FISH SURVEY REPORT

Keystone Lakes

November 20, 2014

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INTRODUCTION

A survey of the fish communities and other physical, biological, and chemical factors directly affecting the fish communities was completed at Keystone Lakes on November 2, 2015. Five lakes were surveyed, and will be referred to as Keystone 1 Southwest (14.60 acres), Keystone 2 South (10.08 acres), Keystone 4 North (2.60 acres), Keystone 5 Northeast (3.20 acres), and Keystone 7 Far East (2.40 acres). Keystone 3 Northwest and Keystone 6 East Central were not surveyed due to wet accesses. The major objectives of this survey and report are:

1. To provide a current status report on the fish communities of the lakes.
2. To compare the current characteristics of the fish communities with established indices and averages for Indiana lakes.
3. To provide recommendations for management strategies to enhance or sustain the sport fish communities.

The data collected are adequate for the intended uses; however, there will be unanswered questions regarding aspects of the fish populations and other related factors of the biological communities in the lakes. 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 lakes. General information regarding water chemistry, fish communities, and methods are described in Appendix A. Detailed fish collection tables are presented in Appendix B.

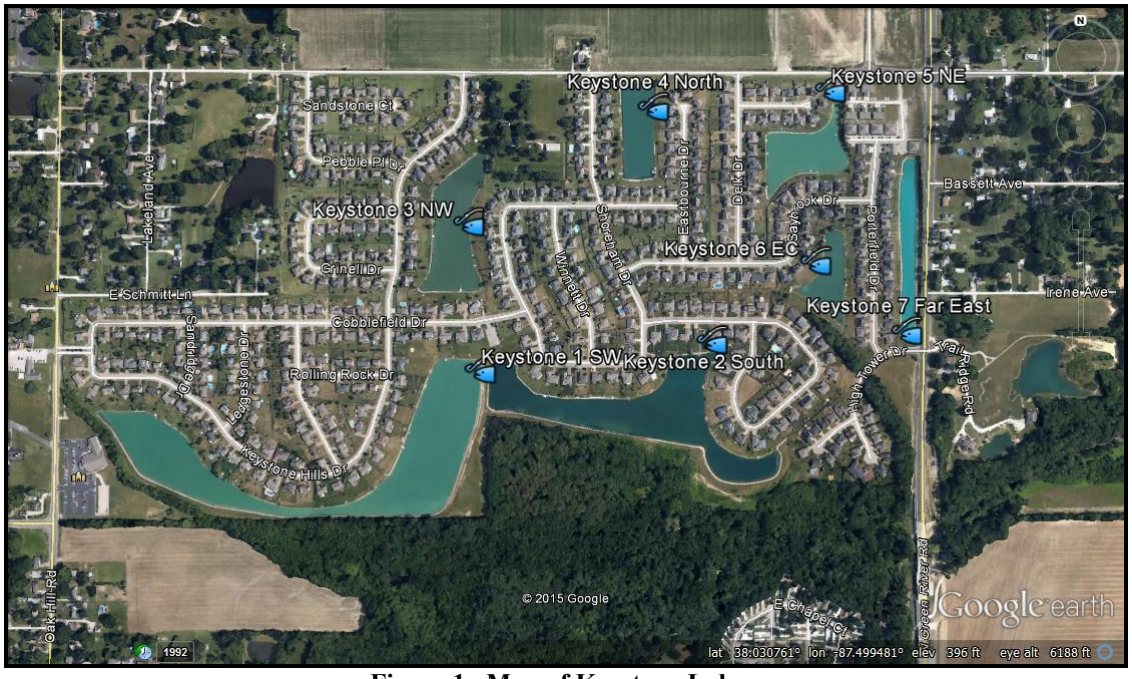

Figure 1. Map of Keystone Lakes.

RESULTS AND DISCUSSION-KEYSTONE 1 SOUTHWEST

WATER CHEMISTRY

The results of selected physio-chemical parameters from Keystone 1 Southwest are presented in Table 1. Water temperatures ranged from 64.8 degrees Fahrenheit at the surface to 59.4 degrees Fahrenheit at the bottom. Dissolved oxygen ranged from 7.23 parts per-million (ppm) at the surface to 6.69 ppm at the bottom (Figure 2). A desirable oxygen level for maintenance of healthy stress free fish was present throughout the water column. These numbers indicate Keystone 1 Southwest was de-stratified at the time of the survey, which is typical for this time of year (See Appendix A for further details on lake stratification). The alkalinity level was 85.5 ppm. The hardness level was 119.7 ppm. The pH was 7.3. These numbers are normal for lakes in this area and indicate the lake is capable of good fish production. The Secchi disk depth was measured at 2.0 feet. Nitrate-nitrogen levels were 0.30 ppm. Ortho-phosphate levels were undetectable. Keystone 1 Southwest appears to have water quality which is capable of supporting a healthy fish population.

Table 1. Selected water quality parameters measured on Keystone 1 Southwest, November 2, 2015.

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	64.80	7.23	7.3	85.5	119.7	0.30	0.00	0.02
3	60.30	7.22	-	-	-	-	-	-
6	59.70	6.70	-	-	-	-	-	-
9	59.50	6.69	-	-	-	-	-	-
10	59.40	6.69	-	-	-	-	-	-

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

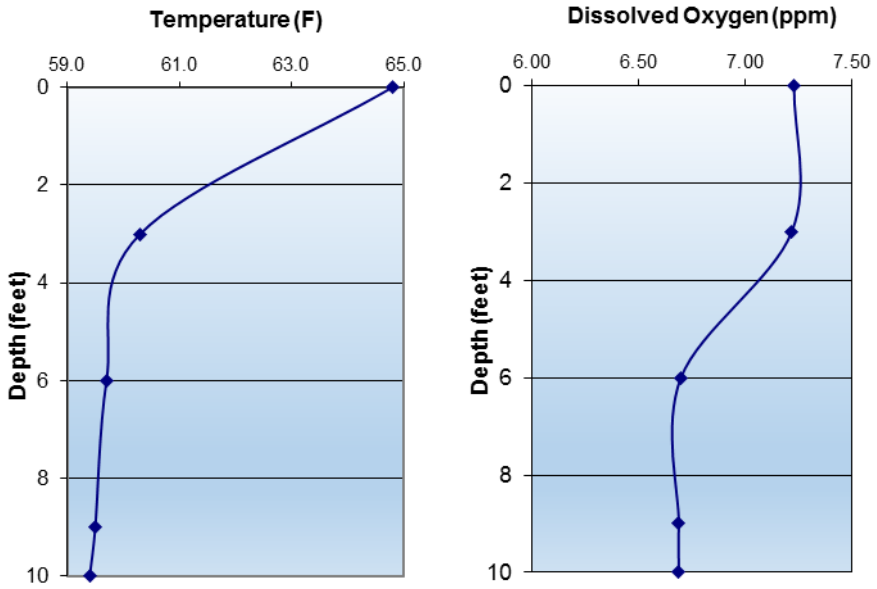

Figure 2. Temperature and dissolved oxygen profiles for Keystone 1 Southwest, November 2, 2015.

FISH COLLECTION

A total of 258 fish weighing 61.22 pounds and representing eight species was collected from Keystone 1 Southwest (Table 2 & Figure 3). Bluegill *Lepomis macrochirus* was the most abundant species comprising 53.88% of the fish collected. Gizzard shad *Dorosoma cepedianum* was the second most abundant species (34.88%), followed by largemouth bass *Micropterus salmoides* (4.65%), redear sunfish *Lepomis microlophus* (2.33%), white crappie *Pomoxis annularis* (1.94%), channel catfish *Ictalurus punctatus* (1.16%), green sunfish *Lepomis cyanellus* (0.78%), and grass carp *Ctenopharyngodon idella* (0.39%). All of these species are desirable in a lake of this size with the exception of gizzard shad, white crappie, and green sunfish.

Table 2. Species collected from Keystone 1 Southwest, November 2, 2015.

Species	N	% N	Size Range (in)	Total Weight (lbs.)	% Wt	N/hr.
Bluegill	139	53.88	<3-7.0	5.81	9.49	288
Gizzard shad	90	34.88	4.0-12.0	18.35	29.97	186
Largemouth bass	12	4.65	5.0-16.0	9.70	15.84	25
Redear sunfish	6	2.33	6.0-10.0	1.86	3.04	12
White crappie	5	1.94	6.0-13.0	2.06	3.36	10
Channel catfish	3	1.16	7.0-23.0	7.44	12.15	6
Green sunfish	2	0.78	5.5-6.0	0.25	0.41	4
Grass carp	1	0.39	30.0	15.75	25.73	2
Total	258	100.00		61.22	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)

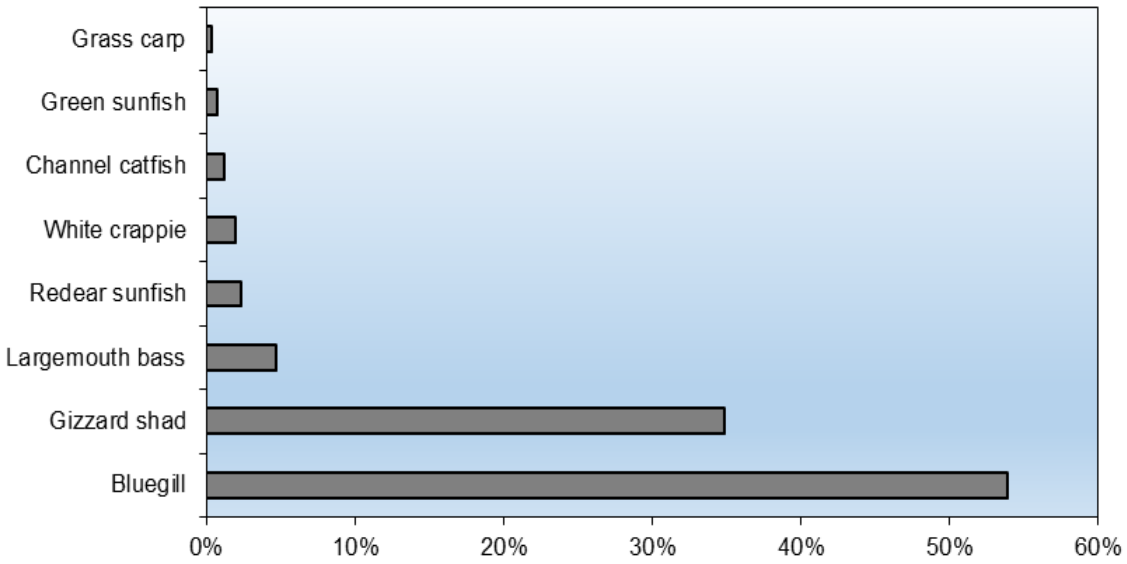

Figure 3. Relative abundance of species collected from Keystone 1 Southwest, November 2, 2015.

Bluegill

Bluegill (Figure 4) was the most abundant species collected (53.88%) and ranked fifth by weight (9.49%). Individuals ranged in size from less than 3.0 to 7.0 inches (Figure 5). Nearly 12% of bluegill collected were less than 3.0 inches, indicating poor reproduction occurred in 2015. There were very few quality bluegill collected. This led to a proportional stock density of 7, which is well 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 (Figure 6). Poor condition factors and below average weights are indicators of a stunted bluegill population. This is likely due to the presence of gizzard shad. Bluegill reproduction also typically suffers in lakes containing this species.

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

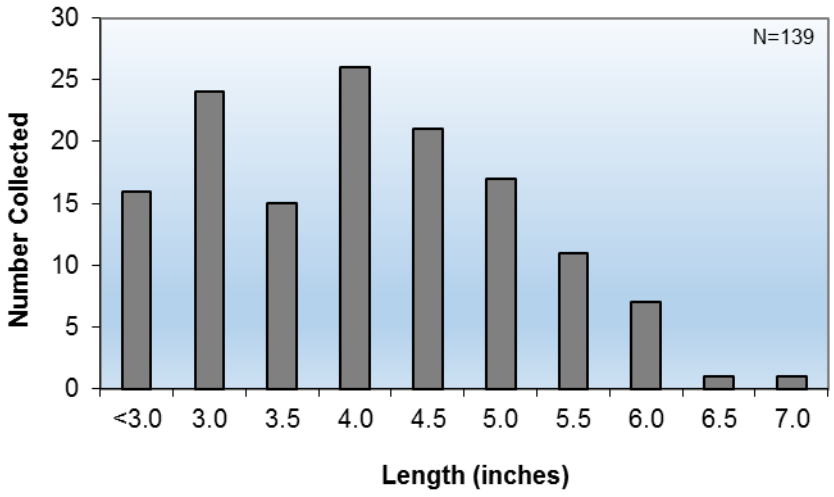

Figure 5. Length frequency distribution of bluegill collected from Keystone 1 Southwest, November 2, 2015.

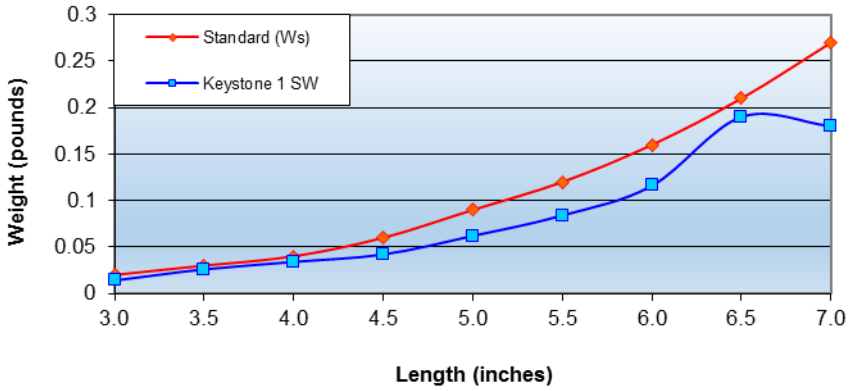

Figure 6. Comparison of Keystone 1 Southwest bluegill weights to standard bluegill weights.

Gizzard shad

Gizzard shad (Figure 7) was the second most abundant species collected (34.88%), and ranked first by weight (29.97%). A total of 90 gizzard shad ranging in size from less than 4.0 to 12.0 inches was collected. Largemouth bass typically grow well in the lakes containing gizzard shad, especially individuals that are 15.0 inches and larger; gizzard shad grow rapidly and reach sizes that bass cannot eat. This species competes with juvenile bluegill for food resources typically leading to poor recruitment and slower growth conditions. Shad also has a very high reproductive potential. Steps should be taken to monitor the gizzard shad population, and another predator species like hybrid striped bass may need to be stocked to ensure that the population remains under control.

Figure 7. Photograph of gizzard shad, *Dorosoma cepedianum.*

Largemouth Bass

Largemouth bass (Figure 8) was the third most abundant species collected (4.65%) and ranked third by weight (15.84%). A total of 12 largemouth bass ranging in size from less than 5.0 to 16.0 inches was collected (Figure 9). Very few young-of-the-year bass were collected indicating poor reproduction has occurred in the past year. Of the largemouth bass collected, nearly 50% were between 12.0 and 16.0 inches. This led to a PSD of 75 for largemouth bass, which is well above the desired range of 40-60. Condition factors (measurement of overall plumpness) were good for most size classes. The average weights for the bass were below what is expected as normal weight at length in most sizes collected (Figure 10). It appears that the largemouth bass population is very small. Bass reproduction and recruitment typically suffer in gizzard shad lakes. This species should be protected and a supplemental stocking should take place in order to ensure that there is a viable population for the future.

Figure 8. Photograph of largemouth bass, *Micropterus salmoides*.

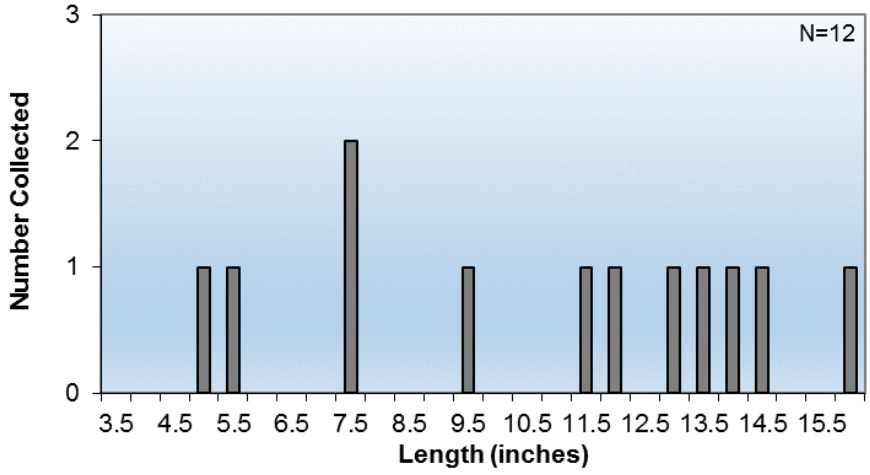

Figure 9. Length frequency distribution of largemouth bass collected from Keystone 1 Southwest, November 2, 2015.

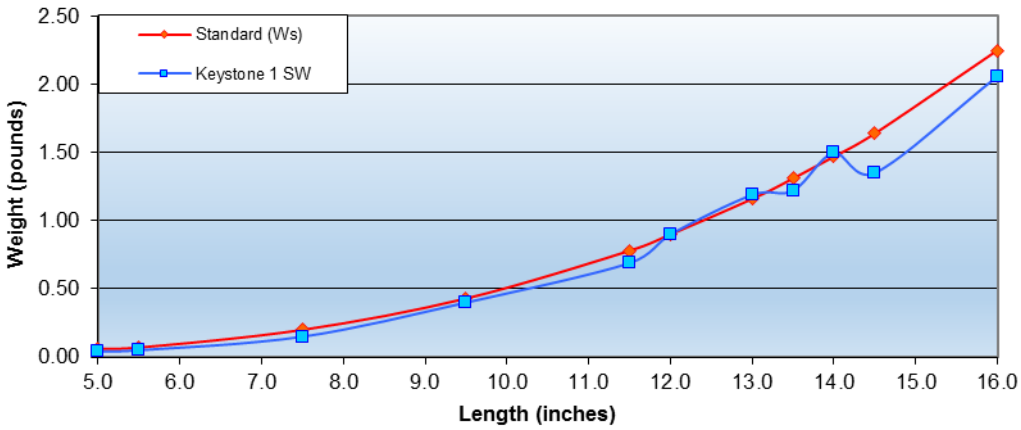

Figure 10. Comparison of Keystone 1 Southwest largemouth bass weights to standard largemouth bass weights.

Redear sunfish

Redear sunfish (Figure 11) was the fourth most abundant species collected (2.33%), and ranked seventh by weight (3.04%). A total of 6 redear sunfish ranging in size from less than 6.0 to 10.0 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. Due to their slower reproductive potential and small population, this species should be protected with more restrictive bag limits.

Figure 11. Photograph of redear sunfish, Lepomis microlophus.

Other species

Five white crappie (Figure 12) ranging in size from 6.0 to 13.0 inches were collected. This species has a tendency to over-populate and form stunted populations in lakes of this size.

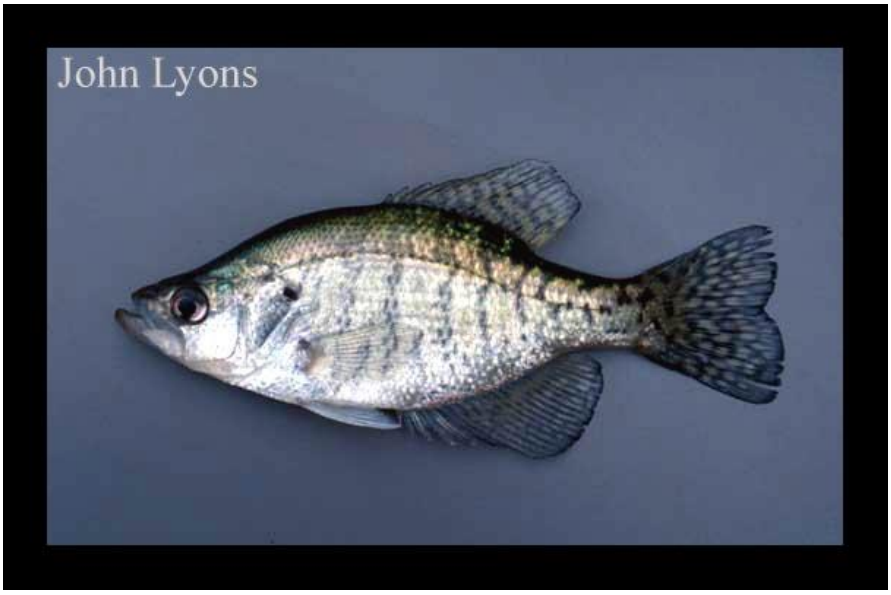

Figure 12. Photograph of white crappie, *Pomoxis annularis*.

Three channel catfish (Figure 13) were collected during the survey. Channel catfish typically do not sample well with electrofishing equipment. Young-of-the-year channel catfish are normally eliminated by largemouth bass and other predators leading to little or no recruitment into the population. Channel catfish should be stocked periodically if they are desired in the fishery.

Figure 13. Photograph of channel catfish, *Ictalurus punctatus*.

Two green sunfish were collected during the survey. 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 14 illustrates the differences in appearance between bluegill and green sunfish.

Figure 14. Photographic comparison of bluegill (top) and green sunfish (bottom), *Lepomis cyanellus*.

A single 30.0 inch grass carp that weighed 15.75 pounds was also collected (Figure 15). When grass carp reach this size, their metabolism has slowed down and they don't eat much. They destroy desirable fish species nests and increase turbidity. They are very hard to catch on hook and line; however if they happen to be caught they should be removed from the lake.

Figure 15. Photograph of grass carp, *Ctenopharyngodon idella*.

SUMMARY AND RECOMMENDATIONS-KEYSTONE 1 SOUTHWEST

The fishery in this lake is suffering from the presence of gizzard shad. The bluegill population is dominated by small, slow growing individuals. It appears that largemouth bass reproduction/recruitment are suffering due to the presence of gizzard shad. It is vital that largemouth bass be protected, and a supplemental stocking should also take place. Adding another predator to the population would be a great management tool in aiding with predation on gizzard shad. Hybrid striped bass would be the best choice in this situation, as they are especially adept at feeding on gizzard shad. This species will grow quickly and provide another angling opportunity in the lake. The lake also lacks structure. Artificial structure that can consist of brush/rock piles, Christmas trees, or man-made artificial fish reefs is excellent cover for juvenile fish.

The following recommendations, **listed in order of importance**, will help protect and enhance the fishery in Keystone 1 Southwest:

1. Restrict harvest of largemouth bass for the next two years. The population is very small and protection of this species is paramount.
2. Stock 300 5.0 to 7.0 inch largemouth bass in the spring of 2017.
3. Stock 175 5.0 to 7.0 inch hybrid striped bass in the spring of 2016.
4. No restrictions are necessary on bluegill harvest. Harvest will reduce competition and increase growth rates.
5. Restrict redear sunfish harvest for the next two years

6. Add structure to the lake to provide cover for juvenile fish.
7. Conduct a Standard Fish Survey in 2018 in order to monitor the effects of the above recommendations and assess needs for further management activities.
8. Remove all green sunfish that are caught.
9. If channel catfish are desired, stock 500 8.0 to 10.0 inch fish. This species will provide an additional angling opportunity and may prey on overabundant forage.

RESULTS AND DISCUSSION-KEYSTONE 2 SOUTH

WATER CHEMISTRY

The results of selected physio-chemical parameters from Keystone 2 South are presented in Table 3. Water temperatures ranged from 64.8 degrees Fahrenheit at the surface to 60.1 degrees Fahrenheit at the bottom. Dissolved oxygen ranged from 9.64 ppm at the surface to 5.67 ppm at the bottom (Figure 16). A desirable oxygen level for maintenance of healthy stress free fish was present throughout the water column. These numbers indicate Keystone 2 South was de-stratified at the time of the survey. The alkalinity level was 102.6 ppm. The hardness level was 136.8 ppm. The pH was 7.5. These numbers are normal for lakes in this area and indicate the lake is capable of good fish production. The Secchi disk depth was measured at 2.0 feet. Nitrate-nitrogen levels were 0.40 ppm. Ortho-phosphate levels were undetectable. Keystone 2 South appears to have water quality which is capable of supporting a healthy fish population.

Table 3. Selected water quality parameters measured on Keystone 2 South, November 2, 2015.

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	64.80	9.64	7.5	102.6	136.8	0.40	0.00	0.22
3	62.80	9.01	-	-	-	-	-	-
6	60.60	7.23	-	-	-	-	-	-
9	60.40	6.37	-	-	-	-	-	-
12	60.30	5.93	-	-	-	-	-	-
14	60.10	5.67	-	-	-	-	-	-

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

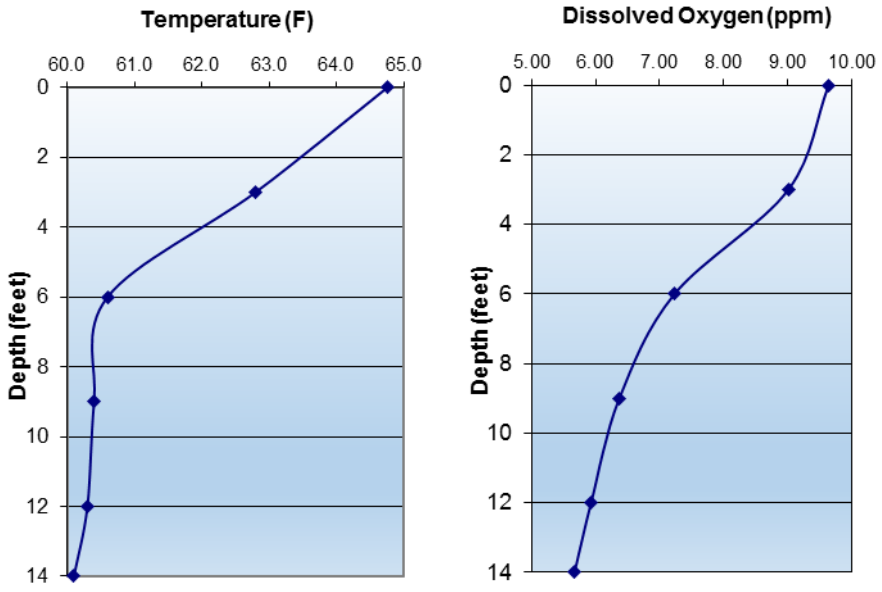

Figure 16. Temperature and dissolved oxygen profiles for Keystone 2 South, November 2, 2015.

FISH COLLECTION

A total of 141 fish weighing 50.02 pounds and representing eight species was collected from Keystone 2 South (Table 4 & Figure 17). Bluegill was the most abundant species comprising 39.01% of the fish collected. Gizzard shad was the second most abundant species (26.24%), followed by largemouth bass (19.86%), redear sunfish (12.06%), black crappie *Pomoxis nigromaculatus* (0.71%), smallmouth bass *Micropterus dolomieu* (0.71%), green sunfish (0.71%), and channel catfish (0.71%). All of these species are desirable in a lake of this size with the exception of gizzard shad, black crappie, and green sunfish.

Table 4. Species collected from Keystone 2 South, November 2, 2015.

Species	N	% N	Size Range (in)	Total Weight (lbs.)	% Wt	N/hr.
Bluegill	55	39.01	<3-9.0	4.35	8.70	141
Gizzard shad	37	26.24	3.5-12.5	11.44	22.87	95
Largemouth bass	28	19.86	5.5-15.0	21.47	42.92	72
Redear sunfish	17	12.06	6.5-9.5	7.09	14.17	44
Black crappie	1	0.71	5.5	0.07	0.14	3
Smallmouth bass	1	0.71	15.00	1.21	2.42	3
Green sunfish	1	0.71	4.00	0.04	0.08	3
Channel catfish	1	0.71	22.5	4.35	8.70	3
Total	141	100.00		50.02	100.00	

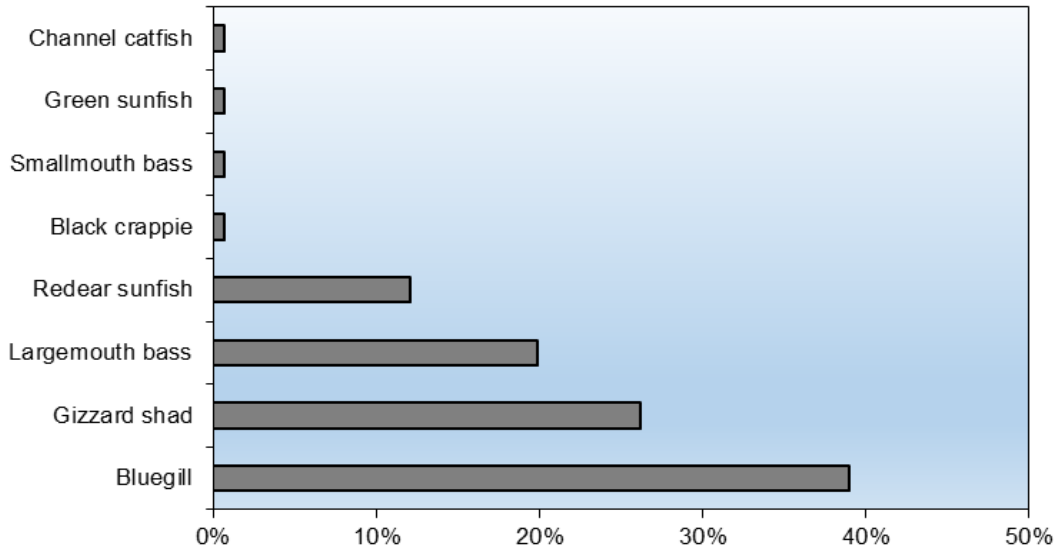

Figure 17. Relative abundance of species collected from Keystone 2 South, November 2, 2015.

Bluegill

Bluegill was the most abundant species collected (39.01%) and tied for fourth by weight (8.70%). Individuals ranged in size from less than 3.0 to 9.0 inches (Figure 18). Nearly 24% of bluegill collected were between 6.0 and 9.0 inches. This led to a proportional stock density of 30, which is within the desired range of 20-40 for bluegill. Condition factors were below average for most size ranges. Bluegill weights were also found to be below standard weights in most size ranges (Figure 19).

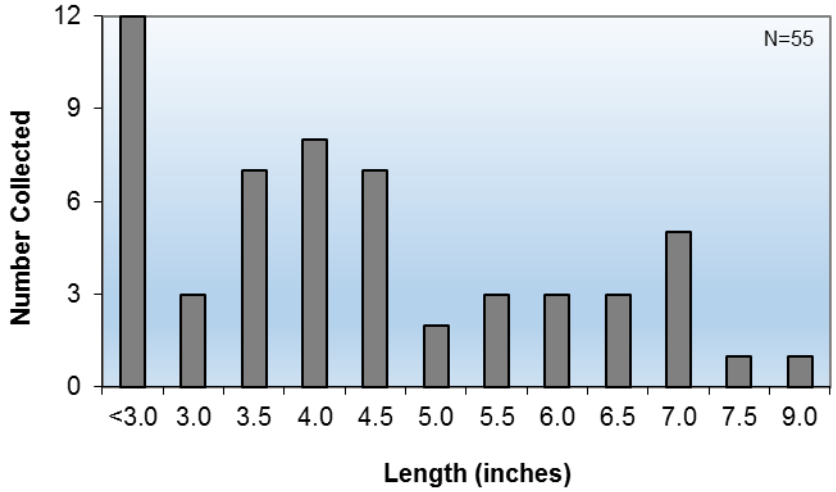

Figure 18. Length frequency distribution of bluegill collected from Keystone 2 South, November 2, 2015.

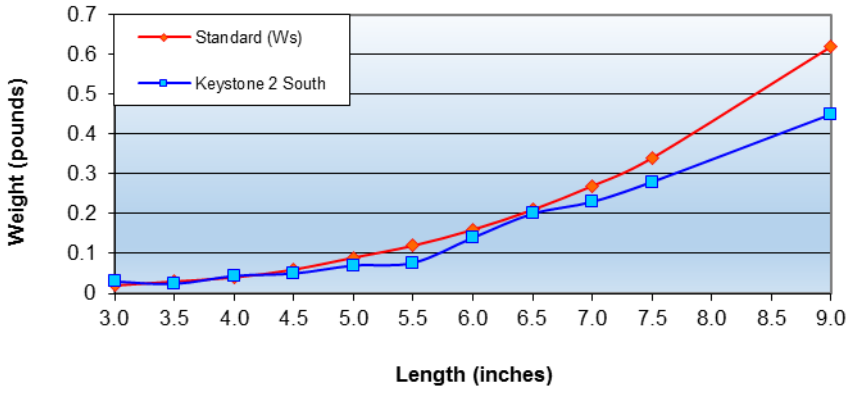

Figure 19. Comparison of Keystone 2 South bluegill weights to standard bluegill weights.

Gizzard shad

Gizzard shad was the second most abundant species collected (26.24%), and ranked second by weight (22.87%). A total of 37 gizzard shad ranging in size from 3.5 to 12.5 inches was collected.

Largemouth Bass

Largemouth bass was the third most abundant species collected (19.86%) and ranked first by weight (42.92%). A total of 28 largemouth bass ranging in size from 5.5 to 15.5

inches was collected (Figure 20). There were no young-of-the-year bass collected indicating poor reproduction has occurred in the 2015. Nearly 43% of largemouth bass collected were between 12.0 and 16.0 inches. This led to a PSD of 55 for largemouth bass, which is within the desired range of 40-60. Condition factors were good for most size classes. The average weights for the bass were below average compared to standard weights in most sizes collected (Figure 21). The largemouth bass population appears small in this lake as well and needs protected.

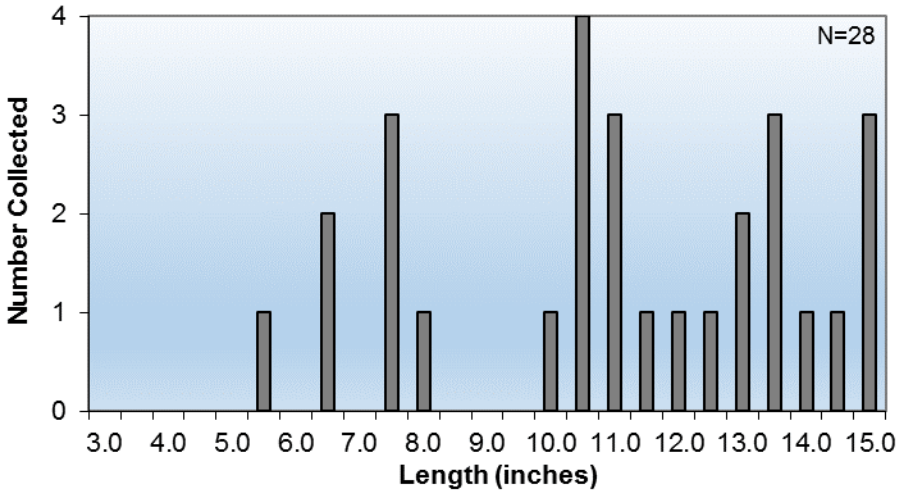

Figure 20. Length frequency distribution of largemouth bass collected from Keystone 2 South, November 2, 2015.

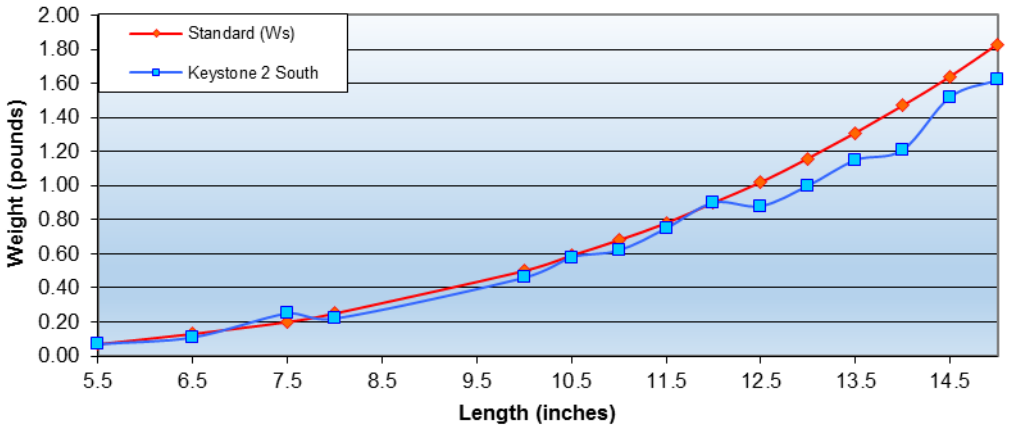

Figure 21. Comparison of Keystone 2 South largemouth bass weights to standard largemouth bass weights.

Redear sunfish

Redear sunfish was the fourth most abundant species collected (12.06%), and ranked third by weight (14.17%). A total of 17 redear sunfish ranging in size from 6.5 to 9.5 inches was collected. The redear population appears small in the lake and needs protected.

Other species

A single black crappie (Figure 22), smallmouth bass (Figure 23), green sunfish, and channel catfish were collected. Black crappie, similar to white crappie, have a tendency to over-populate and form stunted populations in lakes of this size. The smallmouth bass that was collected was 15.0 inches long and weighed 1.21 pounds. This species may provide an additional angling opportunity; however, if smallmouth are desired they will have to be stocked regularly. This species does not reproduce well in small lake environments when largemouth bass are present. Green sunfish compete with desirable species for food resources and habitat, and should be removed if caught. The channel catfish population may be larger than indicated, but will have to be restocked periodically if they are a desired game fish.

Figure 22. Photograph of black crappie, *Pomoxis nigromaculatus*.

Figure 23. Photograph of smallmouth bass, *Micropterus dolomieu*.

SUMMARY AND RECOMMENDATIONS-KEYSTONE 2 SOUTH

The fishery in this lake is also suffering from the presence of gizzard shad. Bluegill and largemouth bass reproduction/recruitment are poor. Largemouth bass need protected, and a supplemental stocking should take place. Hybrid striped bass should also be added to the population to aid in gizzard shad predation. Structure should also be added to the lake.

The following recommendations, **listed in order of importance**, will help protect and enhance the fishery in Keystone 2 South:

1. Restrict harvest of largemouth bass for the next two years.
2. Stock 150 5.0 to 8.0 inch largemouth bass in the spring of 2017.
3. Stock 150 5.0 to 7.0 inch hybrid striped bass in the spring of 2016.
4. No restrictions are necessary on bluegill harvest. Harvest will reduce competition and increase growth rates.
5. Limit redear sunfish harvest to 5 fish per day.
6. Add structure to the lake to provide cover for juvenile fish.
7. Conduct a Standard Fish Survey in 2018 in order to monitor the effects of the above recommendations and assess needs for further management activities.
8. Remove all green sunfish that are caught.
9. Stock 300 8.0 to 10.0 inch channel catfish if desired.

RESULTS AND DISCUSSION-KEYSTONE 4 NORTH

WATER CHEMISTRY

The results of selected physio-chemical parameters from Keystone 4 North are presented in Table 5. Water temperatures ranged from 64.8 degrees Fahrenheit at the surface to 60.3 degrees Fahrenheit at the bottom. Dissolved oxygen ranged from 7.07 ppm at the surface to 5.61 ppm at the bottom (Figure 24). A desirable oxygen level for maintenance of healthy stress free fish was present throughout the water column. These numbers indicate Keystone 4 North was partially stratified at the time of the survey. The alkalinity level was 85.5 ppm. The hardness level was 119.7 ppm. The pH was 7.4. 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 5.0 feet. Nitrate-nitrogen levels were 0.03 ppm. Ortho-phosphate levels were 0.01 ppm. Keystone 4 North appears to have water quality which is capable of supporting a healthy fish population.

Table 5. Selected water quality parameters measured on Keystone 4 North, November 2, 2015.

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	64.80	7.07	7.4	85.5	119.7	0.03	0.01	0.14
3	61.00	6.52	-	-	-	-	-	-
6	60.40	5.98	-	-	-	-	-	-
9	60.30	5.61	-	-	-	-	-	-

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

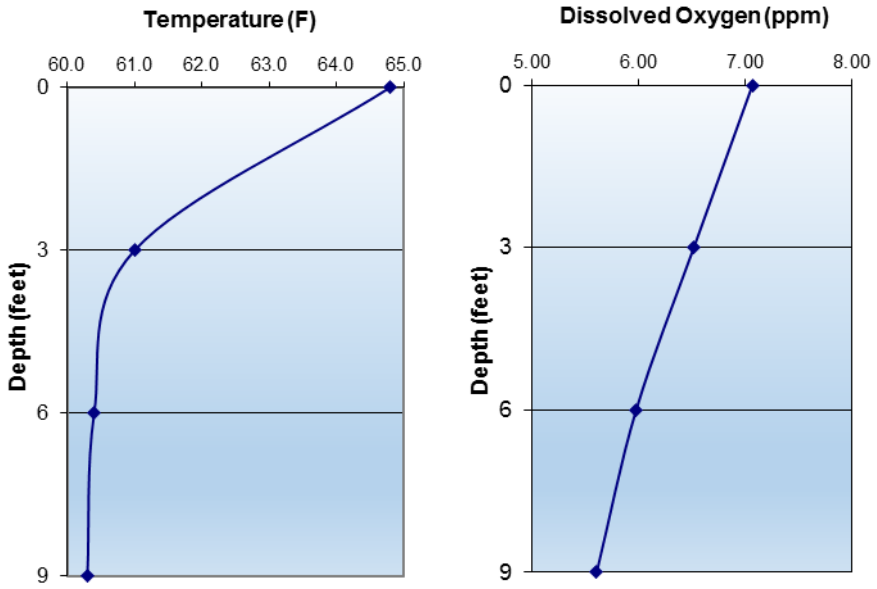

Figure 24. Temperature and dissolved oxygen profiles for Keystone 4 North, November 2, 2015.

FISH COLLECTION

A total of 62 fish weighing 26.44 pounds and representing six species was collected from Keystone 4 North (Table 6 & Figure 25). Bluegill was the most abundant species comprising 41.94% of the fish collected. Largemouth bass was the second most abundant species (40.32%), followed by green sunfish (8.06%), warmouth *Lepomis gulosus* (6.45%), gizzard shad (1.61%), and grass carp (1.61%). All of these species are desirable in a lake of this size with the exception of green sunfish, warmouth, and gizzard shad.

Table 6. Species collected from Keystone 4 North, November 2, 2015.

Species	N	% N	Size Range (in)	Total Weight (lbs.)	% Wt	N/hr.
Bluegill	26	41.94	<3-7.0	0.70	2.65	79
Largemouth bass	25	40.32	4.0-14.5	14.80	55.98	76
Green sunfish	5	8.06	5.5-7.0	1.06	4.01	15
Warmouth	4	6.45	6.5-7.0	0.89	3.37	12
Gizzard shad	1	1.61	6.0	0.06	0.23	3
Grass carp	1	1.61	25.5	8.93	33.77	3
Total	62	100.00		26.44	100.00	

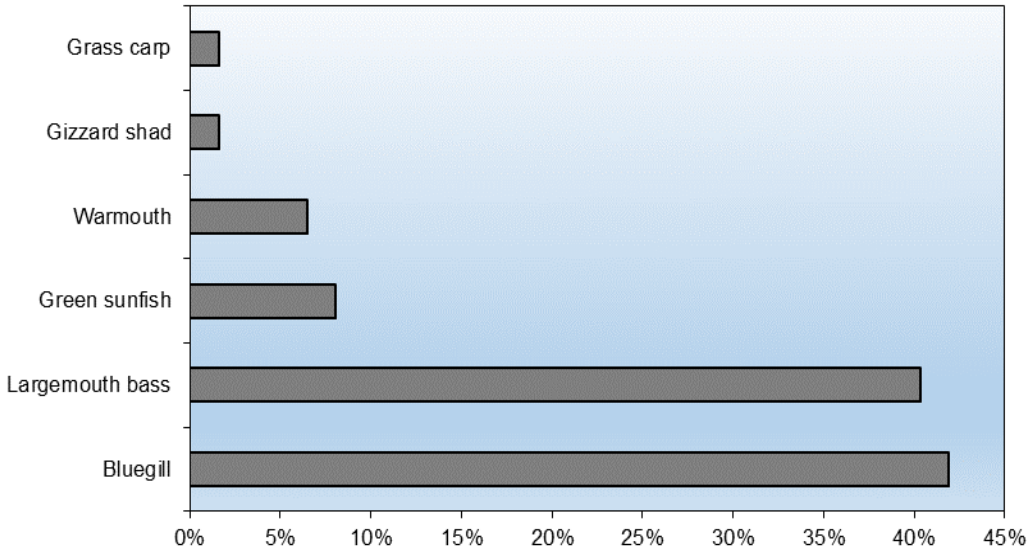

Figure 25. Relative abundance of species collected from Keystone 4 North, November 2, 2015.

Bluegill

Bluegill was the most abundant species collected (41.94%) and ranked fifth by weight (2.65%). A total of 26 bluegill ranging in size from less than 3.0 to 7.0 inches was collected (Figure 26). Nearly 73% of bluegill collected were less than 3.0 inches. Condition factors were below average for all sizes collected. Bluegill weights were also found to be below standard weights in most size ranges (Figure 27).

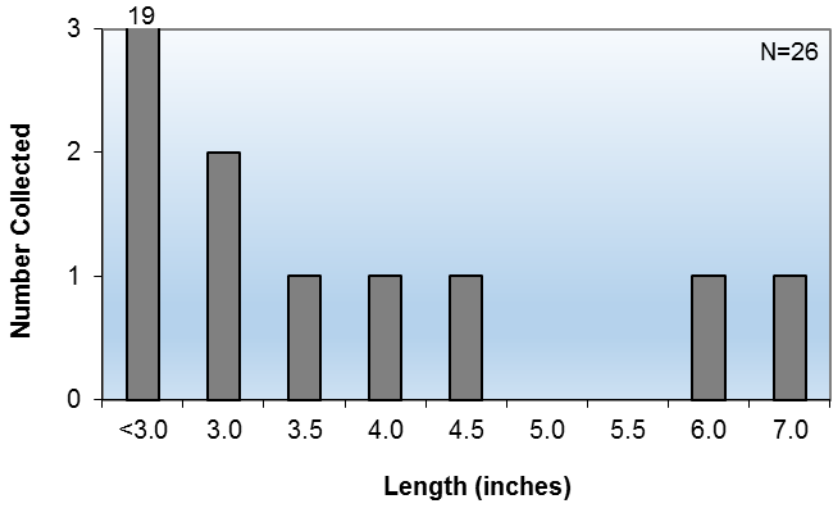

Figure 26. Length frequency distribution of bluegill collected from Keystone 4 North, November 2, 2015.

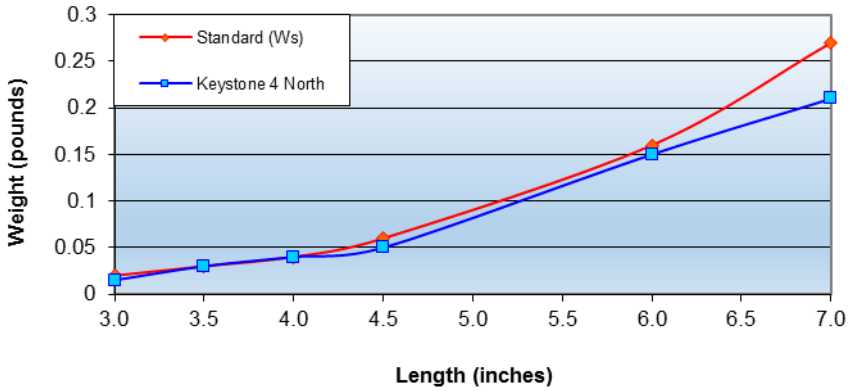

Figure 27. Comparison of Keystone 4 North bluegill weights to standard bluegill weights.

Largemouth Bass

Largemouth bass was the second most abundant species collected (40.32%) and ranked first by weight (55.98%). A total of 25 largemouth bass ranging in size from 4.0 to 14.5 inches was collected (Figure 28). Nearly 56% of largemouth bass collected were between 12.0 and 14.5 inches. This led to a PSD of 100 for largemouth bass, which is well above the desired range of 40-60. Condition factors were below average for most size classes.

The average weights for the bass were below average compared to standard weights in most sizes collected (Figure 29).

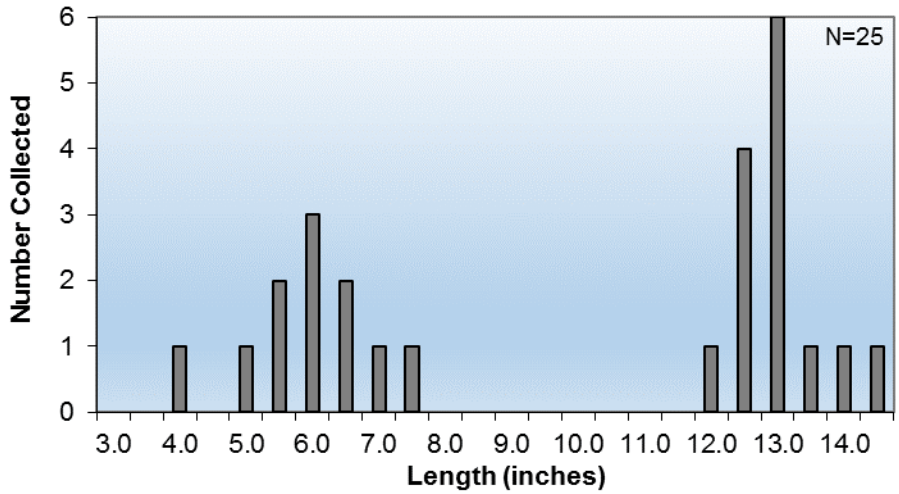

Figure 28. Length frequency distribution of largemouth bass collected from Keystone 4 North, November 2, 2015.

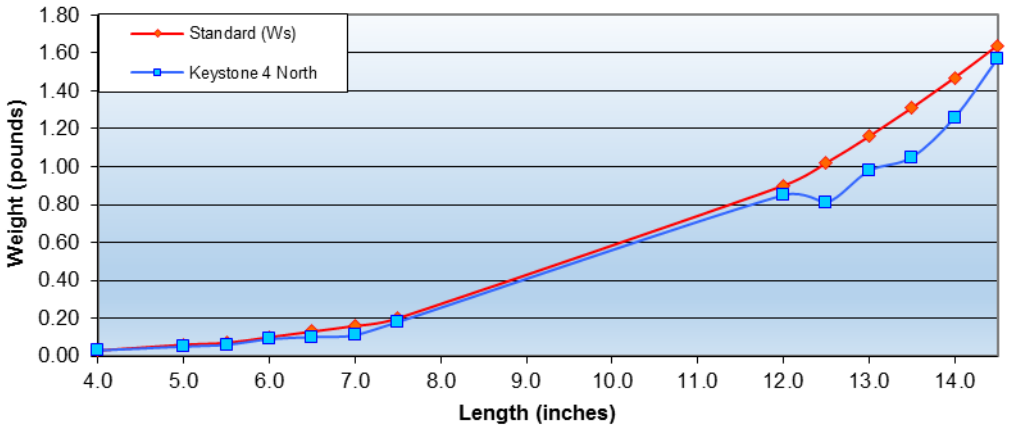

Figure 29. Comparison of Keystone 4 North largemouth bass weights to standard largemouth bass weights.

Other species

Five green sunfish were collected and should be removed if caught. Four warmouth (Figure 30) were collected during the survey. Warmouth, similar to green sunfish, compete with bluegill for food resource and habitat and should be removed if caught. A

single gizzard shad and grass carp were also collected. The gizzard shad population appears low; however, this species has a very high reproductive potential.

Figure 30. Photograph of warmouth, *Lepomis gulosus*.

SUMMARY AND RECOMMENDATIONS-KEYSTONE 4 NORTH

The fishery in Keystone 4 North suffers from an imbalance in the predator/prey assemblage. It appears that there is not enough forage for the largemouth bass population. Sometimes in this situation, largemouth bass cannibalize their young, which explains the small number of juvenile bass.

The following recommendations, **listed in order of importance**, will help protect and enhance the fishery in Keystone 4 North:

1. Implement a 14.0 to 18.0 inch slot limit on largemouth bass. Under this limit, 5 bass under 14.0 inches can be harvested per day. One bass over 18.0 inches can be harvested, but catch and release of larger fish is encouraged. This limit will only work if smaller bass are harvested.
2. Restrict bluegill harvest for the next two years.
3. Stock 100 lbs. of fathead minnows (50 lbs. in spring/50 lbs. in fall). This will help take some pressure off of bluegill predation.
4. Add structure to the lake to provide cover for juvenile fish.
5. Conduct a Standard Fish Survey in 2018 in order to monitor the effects of the above recommendations and assess needs for further management activities.
6. Remove all green sunfish and warmouth that are caught.

RESULTS AND DISCUSSION-KEYSTONE 5 NORTHEAST

WATER CHEMISTRY

The results of selected physio-chemical parameters from Keystone 5 Northeast are presented in Table 7. Water temperatures ranged from 65.8 degrees Fahrenheit at the surface to 59.5 degrees Fahrenheit at the bottom. Dissolved oxygen ranged from 7.20 ppm at the surface to 6.31 ppm at the bottom (Figure 31). A desirable oxygen level for maintenance of healthy stress free fish was present throughout the water column. These numbers indicate Keystone 5 Northeast was partially stratified at the time of the survey. The alkalinity level was 102.6 ppm. The hardness level was 136.8 ppm. The pH was 7.4. 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 1.25 feet. Nitrate-nitrogen levels were 0.60 ppm. Ortho-phosphate levels were 0.01 ppm. Keystone 5 Northeast appears to have water quality which is capable of supporting a healthy fish population.

Table 7. Selected water quality parameters measured on Keystone 5 Northeast, November 2, 2015.

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	65.80	7.20	7.4	102.6	136.8	0.60	0.01	0.12
3	60.60	6.83	-	-	-	-	-	-
6	59.70	6.49	-	-	-	-	-	-
9	59.50	6.31	-	-	-	-	-	-

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

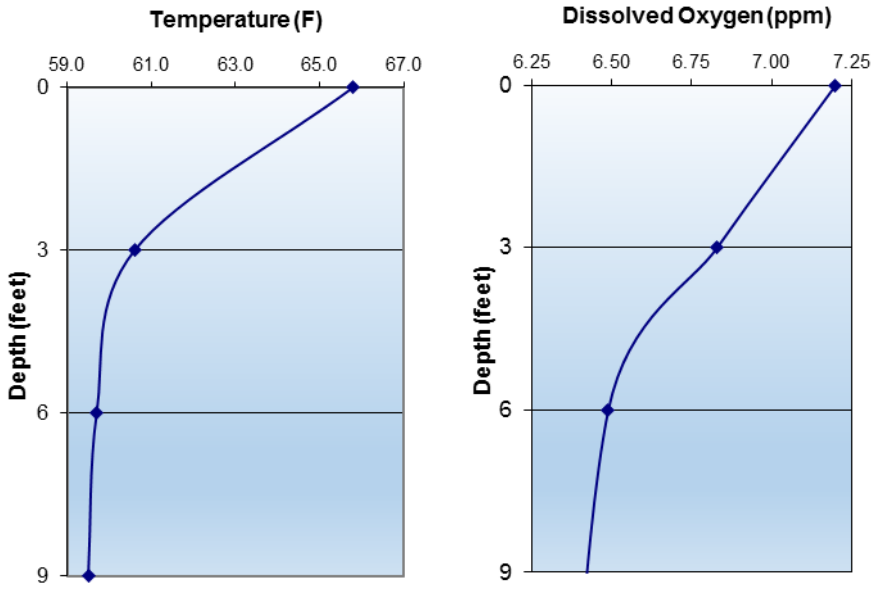

Figure 31. Temperature and dissolved oxygen profiles for Keystone 5 Northeast, November 2, 2015.

FISH COLLECTION

A total of 170 fish weighing 17.81 pounds and representing seven species was collected from Keystone 5 Northeast (Table 8 & Figure 32). Bluegill was the most abundant species comprising 80.59% of the fish collected. Gizzard shad was the second most abundant species (6.47%), followed by green sunfish (5.88%), largemouth bass (3.53%), redear sunfish (2.35%), white crappie (0.59%) and black crappie (0.59%). All of these species are desirable in a lake of this size with the exception of gizzard shad, green sunfish, white crappie, and black crappie.

Table 8. Species collected from Keystone 5 Northeast, November 2, 2015.

Species	N	% N	Size Range (in)	Total Weight (lbs.)	% Wt	N/hr.
Bluegill	137	80.59	<3-8.0	6.31	35.43	548
Gizzard shad	11	6.47	4.5-10.0	2.50	14.04	44
Green sunfish	10	5.88	3.0-6.0	0.80	4.49	40
Largemouth bass	6	3.53	3.0-15.0	6.89	38.69	24
Redear sunfish	4	2.35	7.0-8.0	0.97	5.45	16
White crappie	1	0.59	7.0	0.14	0.79	4
Black crappie	1	0.59	8.0	0.2	1.12	4
Total	170	100.00		17.81	100.00	

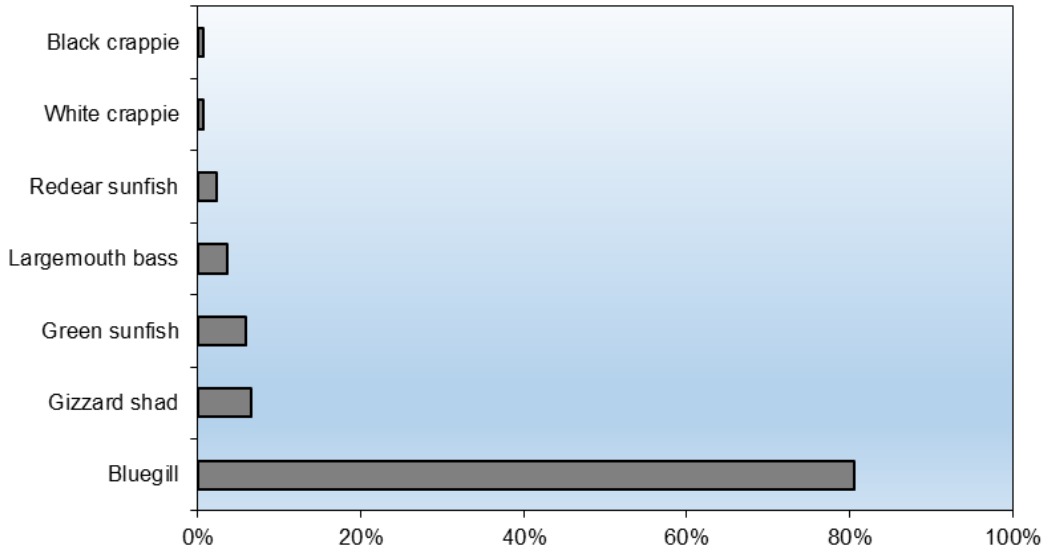

Figure 32. Relative abundance of species collected from Keystone 5 Northeast, November 2, 2015.

Bluegill

Bluegill was the most abundant species collected (80.59%) and ranked second by weight (35.43%). Individuals ranged in size from less than 3.0 to 8.0 inches (Figure 33). Nearly 46% of bluegill collected were less than 3.0 inches. There was a fair number of quality bluegill collected. This led to a proportional stock density of 19, which is just below the desired range of 20-40 for bluegill. Condition factors were below average for most sizes collected. Bluegill weights were below average compared to standard weights for most sizes collected (Figure 34).

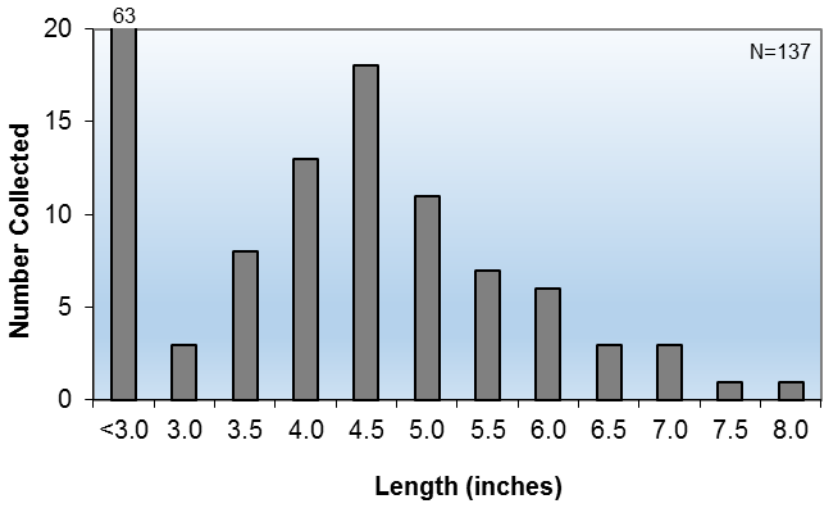

Figure 33. Length frequency distribution of bluegill collected from Keystone 5 Northeast, November 2, 2015.

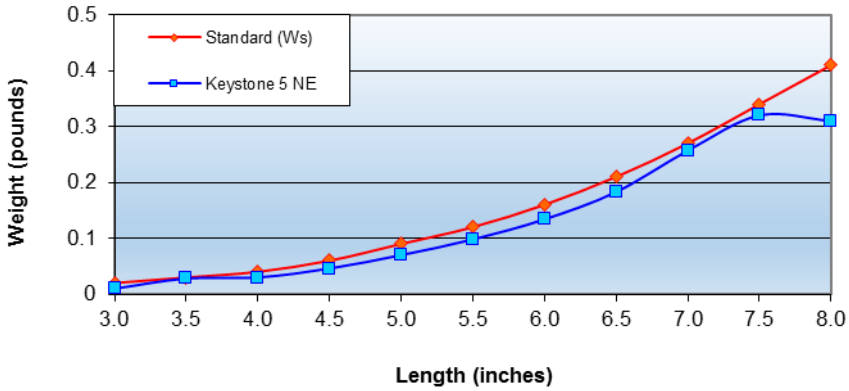

Figure 34. Comparison of Keystone 5 Northeast bluegill weights to standard bluegill weights.

Gizzard shad

Gizzard shad was the second most abundant species collected (6.47%), and ranked third by weight (14.04%). A total of 11 gizzard shad ranging in size from 4.5 to 10.0 inches was collected.

Green sunfish

Green sunfish was the third most abundant species collected (5.88%) and ranked fifth by weight (4.49%). Green sunfish should be removed if caught.

Largemouth Bass

Largemouth bass was the fourth most abundant species collected (3.53%) and ranked first by weight (38.69%). There were only 6 largemouth bass collected ranging in size from 12.5 to 15.5 inches (Figure 35). Condition factors were below average for most size classes. The average weights for the bass were below average compared to standard weights in all sizes collected (Figure 36).

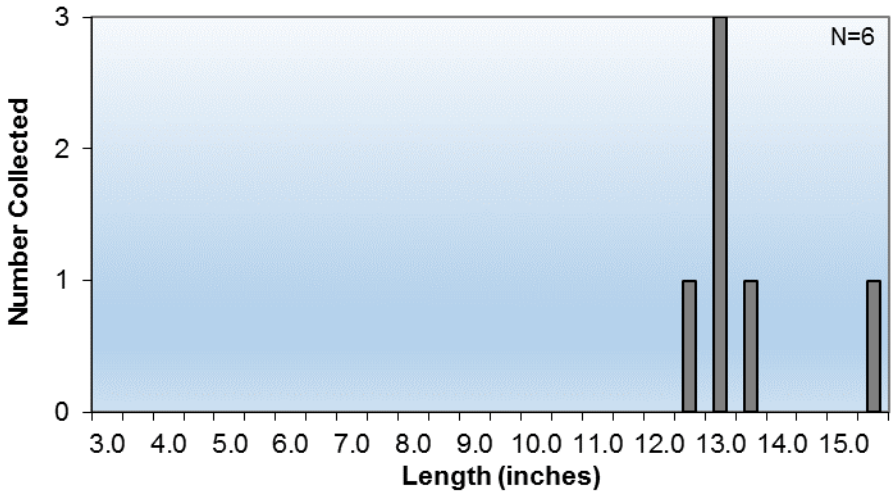

Figure 35. Length frequency distribution of largemouth bass collected from Keystone 5 Northeast, November 2, 2015.

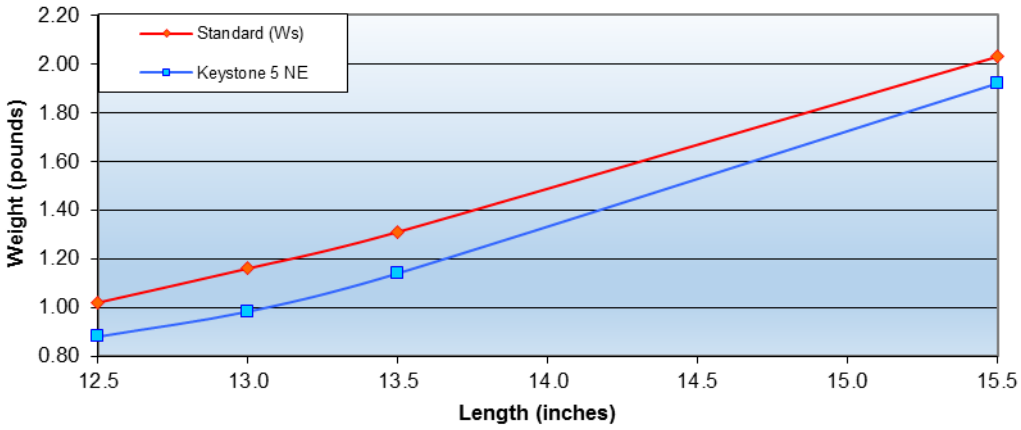

Figure 36. Comparison of Keystone 5 Northeast largemouth bass weights to standard largemouth bass weights.

Other species

Four redear sunfish were collected. The population is small and needs protected. A single white and black crappie were collected. These species are difficult to manage in

lakes of this size; however, the largemouth bass population is very small and crappie are likely preying on small gizzard shad.

SUMMARY AND RECOMMENDATIONS-KEYSTONE 5 NORTHEAST

The fishery in Keystone 5 Northeast is has an imbalance in the predator/prey assemblage. It appears that largemouth bass reproduction/recruitment has been suffering due to the presence of gizzard shad. A supplemental stocking should take place. Adding hybrid striped bass will aide in gizzard shad predation and provide an additional angling opportunity.

The following recommendations, **listed in order of importance**, will help protect and enhance the fishery in Keystone 5 Northeast:

1. Stock 75 5.0 to 8.0 inch largemouth bass in the spring of 2017.
2. Restrict largemouth bass harvest for the next two years.
3. Stock 25 5.0 to 7.0 inch hybrid striped bass in the spring of 2016.
4. No harvest restrictions are necessary on bluegill at this time. Harvest will reduce competition and improve growth rates.
5. Restrict harvest of redear sunfish for the next two years.
6. Add structure to the lake to provide cover for juvenile fish.
7. Conduct a Standard Fish Survey in 2018 in order to monitor the effects of the above recommendations and assess needs for further management activities.
8. Remove all green sunfish that are caught.
9. Stock 300 6.0 to 8.0 inch channel catfish if desired.

RESULTS AND DISCUSSION-KEYSTONE 7 FAR EAST

WATER CHEMISTRY

The results of selected physio-chemical parameters from Keystone 7 Far East are presented in Table 9. Water temperatures ranged from 65.8 degrees Fahrenheit at the surface to 59.5 degrees Fahrenheit at the bottom. Dissolved oxygen ranged from 8.40 ppm at the surface to 6.24 ppm at the bottom (Figure 37). A desirable oxygen level for maintenance of healthy stress free fish was present throughout the water column. These numbers indicate Keystone 7 Northeast was partially stratified at the time of the survey. The alkalinity level was 85.5 ppm. The hardness level was 119.7 ppm. The pH was 7.4. 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 1.0 feet. Nitrate-nitrogen levels were 0.50 ppm. Ortho-phosphate levels were 0.02 ppm. Keystone 7 Far East appears to have water quality which is capable of supporting a healthy fish population; however, high nutrient levels are concerning. These high levels can lead to nuisance microscopic algae blooms and dissolved oxygen fluctuations.

Table 9. Selected water quality parameters measured on Keystone 7 Far East, November 2, 2015.

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	65.80	8.40	7.4	85.5	119.7	0.50	0.02	0.65
3	60.40	7.45	-	-	-	-	-	-
6	59.50	6.24	-	-	-	-	-	-

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

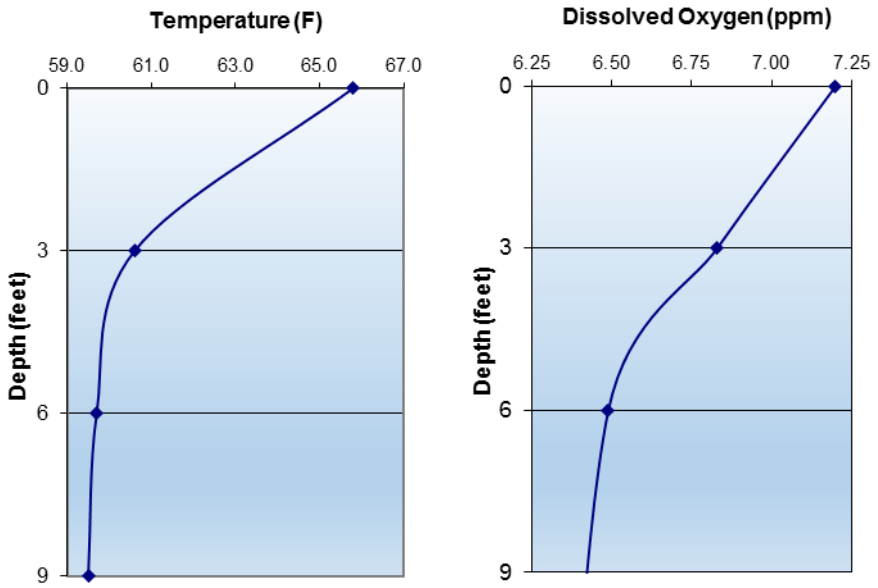

Figure 37. Temperature and dissolved oxygen profiles for Keystone 7 Far East, November 2, 2015.

FISH COLLECTION

A total of 71 fish weighing 7.74 pounds and representing six species was collected from Keystone 7 Far East (Table 10 & Figure 38). Bluegill was the most abundant species

comprising 63.38% of the fish collected. Gizzard shad and green sunfish tied for the second most abundant species (9.86%), followed by black crappie (8.45%), largemouth bass (3.53%), and channel catfish (2.82%). All of these species are desirable in a lake of this size with the exception of gizzard shad, green sunfish, and black crappie.

Table 10. Species collected from Keystone 7 Far East, November 2, 2015.

Species	N	% N	Size Range (in)	Total Weight (lbs.)	% Wt	N/hr.
Bluegill	45	63.38	<3-7.0	0.86	11.11	180
Gizzard shad	7	9.86	4.0-10.0	0.81	10.47	28
Green sunfish	7	9.86	<3-5.5	0.28	3.62	28
Black crappie	6	8.45	3.5-7.0	0.46	5.94	24
Largemouth bass	4	5.63	11.0-15.0	5.12	66.15	16
Channel catfish	2	2.82	7.5	0.21	2.71	8
Total	71	100.00		7.74	100.00	

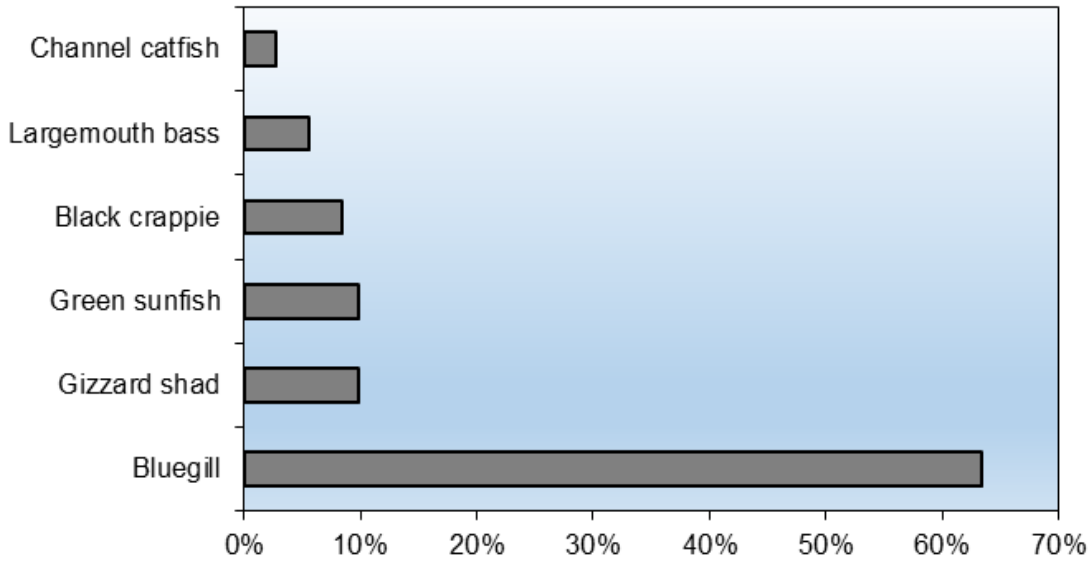

Figure 38. Relative abundance of species collected from Keystone 7 Far East, November 2, 2015.

Bluegill

Bluegill was the most abundant species collected (63.38%) and ranked second by weight (11.11%). Individuals ranged in size from less than 3.0 to 7.0 inches (Figure 39). Nearly

76% of bluegill collected were less than 3.0 inches. There were very few quality bluegill collected. This led to a proportional stock density of 9, which is well below the desired range of 20-40 for bluegill. Condition factors were below average for most sizes collected. Bluegill weights were average compared to standard weights for most sizes collected (Figure 40).

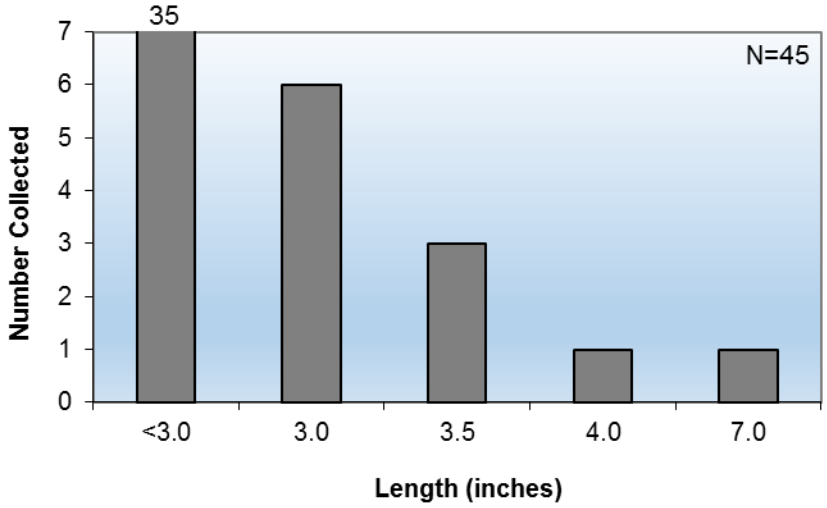

Figure 39. Length frequency distribution of bluegill collected from Keystone 7 Far East, November 2, 2015.

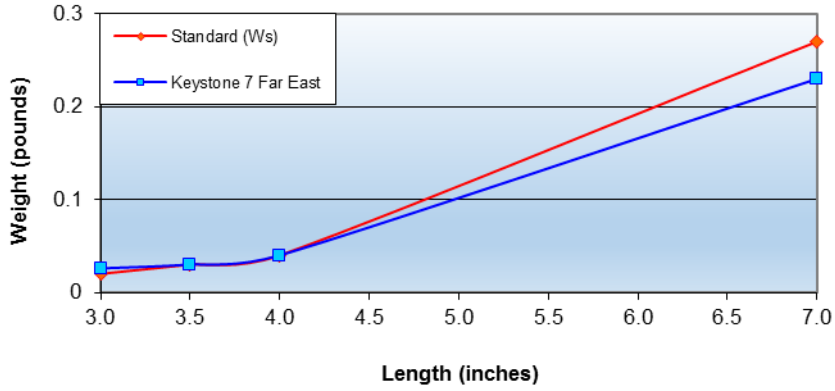

Figure 40. Comparison of Keystone 7 Far East bluegill weights to standard bluegill weights.

Gizzard shad

Gizzard shad was tied for second most abundant species collected (9.86%), and ranked third by weight (10.47%). A total of 7 gizzard shad ranging in size from 4.0 to 10.0 inches was collected.

Green sunfish

Green sunfish was tied for the second most abundant species collected (9.86%) and ranked fifth by weight (3.62%).

Black crappie

Black crappie was the third most abundant species (8.45%) and ranked fourth by weight (5.94%). Crappie typically aren't recommended in ponds this size; however, the largemouth bass population is very small, and they are likely preying on small gizzard shad.

Largemouth Bass

Largemouth bass was the fourth most abundant species collected (5.63%) and ranked first by weight (66.15%). There were only 4 largemouth bass collected ranging in size from 11.0 to 15.0 inches (Figure 41). Condition factors were good for all sizes collected. The average weights for the bass were below average compared to standard weights in all sizes collected (Figure 42).

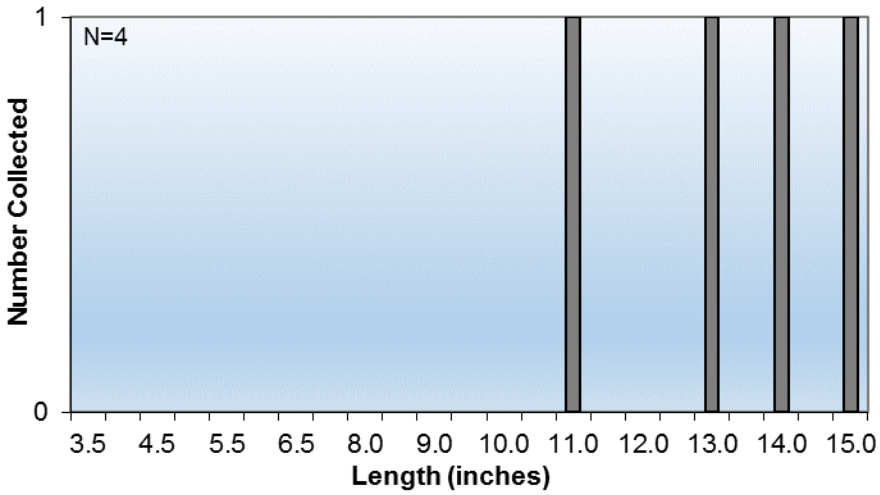

Figure 41. Length frequency distribution of largemouth bass collected from Keystone 7 Far East, November 2, 2015.

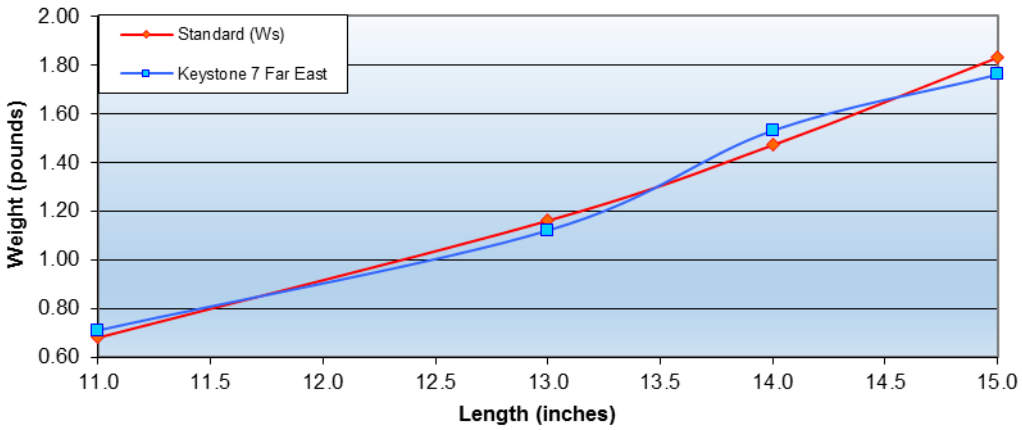

Figure 42. Comparison of Keystone 7 Far East largemouth bass weights to standard largemouth bass weights.

Channel catfish

Two channel catfish were collected during the survey. The population is likely larger than indicated; however, channel catfish don't reproduce well in ponds this size and will need to be restocked every 2-3 years if desired.

SUMMARY AND RECOMMENDATIONS-KEYSTONE 7 FAR EAST

The fishery in Keystone 7 Far East also suffers from the presence of gizzard shad and an imbalance in the predator/prey assemblage. The largemouth bass population is very small and needs restocked. The bluegill population primarily consists of small, juvenile fish. Stocking largemouth bass to supplement the population and careful management of other species should help shift the fishery towards a balanced state.

The following recommendations, **listed in order of importance**, will help protect and enhance the fishery in Keystone 7 Far East:

1. Stock 50 5.0 to 8.0 inch largemouth bass in the spring of 2017.
2. Restrict largemouth bass harvest for the next two years
3. No harvest restrictions are necessary at this time for bluegill.
4. Add structure to the lake to provide cover for juvenile fish.
5. Conduct a Standard Fish Survey in 2018 in order to monitor the effects of the above recommendations and assess needs for further management activities.
6. Remove all green sunfish that are caught.
7. Stock 250 6.0 to 8.0 inch channel catfish if desired.

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

APPENDIX A

GENERAL INFORMATION

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

Water temperature of a lake or pond affects the activity of "cold-blooded" animals such as fish and invertebrates as well as the amount of D.O. that water is capable of holding. Deeper ponds and lakes may thermally stratify in the summer months and result in deeper waters becoming depleted of oxygen. Lake stratification is a result of the peculiar property of water density changes with temperature. The density of all liquid changes with changes in temperature, however, water behaves in a special way. As most liquids are cooled the density, or relative weight, of the liquid increases due to the compaction of the molecules in the liquid, and conversely, as liquids are heated the density decreases. Water, because of its unique characteristics, is at its maximum density at 4 degrees Centigrade, or approximately 39.2 degrees Fahrenheit. When water is either heated above this temperature or cooled below this temperature its density decreases. This is why ice floats, or forms on the surface of lakes and ponds. A normal cycle of stratification in lakes in our region of the country, in early spring after ice out is as follows: the lake water will all be nearly the same temperature shortly after ice out and wind action on the lake

surface will induce circulation of the entire volume of water. As spring advances and the increased sunlight energy warms the surface waters, these become lighter and tend to separate from the deeper waters and essentially float on top of the cooler water. This continues until there is a very stable "layering" or stratification of water in the lake. There are three distinct layers of water in stratified lakes, as described by limnologists:

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

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

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

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

Alkalinity is the ability of water to buffer against pH changes upon the addition of an acid or base. The alkalinity of a lake or pond is generally determined by the characteristics of

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

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

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

Phosphorus is a major plant nutrient and is most often the limiting factor for algae and macrophyte (vascular plants) growth within an aquatic system. Total phosphorus levels in excess of 0.03 ppm indicate eutrophic conditions (Vollenwieder, 1968). Waters with excessive plant growth high nutrients and degraded water quality are typical of eutrophic lakes and ponds. Ortho-phosphorus is a measure of the dissolved inorganic phosphorus available for immediate plant uptake. Concentrations of ortho-phosphate above 0.045 ppm may be considered critical concentrations above which nuisance algae blooms could

be expected (Sawyer, 1948). The remainder of the total phosphorus is most likely bound onto particulate material and although not immediately available for uptake, could become available through biochemical degradation. Dissolved phosphorus is absorbed from the water column primarily by phytoplankton. Phosphorus supply to aquatic macrophytes is primarily from the sediment rather than from the water column. Phosphorus is released from sediment under anaerobic conditions but is precipitated to the sediment under aerobic conditions. Phosphorus can be precipitated from the water column by use of alum (aluminum sulfate). Sediment phosphorus can be inactivated and made unavailable to macrophytes by heavy applications of alum to the sediment surface.

EQUIPMENT AND METHODS

Water quality analysis equipment used in this survey included a YSI ProODO 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 Midwest Lake Electrofishing Systems Infinity Box 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

Keystone 1 Southwest

SIZE GROUP (IN)	NUMBER	PERCENTAGE	AVERAGE WEIGHT (lbs.)	TOTAL WEIGHT (lbs.)	CONDITION FACTOR	WS	RELATIVE WEIGHT
BLUEGILL							
<3.0	16	11.51%	0.01	0.16	-	-	-
3.0	24	17.27%	0.01	0.34	5.19	0.02	86
3.5	15	10.79%	0.03	0.39	6.06	0.03	96
4.0	26	18.71%	0.03	0.88	5.31	0.04	81
4.5	21	15.11%	0.04	0.88	4.61	0.06	67
5.0	17	12.23%	0.06	1.05	4.96	0.09	70
5.5	11	7.91%	0.08	0.92	5.05	0.12	69
6.0	7	5.04%	0.12	0.81	5.37	0.16	72
6.5	1	0.72%	0.19	0.19	6.92	0.21	90
7.0	1	0.72%	0.18	0.18	5.25	0.27	67
TOTAL	139			5.81			
GIZZARD SHAD							
4.0	1	1.11%	0.02	0.02			
4.5	4	4.44%	0.03	0.10			
5.0	3	3.33%	0.04	0.13			
5.5	1	1.11%	0.04	0.04			
6.5	1	1.11%	0.09	0.09			
7.0	20	22.22%	0.11	2.20			
7.5	19	21.11%	0.12	2.24			
8.0	5	5.56%	0.15	0.76			
8.5	8	8.89%	0.20	1.63			
9.0	3	3.33%	0.23	0.70			
10.0	4	4.44%	0.33	1.31			
10.5	2	2.22%	0.31	0.61			
11.0	9	10.00%	0.40	3.62			
11.5	6	6.67%	0.47	2.82			
12.0	4	4.44%	0.52	2.08			
TOTAL	90			18.35			
LARGEMOUTH BASS							
3.0	0	0.00%	-	-	-	0.01	-
3.5	0	0.00%	-	-	-	0.02	-
4.0	0	0.00%	-	-	-	0.03	-
4.5	0	0.00%	-	-	-	0.04	-
5.0	1	8.33%	0.04	0.04	3.20	0.06	-
5.5	1	8.33%	0.05	0.05	3.13	0.07	-

6.0	0	0.00%	-	-	-	0.10	-
6.5	0	0.00%	-	-	-	0.13	-
7.0	0	0.00%	-	-	-	0.16	-
7.5	2	16.67%	0.15	0.30	3.56	0.20	
8.0	0	0.00%	-	-	-	0.25	-
8.5	0	0.00%	-	-	-	0.30	-
9.0	0	0.00%	-	-	-	0.36	-
9.5	1	8.33%	0.40	0.40	4.67	0.43	94
10.0	0	0.00%	-	-	-	0.50	-
10.5	0	0.00%	-	-	-	0.59	-
11.0	0	0.00%	-	-	-	0.68	-
11.5	1	8.33%	0.69	0.69	4.54	0.78	88
12.0	1	8.33%	0.90	0.90	5.21	0.90	100
12.5	0	0.00%	-	-	-	1.02	-
13.0	1	8.33%	1.19	1.19	5.42	1.16	103
13.5	1	8.33%	1.22	1.22	4.96	1.31	93
14.0	1	8.33%	1.50	1.50	5.47	1.47	102
14.5	1	8.33%	1.35	1.35	4.43	1.64	82
15.0	0	0.00%	-	-	-	1.83	-
15.5	0	0.00%	-	-	-	2.03	-
16.0	1	8.33%	2.06	2.06	5.03	2.25	92
TOTAL	12			9.70			

REDEAR SUNFISH

6.0	1	16.67%	0.15	0.15
6.5	1	16.67%	0.18	0.18
7.0	2	33.33%	0.15	0.29
8.5	1	16.67%	0.50	0.50
10.0	1	16.67%	0.74	0.74
TOTAL	6			1.86

WHITE CRAPPIE

6.0	1	20.00%	0.08	0.08
6.5	2	40.00%	0.10	0.20
11.5	1	20.00%	0.62	0.62
13.0	1	20.00%	1.16	1.16
TOTAL	5			2.06

CHANNEL CATFISH

7.0	1	33.33%	0.08	0.08
21.0	1	33.33%	3.13	3.13
23.0	1	33.33%	4.23	4.23
TOTAL	3			7.44

GREEN SUNFISH

5.5	1	50.00%	0.10	0.10
6.0	1	50.00%	0.15	0.15
TOTAL	2			0.25

GRASS CARP

30.0	1	100.00%	15.75	15.75
TOTAL	1			15.75

Keystone 2 South

SIZE GROUP (IN)	NUMBER	PERCENTAGE	AVERAGE WEIGHT (lbs.)	TOTAL WEIGHT (lbs.)	CONDITION FACTOR	WS	RELATIVE WEIGHT
BLUEGILL							
<3.0	12	21.82%	0.01	0.12	-	-	-
3.0	3	5.45%	0.03	0.09	11.11	0.02	184
3.5	7	12.73%	0.02	0.17	5.60	0.03	89
4.0	8	14.55%	0.04	0.35	6.88	0.04	104
4.5	7	12.73%	0.05	0.35	5.49	0.06	80
5.0	2	3.64%	0.07	0.14	5.60	0.09	79
5.5	3	5.45%	0.08	0.23	4.63	0.12	63
6.0	3	5.45%	0.14	0.42	6.48	0.16	86
6.5	3	5.45%	0.20	0.60	7.28	0.21	95
7.0	5	9.09%	0.23	1.15	6.71	0.27	85
7.5	1	1.82%	0.28	0.28	6.64	0.34	83
9.0	1	1.82%	0.45	0.45	6.17	0.62	72
TOTAL	55			4.35			
GIZZARD SHAD							
3.5	1	2.70%	0.02	0.02			
6.5	2	5.41%	0.11	0.22			
7.0	3	8.11%	0.11	0.33			
7.5	4	10.81%	0.14	0.56			
8.0	3	8.11%	0.18	0.54			
8.5	1	2.70%	0.19	0.19			
9.0	4	10.81%	0.28	1.12			
9.5	2	5.41%	0.31	0.62			
10.0	8	21.62%	0.40	3.20			
10.5	4	10.81%	0.45	1.80			
11.0	3	8.11%	0.54	1.62			
12.0	1	2.70%	0.66	0.66			
12.5	1	2.70%	0.56	0.56			
TOTAL	37			11.44			
LARGEMOUTH BASS							
3.0	0	-	-	-	-	0.01	-
3.5	0	-	-	-	-	0.02	-
4.0	0	-	-	-	-	0.03	-
4.5	0	-	-	-	-	0.04	-
5.0	0	-	-	-	-	0.06	-

5.5	1	3.57%	0.07	0.07	4.21	0.07	-
6.0	0	-	-	-	-	0.10	-
6.5	2	7.14%	0.11	0.22	4.01	0.13	-
7.0	0	-	-	-	-	0.16	-
7.5	3	10.71%	0.25	0.75	5.93	0.20	-
8.0	1	3.57%	0.22	0.22	4.30	0.25	89
8.5	0	-	-	-	-	0.30	-
9.0	0	-	-	-	-	0.36	-
9.5	0	-	-	-	-	0.43	-
10.0	1	3.57%	0.46	0.46	4.60	0.50	92
10.5	4	14.29%	0.58	2.32	5.01	0.59	99
11.0	3	10.71%	0.62	1.86	4.66	0.68	91
11.5	1	3.57%	0.75	0.75	4.93	0.78	96
12.0	1	3.57%	0.90	0.90	5.21	0.90	100
12.5	1	3.57%	0.88	0.88	4.51	1.02	86
13.0	2	7.14%	1.00	2.00	4.55	1.16	86
13.5	3	10.71%	1.15	3.45	4.67	1.31	88
14.0	1	3.57%	1.21	1.21	4.41	1.47	82
14.5	1	3.57%	1.52	1.52	4.99	1.64	92
15.0	3	10.71%	1.62	4.86	4.80	1.83	88
TOTAL	28			21.47			

REDEAR SUNFISH

6.5	1	5.88%	0.17	0.17
7.0	3	17.65%	0.20	0.60
7.5	1	5.88%	0.24	0.24
8.0	4	23.53%	0.35	1.40
8.5	1	5.88%	0.32	0.32
9.0	5	29.41%	0.68	3.40
9.5	2	11.76%	0.48	0.96
TOTAL	17			7.09

BLACK CRAPPIE

5.5	1	100.00%	0.07	0.07
TOTAL	1			0.07

SMALLMOUTH BASS

15.0	1	100.00%	1.21	1.21
TOTAL	1			1.21

GREEN SUNFISH

4.0	1	100.00%	0.04	0.04
TOTAL	1			0.04

CHANNEL CATFISH

22.5	1	100.00%	4.35	4.35
TOTAL	1			4.35

Keystone 4 North

SIZE GROUP (IN)	NUMBER	PERCENTAGE	AVERAGE WEIGHT (lbs.)	TOTAL WEIGHT (lbs.)	CONDITION FACTOR	WS	RELATIVE WEIGHT
BLUEGILL							
<3.0	19	73.08%	0.01	0.19	-	-	-
3.0	2	7.69%	0.02	0.03	5.56	0.02	92
3.5	1	3.85%	0.03	0.03	7.00	0.03	111
4.0	1	3.85%	0.04	0.04	6.25	0.04	95
4.5	1	3.85%	0.05	0.05	5.49	0.06	80
6.0	1	3.85%	0.15	0.15	6.94	0.16	93
7.0	1	3.85%	0.21	0.21	6.12	0.27	78
TOTAL	26			0.70			
LARGEMOUTH BASS							
3.0	0	0.00%	-	-	-	0.01	-
3.5	0	0.00%	-	-	-	0.02	-
4.0	1	4.00%	0.03	0.03	4.69	0.03	-
4.5	0	0.00%	-	-	-	0.04	-
5.0	1	4.00%	0.05	0.05	4.00	0.06	-
5.5	2	8.00%	0.06	0.12	3.61	0.07	-
6.0	3	12.00%	0.09	0.27	4.17	0.10	-
6.5	2	8.00%	0.10	0.20	3.64	0.13	-
7.0	1	4.00%	0.11	0.11	3.21	0.16	-
7.5	1	4.00%	0.18	0.18	4.27	0.20	90
8.0	0	0.00%	-	-	-	0.25	-
8.5	0	0.00%	-	-	-	0.30	-
9.0	0	0.00%	-	-	-	0.36	-
9.5	0	0.00%	-	-	-	0.43	-
10.0	0	0.00%	-	-	-	0.50	-
10.5	0	0.00%	-	-	-	0.59	-
11.0	0	0.00%	-	-	-	0.68	-
11.5	0	0.00%	-	-	-	0.78	-
12.0	1	4.00%	0.85	0.85	4.92	0.90	95
12.5	4	16.00%	0.81	3.24	4.15	1.02	79
13.0	6	24.00%	0.98	5.87	4.45	1.16	84
13.5	1	4.00%	1.05	1.05	4.27	1.31	80
14.0	1	4.00%	1.26	1.26	4.59	1.47	86
14.5	1	4.00%	1.57	1.57	5.15	1.64	95
TOTAL	25			14.80			
GREEN SUNFISH							
5.5	1	20.00%	0.11	0.11			
7.0	4	80.00%	0.24	0.95			
TOTAL	5			1.06			

WARMOUTH

6.5	2	50.00%	0.20	0.39
7.0	2	50.00%	0.25	0.50
TOTAL	4			0.89

GIZZARD SHAD

6.0	1	100.00%	0.06	0.06
TOTAL	1			0.06

GRASS CARP

25.5	1	100.00%	8.93	8.93
TOTAL	1			8.93

Keystone 5 Northeast

SIZE GROUP (IN)	NUMBER	PERCENTAGE	AVERAGE WEIGHT (lbs.)	TOTAL WEIGHT (lbs.)	CONDITION FACTOR	WS	RELATIVE WEIGHT
BLUEGILL							
<3.0	63	45.99%	0.01	0.63	-	-	-
3.0	3	2.19%	0.01	0.03	3.70	0.02	61
3.5	8	5.84%	0.03	0.22	6.53	0.03	103
4.0	13	9.49%	0.03	0.39	4.69	0.04	71
4.5	18	13.14%	0.05	0.83	5.05	0.06	74
5.0	11	8.03%	0.07	0.77	5.60	0.09	79
5.5	7	5.11%	0.10	0.69	5.89	0.12	81
6.0	6	4.38%	0.13	0.80	6.20	0.16	83
6.5	3	2.19%	0.18	0.55	6.66	0.21	87
7.0	3	2.19%	0.26	0.77	7.49	0.27	95
7.5	1	0.73%	0.32	0.32	7.59	0.34	94
8.0	1	0.73%	0.31	0.31	6.05	0.42	74
TOTAL	137			6.31			
GIZZARD SHAD							
4.5	1	9.09%	0.04	0.04			
5.0	2	18.18%	0.05	0.09			

8.5	1	9.09%	0.18	0.18			
9.0	1	9.09%	0.24	0.24			
9.5	1	9.09%	0.30	0.30			
10.0	5	45.45%	0.33	1.65			
TOTAL	11			2.50			

GREEN SUNFISH

3.0	2	20.00%	0.01	0.02			
3.5	1	10.00%	0.02	0.02			
4.0	1	10.00%	0.05	0.05			
5.0	1	10.00%	0.01	0.01			
5.5	2	20.00%	0.13	0.25			
6.0	3	30.00%	0.15	0.45			
TOTAL	10			0.80			

LARGEMOUTH BASS

3.0	0	0.00%	-	-	-	-	-
3.5	0	0.00%	-	-	-	-	-
4.0	0	0.00%	-	-	-	-	-
4.5	0	0.00%	-	-	-	-	-
5.0	0	0.00%	-	-	-	-	-
5.5	0	0.00%	-	-	-	-	-
6.0	0	0.00%	-	-	-	-	-
6.5	0	0.00%	-	-	-	-	-
7.0	0	0.00%	-	-	-	-	-
7.5	0	0.00%	-	-	-	-	-
8.0	0	0.00%	-	-	-	-	-
8.5	0	0.00%	-	-	-	-	-
9.0	0	0.00%	-	-	-	-	-
9.5	0	0.00%	-	-	-	-	-
10.0	0	0.00%	-	-	-	-	-
10.5	0	0.00%	-	-	-	-	-
11.0	0	0.00%	-	-	-	-	-
11.5	0	0.00%	-	-	-	-	-
12.0	0	0.00%	-	-	-	-	-
12.5	1	16.67%	0.88	0.88	4.51	1.02	86
13.0	3	50.00%	0.98	2.95	4.47	1.16	85
13.5	1	16.67%	1.14	1.14	4.63	1.31	87
14.0	0	0.00%	-	-	-	-	-
14.5	0	0.00%	-	-	-	-	-
15.0	0	0.00%	-	-	-	-	-
15.5	1	16.67%	1.92	1.92	5.16	2.03	94
TOTAL	6			6.89			

REDEAR SUNFISH

7.0	1	25.00%	0.17	0.17			
7.5	2	50.00%	0.28	0.55			
8.0	1	25.00%	0.25	0.25			
TOTAL	4			0.97			

WHITE CRAPPIE

7.0	1	100.00%	0.14	0.14
TOTAL	1			0.14

BLACK CRAPPIE

8.0	1	100.00%	0.20	0.20
TOTAL	1			0.20

Keystone 7 Far East

SIZE GROUP (IN)	NUMBER	PERCENTAGE	AVERAGE WEIGHT (lbs.)	TOTAL WEIGHT (lbs.)	CONDITION FACTOR	WS	RELATIVE WEIGHT
BLUEGILL							
<3.0	34	75.56%	0.01	0.34	-	-	-
3.0	6	13.33%	0.03	0.16	9.63	0.02	160
3.5	3	6.67%	0.03	0.09	7.00	0.03	111
4.0	1	2.22%	0.04	0.04	6.25	0.04	95
7.0	1	2.22%	0.23	0.23	6.71	0.27	85
TOTAL	45			0.86			
GIZZARD SHAD							
4.0	1	14.29%	0.03	0.03			
4.5	1	14.29%	0.08	0.08			
5.0	3	42.86%	0.04	0.13			
9.0	1	14.29%	0.22	0.22			
10.0	1	14.29%	0.35	0.35			
TOTAL	7			0.81			
GREEN SUNFISH							
<3.0	1	14.29%	0.01	0.01			
3.0	2	28.57%	0.03	0.06			
3.5	2	28.57%	0.03	0.06			
4.0	1	14.29%	0.04	0.04			
5.5	1	14.29%	0.11	0.11			
TOTAL	7			0.28			
BLACK CRAPPIE							
3.5	1	16.67%	0.02	0.02			
5.0	1	16.67%	0.05	0.05			
5.5	1	16.67%	0.07	0.07			
6.0	2	33.33%	0.09	0.18			
7.0	1	16.67%	0.14	0.14			

TOTAL	6			0.46			

LARGEMOUTH BASS

3.0	0	0.00%	-	-	-	-	-
3.5	0	0.00%	-	-	-	-	-
4.0	0	0.00%	-	-	-	-	-
4.5	0	0.00%	-	-	-	-	-
5.0	0	0.00%	-	-	-	-	-
5.5	0	0.00%	-	-	-	-	-
6.0	0	0.00%	-	-	-	-	-
6.5	0	0.00%	-	-	-	-	-
7.0	0	0.00%	-	-	-	-	-
8.0	0	0.00%	-	-	-	-	-
8.5	0	0.00%	-	-	-	-	-
9.0	0	0.00%	-	-	-	-	-
9.5	0	0.00%	-	-	-	-	-
10.0	0	0.00%	-	-	-	-	-
10.5	0	0.00%	-	-	-	-	-
11.0	1	25.00%	0.71	0.71	5.33	0.68	104
11.5	0	0.00%	-	-	-	-	-
12.0	0	0.00%	-	-	-	-	-
12.5	0	0.00%	-	-	-	-	-
13.0	1	25.00%	1.12	1.12	5.10	1.16	97
13.5	0	0.00%	-	-	-	-	-
14.0	1	25.00%	1.53	1.53	5.58	1.47	104
14.5	0	0.00%	-	-	-	-	-
15.0	1	25.00%	1.76	1.76	5.21	1.83	96
TOTAL	4			5.12			

CHANNEL CATFISH

7.5	2	100.00%	0.11	0.21			
TOTAL	2			0.21			