2021 AURORA LAKE FISHERY EVALUATION

Prepared for:

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2021 Aurora Lake Fishery Evaluation

Final Report

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Authorization for Release

The analyses, opinions, and conclusions in this document are based entirely on EnviroScience's unbiased, professional judgment. EnviroScience's compensation is not in any way contingent on any action or event resulting from this study.

To the best of their knowledge, the undersigned attest that this document and the information contained herein are accurate and conform to EnviroScience's internal Quality Assurance standards.

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Biologist / Project Manager

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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 1, 2021. 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 in an effort to effectively sample the most complete representative sample possible of the fish community. The goal of the study was to assess the current 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 as well as a baseline to compare future surveys.

During the fishery evaluation, nuisance species that were encountered such as common carp (*Cyprinus carpio*) and grass carp (*Ctenopharyngodon idella*) 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 approximately 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 on fish data sheets (Appendix B).

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 black 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 longer than the minimum stock size and multiplying the quotient by 100 (Anderson 1979, Murphy and Willis 2000). A quality size fish 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 black 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. Black crappie was 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 black 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 black 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 a large number of small fish, and a small number of 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, dissolved oxygen, conductivity, and pH. The data were collected at depths of 0.5 to 2.5 meters at approximately 7:12 p.m. All water quality values observed were typical for lakes in Northeast Ohio during spring.

Table 2.1 Water Chemistry Data, 6/1/2021, 7:12 p.m.

Location: Open Water 41.3328, -81.3833				
Depth (meters)	**Temp. (°C)**	**Dissolved Oxygen (mg/L)**	**Conductivity (µS/cm)**	**pH**
0.5	20.8	12.13	709	8.77
1	19.9	10.23	712	8.43
2	18.3	8.45	710	8.06
2.5	18.2	7.41	709	7.58

3.0 RESULTS

3.1 FISH SURVEY

In total, 12 species of fish were collected in the Aurora Lake study area (Table 3.1). An additional species (grass carp) was collected outside of the survey event. The fish collection totaled 1,398 individuals and 185.8 kg (409.6 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 921 bluegill sunfish were encountered during the survey, contributing to 65.9% of the total fish abundance. A total of 148 pumpkinseed sunfish were encountered, contributing to 10.6% abundance. A total of 86 largemouth bass were encountered, contributing to 6.2% abundance (Figure 3.1; Table 3.2). Largemouth bass contributed 7.3% to the total mass, while bluegill sunfish and pumpkinseed sunfish contributed 17.1% and 3.4% to the mass, respectively (Figure 3.2; Table 3.3). Nuisance fish species collected during the fishery evaluation were removed from Aurora Lake. These included a total of 206 common carp (1974.24 lbs, 895.5 kg) and 1 grass carp (9.58 lbs, 4.35 kg).

Figure 3.1 Aurora Lake Electrofishing Sampling Zones

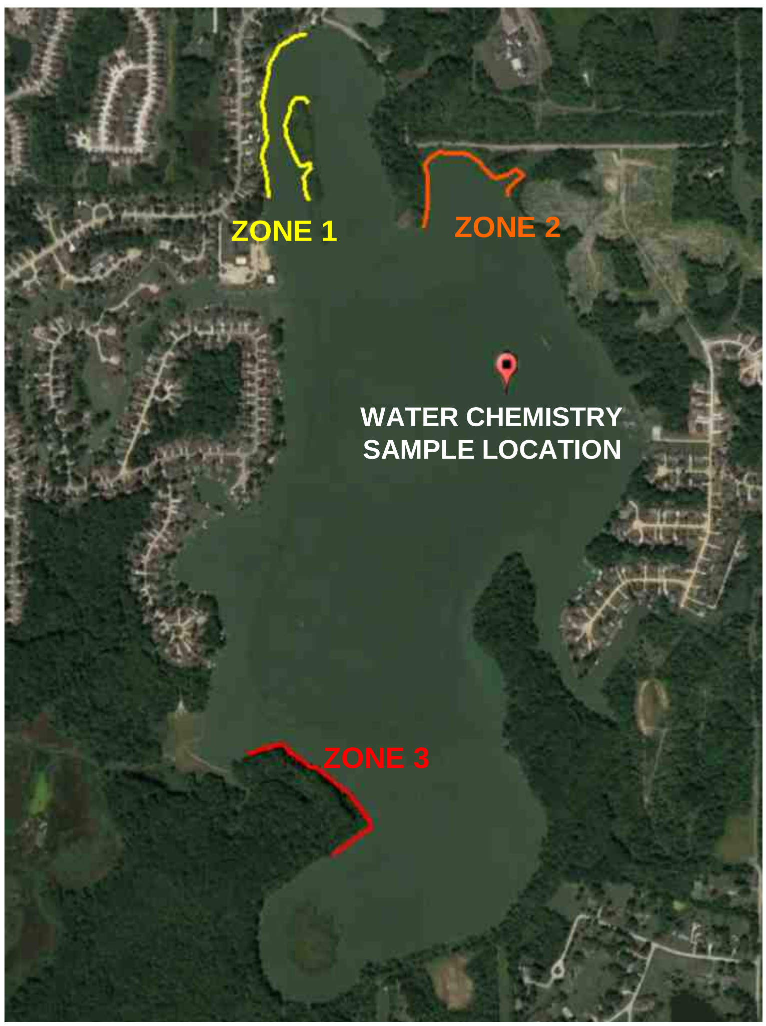


Table 3.1 Fish Species List

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

*encountered during carp management, but not during survey

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 0-14 cm	0	12	38	50	3.1
Black crappie 15-25 cm	10	2	1	13	0.8
Black crappie 26-40 cm	4	1	0	5	0.3
Bluegill sunfish 0-7 cm	236	137	124	497	31.0
Bluegill sunfish 8-15 cm	174	267	156	597	37.2
Bluegill sunfish >15 cm	23	15	38	76	4.7
Brook silverside	8	1	2	11	0.7
Brown bullhead	0	1	0	1	0.1
Channel catfish	2	6	1	9	0.6
Common carp	16	15	4	35	2.2
Golden shiner	14	30	29	73	4.5
Largemouth bass 0-15 cm	17	10	15	42	2.6
Largemouth bass 16-25 cm	13	13	18	44	2.7
Largemouth bass 26-40 cm	8	14	4	26	1.6
Pumpkinseed sunfish 0-7 cm	8	6	0	14	0.9
Pumpkinseed sunfish 8-15 cm	46	32	31	109	6.8
Pumpkinseed sunfish >15 cm	15	3	7	25	1.6
Warmouth sunfish	2	0	0	2	0.1
Yellow bullhead	5	2	0	7	0.4
Yellow perch 15-20 cm	6	2	11	19	1.2
Yellow perch >21 cm	0	1	2	3	0.2
Total #	**607**	**570**	**481**	**1605**	**100**

Table 3.3 Electrofishing Mass Results (lbs)

Species	Zone 1	Zone 2	Zone 3	Total	% Total Mass	Avg Mass / Fish (lbs)
Black crappie 0-14 cm	0.6	0.4	1.7	2.8	0.6	0.1
Black crappie 15-25 cm	4.1	0.9	0.5	5.5	1.1	0.4
Black crappie 26-40 cm	4.6	1.0	0.0	5.6	1.1	1.1
Bluegill sunfish 0-7 cm	4.8	2.0	0.9	7.7	1.5	0.0
Bluegill sunfish 7-15 cm	1.0	26.7	13.8	41.4	8.3	0.1
Bluegill sunfish >15 cm	3.0	4.3	13.8	21.1	4.2	0.3
Brook silverside	0.1	0.0	0.0	0.1	0.0	0.0
Brown bullhead	0.0	0.3	0.0	0.3	0.1	0.3
Channel catfish 40-65 cm	4.1	16.5	3.5	24.0	4.8	2.7
Common carp	164.5	123.3	47.7	335.4	67.0	9.6
Golden shiner	1.0	1.0	1.7	3.7	0.7	0.1
Largemouth bass 0-25 cm	1.0	0.6	1.3	2.9	0.6	0.1
Largemouth bass 15-25 cm	4.2	2.7	3.2	10.1	2.0	0.2
Largemouth bass 25-40 cm	6.6	7.2	3.1	16.9	3.4	0.6
Pumpkinseed sunfish 0-7 cm	0.2	0.1	0.0	0.3	0.1	0.0
Pumpkinseed sunfish 7-15 cm	3.5	1.7	2.3	7.4	1.5	0.1
Pumpkinseed sunfish >15 cm	3.7	0.7	1.8	6.3	1.3	0.3
Warmouth sunfish	0.3	0.0	0.0	0.3	0.1	0.1
Yellow bullhead	1.0	1.0	0.0	2.0	0.4	0.3
Yellow perch 10-25 cm	1.7	0.2	3.3	5.2	1.0	0.3
Yellow perch >26 cm	0.0	0.9	0.9	1.8	0.4	0.6
Total mass (lbs)	**209.8**	**191.5**	**99.4**	**500.6**	**100.0**	

Figure 3.1 Fish Species Percent Contribution to Abundance

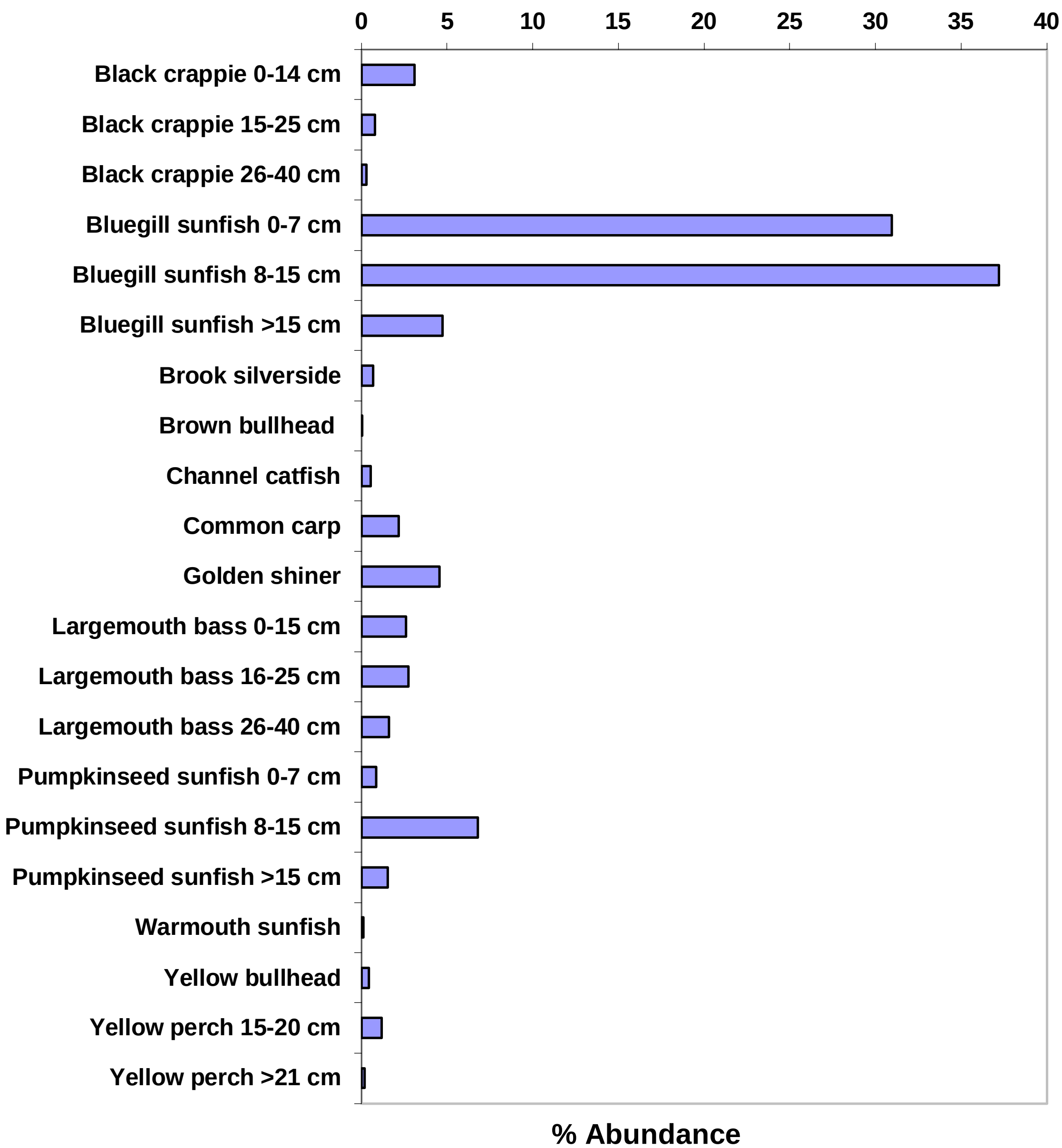
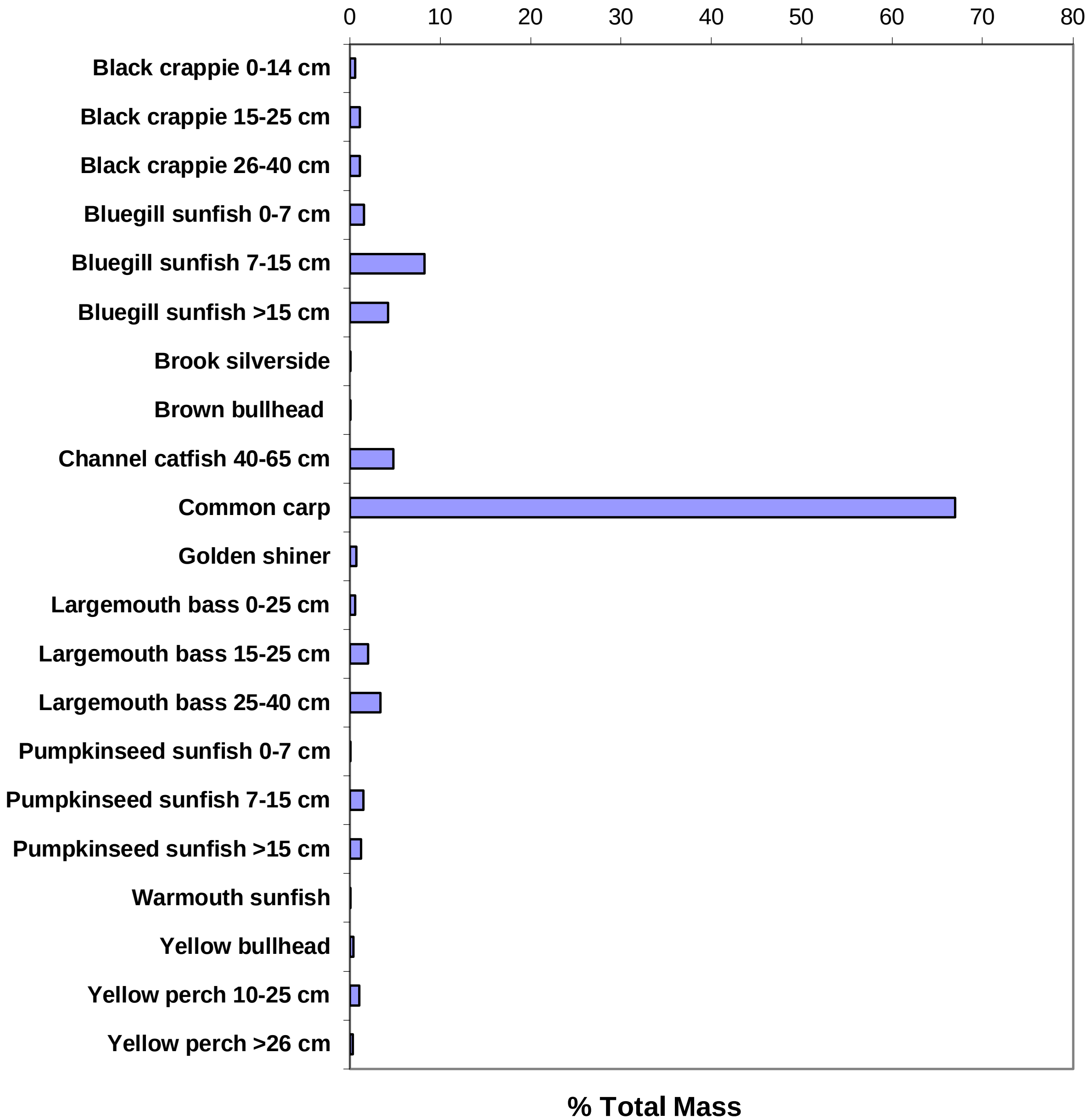


Figure 3.2 Fish Species Percent Contribution to Mass



3.2 CATCH PER UNIT EFFORT AND PROPORTIONAL STOCK DENSITY ANALYSIS

Each sampling zone was electrofished for 2000 seconds. Catch per unit effort (CPUE) was highest overall at zones 2 and 3, where 567 and 473 fish were recorded, respectively (Table 3.2). Zone 1 had a slightly lower CPUE of 358 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 37 (Table 3.4). This value is slightly below the target largemouth bass PSD range of 40-60 (Murphy and Willis 2000), which indicates a larger proportion of stock size largemouth bass (≥38 cm) to quality size largemouth bass (≥20 cm). The PSD value for bluegill was 11. This value is well below the desired bluegill PSD range of 20-40, indicating a much higher proportion of stock sized bluegill (≥8 cm) to quality sized fish (≥15 cm). The PSD value for black crappie was 28. This value is just slightly below the desired crappie PSD range of 30-60, indicating a higher proportion of stock size black crappie (≥20 cm) to larger size fish (≥13 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 managing efforts such as stocking and habitat modifications.

Table 3.4. Proportional Stock Density (PSD) Results

Species	PSD value	Optimal range
Largemouth bass	37	40-60
Bluegill sunfish	11	20-40
Black crappie	28	30-60

Figure 3.4 Largemouth Bass Length-Frequency

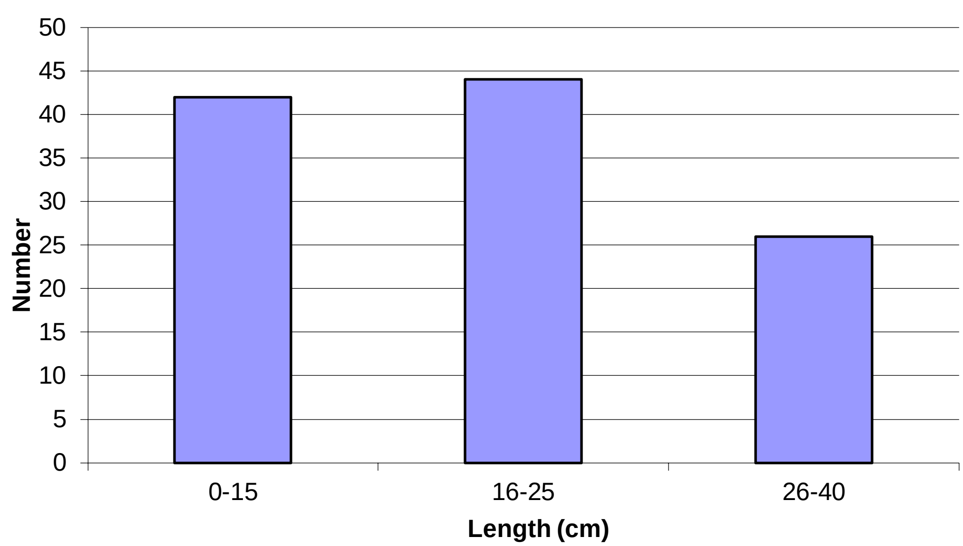


Figure 3.4 Bluegill Length-Frequency

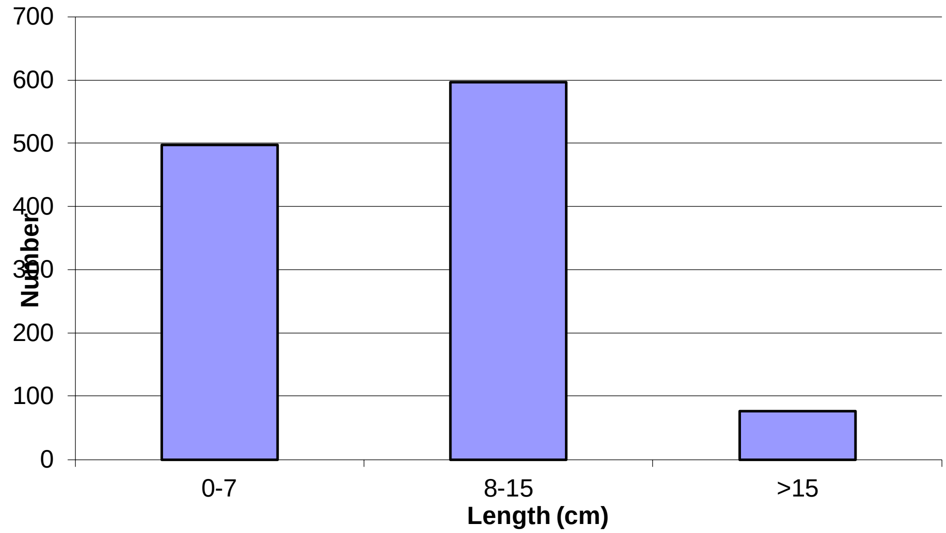
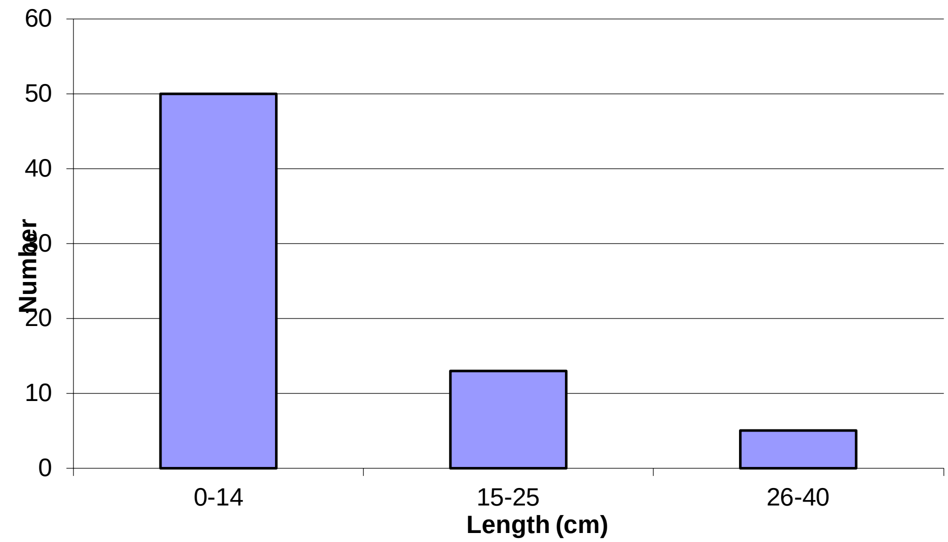


Figure 3.4 Black Crappie Length-Frequency



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 highest catch per unit effort value for largemouth bass at 38, although zones 2 and 3 both contained 37. This zone was characterized by having the highest number of bluegill sunfish, with a CPUE value of 433. Pumpkinseed sunfish were the second most abundant species, with a CPUE value of 69. Eleven species were encountered in this zone, and it was the only zone in which warmouth were encountered. This sampling zone presented the highest number of pumpkinseed sunfish than the other two zones.

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 419. Largemouth bass CPUE value was 37, and pumpkinseed sunfish CPUE value was 41, which was higher than in zone 3, but lower than in zone 1. This zone also contained eleven species and was the only zone that contained brown bullhead. This zone contained the best habitat of the three zones, which is reflected by the number of bluegill sunfish; more than twice the amount encountered in zone 1, while containing almost the same number of largemouth bass observed in zone 1. This zone contained more big largemouth bass (26-40 cm) than any other zone (CPUE 14).

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. Nine species were encountered in this zone. Bluegill sunfish were the most abundant fish in this zone, with a CPUE value of 318. Pumpkinseed sunfish were the second most abundant at 38, and largemouth bass were the third most abundant species encountered, with a CPUE value of 37. This zone also contained consistent, quality habitat, which is reflected by the numbers of not only small bluegill, but large bluegill as well. In fact, this zone contained more than twice the number of >15 cm bluegill sunfish than zone 2, and almost four times the amount of >15 cm bluegill than that of zone 1. Still, zone 3 contained relatively similar numbers of largemouth bass (CPUE = 37).

4.0 DISCUSSION

The results of the fishery evaluation indicate that Aurora Lake is currently a bluegill dominated fishery, with a somewhat limited largemouth bass and black crappie fishery. However, the 2021 fish survey shows a potential upward trend in the numbers of largemouth bass and bluegill, while a potential downward trend in the numbers of black crappie. Water chemistry was typical for Northeast Ohio impoundments during the late spring, and the parameters recorded were all within healthy ranges for warm-water fish species' tolerances.

The largemouth bass population at Aurora Lake in the last 20 years has been a relatively suboptimal fishery, given the numbers of forage-sized bluegill encountered during the survey as well as other forage species observed such as golden shiners. According to the PSD value, the population structure is favoring more stock size bass than quality size bass. Since 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), it is likely that limited lakebed spawning habitat and lake turbidity are contributors to the perennial low abundance and size distribution of largemouth bass. As stated previously, there is a good forage base of juvenile bluegill and pumpkinseed, but turbidity may be a negative effect on predation efficiency of bass. Increasing and enhancing cover and habitat would help, but ultimately a reduction in turbidity will have a greater effect of success on the largemouth bass population.

Interestingly, there were much more largemouth bass collected this year (112) than any other monitoring year. The next highest number of bass collected was in 2007 when there were 61 individuals collected. That's an increase of 183% over the next highest CPUE, albeit mostly bass that were 10 inches and less. It has been as low as 18 individuals in 2004 and 2005, so although there is still plenty of room for improvement, the largemouth bass fishery could be on an upward trend and should continue to be monitored. This is also the case with bluegill. The PSD values show that the population structure is favoring more stock size than quality size bluegill. But once again 2021 had an excellent yield of bluegill at 1170, the highest CPUE observed in any previous survey.

The black crappie population is showing a similar structure, favoring stock size fish to quality size fish. However, the overall black crappie sample size was small compared to largemouth bass and bluegill, and the 2021 survey in particular had a relatively low yield of black crappie compared to 2007 – 2013. The crappie fishery should continue to be monitored for population trends, especially since it has been some time since the last fish survey and the CPUE was much lower than it was in those years.

Common carp continue to be a major problem at Aurora Lake. The species has been part of the fish community since before EnviroScience began surveying the lake approximately 20 years ago. 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. 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 & Grass carp	
				Abundance	Mass (lbs)
2002	21	201	60	45	286
2003	25	231	60	37	259
2004	18	177	119	60	401
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	***217***	1854
2011	61	978	85	66	538
2012					
2013	46	507	145	50	461
2014					
2015					
2016					
2017					
2018					
2019					
2020					
2021	***112***	***1170***	68	207	***1984***

Figure 4.1 Largemouth Bass Abundance by Year

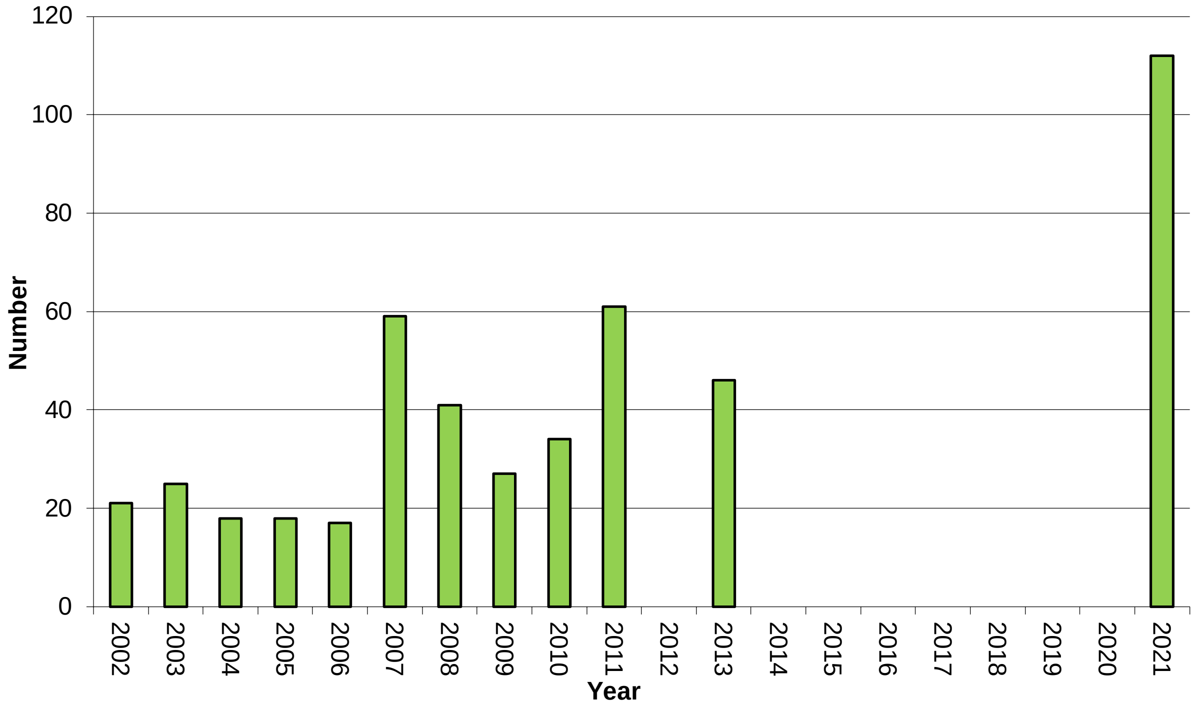


Figure 4.2 Bluegill Abundance by Year

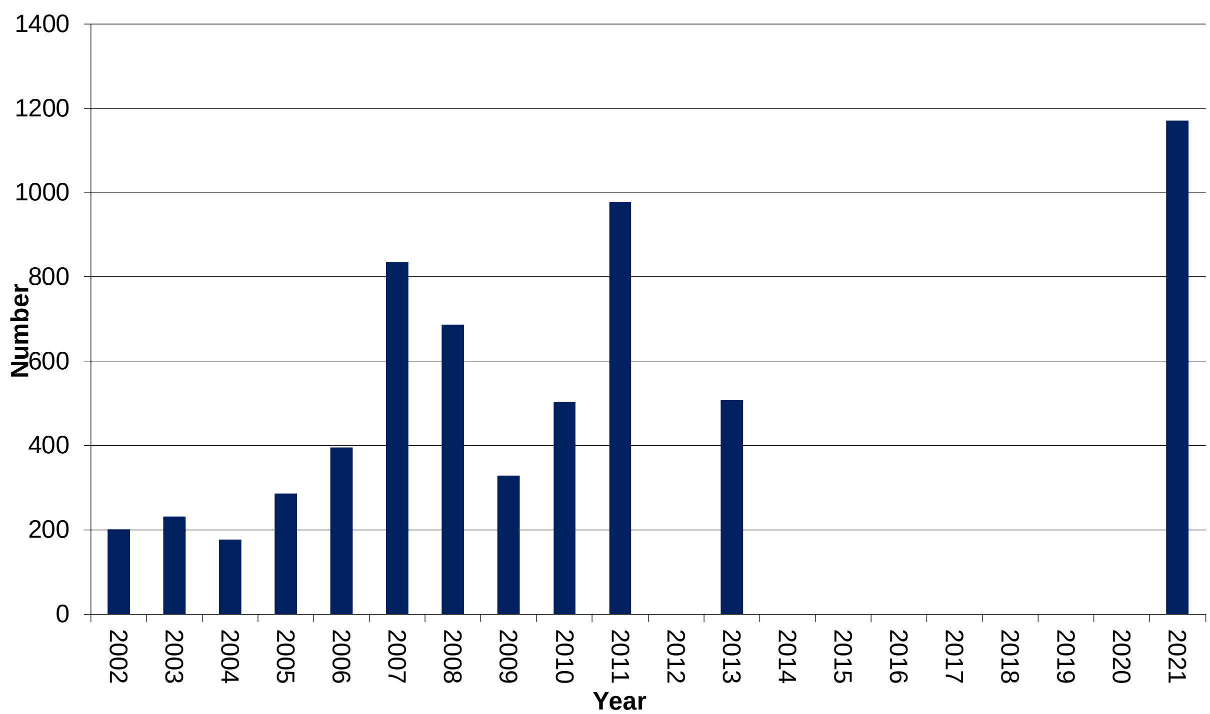


Figure 4.3 Black Crappie Abundance by Year

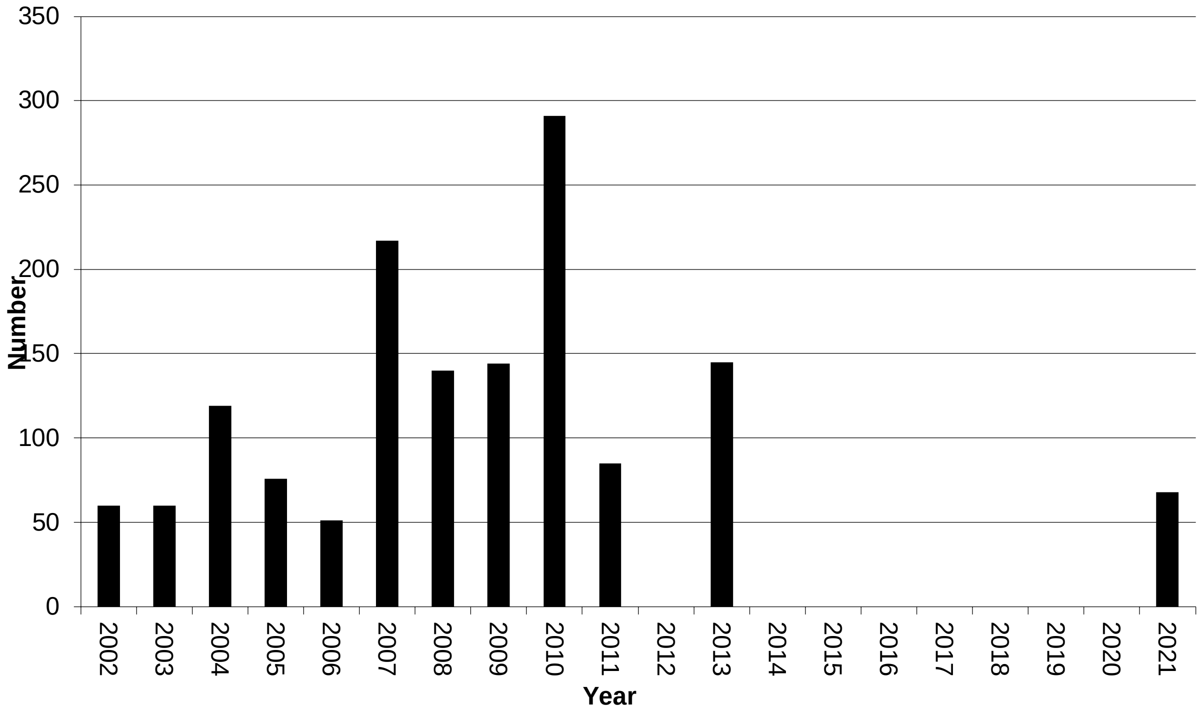
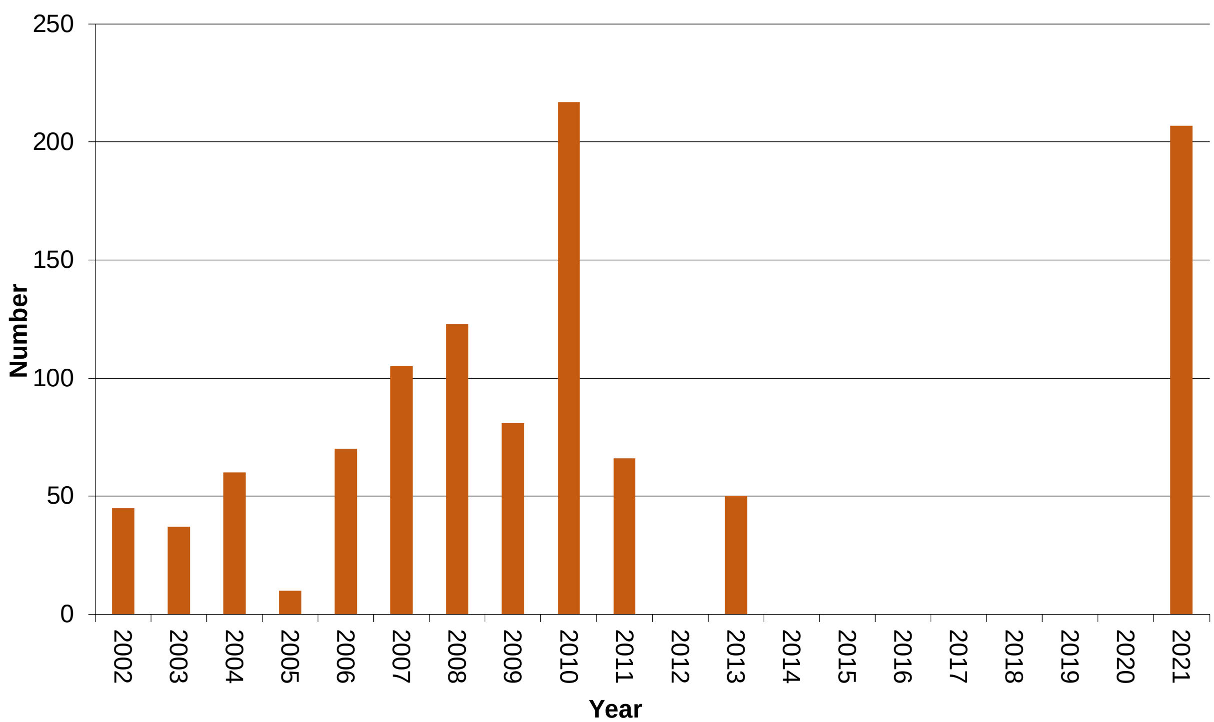


Figure 4.4 Common carp + Grass carp Abundance by Year



5.0 RECOMMENDATIONS

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

- Largemouth Bass:

  Catch and release only for bass 12 inches and greater, to promote a stronger population of larger (15-20 inch) bass. If future surveys show a PSD value that continues to be below an optimal balance of stock to quality size bass, harvesting smaller bass could be encouraged to reduce competition of food and resources for larger fish. However, habitat improvement is probably a higher priority currently than size limits, slot limits or bag limits. 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 is recommended first and foremost. 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. 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 an 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:

  <u>Vegetation restoration</u>

  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.

<u>Fish Strutures</u>

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 should 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. Brown bullhead (*Ameiurus nebulosus)*

Photo 3. Yellow bullhead (*Ameiurus natalis)*

Photo 4. Channel catfish (*Ictalurus punctatus*)

Photo 5. Pumpkinseed sunfish (*Lepomis gibbosus*)

Photo 6. Bluegill sunfish (*Lepomis macrochirus*)

Photo 7. Largemouth bass (*Micropterus salmoides*)

Photo 8. Warmouth (*Lepomis gulosus*)

Photo 9. Brook silverside (*Labidesthes sicculus*)

Photo 10. Golden shiner (*Notemigonus chrysoleucas*)

Photo 11. Black crappie (*Pomoxis nigromaculatus*)