largemouth bass | 68 | 29.44 | 3.5-18.0 | 30.40 | 54.79 | 119 |
| Redear sunfish | 38 | 16.45 | <3-10.5 | 13.75 | 24.78 | 67 |
| Warmouth | 22 | 9.52 | <3-8.0 | 2.85 | 5.14 | 39 |
| Black crappie | 1 | 0.43 | 11.0 | 0.76 | 1.37 | 2 |
| Total | 231 | 100.00 | | 55.48 | 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)

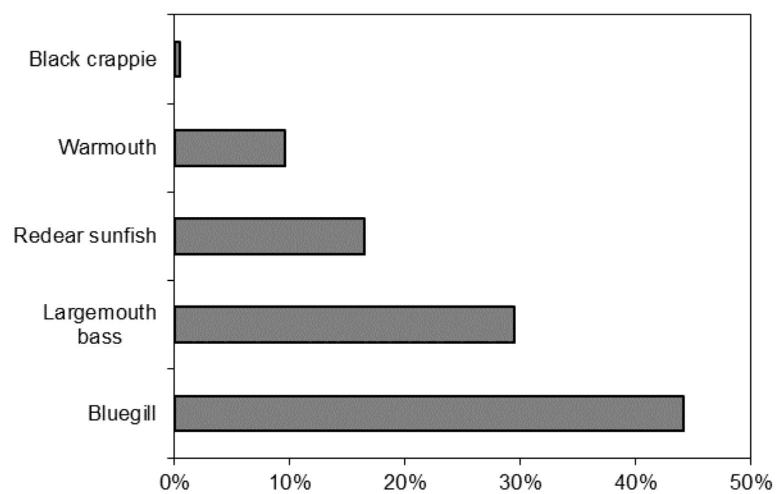


Figure 2. Relative abundance of species collected from Lake Holly, November 3, 2014.

*Bluegill*

Bluegill (Figure 3) was the most abundant species collected (44.16%) and ranked third by weight (13.91%). Individuals ranged in size from less than 3.0 to 9.0 inches (Figure 4). Nearly 37% of bluegill collected were less than 3.0 inches, indicating successful reproduction occurred in 2014. There was also a decent number of quality bluegill collected. This led to a proportional stock density of 17, which is just below the desired range of 20-40 for bluegill (proportion of quality fish within a population, see Appendix A). Condition factors (measurement of overall plumpness) were below average for all size ranges. Bluegill weights were also found to be below standard weights in most size ranges (Figure 5).

Figure 3. Photograph of bluegill, *Lepomis macrochirus*.

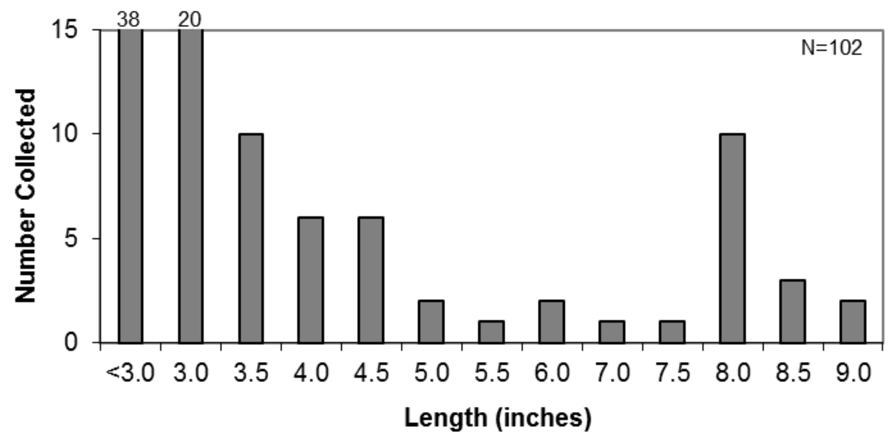


Figure 4. Length frequency distribution of bluegill collected from Lake Holly, November 3, 2014.

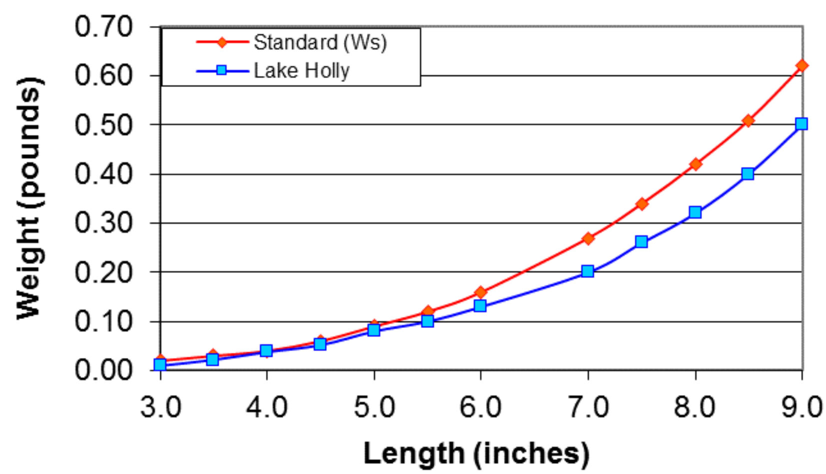


Figure 5. Comparison of Lake Holly bluegill weights to standard bluegill weights.

### *Largemouth Bass*

Largemouth bass (Figure 6) was the second most abundant species collected (29.44%) and ranked first by weight (54.79%). A total of 68 largemouth bass ranging in size from less than 3.5 to 18.0 inches was collected (Figure 7). Approximately 25% of largemouth bass collected were less than 7.5 inches indicating moderate reproduction and recruitment has occurred in the past two years. Of the largemouth bass collected, nearly 49% were between 9.0 and 12.0 inches. This led to a PSD of 27 for largemouth bass, which is well below the desired range of 40-60. Condition factors (measurement of overall plumpness) were slightly below average for most size classes. The average weights for the bass were good for smaller fish and below what is expected as normal weight at length in most of the larger fish (Figure 8).

Figure 6. Photograph of largemouth bass, *Micropterus salmoides*.

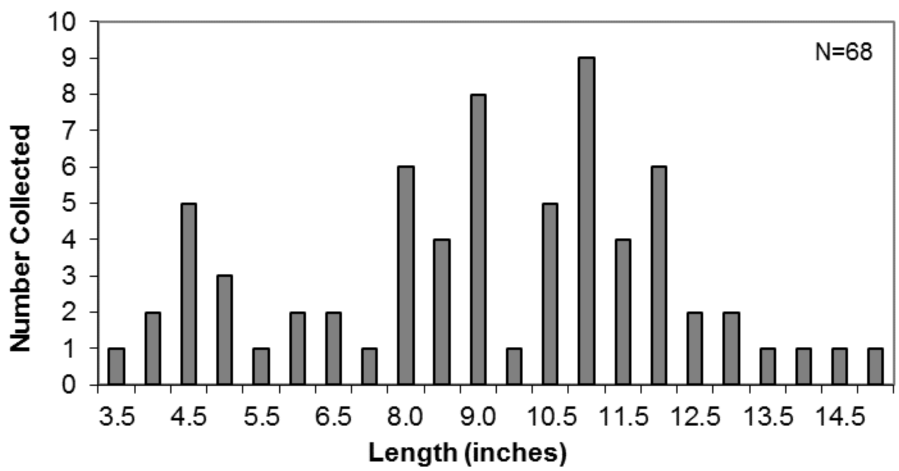


Figure 7. Length frequency distribution of largemouth bass collected from Lake Holly, November 3, 2014.

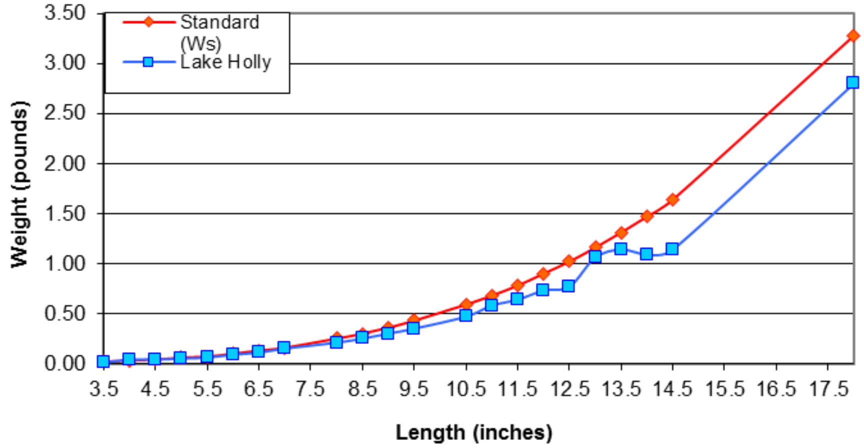


Figure 8. Comparison of Lake Holly largemouth bass weights to standard largemouth bass weights.

*Redear sunfish*

Redear sunfish (Figure 9) was the third most abundant species collected (16.45%), and ranked second by weight (24.78%). A total of 38 redear sunfish ranging in size from less than 3.0 to 10.5 inches was collected. Redear are not prolific spawners like bluegill, so their populations will not become overly abundant in this lake. Redear sunfish inhabit deeper water than bluegill and feed primarily on insects and snails. They also tend to grow faster than bluegill. This species should provide an additional sport fish in Lake Holly. Due to their slower reproductive potential and small population, this species should be protected with more restrictive bag limits.

Figure 9. Photograph of redear sunfish, *Lepomis microlophus*.

*Warmouth*

Warmouth (Figure 10) was the fourth most abundant species collected (9.52%) and ranked fourth by weight (5.14%). They ranged in size from less than 3.0 to 8.0 inches. This species is not beneficial to Lake Holly. Predators are currently keeping the population low; however, all warmouth caught should be harvested from the lake.

Figure 10. Photograph of warmouth, *Lepomis gulosus*.

*Black crappie*

A single 11.0 inch black crappie (Figure 11) was collected while electrofishing. Crappie inhabit deeper water and are usually not well represented in electrofishing surveys, so the crappie population is most likely higher than indicated by the survey. This species competes with largemouth bass for food resources, and should be harvested when caught.


Figure 11. Photograph of black crappie, *Pomoxis nigromaculatus*.

## SUMMARY AND RECOMMENDATIONS

Lake Holly should provide good angling opportunities for bluegill, largemouth bass, and redear sunfish. However, the survey indicates that the lake has an imbalance in the predator/prey assemblage. It appears that overabundant largemouth bass in certain size ranges are cropping all of the smaller bluegill. This is evident in the crowding of largemouth bass in the 9.0 to 12.0 inch size classes. Removing some largemouth bass in this length group should allow for less competition and better growth rates. There are some quality bluegill (6.0 inches and larger) in the population, but harvest should be limited to protect the population. No channel catfish were collected while sampling, but the sign at the lake indicates that they are present. Channel catfish will have to be restocked every 2-3 years if desired. Young-of-the-year channel catfish are typically eliminated by largemouth bass and other predators leading to little or no recruitment into the population. The lake also has a lack of structure. Installing artificial structure will provide great cover for juvenile fish.

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

1. Implement a 12.0 to 16.0 inch slot limit on largemouth bass. Under this limit 5 bass under 12.0 inches and 1 bass over 16.0 inches can be harvested per angler per day. One bass over the slot could be kept, but catch and release of the larger fish should be encouraged. This limit will only be effective if smaller bass are harvested.
2. Limit bluegill harvest to 15 fish per angler per day in order to allow for an increase in numbers and forage for largemouth bass.
3. Limit redear sunfish harvest to 5 fish per angler per day for the next two years.
4. Install artificial structure in the lake. This can consist of rock/brush piles, fall downs, Christmas trees, or man-made fish reefs.
5. Remove all warmouth when caught. Currently, this species poses no serious threat to the fishery, but harvest will help aide in maintaining the population.
6. No restrictions are needed for harvest of crappie. Crappie are prolific spawners and can maintain their own population without harvest restrictions.

7. Conduct a Standard Fish Survey in 2017 in order to monitor the effects of the above recommendations and assess needs for further management activities.
8. Encourage residents to feel out Creel Survey forms. An example is located in Appendix C. This could be mailed out to residents or left in a box by the ramp for fishermen to fill out during their fishing trips.
9. Educate lake users of the dangers of bait bucket dumping into the lake. All unused bait should be disposed of in waste containers, not dumped into the lake. Do not allow gizzard shad to be used as bait. This will help keep the fish assemblage in proper balance and undesirable fish species will not be introduced to the lake. The high abundance of shad in Christmas Lake makes this VERY important.
10. If channel catfish are desired, stock five-hundred 8.0 to 10.0 inch fish. This species will provide an additional angling opportunity.

## RESULTS AND DISCUSSION-Lake Noel

WATER CHEMISTRY

The results of selected physio-chemical parameters from Lake Noel are presented in Table 3. Lake Noel was measured at 19.6 surface acres and had a maximum depth of 19.0 feet at the time of the survey. Water temperatures ranged from 55.8 degrees Fahrenheit at the surface to 55.1 degrees Fahrenheit at the bottom. Dissolved oxygen ranged from 8.61 ppm at the surface to 7.81 ppm at the bottom (Figure 12). A desirable oxygen level for maintenance of healthy stress free fish was present throughout the water column. These numbers indicate Lake Noel was de-stratified at the time of the survey. The alkalinity level was 51.3 ppm at the surface and at the bottom. The hardness level was 51.3 ppm at the surface and at the bottom. The pH was 7.25 at the surface and 7.14 on the bottom. These pH levels are normal, but the hardness and alkalinity levels indicate the lake is capable of moderate fish production. The Secchi disk depth was measured at 4.0 feet. Nitrate-nitrogen levels were 0.3 ppm at the surface and on the bottom. Ortho-phosphate levels were 0.01 ppm at the surface and on the bottom. Lake Noel appears to have water quality which is capable of supporting a healthy fish population.

**Table 3. Selected water quality parameters measured on Lake Noel, November 3, 2014.**

| Sample Depth (ft.) | Temp. (°F) | Dissolved Oxygen (ppm) | pH (standard units) | Total Alkalinity (ppm) | Total Hardness (ppm) | Nitrate/ Nitrogen (ppm) | Ortho phosphate (ppm) | Total phosphorus (ppm) |
|---|---|---|---|---|---|---|---|---|
| Surface | 55.80 | 8.61 | 7.25 | 51.3 | 51.3 | 0.30 | 0.01 | 0.35 |
| 3 | 55.80 | 8.60 | - | - | - | - | - | - |
| 6 | 55.70 | 8.56 | - | - | - | - | - | - |
| 9 | 55.60 | 8.52 | - | - | - | - | - | - |
| 12 | 55.40 | 8.31 | - | - | - | - | - | - |
| 15 | 55.30 | 8.27 | - | - | - | - | - | - |
| 18 | 55.20 | 7.93 | - | - | - | - | - | - |
| 19 | 55.10 | 7.81 | 7.14 | 51.3 | 51.3 | 0.30 | 0.01 | 0.35 |

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

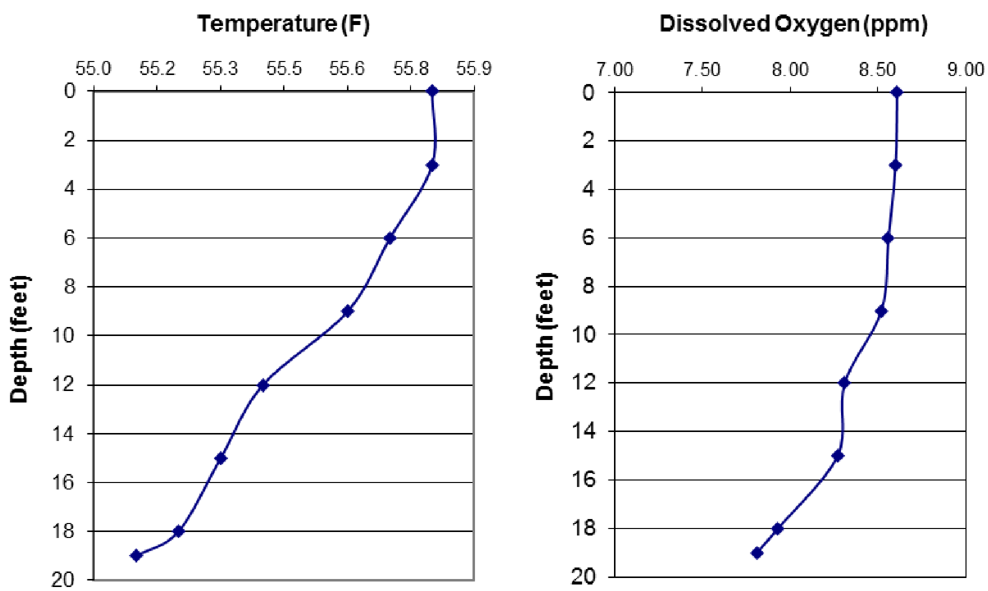


Figure 12. Temperature and dissolved oxygen profiles for Lake Noel, November 3, 2014.

FISH COLLECTION

A total of 223 fish weighing 106.08 pounds and representing six species was collected from Lake Noel (Table 4 & Figure 13). Bluegill *Lepomis macrochirus* was the most abundant species comprising 53.36% of the fish collected. Green sunfish *Lepomis cyanellus* was the second most abundant species (24.22%), followed by largemouth bass

*Micropterus salmoides* (13.45%), hybrid sunfish *Lepomis spp. X Lepomis spp.* (4.04%), channel catfish *Ictalurus punctatus* (3.14%), and common carp *Cyprinus carpio* (1.79%). Redear sunfish were collected in past surveys, but were not represented in this survey. All of these species are desirable in a lake of this size with the exception of green sunfish and hybrid sunfish.

**Table 4. Species collected from Lake Noel, November 3, 2014.**

| Species | N | % N | Size Range (in) | Total Weight (lbs.) | % Wt | N/hr. |
|---|---|---|---|---|---|---|
| Bluegill | 119 | 53.36 | <3-8.0 | 14.08 | 13.27 | 170 |
| Green sunfish | 54 | 24.22 | <3-8.0 | 5.69 | 5.36 | 77 |
| Largemouth bass | 30 | 13.45 | <3-12.0 | 13.06 | 12.31 | 43 |
| Hybrid sunfish | 9 | 4.04 | 5.0-8.5 | 2.66 | 2.51 | 13 |
| Channel catfish | 7 | 3.14 | 19.5-25.0 | 26.34 | 24.83 | 10 |
| Common carp | 4 | 1.79 | 26.0-30.0 | 44.25 | 41.71 | 6 |
| Total | 223 | 100.00 | | 106.08 | 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)

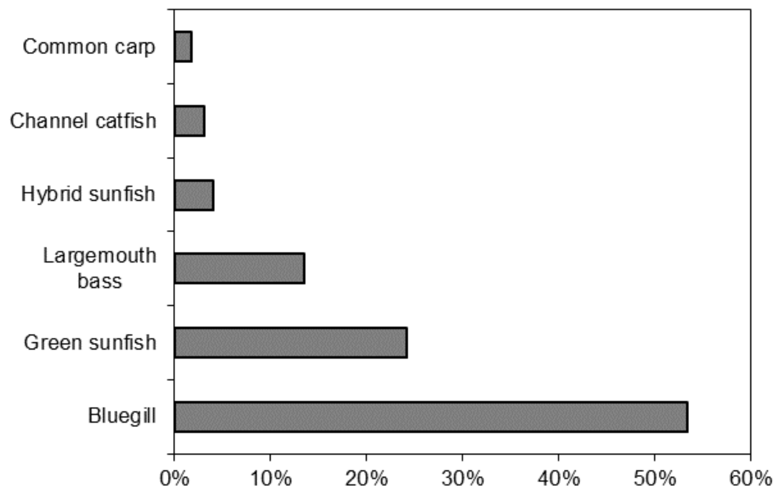


Figure 13. Relative abundance of species collected from Lake Noel, November 3, 2014.

*Bluegill*

Bluegill was the most abundant species collected (53.36%) and ranked third by weight (13.27%). Individuals ranged in size from less than 3.0 to 8.0 inches (Figure 14). Nearly 30% of bluegill collected were less than 3.0 inches, indicating moderate reproduction occurred in 2014. There was also a large number of quality bluegill collected. This led to a proportional stock density of 56, which is well above the desired range of 20-40 for bluegill (proportion of quality fish within a population, see Appendix A). Condition factors (measurement of overall plumpness) were slightly below average for most size ranges. Bluegill weights were also found to be below standard weights in most sizes collected (Figure 15).

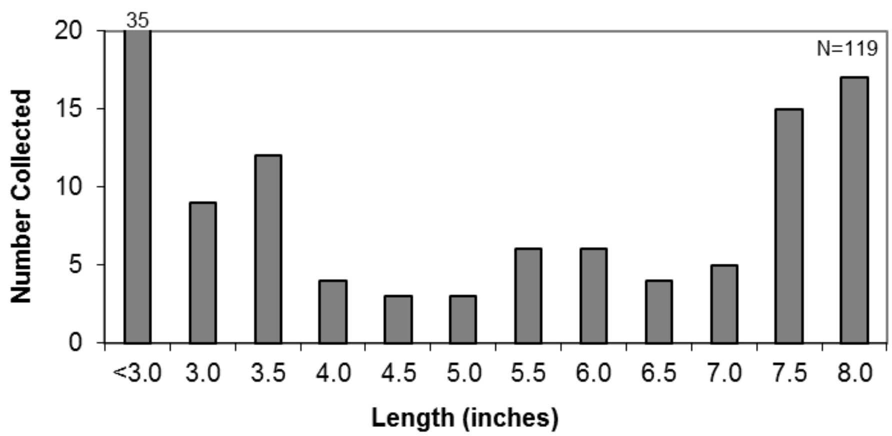


Figure 14. Length frequency distribution of bluegill collected from Lake Noel, November 3, 2014.

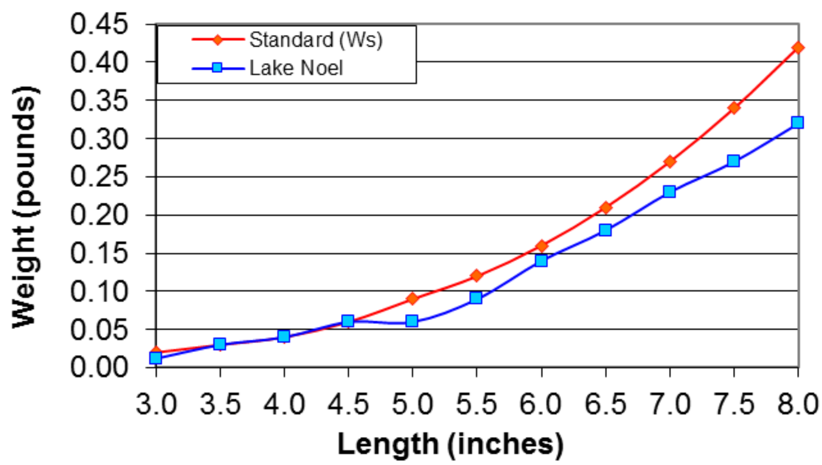


Figure 15. Comparison of Lake Noel bluegill weights to standard bluegill weights.

### *Green sunfish*

Green sunfish was the second most abundant species collected (24.22%) and ranked fifth by weight (5.36%). Green sunfish are undesirable due to their tendency to overpopulate and compete with bluegill for food resources. Green sunfish look superficially like bluegill. They can easily be distinguished by their larger mouths and more rounded pectoral fins. Figure 16 illustrates the differences in appearance between bluegill and green sunfish. Green sunfish should be removed when caught.

Figure 16. Photographic comparison of bluegill (top) and green sunfish (bottom), ***Lepomis cyanellus***.

### *Largemouth Bass*

Largemouth bass was the third most abundant species collected (13.45%) and ranked fourth by weight (12.31%). A total of 30 largemouth bass ranging in size from less than 5.5 to 12.0 inches was collected (Figure 17). Approximately 7% of largemouth bass collected were less than 7.5 inches indicating poor reproduction and recruitment has occurred in the past two years. Of the largemouth bass collected, nearly 83% were between 9.5 and 11.5 inches. This led to a PSD of 4 for largemouth bass, which is well below the desired range of 40-60. Condition factors (measurement of overall plumpness) were slightly below average for most size classes. The average weights for the bass were below average compared to standard weights for most sizes collected (Figure 18).

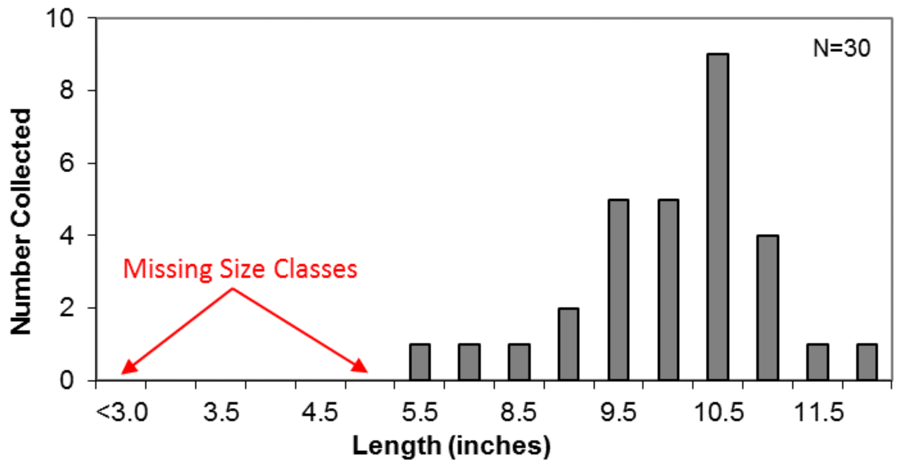


Figure 17. Length frequency distribution of largemouth bass collected from Lake Noel, November 3, 2014.

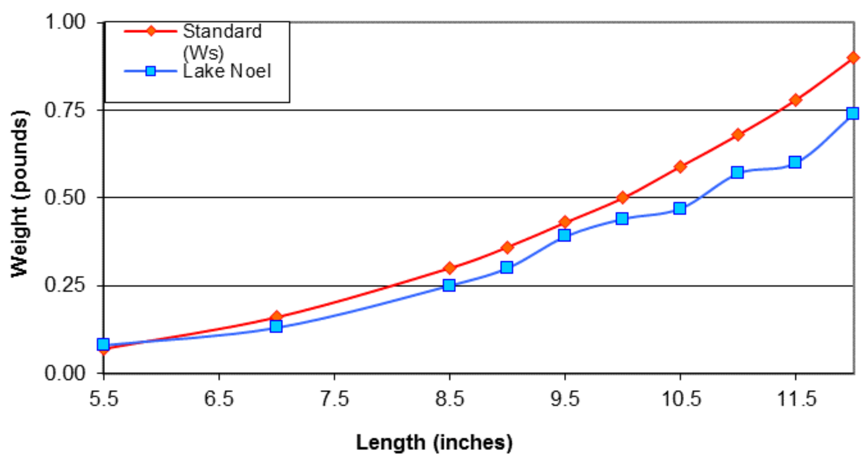


Figure 18. Comparison of Lake Noel largemouth bass weights to standard largemouth bass weights.

*Other species*

Nine hybrid sunfish (Figure 19) were collected while electrofishing. Hybrid sunfish are generally a cross between bluegill and green sunfish. Hybrid sunfish are often stocked because of their potential for large growth and their aggressiveness when caught by anglers. Bluegill and green sunfish are also very abundant in Lake Holly, and could have interbred, resulting in a small population of hybrid sunfish. Most hybrid sunfish are male and sterile, but some reproduction is possible. The offspring tend to revert to one of the parent fish, typically the green sunfish. Any hybrid sunfish that are caught should be harvested from the lake.

Figure 19. Photograph of hybrid sunfish, *Lepomis spp. X Lepomis spp.*

Seven channel catfish (Figure 20) were collected ranging in size from 19.5 to 25.0 inches. Channel catfish are typically not sampled well with electrofishing equipment. Young-of-the-year channel catfish are typically eliminated by largemouth bass and other predators leading to little or no recruitment into the population.

Figure 20. Photograph of channel catfish, *Ictalurus punctatus*.

Four common carp (Figure 21) were collected ranging in size from 26.0 to 30.0 inches (Appendix B). Numerically this species comprised only 1.79% of the sample; however, by weight, they accounted for 41.71% of the sample. Carp have the potential to disrupt a fishery by destroying bass and bluegill nests as well as increasing turbidity levels from their foraging habits. Currently this species is being controlled by predators and does not pose a serious threat to the fishery; however, all carp caught should be removed from the lake.


Figure 21. Photograph of common carp, *Cyrpinus carpio*.

## SUMMARY AND RECOMMENDATIONS

It appears that the fishery at Lake Noel is suffering from an imbalance in the fish population. Channel catfish typically do not sample well with electrofishing equipment; however, the catch rate was unusually high for this species. Correspondence has also shown that this lake has been heavily stocked with catfish in the past. Although this situation is not very common, it appears that overabundant catfish are putting high pressure on the bluegill population. With the lack of bluegill forage, largemouth bass turn to cannibalizing their young. This would explain the missing size classes of juvenile bass. Channel catfish harvest is encouraged and stocking should be discontinued until another survey is completed.

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

1. Harvest of channel catfish is heavily encouraged. No stocking of this species should occur until another survey is conducted.
2. Continue to enforce the 14.0 inch minimum length limit on largemouth bass.
3. Continue to limit bluegill harvest to 20 fish per angler per day in order to allow for an increase in numbers and forage for largemouth bass.
4. Restrict harvest of redear sunfish for the next two years. This species was not collected during the survey, and this should ensure that there is a viable population for the future.
5. Install artificial structure in the lake. This can consist of rock/brush piles, fall downs, Christmas trees, or man-made fish reefs.
6. Remove all green sunfish, hybrid sunfish, channel catfish, and common carp when caught.
7. No crappie were collected but the sign at the ramp indicates that they should be released when caught. There should be no harvest restrictions on this species, as this species competes with largemouth bass for food, and has the potential to overpopulate.
8. Conduct a Standard Fish Survey in 2017 in order to monitor the effects of the above recommendations and assess needs for further management activities.
9. Encourage residents to feel out Creel Survey forms. An example is located in Appendix C. This could be mailed out to residents or left in a box by the ramp for fishermen to fill out during their fishing trips.
10. Educate lake users of the dangers of bait bucket dumping into the lake. All unused bait should be disposed of in waste containers, not dumped into the lake. Do not allow gizzard shad to be used as bait. This will help keep the fish assemblage in proper balance and undesirable fish species will not be introduced to the lake.

## RESULTS AND DISCUSSION-Christmas Lake

WATER CHEMISTRY

The results of selected physio-chemical parameters from Christmas Lake are presented in Table 5. Christmas Lake was measured at 196.0 surface acres and had a maximum depth of 21.0 feet at the time of the survey. Water temperatures ranged from 57.1 degrees

Fahrenheit at the surface to 55.7 degrees Fahrenheit at the bottom. Dissolved oxygen ranged from 9.60 ppm at the surface to 8.91 ppm at the bottom (Figure 22). A desirable oxygen level for maintenance of healthy stress free fish was present throughout the water column. These numbers indicate Christmas Lake was de-stratified at the time of the survey. The alkalinity level was 85.5 ppm at the surface and at the bottom. The hardness level was 85.5 ppm at the surface and at the bottom. The pH was 7.25 at the surface and 7.14 on the bottom. These numbers are normal for lakes in this area and indicate the lake is capable of good fish production. The Secchi disk depth was measured at 5.5 feet. Nitrate-nitrogen levels were 0.1 ppm at the surface and 0.2 ppm on the bottom. Ortho-phosphate levels were 0.01 ppm at the surface and on the bottom. Christmas Lake appears to have water quality which is capable of supporting a healthy fish population.

**Table 5. Selected water quality parameters measured on Christmas Lake, November 3, 2014.**

| Sample Depth (ft.) | Temp. (°F) | Dissolved Oxygen (ppm) | pH (standard units) | Total Alkalinity (ppm) | Total Hardness (ppm) | Nitrate/ Nitrogen (ppm) | Ortho phosphate (ppm) | Total phosphorus (ppm) |
|---|---|---|---|---|---|---|---|---|
| Surface | 57.10 | 9.60 | 7.25 | 85.5 | 85.5 | 0.10 | 0.01 | 0.63 |
| 3 | 56.80 | 9.62 | - | - | - | - | - | - |
| 6 | 56.60 | 9.60 | - | - | - | - | - | - |
| 9 | 56.50 | 9.51 | - | - | - | - | - | - |
| 12 | 56.30 | 9.57 | - | - | - | - | - | - |
| 15 | 56.00 | 9.30 | - | - | - | - | - | - |
| 18 | 55.90 | 9.21 | - | - | - | - | - | - |
| 21 | 55.70 | 8.91 | 7.38 | 85.5 | 85.5 | 0.20 | 0.01 | 0.51 |

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

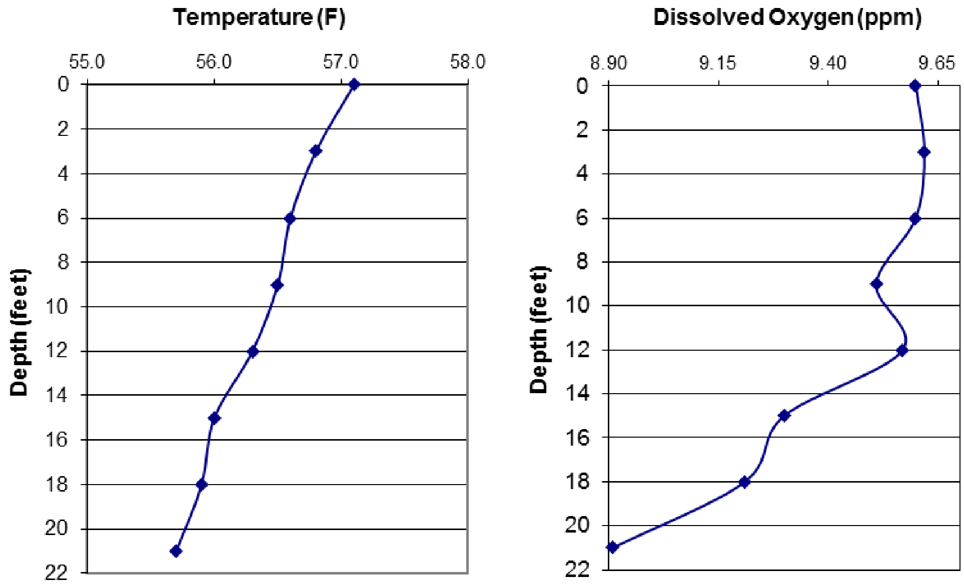


Figure 22. Temperature and dissolved oxygen profiles for Christmas Lake, November 3, 2014.

FISH COLLECTION

A total of 1205 fish weighing 233.01 pounds and representing twelve species was collected from Christmas Lake (Table 6 & Figure 23). Bluegill *Lepomis macrochirus* was the most abundant species comprising 43.24% of the fish collected. Gizzard shad *Dorosoma cepedianum* was the second most abundant species (14.19%), followed by largemouth bass *Micropterus salmoides* (9.71%), bluntnose minnow *Pimephales notatus* (6.89%), warmouth *Lepomis gulosus* (7.14%), longear sunfish *Lepomis megalotis* (6.06%), black crappie *Pomoxis nigromaculatus* (3.65%), redear sunfish *Lepomis microlophus* (3.49%), yellow perch *Perca flavescens* (2.66%), green sunfish *Lepomis cyanellus* (2.32%), common carp *Cyprinus carpio* (0.41%), and yellow bullhead *Ameiurus natalis* (0.25%). Bigmouth buffalo, channel catfish, hybrid striped bass, hybrid sunfish, and white crappie were collected in past surveys, but were not represented in this survey. All of these species are desirable in a lake of this size with the exception of gizzard shad, warmouth, longear sunfish, green sunfish, common carp, and yellow bullhead.

**Table 6. Species collected from Christmas Lake, November 3, 2014.**

| Species | N | % N | Size Range (in) | Total Weight (lbs.) | % Wt | N/hr. |
|---|---|---|---|---|---|---|
| Bluegill | 521 | 43.24 | <3-9.0 | 37.35 | 16.03 | 208 |
| Gizzard shad | 171 | 14.19 | <3-15.0 | 24.08 | 10.33 | 68 |
| Largemouth bass | 117 | 9.71 | 3.5-21.5 | 100.09 | 42.96 | 47 |
| Warmouth | 86 | 7.14 | <3-9.5 | 3.94 | 1.69 | 34 |
| Bluntnose minnow | 83 | 6.89 | <3-3.5 | 0.83 | 0.36 | 33 |
| Longear sunfish | 73 | 6.06 | <3-6.5 | 3.55 | 1.52 | 29 |
| Black crappie | 44 | 3.65 | <3-12.0 | 4.54 | 1.95 | 18 |
| Redear sunfish | 42 | 3.49 | <3-9.5 | 9.86 | 4.23 | 17 |
| Yellow perch | 32 | 2.66 | <3-3.5 | 0.32 | 0.14 | 13 |
| Green sunfish | 28 | 2.32 | 3.0-7.5 | 4.45 | 1.91 | 11 |
| Common carp | 5 | 0.41 | 21.0-28.5 | 42.19 | 18.11 | 2 |
| Yellow bullhead | 3 | 0.25 | 6.0-12.0 | 1.81 | 0.78 | 1 |
| Total | 1205 | 100.00 | | 233.01 | 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)

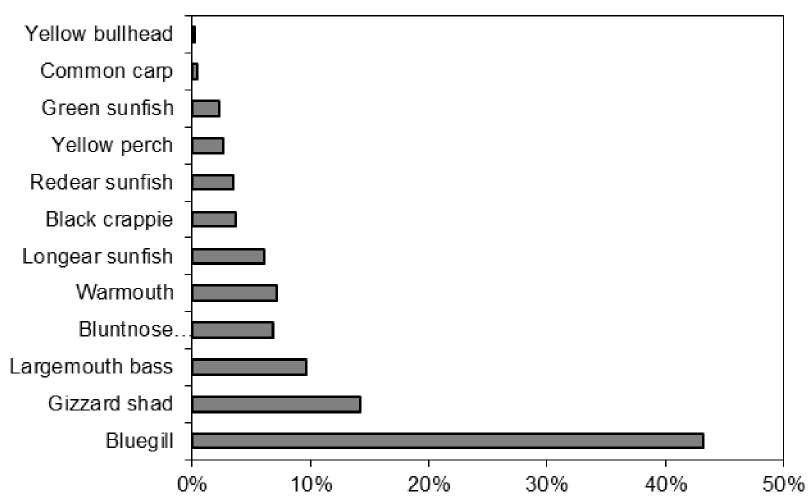


Figure 23. Relative abundance of species collected from Christmas Lake, November 3, 2014.

*Bluegill*

Bluegill was the most abundant species collected (43.24%) and ranked third by weight (16.03%). Individuals ranged in size from less than 3.0 to 9.0 inches (Figure 24). Nearly 26% of bluegill collected were less than 3.0 inches, indicating moderate reproduction occurred in 2014. There was also a large number of quality bluegill collected. This led to a proportional stock density of 33, which is within the desired range of 20-40 for bluegill (proportion of quality fish within a population, see Appendix A). Condition factors (measurement of overall plumpness) were below average for most size ranges. Bluegill weights were also found to be below standard weights in most sizes collected (Figure 25).

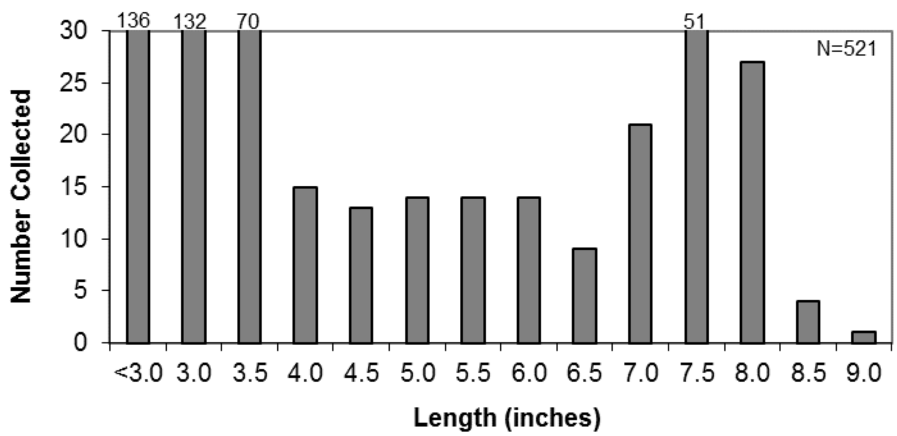


Figure 24. Length frequency distribution of bluegill collected from Christmas Lake, November 3, 2014.

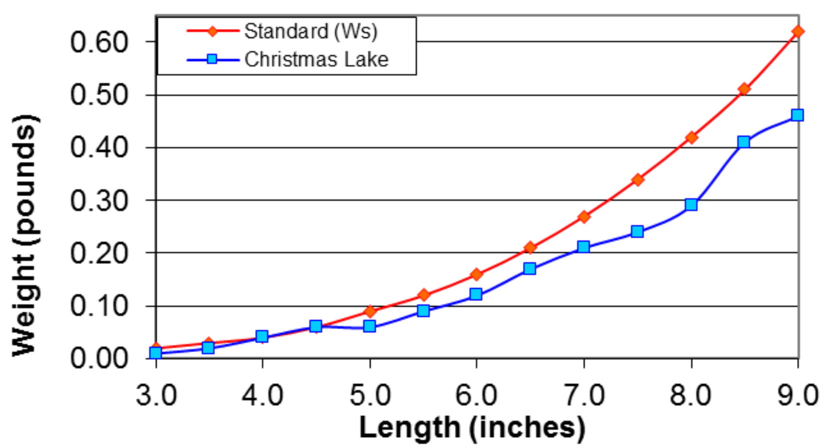


Figure 25. Comparison of Christmas Lake bluegill weights to standard bluegill weights.

*Gizzard shad*

Gizzard shad (Figure 26) was the second most abundant species collected (14.19%), and ranked fourth by weight (10.33%). A total of 171 gizzard shad ranging in size from less than 3.0 to 15.0 inches was collected (Figure 27). Gizzard shad grow quickly, and often reach sizes too large for largemouth bass to prey upon. Also, small gizzard shad compete with desirable species for food. A large abundance of young-of-the-year gizzard shad were present and indicates largemouth bass and other predators are currently not able to keep the population in check. Hybrid striped bass should be stocked again. This species feeds very efficiently on shad.


Figure 26. Photograph of gizzard shad, *Dorosoma cepedianum*.

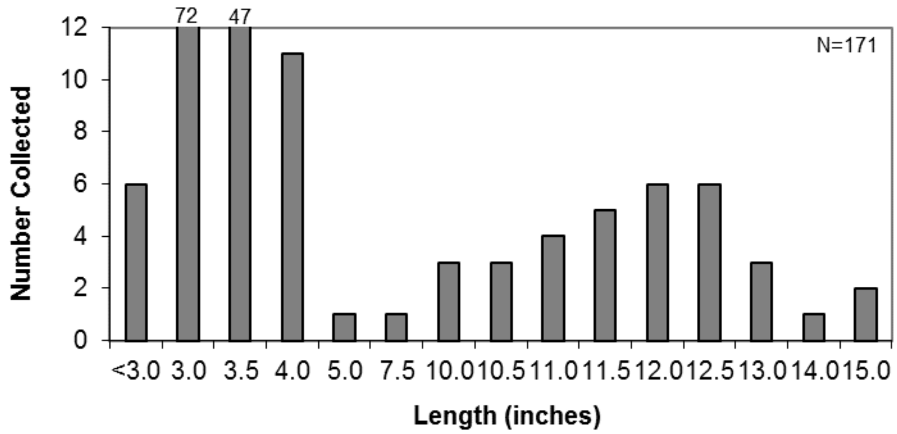


Figure 27. Length frequency distribution of gizzard shad collected from Christmas Lake, November 3, 2014.

*Largemouth Bass*

Largemouth bass was the third most abundant species collected (9.71%) and ranked first by weight (42.96%). A total of 117 largemouth bass ranging in size from less than 3.5 to 21.5 inches was collected (Figure 28). Approximately 33% of largemouth bass collected were less than 7.5 inches indicating good reproduction and recruitment has occurred in the past two years. Of the largemouth bass collected, nearly 39% were between 10.0 and 14.0 inches. This led to a PSD of 76 for largemouth bass, which is well above the desired range of 40-60. Condition factors (measurement of overall plumpness) were normal for most size classes. The average weights for the bass were also good compared to standard weights for most sizes collected (Figure 29).

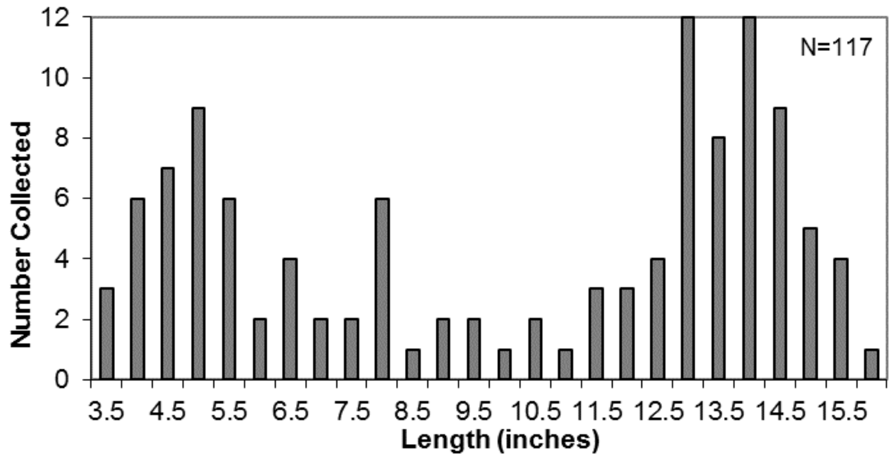


Figure 28. Length frequency distribution of largemouth bass collected from Christmas Lake, November 3, 2014.

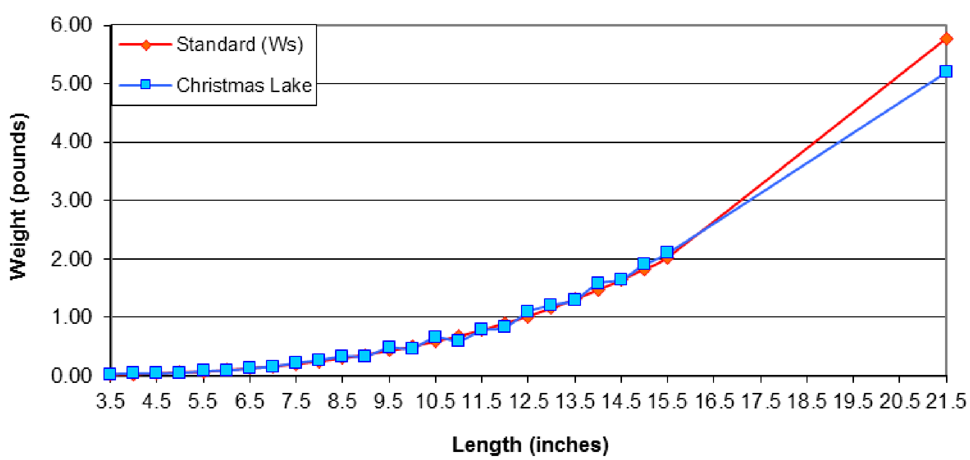


Figure 29. Comparison of Christmas Lake largemouth bass weights to standard largemouth bass weights.

*Warmouth*

Warmouth was the fourth most abundant species collected (7.14%) and ranked eighth by weight (5.14%). They ranged in size from less than 3.0 to 9.5 inches. Warmouth that are caught should be removed from the lake.

*Bluntnose minnnow*

Bluntnose minnow (Figure 30) was the fifth most abundant species collected (6.89%) and ranked eleventh by weight (0.36%). This species likely provides another forage fish for largemouth bass and other predators.


Figure 30. Photograph of bluntnose minnow, ***Pimephales notatus.***

*Longear sunfish*

Longear sunfish (Figure 31) was the sixth most abundant species collected (6.06%) and ranked ninth by weight (1.52%). Longear sunfish, like green sunfish, are undesirable due to their potential to compete with bluegill for food resources and habitat. This species should be removed when caught.

Figure 31. Photograph of longear sunfish, ***Lepomis megalotis***.

*Black crappie*

Black crappie was the seventh most abundant species collected (3.65%) and ranked sixth by weight (1.95%). They ranged in size from less than 3.0 to 12.0 inches. The crappie population is most likely higher than indicated by the survey.

*Redear sunfish*

Redear sunfish was the eighth most abundant species collected (3.49%), and ranked fifth by weight (4.23%). A total of 42 redear sunfish ranging in size from less than 3.0 to 9.5 inches was collected. Due to their slower reproductive potential and very small population, this species should be protected with more restrictive bag limits.

*Other species*

Thirty-two yellow perch (Figure 32) ranging in size from 3.0 to 3.5 inches were collected during the survey. Yellow perch likely provide another forage fish for predatory species. This species may also provide an additional angling opportunity in the lake.

Twenty-eight green sunfish were collected while sampling. Green sunfish compete with bluegill for habitat and food resources, and should be removed when caught.

Five common carp were collected ranging in size from 21.0 to 28.5 inches. Carp have destructive tendencies and should be removed if possible.

Three yellow bullhead (Figure 33) were collected while electrofishing. Bullheads are considered undesirable and compete with desirable species for food resources. This species isn't usually considered an important game fish. They don't reach sizes comparable to channel catfish, and most anglers don't find them very palatable. All bullheads that are caught should continue to be removed from the lake.


Figure 32. Photograph of yellow perch, *Perca flavescens*.


Figure 33. Photograph of yellow bullhead, *Ameiurus natalis*.

## SUMMARY AND RECOMMENDATIONS

Christmas Lake should provide excellent fishing for quality bluegill, largemouth bass, and redear sunfish. The bluegill population, despite the very abundant gizzard shad population, has not become overabundant and slow-growing. Harvest of bluegill is necessary and should keep numbers in check and growth rates good. The largemouth bass population does have a good number of large fish, but recruitment seems to be suffering, which is probably due to gizzard shad abundance. It appears that largemouth bass and other predator species are not currently able to keep gizzard shad number in check. Hybrid striped bass should be stocked again to aide in gizzard shad reduction.

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

1. Implement an 18.0 inch minimum length limit on largemouth bass. This will help keep pressure on the gizzard shad population and help aide in recruitment.
2. Stock 1,000 5.0 to 7.0 inch hybrid striped bass in the spring of 2015. The lifespan of the hybrid striped bass is 5-7 years, so they will need to be replaced. This stocking is essential to keeping gizzard shad under control.
3. No harvest restrictions are necessary on bluegill. Harvest is encouraged to try and keep the population from becoming overabundant and slow-growing. This is common in gizzard shad lakes.
4. Continue to limit redear sunfish harvest to 20 fish per angler per day for the next two years.
5. Install artificial structure in the lake. This can consist of rock/brush piles, fall downs, Christmas trees, or man-made fish reefs.
6. Remove all warmouth, longear sunfish, green sunfish, common carp, and yellow bullhead when caught. Harvesting will help aide in maintaining the populations of these species.
7. No restrictions are needed for harvest of crappie. Crappie are prolific spawners and can maintain their own population without harvest restrictions.
8. Conduct a Standard Fish Survey in 2017 in order to monitor the effects of the above recommendations and assess needs for further management activities.

9. Encourage residents to feel out Creel Survey forms. An example is located in Appendix C. This could be mailed out to residents or left in a box by the ramp for fishermen to fill out during their fishing trips.
10. Educate lake users of the dangers of bait bucket dumping into the lake. All unused bait should be disposed of in waste containers, not dumped into the lake. Do not allow gizzard shad to be used as bait. This will help keep the fish assemblage in proper balance and undesirable fish species will not be introduced to the lake.

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Jimmy Ferguson, Aquatic Biologist

# APPENDIX A

## GENERAL INFORMATION

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

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

1. Epilimnion (upper warm layer) - this is, generally speaking, confined to the top 10 ft. to 15 ft. of the lake volume. This is a warm region, mixed thoroughly by wind to a more or less uniform temperature. It is also the zone of most photosynthetic production and is usually high in dissolved oxygen.

2. Thermocline or Metalimnion (middle layer of rapidly changing temperature) this layer is the area in the lake where temperature decreases rapidly, usually about 1 degree centigrade or more per meter (or approximately 3 ft.). Oxygen depletion generally begins in this layer.

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

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

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

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

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

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

## EQUIPMENT AND METHODS

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

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 6500 watt portable generator and a boom mounted electrosphere designed by Coffelt Manufacturing. The electrosphere allows the use of higher voltages at lower amperage. This has proven to improve the efficiency of the electrofishing technique with lower damage to captured fish. The electrofisher was operated in the pulsed DC mode using an output level of 400 to 750 volts. The increased effectiveness of this electrofishing system makes fish of all species, including channel catfish, more vulnerable to capture. This results in a better sampling of all fish species with a higher capture rate of the more vulnerable species (bass, bluegill, redear, and green sunfish) in the samples taken. All fish collected were placed in water filled containers aboard the sampling boat for processing. A sub-sample of up to five specimens from each species was taken in each one-half inch group. The individual fish in these sub samples were weighed to the nearest hundredth pound for average weight determinations. Additional specimens were recorded by length group.

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

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

1. Reasonably high numbers of bluegill smaller than 2.5 inches (young-of-the-year)
2. Proportional Stock Density index of 20 - 40 for bluegill.
3. Bluegill growth which results in a length of 6.0 inches by age III or IV, with low numbers of age V or older fish.
4. Proportional Stock Density index of 40 - 60 for largemouth bass.
5. A minimum of 20 adult bass per acre.
6. A maximum of 50% annual mortality (harvest) of bass in age II - V.
7. Growth rate that results in 8 inch bass reaching quality size (12 inch plus) in approximately 1 year.
8. No missing year classes in ages 0 - V.
9. A maximum of 10% of the lake bottom covered by dense weed beds.

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

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# Appendix B

## Fish Collection Tables

### Lake Holly

| SIZE GROUP (IN) | NUMBER | PERCENTAGE | AVERAGE WEIGHT (lbs.) | TOTAL WEIGHT (lbs.) | CONDITION FACTOR | WS | RELATIVE WEIGHT |
|---|---|---|---|---|---|---|---|
| **BLUEGILL** | | | | | | | |
| <3.0 | 38 | 37.25% | 0.01 | 0.38 | - | - | - |
| 3.0 | 20 | 19.61% | 0.01 | 0.20 | 3.70 | 0.02 | 61 |
| 3.5 | 10 | 9.80% | 0.02 | 0.22 | 5.13 | 0.03 | 81 |
| 4.0 | 6 | 5.88% | 0.04 | 0.23 | 5.94 | 0.04 | 90 |
| 4.5 | 6 | 5.88% | 0.05 | 0.31 | 5.71 | 0.06 | 83 |
| 5.0 | 2 | 1.96% | 0.08 | 0.16 | 6.40 | 0.09 | 90 |
| 5.5 | 1 | 0.98% | 0.10 | 0.10 | 6.01 | 0.12 | 82 |
| 6.0 | 2 | 1.96% | 0.13 | 0.26 | 6.02 | 0.16 | 80 |
| 7.0 | 1 | 0.98% | 0.20 | 0.20 | 5.83 | 0.27 | 74 |
| 7.5 | 1 | 0.98% | 0.26 | 0.26 | 6.16 | 0.34 | 77 |
| 8.0 | 10 | 9.80% | 0.32 | 3.20 | 6.25 | 0.42 | 76 |
| 8.5 | 3 | 2.94% | 0.40 | 1.20 | 6.51 | 0.51 | 78 |
| 9.0 | 2 | 1.96% | 0.50 | 1.00 | 6.86 | 0.62 | 80 |
| TOTAL | 102 | | | 7.72 | | | |
| **LARGEMOUTH BASS** | | | | | | | |
| 3.5 | 1 | 1.47% | 0.01 | 0.01 | 2.33 | 0.02 | - |
| 4.0 | 2 | 2.94% | 0.04 | 0.08 | 6.25 | 0.03 | - |
| 4.5 | 5 | 7.35% | 0.04 | 0.20 | 4.39 | 0.04 | - |
| 5.0 | 3 | 4.41% | 0.05 | 0.15 | 4.00 | 0.06 | - |
| 5.5 | 1 | 1.47% | 0.06 | 0.06 | 3.61 | 0.07 | - |
| 6.0 | 2 | 2.94% | 0.09 | 0.18 | 4.17 | 0.10 | - |
| 6.5 | 2 | 2.94% | 0.11 | 0.22 | 4.01 | 0.13 | - |
| 7.0 | 1 | 1.47% | 0.15 | 0.15 | 4.37 | 0.16 | - |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 8.0 | 6 | 8.82% | 0.21 | 1.26 | 4.10 | 0.25 | - |
| 8.5 | 4 | 5.88% | 0.25 | 1.00 | 0.00 | 0.30 | 84 |
| 9.0 | 8 | 11.76% | 0.30 | 2.40 | 0.00 | 0.36 | 84 |
| 9.5 | 1 | 1.47% | 0.35 | 0.35 | 4.08 | 0.43 | 82 |
| 10.5 | 5 | 7.35% | 0.47 | 2.35 | 4.06 | 0.59 | 80 |
| 11.0 | 9 | 13.24% | 0.58 | 5.22 | 4.36 | 0.68 | 85 |
| 11.5 | 4 | 5.88% | 0.64 | 2.56 | 4.21 | 0.78 | 82 |
| 12.0 | 6 | 8.82% | 0.73 | 4.38 | 4.22 | 0.90 | 81 |
| 12.5 | 2 | 2.94% | 0.77 | 1.54 | 3.94 | 1.02 | 75 |
| 13.0 | 2 | 2.94% | 1.06 | 2.12 | 4.82 | 1.16 | 91 |
| 13.5 | 1 | 1.47% | 1.14 | 1.14 | 4.63 | 1.31 | 87 |
| 14.0 | 1 | 1.47% | 1.09 | 1.09 | 3.97 | 1.47 | 74 |
| 14.5 | 1 | 1.47% | 1.14 | 1.14 | 3.74 | 1.64 | 69 |
| 18.0 | 1 | 1.47% | 2.80 | 2.80 | 4.80 | 3.28 | 85 |
| TOTAL | 68 | | | 30.40 | | | |

**REDEAR SUNFISH**

| | | | | |
|---|---|---|---|---|
| <3.0 | 2 | 5.26% | 0.01 | 0.02 |
| 3.5 | 1 | 2.63% | 0.02 | 0.02 |
| 5.0 | 3 | 7.89% | 0.09 | 0.27 |
| 5.5 | 2 | 5.26% | 0.09 | 0.18 |
| 6.0 | 2 | 5.26% | 0.11 | 0.22 |
| 7.0 | 1 | 2.63% | 0.24 | 0.24 |
| 7.5 | 2 | 5.26% | 0.28 | 0.56 |
| 8.0 | 3 | 7.89% | 0.32 | 0.96 |
| 8.5 | 7 | 18.42% | 0.40 | 2.80 |
| 9.0 | 4 | 10.53% | 0.46 | 1.84 |
| 9.5 | 6 | 15.79% | 0.57 | 3.42 |
| 10.0 | 4 | 10.53% | 0.63 | 2.52 |
| 10.5 | 1 | 2.63% | 0.70 | 0.70 |
| | 38 | | | 13.75 |

**WARMOUTH**

| | | | | |
|---|---|---|---|---|
| <3.0 | 3 | 13.64% | 0.01 | 0.03 |
| 3.0 | 1 | 4.55% | 0.01 | 0.01 |
| 3.5 | 2 | 9.09% | 0.02 | 0.04 |
| 4.0 | 3 | 13.64% | 0.05 | 0.14 |
| 5.0 | 1 | 4.55% | 0.09 | 0.09 |
| 5.5 | 3 | 13.64% | 0.12 | 0.36 |
| 6.0 | 3 | 13.64% | 0.15 | 0.45 |
| 6.5 | 2 | 9.09% | 0.22 | 0.44 |
| 7.0 | 1 | 4.55% | 0.24 | 0.24 |
| 7.5 | 2 | 9.09% | 0.32 | 0.64 |
| 8.0 | 1 | 4.55% | 0.41 | 0.41 |
| TOTAL | 22 | | | 2.85 |

**BLACK CRAPPIE**

| | | | | |
|---|---|---|---|---|
| 11.0 | 1 | 100.00% | 0.76 | 0.76 |
| TOTAL | 1 | | | 0.76 |

# Lake Noel

| SIZE GROUP (IN) | NUMBER | PERCENTAGE | AVERAGE WEIGHT (lbs.) | TOTAL WEIGHT (lbs.) | CONDITION FACTOR | WS | RELATIVE WEIGHT |
|---|---|---|---|---|---|---|---|
| **BLUEGILL** | | | | | | | |
| <3.0 | 35 | 29.41% | 0.01 | 0.35 | - | - | - |
| 3.0 | 9 | 7.56% | 0.01 | 0.11 | 4.44 | 0.02 | 74 |
| 3.5 | 12 | 10.08% | 0.03 | 0.36 | 7.00 | 0.03 | 111 |
| 4.0 | 4 | 3.36% | 0.04 | 0.16 | 6.25 | 0.04 | 95 |
| 4.5 | 3 | 2.52% | 0.06 | 0.18 | 6.58 | 0.06 | 96 |
| 5.0 | 3 | 2.52% | 0.06 | 0.18 | 4.80 | 0.09 | 68 |
| 5.5 | 6 | 5.04% | 0.09 | 0.54 | 5.41 | 0.12 | 74 |
| 6.0 | 6 | 5.04% | 0.14 | 0.84 | 6.48 | 0.16 | 86 |
| 6.5 | 4 | 3.36% | 0.18 | 0.72 | 6.55 | 0.21 | 85 |
| 7.0 | 5 | 4.20% | 0.23 | 1.15 | 6.71 | 0.27 | 85 |
| 7.5 | 15 | 12.61% | 0.27 | 4.05 | 6.40 | 0.34 | 80 |
| 8.0 | 17 | 14.29% | 0.32 | 5.44 | 6.25 | 0.42 | 76 |
| TOTAL | 119 | | | 14.08 | | | |
| **GREEN SUNFISH** | | | | | | | |
| <3.0 | 4 | 7.41% | 0.01 | 0.04 | | | |
| 3.0 | 3 | 5.56% | 0.02 | 0.06 | | | |
| 3.5 | 6 | 11.11% | 0.04 | 0.24 | | | |
| 4.0 | 6 | 11.11% | 0.05 | 0.30 | | | |
| 4.5 | 3 | 5.56% | 0.06 | 0.18 | | | |
| 5.0 | 7 | 12.96% | 0.08 | 0.56 | | | |
| 5.5 | 3 | 5.56% | 0.10 | 0.30 | | | |
| 6.0 | 8 | 14.81% | 0.14 | 1.12 | | | |
| 6.5 | 6 | 11.11% | 0.17 | 1.02 | | | |
| 7.0 | 7 | 12.96% | 0.22 | 1.54 | | | |
| 8.0 | 1 | 1.85% | 0.33 | 0.33 | | | |
| | 54 | | | 5.69 | | | |
| **LARGEMOUTH BASS** | | | | | | | |
| <3.0 | 0 | 0.00% | 0.00 | 0.00 | - | - | - |
| 3.0 | 0 | 0.00% | 0.00 | 0.00 | - | - | - |
| 3.5 | 0 | 0.00% | 0.00 | 0.00 | - | - | - |
| 4.0 | 0 | 0.00% | 0.00 | 0.00 | - | - | - |
| 4.5 | 0 | 0.00% | 0.00 | 0.00 | - | - | - |
| 5.0 | 0 | 0.00% | 0.00 | 0.00 | - | - | - |
| 5.5 | 1 | 3.33% | 0.08 | 0.08 | 4.81 | 0.07 | - |
| 7.0 | 1 | 3.33% | 0.13 | 0.13 | 3.79 | 0.16 | - |
| 8.5 | 1 | 3.33% | 0.25 | 0.25 | 0.00 | 0.30 | 84 |
| 9.0 | 2 | 6.67% | 0.30 | 0.60 | 4.12 | 0.36 | 84 |
| 9.5 | 5 | 16.67% | 0.39 | 1.95 | 4.55 | 0.43 | 91 |
| 10.0 | 5 | 16.67% | 0.44 | 2.20 | 4.40 | 0.50 | 88 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 10.5 | 9 | 30.00% | 0.47 | 4.23 | 4.06 | 0.59 | 80 |
| 11.0 | 4 | 13.33% | 0.57 | 2.28 | 4.28 | 0.68 | 84 |
| 11.5 | 1 | 3.33% | 0.60 | 0.60 | 3.95 | 0.78 | 76 |
| 12.0 | 1 | 3.33% | 0.74 | 0.74 | 4.28 | 0.90 | 82 |
| TOTAL | 30 | | | 13.06 | | | |

**HYBRID SUNFISH**

| | | | | |
|---|---|---|---|---|
| 5.0 | 1 | 11.11% | 0.07 | 0.07 |
| 6.0 | 1 | 11.11% | 0.15 | 0.15 |
| 7.0 | 1 | 11.11% | 0.26 | 0.26 |
| 7.5 | 2 | 22.22% | 0.29 | 0.58 |
| 8.0 | 2 | 22.22% | 0.36 | 0.72 |
| 8.5 | 2 | 22.22% | 0.44 | 0.88 |
| TOTAL | 9 | | | 2.66 |

**CHANNEL CATFISH**

| | | | | |
|---|---|---|---|---|
| 19.5 | 1 | 14.29% | 2.61 | 2.61 |
| 20.0 | 2 | 28.57% | 2.98 | 5.95 |
| 22.0 | 1 | 14.29% | 3.60 | 3.60 |
| 22.5 | 1 | 14.29% | 3.89 | 3.89 |
| 23.0 | 1 | 14.29% | 4.35 | 4.35 |
| 25.0 | 1 | 14.29% | 5.94 | 5.94 |
| TOTAL | 7 | | | 26.34 |

**COMMON CARP**

| | | | | |
|---|---|---|---|---|
| 26.0 | 1 | 25.00% | 8.81 | 8.81 |
| 27.0 | 1 | 25.00% | 10.44 | 10.44 |
| 27.5 | 1 | 25.00% | 10.69 | 10.69 |
| 30.0 | 1 | 25.00% | 14.31 | 14.31 |
| TOTAL | 4 | | | 44.25 |

## Christmas Lake

| SIZE GROUP (IN) | NUMBER | PERCENTAGE | AVERAGE WEIGHT (lbs.) | TOTAL WEIGHT (lbs.) | CONDITION FACTOR | WS | RELATIVE WEIGHT |
|---|---|---|---|---|---|---|---|
| **BLUEGILL** | | | | | | | |
| <3.0 | 136 | 26.10% | 0.01 | 1.36 | - | - | - |
| 3.0 | 132 | 25.34% | 0.01 | 1.32 | 3.70 | 0.02 | 61 |
| 3.5 | 70 | 13.44% | 0.02 | 1.40 | 4.66 | 0.03 | 74 |
| 4.0 | 15 | 2.88% | 0.04 | 0.60 | 6.25 | 0.04 | 95 |
| 4.5 | 13 | 2.50% | 0.06 | 0.78 | 6.58 | 0.06 | 96 |
| 5.0 | 14 | 2.69% | 0.06 | 0.84 | 4.80 | 0.09 | 68 |
| 5.5 | 14 | 2.69% | 0.09 | 1.26 | 5.41 | 0.12 | 74 |
| 6.0 | 14 | 2.69% | 0.12 | 1.68 | 5.56 | 0.16 | 74 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 6.5 | 9 | 1.73% | 0.17 | 1.53 | 6.19 | 0.21 | 81 |
| 7.0 | 21 | 4.03% | 0.21 | 4.41 | 6.12 | 0.27 | 78 |
| 7.5 | 51 | 9.79% | 0.24 | 12.24 | 5.69 | 0.34 | 71 |
| 8.0 | 27 | 5.18% | 0.29 | 7.83 | 5.66 | 0.42 | 69 |
| 8.5 | 4 | 0.77% | 0.41 | 1.64 | 6.68 | 0.51 | 80 |
| 9.0 | 1 | 0.19% | 0.46 | 0.46 | 6.31 | 0.62 | 74 |
| TOTAL | 521 | | | 37.35 | | | |

**GIZZARD SHAD**

| | | | | |
|---|---|---|---|---|
| <3.0 | 6 | 3.51% | 0.01 | 0.06 |
| 3.0 | 72 | 42.11% | 0.01 | 0.72 |
| 3.5 | 47 | 27.49% | 0.01 | 0.47 |
| 4.0 | 11 | 6.43% | 0.02 | 0.22 |
| 5.0 | 1 | 0.58% | 0.04 | 0.04 |
| 7.5 | 1 | 0.58% | 0.11 | 0.11 |
| 10.0 | 3 | 1.75% | 0.35 | 1.05 |
| 10.5 | 3 | 1.75% | 0.35 | 1.05 |
| 11.0 | 4 | 2.34% | 0.54 | 2.16 |
| 11.5 | 5 | 2.92% | 0.57 | 2.85 |
| 12.0 | 6 | 3.51% | 0.75 | 4.50 |
| 12.5 | 6 | 3.51% | 0.81 | 4.86 |
| 13.0 | 3 | 1.75% | 0.91 | 2.73 |
| 14.0 | 1 | 0.58% | 1.00 | 1.00 |
| 15.0 | 2 | 1.17% | 1.13 | 2.26 |
| | 171 | | | 24.08 |

**LARGEMOUTH BASS**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 3.5 | 3 | 2.56% | 0.03 | 0.09 | 7.00 | 0.02 | - |
| 4.0 | 6 | 5.13% | 0.04 | 0.24 | 6.25 | 0.03 | - |
| 4.5 | 7 | 5.98% | 0.04 | 0.28 | 4.39 | 0.04 | - |
| 5.0 | 9 | 7.69% | 0.05 | 0.45 | 4.00 | 0.06 | - |
| 5.5 | 6 | 5.13% | 0.08 | 0.48 | 4.81 | 0.07 | - |
| 6.0 | 2 | 1.71% | 0.09 | 0.18 | 4.17 | 0.10 | - |
| 6.5 | 4 | 3.42% | 0.13 | 0.52 | 4.73 | 0.13 | - |
| 7.0 | 2 | 1.71% | 0.16 | 0.32 | 4.66 | 0.16 | - |
| 7.5 | 2 | 1.71% | 0.22 | 0.44 | 5.21 | 0.20 | - |
| 8.0 | 6 | 5.13% | 0.27 | 1.62 | 0.00 | 0.25 | 110 |
| 8.5 | 1 | 0.85% | 0.33 | 0.33 | 0.00 | 0.30 | 110 |
| 9.0 | 2 | 1.71% | 0.34 | 0.68 | 4.66 | 0.36 | 95 |
| 9.5 | 2 | 1.71% | 0.48 | 0.96 | 5.60 | 0.43 | 113 |
| 10.0 | 1 | 0.85% | 0.47 | 0.47 | 4.70 | 0.50 | 94 |
| 10.5 | 2 | 1.71% | 0.66 | 1.32 | 5.70 | 0.59 | 112 |
| 11.0 | 1 | 0.85% | 0.60 | 0.60 | 4.51 | 0.68 | 88 |
| 11.5 | 3 | 2.56% | 0.78 | 2.34 | 5.13 | 0.78 | 99 |
| 12.0 | 3 | 2.56% | 0.83 | 2.49 | 4.80 | 0.90 | 92 |
| 12.5 | 4 | 3.42% | 1.10 | 4.40 | 5.63 | 1.02 | 107 |
| 13.0 | 12 | 10.26% | 1.21 | 14.52 | 5.51 | 1.16 | 104 |
| 13.5 | 8 | 6.84% | 1.30 | 10.40 | 5.28 | 1.31 | 99 |
| 14.0 | 12 | 10.26% | 1.58 | 18.96 | 5.76 | 1.47 | 107 |
| 14.5 | 9 | 7.69% | 1.65 | 14.85 | 5.41 | 1.64 | 100 |
| 15.0 | 5 | 4.27% | 1.91 | 9.55 | 5.66 | 1.83 | 104 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 15.5 | 4 | 3.42% | 2.10 | 8.40 | 5.64 | 2.03 | 103 |
| 21.5 | 1 | 0.85% | 5.20 | 5.20 | 5.23 | 5.78 | 90 |
| TOTAL | 117 | | | 100.09 | | | |

**WARMOUTH**

| | | | | |
|---|---|---|---|---|
| <3.0 | 6 | 6.98% | 0.01 | 0.06 |
| 3.0 | 11 | 12.79% | 0.02 | 0.22 |
| 3.5 | 11 | 12.79% | 0.03 | 0.33 |
| 4.0 | 9 | 10.47% | 0.04 | 0.36 |
| 4.5 | 1 | 1.16% | 0.06 | 0.06 |
| 5.0 | 11 | 12.79% | 0.07 | 0.77 |
| 5.5 | 8 | 9.30% | 0.13 | 1.04 |
| 6.0 | 11 | 12.79% | 0.15 | 1.65 |
| 6.5 | 7 | 8.14% | 0.17 | 1.19 |
| 7.0 | 4 | 4.65% | 0.29 | 1.16 |
| 7.5 | 5 | 5.81% | 0.36 | 1.80 |
| 8.0 | 1 | 1.16% | 0.44 | 0.44 |
| 9.5 | 1 | 1.16% | 0.54 | 0.54 |
| TOTAL | 86 | | | 3.94 |

**BLUNTNOSE MINNOW**

| | | | | |
|---|---|---|---|---|
| <3.0 | 20 | 24.10% | 0.01 | 0.20 |
| 3.0 | 20 | 24.10% | 0.01 | 0.20 |
| 3.5 | 43 | 51.81% | 0.01 | 0.43 |
| | 83 | | | 0.83 |

**LONGEAR SUNFISH**

| | | | | |
|---|---|---|---|---|
| <3.0 | 2 | 2.74% | 0.01 | 0.02 |
| 3.0 | 19 | 26.03% | 0.02 | 0.38 |
| 3.5 | 19 | 26.03% | 0.03 | 0.57 |
| 4.0 | 15 | 20.55% | 0.05 | 0.75 |
| 4.5 | 4 | 5.48% | 0.06 | 0.24 |
| 5.0 | 5 | 6.85% | 0.08 | 0.40 |
| 5.5 | 3 | 4.11% | 0.11 | 0.33 |
| 6.0 | 4 | 5.48% | 0.13 | 0.52 |
| 6.5 | 2 | 2.74% | 0.17 | 0.34 |
| TOTAL | 73 | | | 3.55 |

**BLACK CRAPPIE**

| | | | | |
|---|---|---|---|---|
| <3.0 | 4 | 9.09% | 0.01 | 0.04 |
| 3.0 | 12 | 27.27% | 0.01 | 0.12 |
| 3.5 | 17 | 38.64% | 0.01 | 0.17 |
| 4.0 | 6 | 13.64% | 0.03 | 0.18 |
| 4.5 | 1 | 2.27% | 0.03 | 0.03 |
| 11.0 | 2 | 4.55% | 0.88 | 1.76 |
| 12.0 | 2 | 4.55% | 1.12 | 2.24 |
| TOTAL | 44 | | | 4.54 |

**REDEAR SUNFISH**

| | | | | |
|---|---|---|---|---|
| <3.0 | 2 | 4.76% | 0.01 | 0.02 |
| 3.0 | 4 | 9.52% | 0.02 | 0.08 |
| 3.5 | 2 | 4.76% | 0.03 | 0.06 |
| 4.5 | 1 | 2.38% | 0.06 | 0.06 |
| 5.0 | 2 | 4.76% | 0.06 | 0.12 |
| 5.5 | 3 | 7.14% | 0.10 | 0.30 |
| 6.0 | 5 | 11.90% | 0.13 | 0.65 |
| 6.5 | 3 | 7.14% | 0.16 | 0.48 |
| 7.0 | 1 | 2.38% | 0.22 | 0.22 |
| 7.5 | 1 | 2.38% | 0.30 | 0.30 |
| 8.0 | 6 | 14.29% | 0.35 | 2.10 |
| 8.5 | 5 | 11.90% | 0.40 | 2.00 |
| 9.0 | 4 | 9.52% | 0.47 | 1.88 |
| 9.5 | 3 | 7.14% | 0.53 | 1.59 |
| TOTAL | 42 | | | 9.86 |

**YELLOW PERCH**

| | | | | |
|---|---|---|---|---|
| <3.0 | 2 | 6.25% | 0.01 | 0.02 |
| 3.0 | 25 | 78.13% | 0.01 | 0.25 |
| 3.5 | 5 | 15.63% | 0.01 | 0.05 |
| | 32 | | | 0.32 |

**GREEN SUNFISH**

| | | | | |
|---|---|---|---|---|
| 3.0 | 1 | 3.57% | 0.02 | 0.02 |
| 3.5 | 1 | 3.57% | 0.03 | 0.03 |
| 4.0 | 3 | 10.71% | 0.04 | 0.12 |
| 4.5 | 1 | 3.57% | 0.06 | 0.06 |
| 5.0 | 2 | 7.14% | 0.09 | 0.18 |
| 5.5 | 2 | 7.14% | 0.11 | 0.22 |
| 6.0 | 7 | 25.00% | 0.16 | 1.12 |
| 6.5 | 5 | 17.86% | 0.20 | 1.00 |
| 7.0 | 4 | 14.29% | 0.26 | 1.04 |
| 7.5 | 2 | 7.14% | 0.33 | 0.66 |
| TOTAL | 28 | | | 4.45 |

**COMMON CARP**

| | | | | |
|---|---|---|---|---|
| 21.0 | 1 | 20.00% | 4.94 | 4.94 |
| 21.5 | 1 | 20.00% | 5.30 | 5.30 |
| 25.5 | 1 | 20.00% | 10.44 | 10.44 |
| 26.5 | 1 | 20.00% | 10.88 | 10.88 |
| 28.5 | 1 | 20.00% | 10.63 | 10.63 |
| | 5 | | | 42.19 |

**YELLOW BULLHEAD**

| | | | | |
|---|---|---|---|---|
| 6.0 | 1 | 33.33% | 0.51 | 0.51 |
| 9.0 | 1 | 33.33% | 0.35 | 0.35 |
| 12.0 | 1 | 33.33% | 0.95 | 0.95 |
| | 3 | | | 1.81 |

# Appendix C
# Creel Survey Form

Date:

Time you began fishing______
Time you finished fishing______

| | | | |
|---|---|---|---|
| Fishing From: | Bank__ | Boat___ | |
| Location: | Open Water__ | Weeds__ | Woody Structure___ |
| | Man-made structure___ | Rock____ | Other____ |

What species are you fishing for?___________________________

How many have you caught and released?____________________________

How would you rate your fishing success today? Poor___ Fair____ Good____ Excellent____
Write down number and sizes of fish you have harvested

| Species Harvested | Length__number__ | Length__number__ | Length__number__ |
|---|---|---|---|
| Bluegill | _____ ______ | _____ ______ | _____ ______ |
| Largemouth Bass | _____ ______ | _____ ______ | _____ ______ |
| Redear Sunfish | _____ ______ | _____ ______ | _____ ______ |
| Black crappie | _____ ______ | _____ ______ | _____ ______ |
| Channel catfish | _____ ______ | _____ ______ | _____ ______ |
| Other_____________ | _____ ______ | _____ ______ | _____ ______ |

Comments: