2023 AURORA LAKE FISHERY EVALUATION

Prepared for:

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676 Rock Creek Drive
Aurora, OH 44202

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2023 Aurora Lake Fishery Evaluation

Final Report

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Authorization for Release

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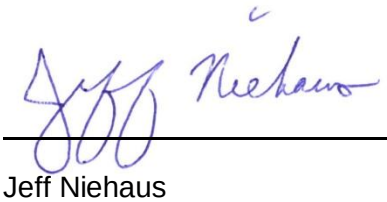

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1.0 INTRODUCTION

EnviroScience, Inc. performed a fish community assessment on Aurora Lake in Summit and Portage Counties, Ohio on June 21 – 22, 2023. The fish community was evaluated using night-boat electrofishing at three sampling zones of representative near-shore habitat (Figure 3.1). Night-boat electrofishing was initiated at dusk to effectively sample the most complete representative sample possible of the fish community. The goal of the study was to assess the status of the Aurora Lake fishery, to formulate recommendations for management of the Aurora Lake fishery, and to provide an update to previous surveys performed.

During the fishery evaluation, nuisance species that were encountered such as common carp (*Cyprinus carpio*) were netted and removed from the lake.

2.0 METHODS

Night-boat electrofishing was used to collect fish community data from representative habitats within Aurora Lake. Length and weight data were recorded for all fish collected. The collection methods are summarized in the following paragraphs.

2.1 ELECTROFISHING

A Smith-Root® 5.0 GPP Electrofisher was used to sample the fish community at three sampling zones. The electrofisher supplied pulsed-direct current to anodes mounted to a boom on the front of a 16-ft boat. During electrofishing, the control unit was adjusted according to the conductivity of the water and fish capture effectiveness and response. The electrofisher was adjusted to 15-20% (600 volts at 4-8 amps) of its available power at 120 pulses per second.

Electrofishing was conducted at night because of the well-established tendency of fish to come closer to shore in shallower water to night feed. When electricity was applied, the fish became temporarily stunned and floated to the surface where they were netted. To aid in capture, the safety rails of the electrofishing boat were equipped with flood lamps. The boat was maneuvered by directing the bow toward the shore and/or submerged objects while shocking the near shore area. The boat continued in this manner in one direction down the shoreline. Each of the sampling zones was approximately 600 meters (1970 ft) in length and all available habitats were sampled for at least 2000 seconds.

All fish were weighed, measured for total length, and examined for the presence of gross external anomalies. Gross external or DELT (deformities, erosions, lesions, and tumors) anomalies are defined as externally visible skin or subcutaneous disorders. Anomalies, if present, were recorded.

In the case of samples composed entirely of one size class of the same species (e.g., adults, juveniles, young-of-year), weighing was performed on a subsample of fish either as individuals or in aggregate as a species. If there was a noticeable variation in sizes between individual fish of a species, individual weights were taken. All results were recorded on data sheets for each sampling zone.

2.2 CATCH PER UNIT EFFORT AND PROPORTIONAL STOCK DENSITY ANALYSIS

An attempt was made to apply equal electrofishing effort (approximately 2000 seconds) in each 600 meter sampling zone. The catch per unit effort (CPUE) was calculated for 2000 seconds, allowing for equal comparison between zones.

To gain further insight to the quality of the largemouth bass, bluegill sunfish, and crappie population structure, a Proportional Stock Density analysis (PSD) was performed. This value was calculated by dividing the number of quality size and larger fish by the total number of fish that were the minimum stock size and larger, then multiplying the quotient by 100 (Anderson 1979, Murphy and Willis 2000). A quality size fish is defined as the minimum length that most anglers prefer to catch. A stock length fish is a fish at approximate maturity, and/or an individual that is the minimum length of fish that can provide recreational value. The minimum stock and quality sizes for largemouth bass are ≥8.0 inches and ≥12.0 inches (20 cm and 30 cm), respectively. The stock sizes and quality sizes for crappie are ≥5.0 inches and ≥8.0 inches (13 cm and 20 cm), respectively. The stock sizes and quality sizes for bluegill are ≥3.0 inches and ≥6.0 inches (8 cm and 15 cm), respectively (Anderson 1979, Murphy and Willis 2000).

The PSD provides valuable understanding of the current adult population and an estimate of recruitment for the following season. The PSD is typically calculated for bass and bluegill, which are generally the major fish of concern to anglers and fishery managers. Crappie were also chosen for this survey since they are also a species of interest to anglers, and because, like bass and bluegill, data have been collected for crappie for many years at Aurora Lake. Analysis of PSD values can also identify problems with reproduction, growth, and mortality. To sustain a quality fishery, optimum PSD values are 40-70 for largemouth bass, 30-60 for crappie, and 20-60 for bluegill (Anderson, 1979, Murphy and Willis 2000). Values within these ranges represent a balanced fish population that is intermediate between the extremes of many small fish, and fewer large fish.

2.3 WATER CHEMISTRY

A multi-parameter YSI ProDSS was used to collect water quality data in an open water location during the survey (Table 2.1; Figure 3.1). The parameters recorded were temperature, pH, dissolved oxygen (DO), DO%, and conductivity. The data were collected at 1.0-meter depths from water surface to 5.0 meters at approximately 8:40 p.m. on June 21, 2023. All water quality values observed were typical for lakes in Northeast Ohio during late spring / early summer.

Table 2.1 Water Chemistry Data, 6/21/2023, 8:40 p.m.

Location: Open Water 41.3301°, -81.3865°					
Depth (meters)	**Temp. (°C)**	**pH**	**Dissolved Oxygen (mg/L)**	**DO%**	**Conductivity (µS/cm)**
Surface	24.5	8.39	8.89	106.8	611
0.5	24.3	8.5	8.33	101.8	612
1	24.5	8.39	8.86	106.4	611
2	24.4	8.37	8.75	104.6	611
3	23.9	8.1	7.72	90.4	614
4	23.6	7.7	6.3	65.4	612
5 (bottom)	23.6	7.52	0.65	4.5	613

3.0 RESULTS

3.1 FISH SURVEY

In total, 11 species of fish were collected in the Aurora Lake study area (Table 3.1). Catch per unit effort was adjusted to 2000 electrofishing seconds per zone. Using this adjustment, the fish collection totaled 985 individuals and 227.4 kg (501.3 lbs.) of fish (Tables 3.2 and 3.3). The three dominant fish species in contribution to total abundance included the bluegill sunfish (*Lepomis macrochirus*), pumpkinseed sunfish (*Lepomis gibbosus*), and largemouth bass (*Micropterus salmoides*). A total of 438 bluegill sunfish were sampled, contributing to 51.7% of the total fish abundance. A total of 115 pumpkinseed sunfish were sampled, contributing to 13.6% abundance. A total of 75 largemouth bass were sampled, contributing to 8.9% abundance (Figure 3.1; Table 3.2). Largemouth bass contributed 12.4% to the total mass, while bluegill sunfish and pumpkinseed sunfish contributed 4.8% and 2.5% to the mass, respectively (Figure 3.2; Table 3.3). Nuisance fish species collected during the fishery evaluation were removed from Aurora Lake. This included a total of 38 common carp (315.1 lbs., 142.9 kg).

Figure 3.1 Aurora Lake Electrofishing Sampling Zones

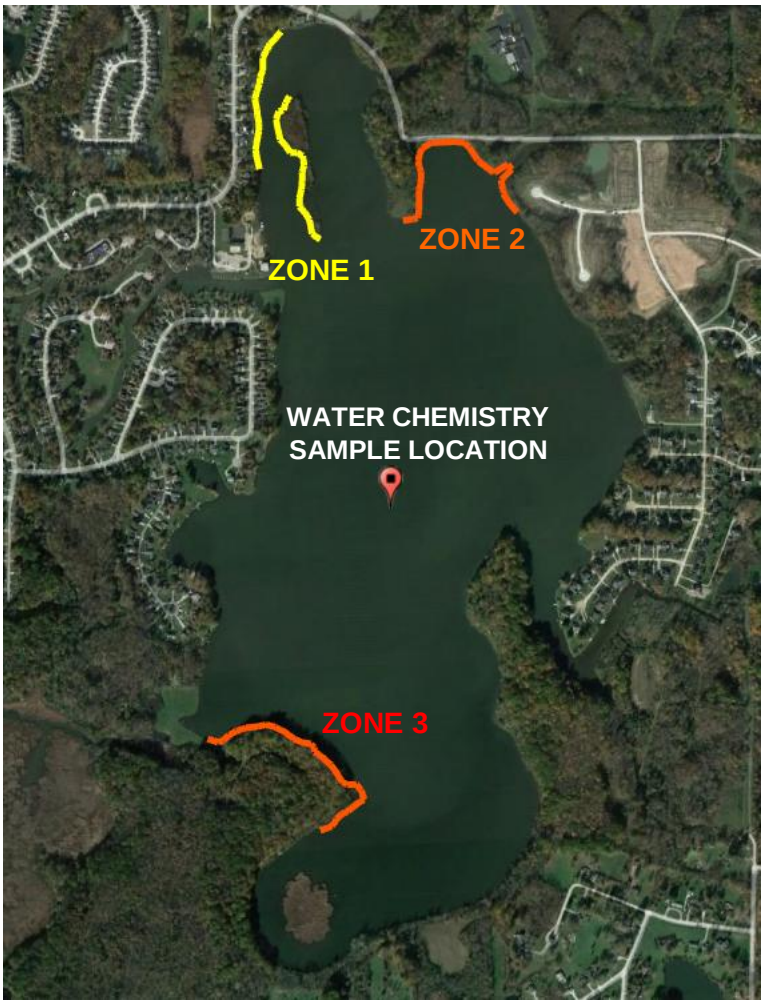


Table 3.1 Fish Species List

Common Name	Species
Black crappie	*Pomoxis nigromaculatus*
Bluegill sunfish	*Lepomis macrochirus*
Brook silverside	*Labidesthes sicculus*
Channel catfish	*Ictalurus punctatus*
Common carp	*Cyprinus carpio*
Golden shiner	*Notemigonus crysoleucas*
Largemouth bass	*Micropterus salmoides*
Pumpkinseed sunfish	*Lepomis gibbosus*
Warmouth sunfish	*Lepomis gulosus*
Yellow bullhead	*Ameiurus natalis*
Yellow perch	*Perca flavescens*

Table 3.2 Electrofishing Abundance and Catch Per Unit Effort for 2000 Seconds Results

Species	Zone 1	Zone 2	Zone 3	Total	% Total Abundance
Black crappie 0-15 cm	0.0	11.9	13.0	24.9	3.0
Black crappie 15-25 cm	9.1	2.4	2.0	13.5	1.6
Black crappie 25-40 cm	2.3	0.8	0.0	3.1	0.4
Bluegill sunfish 0-15 cm	67.0	164.8	92.0	323.9	38.5
Bluegill sunfish >15 cm	25.1	20.7	66.0	111.8	13.3
Brook silverside	0.8	0.8	3.0	4.6	0.5
Channel catfish	8.4	12.7	10.0	31.1	3.7
Common carp	17.5	4.0	10.0	31.5	3.7
Golden shiner	4.6	7.2	4.0	15.7	1.9
Largemouth bass 0-15 cm	1.5	4.8	9.0	15.3	1.8
Largemouth bass 15-25 cm	9.9	10.4	1.0	21.3	2.5
Largemouth bass >25 cm	11.4	15.1	12.0	38.6	4.6
Pumpkinseed sunfish 0-15 cm	13.7	27.1	39.0	79.8	9.5
Pumpkinseed sunfish >15 cm	15.2	12.7	7.0	35.0	4.2
Warmouth sunfish	2.3	0.8	0.0	3.1	0.4
Yellow bullhead	8.4	1.6	3.0	13.0	1.5
Yellow perch 0-20 cm	1.5	16.7	48.0	66.2	7.9
Yellow perch >20 cm	0.8	0.0	9.0	9.8	1.2
Total #	**199.6**	**314.5**	**328.0**	**842.1**	**100.0**

Table 3.3 Electrofishing Mass Results (lbs.)

Species	Zone 1	Zone 2	Zone 3	Total	% Total Mass	Avg Mass / Fish (lbs)
Black crappie 0-15 cm	0.0	0.6	0.6	1.2	0.3	0.04
Black crappie 15-25 cm	1.8	0.8	0.7	3.2	0.8	0.19
Black crappie 25-40 cm	2.2	0.5	0.0	2.7	0.6	0.67
Bluegill sunfish 0-15 cm	0.2	0.8	2.6	3.6	0.9	0.01
Bluegill sunfish >15 cm	6.8	5.6	4.5	16.9	4.0	0.14
Brook silverside	0.01	0.02	0.04	0.1	0.0	0.01
Channel catfish	15.1	21.5	16.7	53.2	12.6	1.44
Common carp	129.0	31.9	105.8	266.6	62.9	7.02
Golden shiner	0.5	0.8	0.4	1.8	0.4	0.09
Largemouth bass 0-15 cm	0.1	0.2	0.2	0.4	0.1	0.03
Largemouth bass 15-25 cm	2.4	2.5	0.2	5.0	1.2	0.19
Largemouth bass >25 cm	13.9	13.1	20.2	47.3	11.2	1.03
Pumpkinseed sunfish 0-15 cm	0.1	1.9	1.7	3.7	0.9	0.04
Pumpkinseed sunfish >15 cm	2.4	2.6	1.8	6.8	1.6	0.16
Warmouth sunfish	0.2	0.1	0.0	0.2	0.0	0.05
Yellow bullhead	3.3	0.5	1.5	5.3	1.2	0.33
Yellow perch <20 cm	0.1	0.0	2.0	2.1	0.5	0.03
Yellow perch >20 cm	0.2	1.4	2.3	3.9	0.9	0.39
Total mass (lbs.)	**178.2**	**84.8**	**160.9**	**423.9**	**100.0**	

Figure 3.2 Fish Species Percent Contribution to Abundance

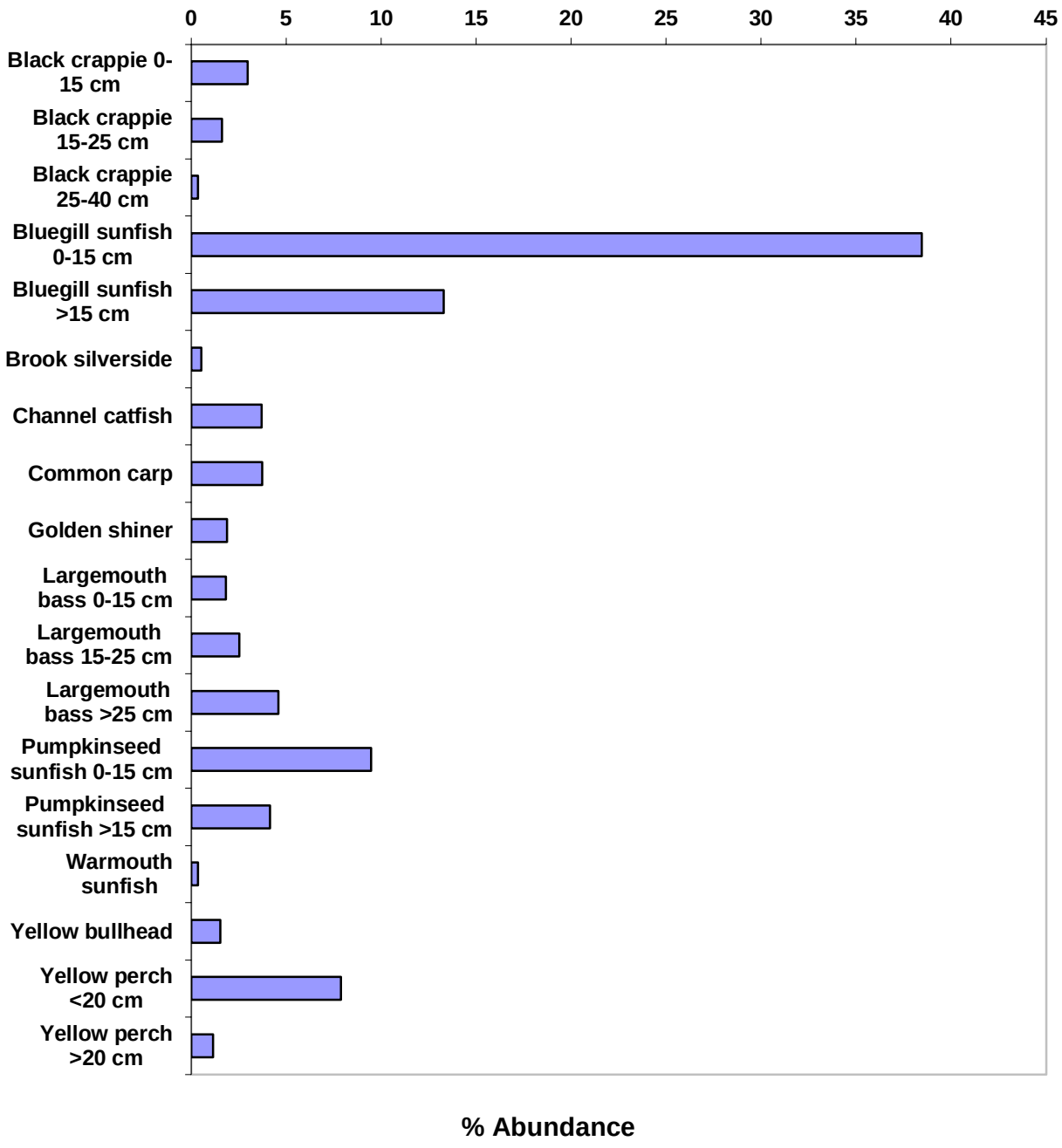
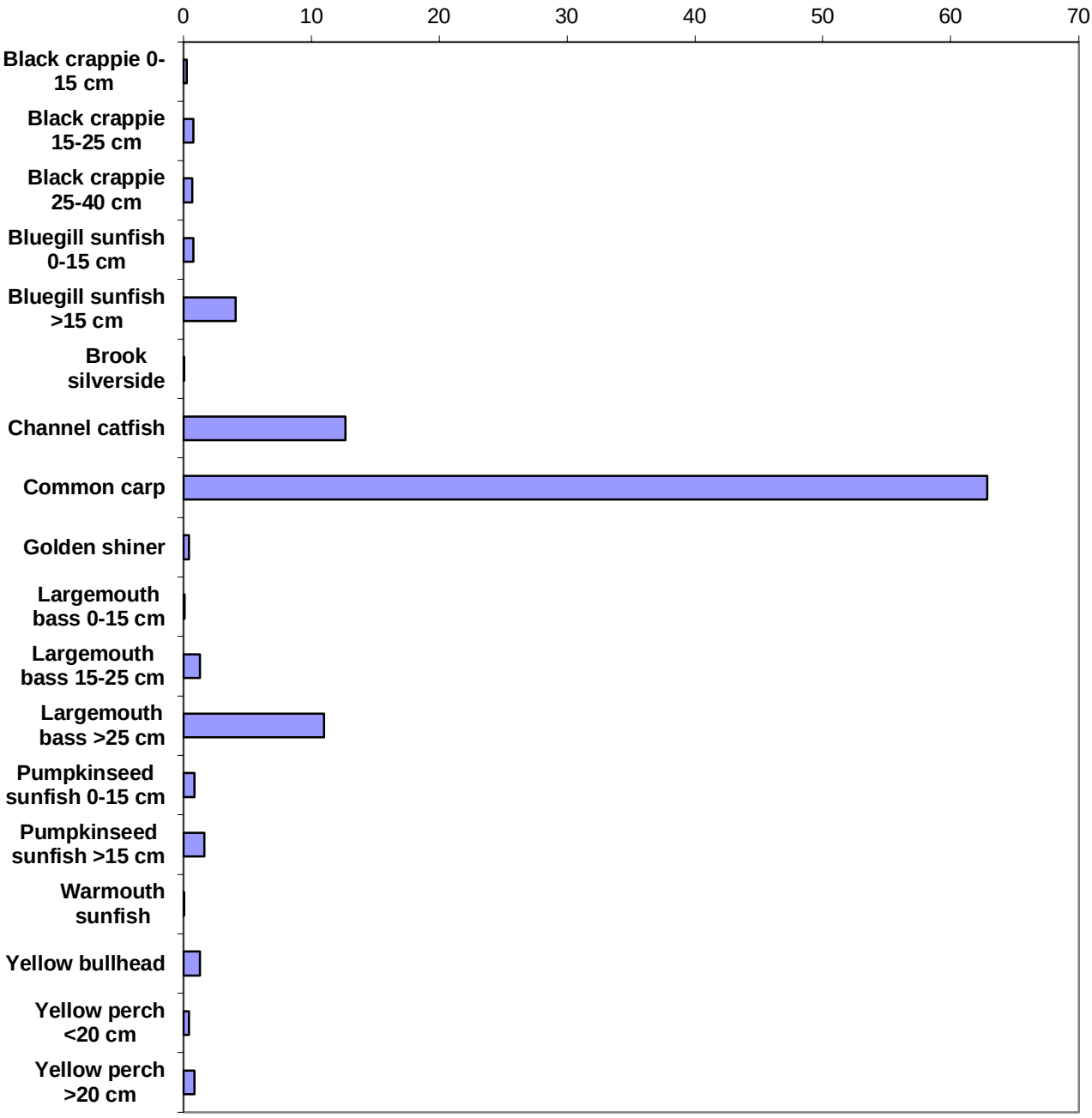


Figure 3.3 Fish Species Percent Contribution to Mass



3.2 CATCH PER UNIT EFFORT AND PROPORTIONAL STOCK DENSITY ANALYSIS

Each sampling zone was electrofished for at least 2000 seconds, then catch per unit effort (CPUE) was calculated at 2000 seconds to standardize comparison between sampling zones for 2023 as well as all previous surveys conducted on Aurora Lake. CPUE was highest overall in zones 2 and 3, where approximately 315 and 328 fish were recorded, respectively (Table 3.2). Zone 1 had a slightly lower CPUE of approximately 200 fish.

The proportional stock density was calculated for largemouth bass, bluegill, and black crappie. The PSD for the total number of largemouth bass collected was 64 (up from 37 in 2021), (Table 3.4). This value is just slightly higher than the target largemouth bass PSD range of 40-60 (Murphy and Willis 2000), which indicates a larger proportion of quality size largemouth bass (30-38 cm) to stock size largemouth bass (20-30 cm). The PSD value for bluegill was 30 (up from 11 in 2021). This value sits in the middle of the optimal range of PSD values of 20-40 and indicates a balance between quality size bluegill (15-20 cm) and stock size bluegill (8-15 cm). The PSD value for black crappie was 19 (down from 28 in 2021). This value has fallen from slightly below the desired crappie PSD range of 30-60, to well below it, indicating a much higher proportion of stock size black crappie (13-20 cm) to quality size black crappie (20-25 cm).

Length-frequency histograms were created for largemouth bass, bluegill, and black crappie to present the proportional size-classes of these fish populations (Figures 3.4, 3.5 and 3.6). These histograms can also be used for evaluations of trends in the fish community between this survey and future surveys, as well as previous surveys where data are available. Monitoring fish population dynamics is an integral part of lake management efforts such as stocking and habitat modifications.

Table 3.4. Proportional Stock Density (PSD) Results

Species	PSD value	Optimal range
Largemouth bass	64	40-60
Bluegill sunfish	30	20-40
Black crappie	19	30-60

Figure 3.4 Largemouth Bass Length-Frequency

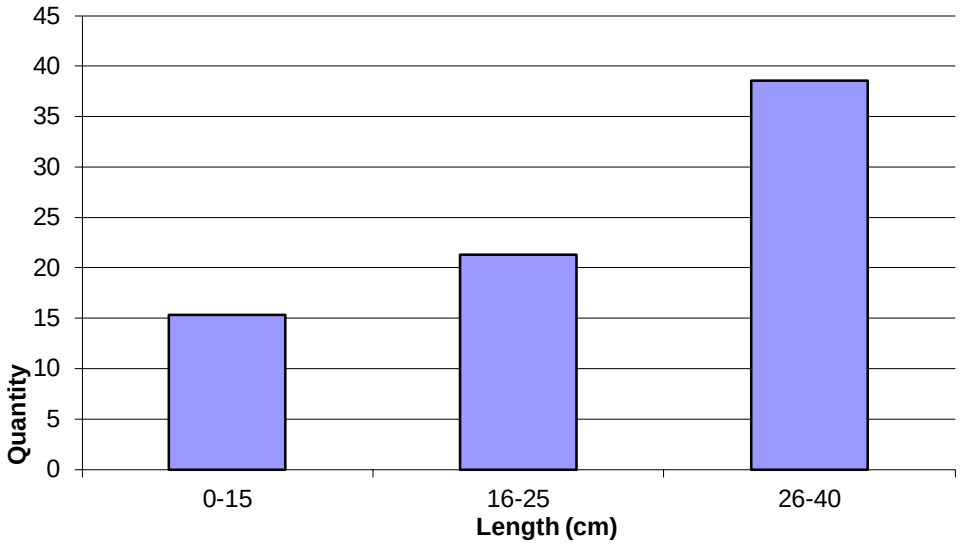


Figure 3.5 Bluegill Length-Frequency

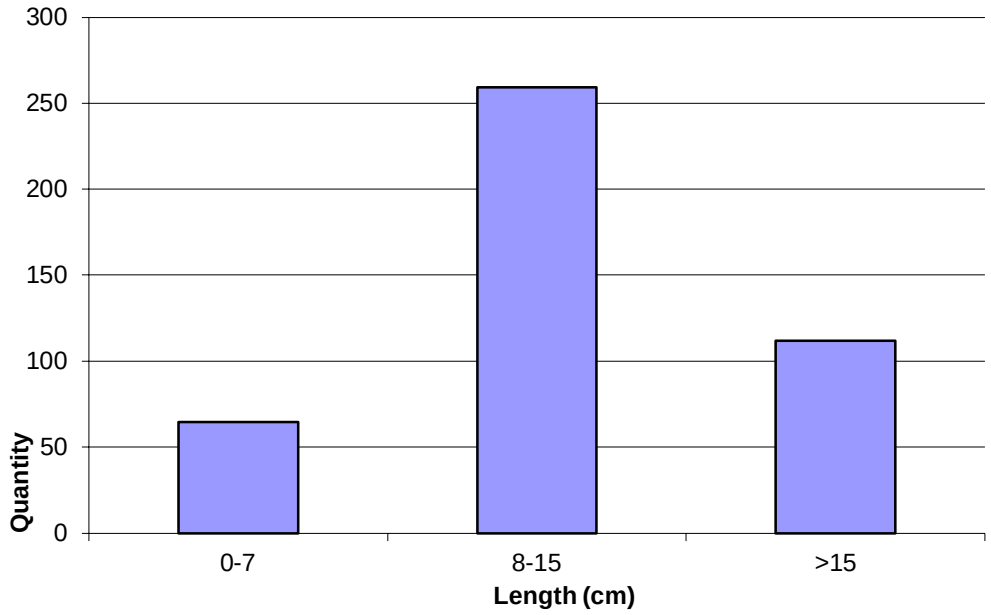
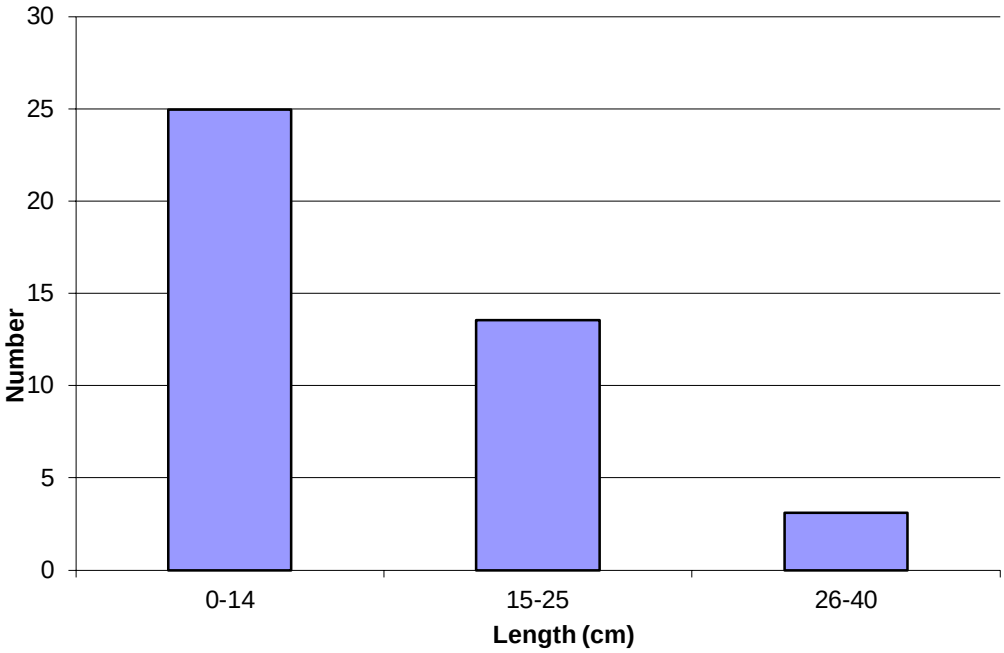


Figure 3.6 Black Crappie Length-Frequency



3.3 SAMPLING ZONE ANALYSIS

Sampling zones were analyzed and compared using total catch per unit effort (Table 3.2).

Zone 1:
This sampling zone was located at the northwest shoreline of Aurora Lake (Figure 3.1), beginning at the first dock north of the swimming area, and continuing north along the shoreline until just after the last house. Then the zone crosses south and includes the island areas. Habitat in this zone is characterized mostly by boat dock platforms, submerged dock supports and shoreline riprap, while the second half of the zone (island areas) includes submerged vegetation, roots, logs, and other woody debris. This zone was characterized as having the lowest CPUE value overall. Approximately 23 largemouth bass were collected when CPUE was adjusted for 2000 seconds. Bluegill was the most abundant species, not only in this zone but across all zones. The CPUE for bluegill was approximately 92 fish. Pumpkinseed were the second most abundant species at 29 fish. All eleven species from were encountered in this zone.

Zone 2:
Sampling zone 2 was located along the northeast shoreline of Aurora Lake, starting at the point across from the island areas and continuing to the east, including a portion of the Aurora Lake Rd inlet cove, and continuing for a bit along the shore to the southeast. Habitat in this zone consisted of overhanging trees and shrubs, submerged logs, and some areas containing riprap. Bluegill sunfish were the most abundant species in this zone with a CPUE value of 185. Largemouth bass CPUE value was approximately 30 individuals, and pumpkinseed sunfish CPUE value was approximately 40. This zone contained the best habitat of the three zones, which is reflected by the number of bluegill and larger largemouth bass (>25 cm, CPUE ~15).

Zone 3:
This sampling zone was located in the southern portion of the Aurora Lake, starting at the point west of the island area, and continuing west towards the dam. Habitat in this zone also consisted mainly of overhanging tree limbs and submerged logs, but shallower overall than zone 2. All species but warmouth were encountered in this zone. Bluegill sunfish were the most abundant fish in this zone, with a CPUE value of 158. Yellow perch were the second most abundant species, with a CPUE of 57. This was considerable higher than the number of yellow perch sampled in zone 1 and zone 2 (approximately 2 and 17, respectively). Pumpkinseed sunfish were the third most abundant at 46, and largemouth bass were the fourth most abundant species encountered, with a CPUE value of 22.

4.0 DISCUSSION

The results of the fishery evaluation indicate that Aurora Lake is currently a largemouth bass and bluegill dominated fishery. The PSD values and size class distributions show a positive trend in both species. Although the overall numbers of bluegill have declined, the proportion of quality size to stock size bluegill is optimal. The 2021 fish survey showed a potential upward trend in the numbers of largemouth bass and bluegill, while a potential downward trend in the numbers of black crappie, and this is exactly what is occurring in 2023.

Black crappie numbers in Aurora Lake are at an all-time low. EnviroScience has been surveying the lake for over 20 years, and not only is black crappie abundance lower than any other survey year, but for the first time there were no white crappies encountered in the survey. The crappie fishery at Aurora Lake in previous years has thrived, especially between the years of 2007 and 2013. It isn't likely that the largemouth bass or other fish predators in the lake are causing the crappie crash; there are ample amounts of forage in the form of juvenile bluegill. Whatever the cause, if the crappie fishery is valued at Aurora Lake, protections such as size limits and daily bag limits should be implemented. The crappie fishery should continue to be monitored in future fish surveys.

The largemouth bass population at Aurora Lake has been trending in a good direction since the last survey in 2021. The results of the surveys up until then implied a suboptimal bass fishery, with relatively low abundance and biomass. Since the largemouth bass population is dependent largely on bluegill for forage, the health of the bluegill population is having a positive effect on the health of the largemouth bass population. There is a variety of shoreline cover and habitat suitable for bass in the lake, including submerged tree limbs and shrubs, boat docks, and some sparse emergent vegetation (i.e., lily pads), that is helping the population thrive. Increasing and enhancing this cover and habitat and reducing turbidity would help to enhance the success of the largemouth bass population and fishery.

Common carp continue to be a problem at Aurora Lake. The species has been part of the fish community since before EnviroScience began fish studies at the lake. EnviroScience has removed common carp and grass carp collected during the surveys, and in many of those years, performed additional carp removal. In 2005, there were only 10 carp encountered and removed during the survey, totaling only 69 lbs. This was the lowest carp occurrence of all surveys. From 2002 to 2009, carp numbers varied anywhere from 10 to 123 fish (2008). In 2010, there were 217 carp removed totaling 1,854 lbs. This was similar to the 2021 total of 207 carp totaling 1,984 lbs. There were 38 common carp and zero grass carp encountered and removed during the 2023 survey, totaling 351 pounds, which is low compared to other years. This could be a sign that carp management strategies such as bowfishing and targeted electrofishing events are working to reduce their numbers. Although it's almost impossible to rid the lake completely of carp, regular removal of carp is strongly recommended on at least an annual basis. Their tendencies to stir the lake's sediment, directly and indirectly impeding the spawning success of other species, destroying beneficial habitat, and increasing turbidity and the already overabundant nutrient levels of lakes, have been well-documented.

Table 4.1 Select Fish Abundance Comparison by Year

Year	Largemouth bass	Bluegill	Black crappie	Common carp and grass carp	
				Abundance	Mass (lbs.)
2002	21	201	60	45	286
2003	25	231	60	93	523
2004	18	177	119	71	602
2005	18	286	76	10	69
2006	17	396	51	70	582
2007	59	836	217	105	738
2008	41	686	140	123	775
2009	27	328	144	81	530
2010	34	503	***291***	***250***	***2141***
2011	61	978	85	66	539
2012					
2013	46	507	145	50	461
2014					
2015					
2016					
2017					
2018				297	
2019					
2020					
2021	***112***	***1170***	68	207	1984
2023	75	436	42	38	351

*numbers in bold are highest value per category

**gray boxes represent years without a fishery survey (targeted carp management only in 2018); 2010 and 2018 contained 3 targeted carp events; 2021 contained one targeted carp event

Figure 4.1 Largemouth Bass Abundance by Year

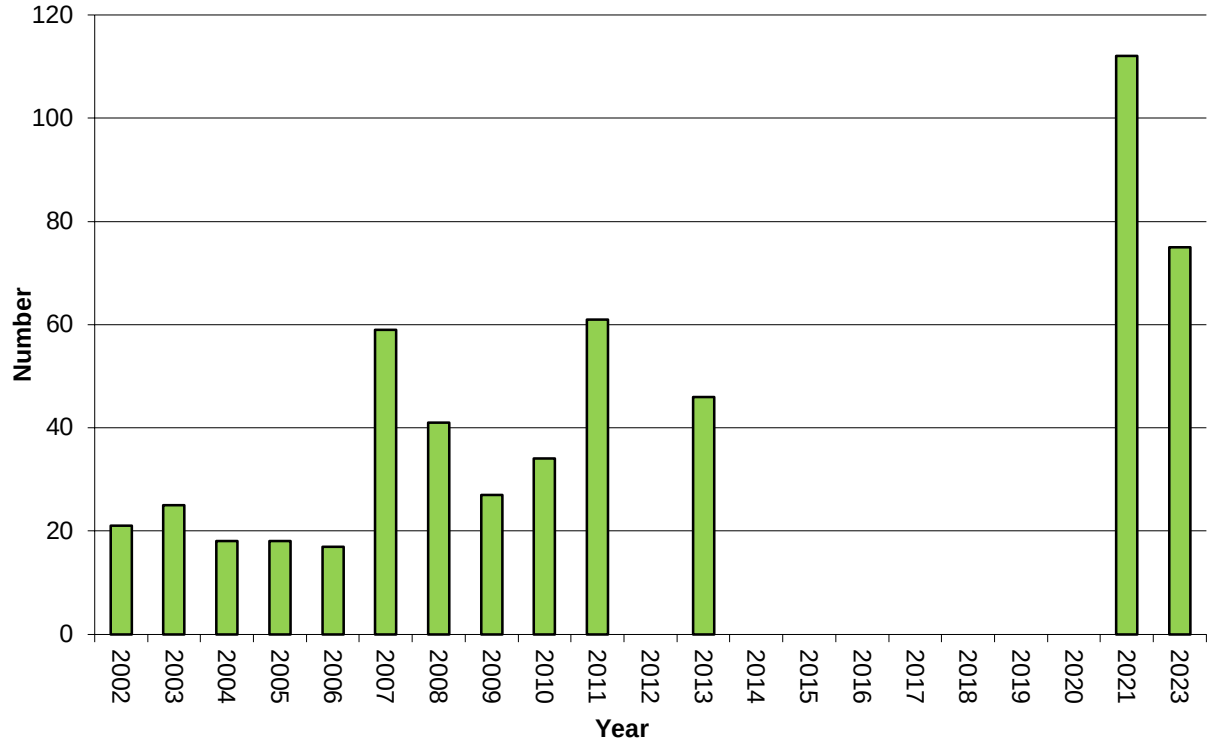


Figure 4.2 Bluegill Abundance by Year

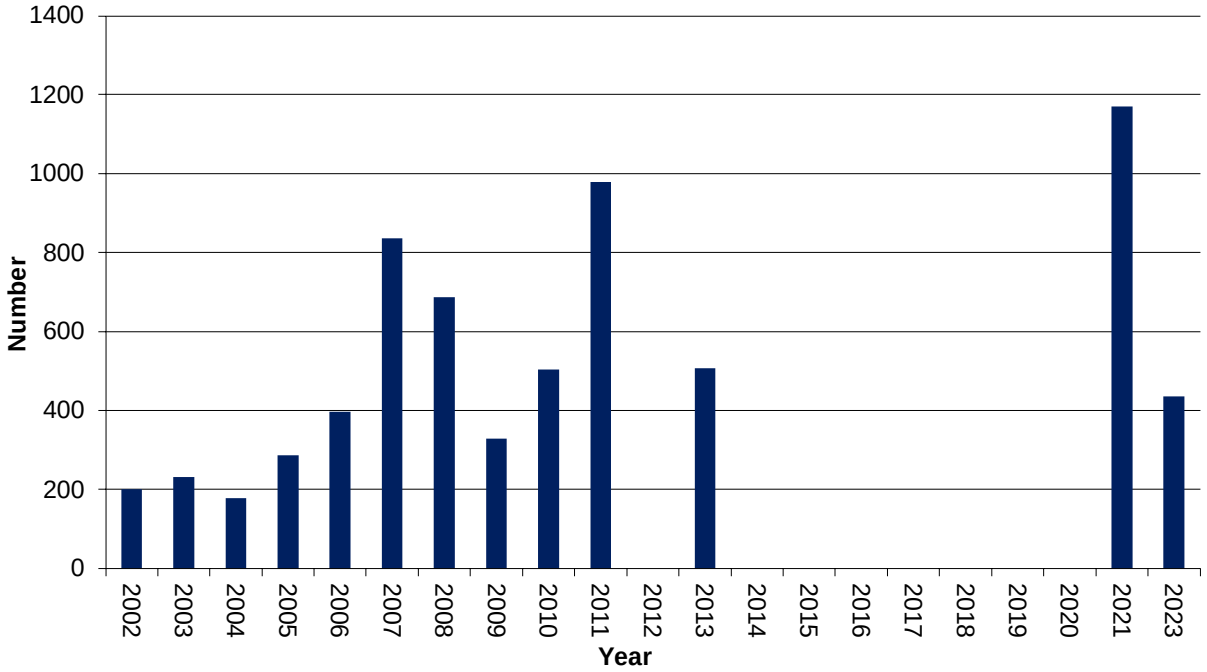


Figure 4.3 Black Crappie Abundance by Year

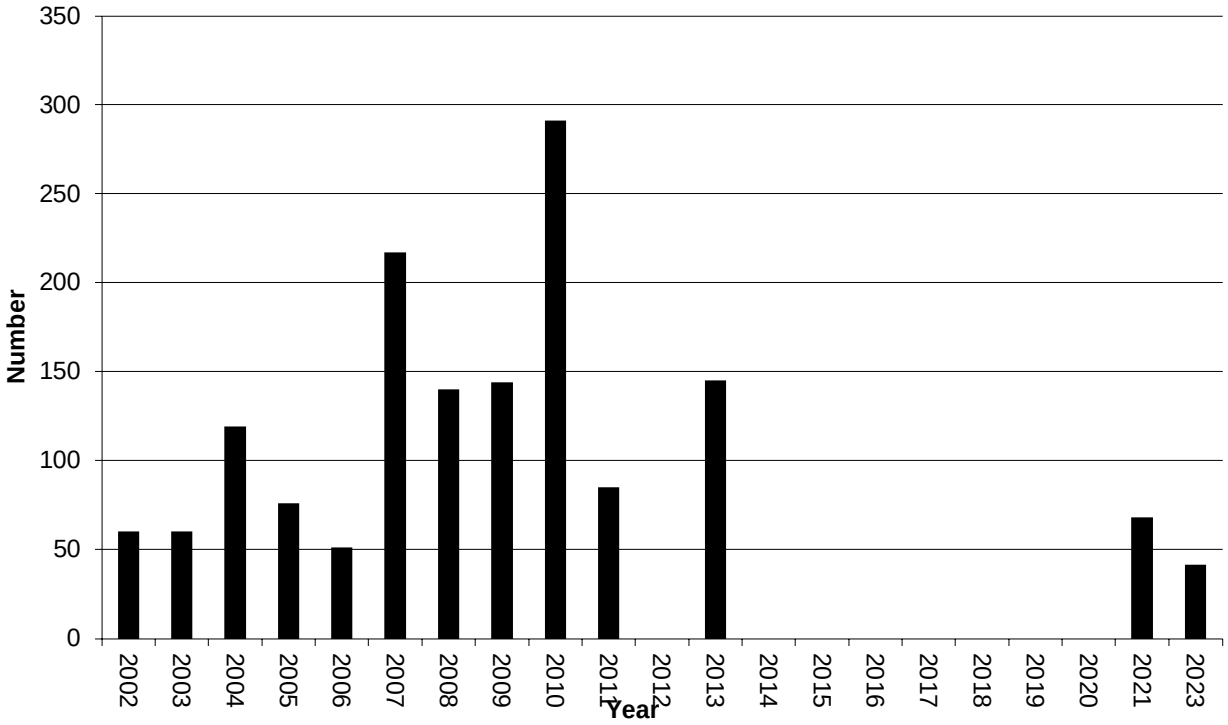
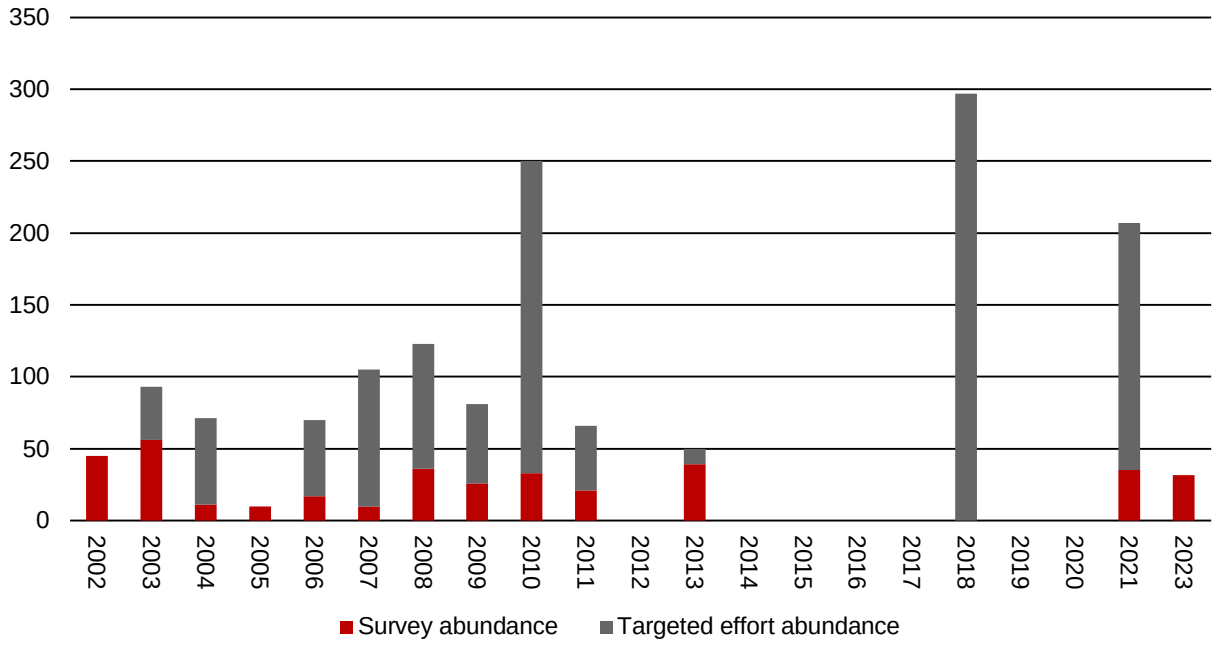


Figure 4.4 Common Carp and Grass Carp Abundance by Year



5.0 RECOMMENDATIONS

EnviroScience, Inc. recommends the following management practices to support a healthy sustained fishery at Aurora Lake.

- Black Crappie:
  The abundance, total mass, and PSD values for black crappie have all decreased since the survey in 2021 and have dramatically decreased compared to the peak years between 2007 – 2013. The results of the 2023 survey show that black crappie abundance is at an all time low at Aurora Lake. A daily bag limit of 10 fish with a minimum size of 9-inches should be instated until the black crappie population returns to a more balanced fishery (PSD value = 30-60). Aurora Lake has supported a strong crappie fishery in the past and should be protected against overharvest. Once the fishery returns to a balance state, it is recommended that the daily bag limit can increase, but the minimum size limit of 9-inches should remain in place. This size limit is consistent with many inland lakes in Ohio.

- Largemouth Bass:
  If there is a current catch and release rule for largemouth bass, it is working. The PSD value for largemouth bass favored quality size bass over stock size bass, which is just outside of that optimal balance, but a better scenario than the lower PSD of the 2021 survey. Regardless, if any anglers are harvesting largemouth bass, a catch and release practice should be encouraged to promote a stronger population of preferred size (15-20 inch) bass and larger. If PSD values get significantly higher, then a bag limit and/or slot limit could be imposed in the future to protect recruitment and smaller size classes as well. Habitat improvement such as increasing existing areas of emergent vegetation near the islands and in coves to enhance cover, and introducing submerged vegetation to areas of the lake in areas where it can thrive, would go a long way to improve the quality of the bass fishery. The challenge with establishing vegetation in Aurora Lake is mainly the high turbidity of the water, the uprooting of plants from carp, increased wave action from boat activity, and possibly the quality of the lakebed substrate itself. Taking steps to decrease turbidity of the lake is a challenge, but it is crucial to improving the health of the lake, from both an ecological and recreational perspective.

- Bluegill:
  Bluegill do not typically need a bag or size restriction as they are usually very prolific and generally provide sufficient forage for largemouth bass, as well as an ample recreational fishery. The 2023 survey shows that the bluegill population is at a strong balance of stock size to quality size fish. Stocking other fish species as forage for largemouth bass and other desirable game fish is unnecessary as the juvenile size class of bluegill in Aurora Lake is currently sufficient. These omnivores will also benefit from reduced turbidity and increased submerged vegetation.

- Other stocking:

  EnviroScience does not recommend stocking any other fish species in Aurora Lake, if the intent is to establish a self-propagating population. It is likely that the introduction of other species such as northern pike, muskellunge, or walleye, while providing a novel angling experience to Aurora Lake, would be short-lived as there is no suitable habitat for their foraging behavior or spawning.

- Habitat enhancement:

  Vegetation restoration

  Attempting to reintroduce native vegetation is highly recommended. EnviroScience suggests planting emergent plants such as white waterlily (*Nymphaea odorata*), American lotus (*Nelumbo lutea*), and lake sedge (*Carex lacustris*), and submerged plants such as pondweeds (*Potamogeton* spp.), or eelgrass (*Vallisneria americana*) in portions of the lake that may not be affected by wave actions of boats. These plants can be obtained through native plant nurseries in Ohio and should not be obtained from other lakes or ponds, to eliminate the chance of dispersal of exotic species such as zebra mussels.

  Fish Structures

  The addition of fish attractors such as stacks of pallets, cinder block piles, Christmas trees, specially designed PVC or corrugated drainage pipe structures, or a combination of these, can be used to provide a variety of cover, resting areas, or feeding areas. A dozen of these structures would be a good start. Combine 2 or 3 structures in 4 to 6 selected locations of Aurora Lake. Sites should be selected in water deep enough so that the tops of the structures do not interfere with boat traffic or other recreational activities. Some site suggestions include along shorelines, off points, and in areas of limited structure or vegetation.

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Appendix A

Fish Photo Vouchers

Photo 1. Yellow Perch (*Perca flavescens)*

Photo 2. Yellow bullhead (*Ameiurus natalis)*

Photo 2. Channel catfish (*Ictalurus punctatus*)

Photo 3. Pumpkinseed sunfish (*Lepomis gibbosus*)

Photo 4. Bluegill sunfish (*Lepomis macrochirus*)

Photo 5. Largemouth bass (*Micropterus salmoides*)

Photo 6. Warmouth (*Lepomis gulosus*)

Photo 7. Brook silverside (*Labidesthes sicculus*)

Photo 8. Golden shiner (*Notemigonus chrysoleucas*)

Photo 9. Black crappie (*Pomoxis nigromaculatus*)