LOCH ERIN 2022 FISHERIES ASSESSMENT

Loch Erin Property Owners Association – Onsted, MI

Prepared for:

Loch Erin Property Owners Association
P.O. Box 302
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Project No.: 16098
Date: 9/11/2022

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Final Report

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Authorization for Release

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EXECUTIVE SUMMARY

This document presents the findings from a fisheries assessment of Loch Erin in Lenawee County, MI, owned and managed by Loch Erin Property Owners Association (LEPOA). EnviroScience field survey methods included measurement of a vertical depth profile and nighttime boat electrofishing. Data analysis was completed using standard fisheries evaluation methods and a scale aging assessment of selected species. This report includes results of the field survey, age assessment of selected sport fish, data analysis, and conclusions for lake management. The survey was performed to assess the community structure, health, and growth rates of collected sport fish and guide current and future lake management programs for Loch Erin.

The overall assessment of Loch Erin based on the results of this study is that the Lake has a healthy fish community and offers excellent angling opportunities for quality size predatory sport fish. Largemouth Bass are growing at above-average rates, particularly among fish in the low and middle range size classes, likely due to the high abundance of available forage fish in Bluegill and Gizzard Shad. Quality sized Walleye are also present but likely in low numbers as the habitat is not preferential for that species. Quality sized Channel Catfish are abundant and may be an underutilized species for anglers. Small Bluegill are abundant and the proportion of smaller individuals is higher than what is generally accepted for balanced fish populations. The panfish population (a collective group of species commonly harvested by anglers –Pumpkinseed, Yellow Perch, and Crappie) [excluding Bluegill] is below average but results may be skewed based on the methods utilized in this study. Gizzard Shad are very abundant and their presence and population size has direct and indirect effects on other species in the Lake. Common Carp are also abundant and were observed throughout the entire lake but likely do not cause much harm to other species.

Several recommendations were provided to maintain the quality and health of the fishery including routine monitoring and surveys, installation of an aeration system, fish harvest recommendations, and other aquatic habitat improvements.

1.0 INTRODUCTION

EnviroScience, Inc. (ES) is pleased to present the findings from a fisheries assessment of Loch Erin in Lenawee County, MI, owned and managed by Loch Erin Property Owners Association (LEPOA). ES field survey methods included measurement of a vertical depth profile and nighttime boat electrofishing. Data analysis was completed using standard fisheries evaluation methods and a scale aging assessment of selected species. This report includes results of the field survey, age assessment of selected sport fish, data analysis, and conclusions for lake management. The survey was performed to assess the community structure, health, and growth rates of collected sport fish and guide current and future lake management programs for Loch Erin.

1.1 BACKGROUND

Loch Erin (Lake) is a privately owned 622-acre impounded lake near Onsted, MI. The Lake is primarily used for recreational purposes, including boating and fishing, and receives considerable boat traffic. Private residences and docks surround most of the lake. The local watershed is dominated by rural agriculture with some forested areas. The Lake shoreline consists mostly of residential lawns with artificial hardening and a relatively small amount of natural shoreline. Several islands are located around the lake which do consist mostly of natural shoreline. Aquatic macrophytes were not widespread throughout the Lake and were mostly observed in shallow, backwater areas near stream inlets.

A Fisheries Survey of Loch Erin with Recommendations and a Management Plan was completed in July 2015 by Freshwater Physicians, Inc. (2016). Study methods included: collection of fish using seines, gill nets, and trap nets; fish diet analysis; fish aging analysis; collection of zooplankton; measurement of water chemistry and clarity; and an aquatic macrophyte evaluation. The results of the 2016 study were not considered for this assessment due to differences in sampling methods.

2.0 METHODS

EnviroScience and LEPOA Vice President, Fish & Wildlife Committee Chairman, and Water Quality Committee Co-Chairman, Christian Malcolm, developed a study plan for the Lake focused on sport fish and included vertical depth profile, nighttime boat electrofishing, fish scale age assessment of selected sport fish, data analysis, and conclusions for lake management. The field survey efforts were completed June 14 - 16, 2022. The survey methods were utilized to assess the community structure, health, and growth rates of collected sport fish. Fish collections were completed under a Scientific Collectors Permit issued by the Michigan Department of Natural Resources – Fisheries Division to ES Aquatic Biologist, Kevin Reed (*Permit no. FSCP0418202210563*).

2.1 VERTICAL DEPTH PROFILE

A vertical depth profile for temperature, pH, dissolved oxygen (DO), and specific conductance was measured using a YSI ProDSS Multiparameter Digital Water Quality Meter. The metalimnion was also identified by observing for a change of ≥ 1 degree Celsius (°C) per meter of depth. The metalimnion is the middle layer of the water column in a thermally stratified lake where the greatest temperature change occurs and contains the thermocline. The thermocline is the thin layer of the water column where the temperature changes most rapidly. Knowing the thermocline during the warmer months of the year can be useful when targeting pelagic sport fish, such as

Walleye. The profile was collected at the deepest part of the lake so that any changes over vertical depth could be measured. The collected data is useful to determine the extent, if any, of thermal stratification and the availability of the appropriate thermal and DO ranges necessary to support fish. The methods used for the vertical depth profile were adapted from USEPA (2022).

2.2 SECCHI DISK TRANSPARENCY

Water clarity was measured using a Secchi disk. A Secchi disk is a black and white patterned weighted disk commonly used to measure the clarity of water based on the distance the disk can be seen when it is lowered into the water column. The Secchi disk transparency is useful information to determine the depth at which fish might be visible and to compare transparencies among different waterbodies. The methods used for Secchi disk transparency were adapted from USEPA (2022).

2.3 ELECTROFISHING

A Smith-Root 5.0 GPP Electrofisher was used to sample the fish community throughout the Lake. The electrofisher supplied pulsed direct current to anodes mounted to a boom on the front of a 16-foot boat. During electrofishing, the control unit was adjusted according to the conductivity of the water and fish capture effectiveness and response. Water with low conductivity requires higher voltage to effectively sample the area. Applying higher voltage will increase the electrical current flowing through the water. The degree to which fish are affected by electrical current is a function of their surface area. Generally, larger fish are more sensitive to the electrical currents.

Electrofishing was conducted at night due to the well-documented tendency of fish to come within four to six feet of the surface of the water to feed at night. When shocked, the fish become temporarily stunned and float toward the surface where they can be netted. To aid in capture, the bow of the boat was equipped with LED lights to illuminate the area where fish were to be netted. 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.

Five sampling locations were identified by LEPOA with input from ES using best professional judgement based on habitat, sampling distribution, and method effectiveness: LE1, LE2, LE3, LE4, and LE5. All available habitats in each of the zones were each sampled for 1500 - 2000 seconds. Approximate sampling locations are presented in Figure 2.1.

2.3.1 Sample Processing

After sampling at each zone, all collected fish were identified to species, enumerated, and examined for the presence of DELT (deformities, erosions, lesions, and tumors) external anomalies. External anomalies in fish can be caused by a variety of stressors such as low dissolved oxygen levels, elevated temperatures, toxins, bacterial agents, carcinogens, and parasites. Length in millimeters [mm] and weight in grams [g] were measured on all collected individuals of each species except smaller sunfish. A subsample of 15 individuals was analyzed when more than 15 were collected per zone for Bluegill (*Lepomis macrochirus*) and Pumpkinseed (*Lepomis gibbosus*). Additional individuals by species were batch weighed to calculate a total biomass for each of these sunfish species. All catch results for each sampling zone were recorded into an electronic fish data application. Collected fish were released, unharmed, back to the Lake.

2.3.2 Analysis Methods

2.3.2.1 Catch Per Unit Effort

Because the total number of fish collected in each zone can be dependent on sampling effort, catch results can be standardized for each species using a Catch Per Unit Effort (CPUE) value. CPUE was calculated for each zone allowing for equal comparisons of catch rates between zones. The value is expressed as number of fish per unit of effort. This information is valuable for estimating species density and provides rationale for differences in abundance from zone to zone, possibly due to habitat. CPUE for each zone calculated using the following equation:

$$CPUE\ (Species\ A, Zone\ X) = \frac{Total\ Catch\ (Species\ A, Zone\ X)}{Effort\ (Zone\ X)}$$

It should be noted that CPUE inherently assumes there is no upper limit to the size of a population as it is only a catch rate and the results may overestimate the number of individuals of a species found within the sampled zone or waterbody. The total CPUE for each species collected for the entire survey was then calculated using the total catch of each species and total effort for all zones using the following equation:

$$CPUE\ (Species\ A) = \frac{Total\ Catch\ (Species\ A)}{Total\ Effort}$$

2.3.2.2 Proportional Stock Density

To determine the quality of selected sport fish populations in Loch Erin, a Proportional Stock Density (PSD) was calculated. PSD was calculated for the following sport fish: Bluegill, Largemouth Bass (*Micropterus salmoides*), and Walleye (*Sander vitreus*). These species were evaluated because there are published, generally accepted PSD ranges for balanced fish populations. PSD was calculated using the following equation:

$$PSD = \frac{No.\ of\ individuals\ (\geq)\ Quality\ Length}{No.\ of\ individuals\ (\geq)\ Stock\ Lengths} \times 100$$

The quality length of a fish is the minimum length that most anglers prefer to catch. The stock length of a fish is the approximate length at maturity and/or the minimum length of fish that may provide recreational value. The PSD metric provides valuable understanding of the current adult population structure and an estimate of recruitment for the following season. Analysis of PSD values can also identify problems with reproduction, growth, and mortality. The values indicated for minimum stock and quality sizes for these species are widely-used, standardized sizes provided by Willis et al. (1993). Minimum stock and quality sizes and generally accepted PSD ranges for balanced fish populations for each evaluated species are displayed in Table 2.1.

Table 2.1 Minimum Stock and Quality Sizes and PSD Ranges

Species	Minimum Stock Size (mm)	Minimum Quality Size (mm)	PSD Range
Bluegill	80	150	26-60
Largemouth Bass	200	300	40-70
Walleye	250	380	30-60

2.3.2.3 Relative Condition

Relative Condition (Wr) is an index that enables fisheries managers to assess individual fish health based on weight and length relationships. Wr values were calculated for the following sport fish species: Bluegill, Channel Catfish (*Ictalurus punctatus*), Largemouth Bass, Smallmouth Bass (*Micropterus dolomieu*), and Walleye. The Wr of fish was determined using the following equation:

$$Wr = \frac{Weight\ of\ individual\ (g)}{Standard\ weight\ for\ fish\ of\ same\ length\ (g)} \times 100$$

Standard weights for each species at given lengths are provided by Blackwell et al. (2000). Analysis of the Wr values for each species can identify competition factors or food availability issues. A value of 1.0 represents statistically average conditions for the weight and length relationship of a particular species and suggests average growing conditions. Values slightly below or above 1.0 indicate average-sized fish and suggest favorable growing conditions. Wr values that exceed 1.0 indicate above average-sized fish and suggest better growing conditions. Values that are below and not approaching 1.0 may indicate stunted or emaciated fish and environmental conditions not suitable for fish growth.

2.4 AGE ASSESSMENT OF SELECTED SPORT FISH

Individual fish age can be estimated using annuli observed on fish scales and counted, much like counting the rings of a tree. The estimated age of individual fish can be compared to the fish's total length to determine an estimated growth rate. Growth rates are impacted by water quality, food and habitat quality and availability, as well as the overall fish community structure. Fish scale aging analysis is useful as supplemental information to the fish community analysis and can provide more insight into the health of the fish community. This method can be valuable to lake owners because, contrary to other methods, it allows for aged fish to be released unharmed.

Approximately 10 – 15 fish scales were removed from 15 Largemouth Bass and five Walleye for estimated age determination. Scales were removed in the field and analyzed in ES' laboratory utilizing methods adapted from Schneider (2000). The length and weight of each individual fish from which scales were collected were recorded on the envelope in which the scales were placed. Estimated age determinations were recorded on the scale envelopes and a fish aging data sheet. Estimated age determinations of collected Largemouth Bass and Walleye were compared to state average total lengths by age and month range (June-July) to determine growth rates relative to the state average for each species. The state average total lengths were sourced from Schneider (2000).

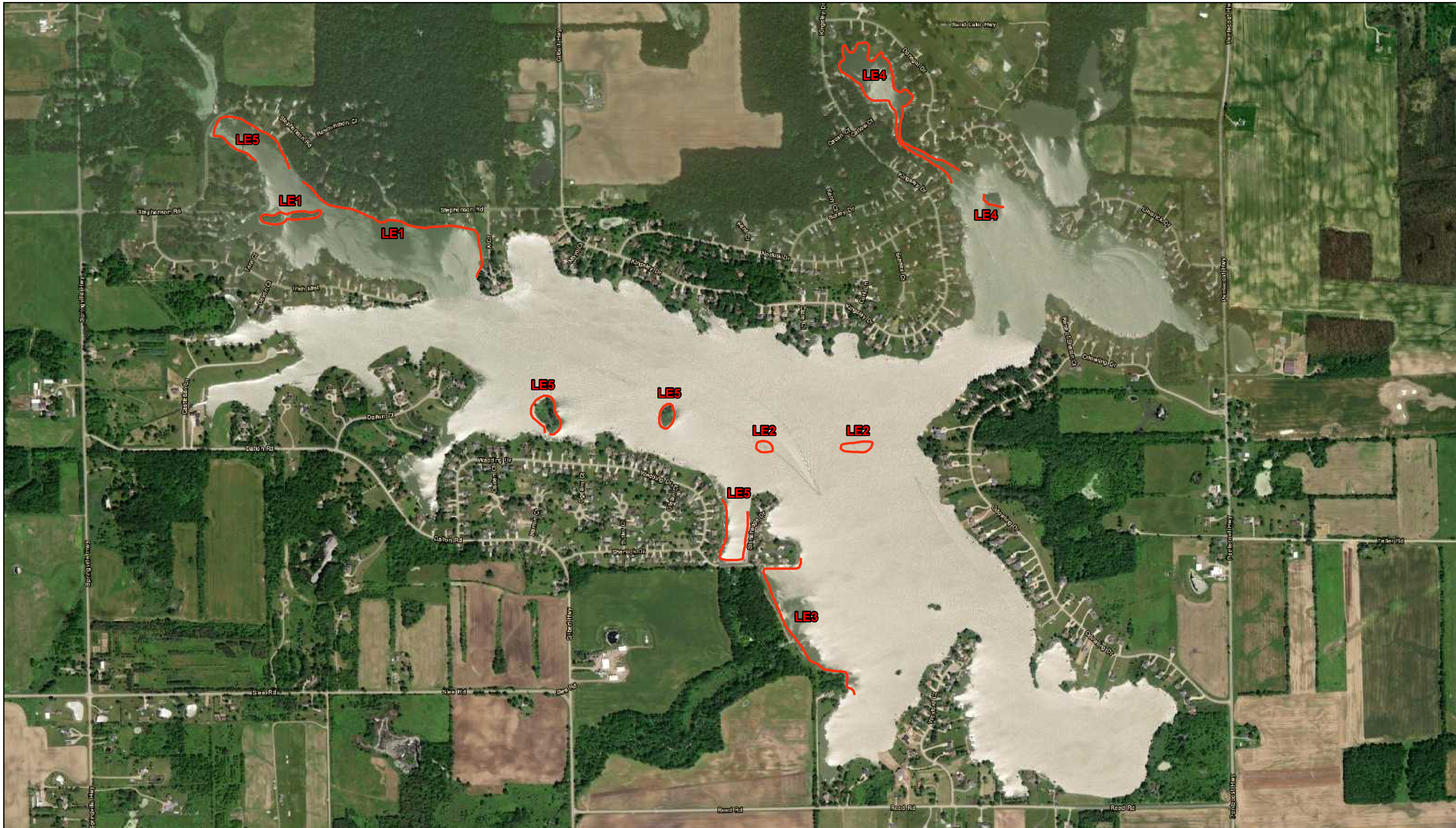

Figure 2.1 Loch Erin 2022 Fisheries Assessment Survey Locations, Loch Erin Property Owners Association.

Survey Locations

0 750 1,500 3,000 Feet

0 250 500 1,000 Meters

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Path: P:\10_Projects\L\Loch Erin Property Owners Association\GIS\Map1_Survey_Locations.mxd

Date: 9/6/2022

Basemap courtesy of Esri.

3.0 RESULTS

The results of the fisheries assessment of Loch Erin are presented below. This section includes results for the following: vertical depth profile, Secchi disk transparency, fisheries survey, and proportional stock density, relative condition, and age assessment of selected sport fish.

3.1 VERTICAL DEPTH PROFILE

A vertical depth profile for temperature, pH, dissolved oxygen (DO), and specific conductance was measured at the deepest part of the Lake found, which measured 3.7 meters (m). The results are presented in Table 3.1. A chart displaying the profiles for temperature and DO is presented in Figure 3.1. The field data sheet for the vertical depth profile is included as Appendix A.

Table 3.1 Vertical Depth Profile – Loch Erin, Onsted, MI, 2022

Depth (m)	DO (mg/L)	Temp (°C)	pH (su)	SpC (µS/cm)	Metalimnion
0.1	9.39	26.10	8.49	468.60	
1.0	9.36	26.00	8.49	468.70	
1.5	8.83	25.70	8.44	471.00	Top
2.0	3.78	24.10	7.87	478.60	
2.5	2.10	23.10	7.67	479.20	Bottom
3.0	1.05	22.90	7.65	480.50	
3.2	0.38	22.80	7.57	481.00	

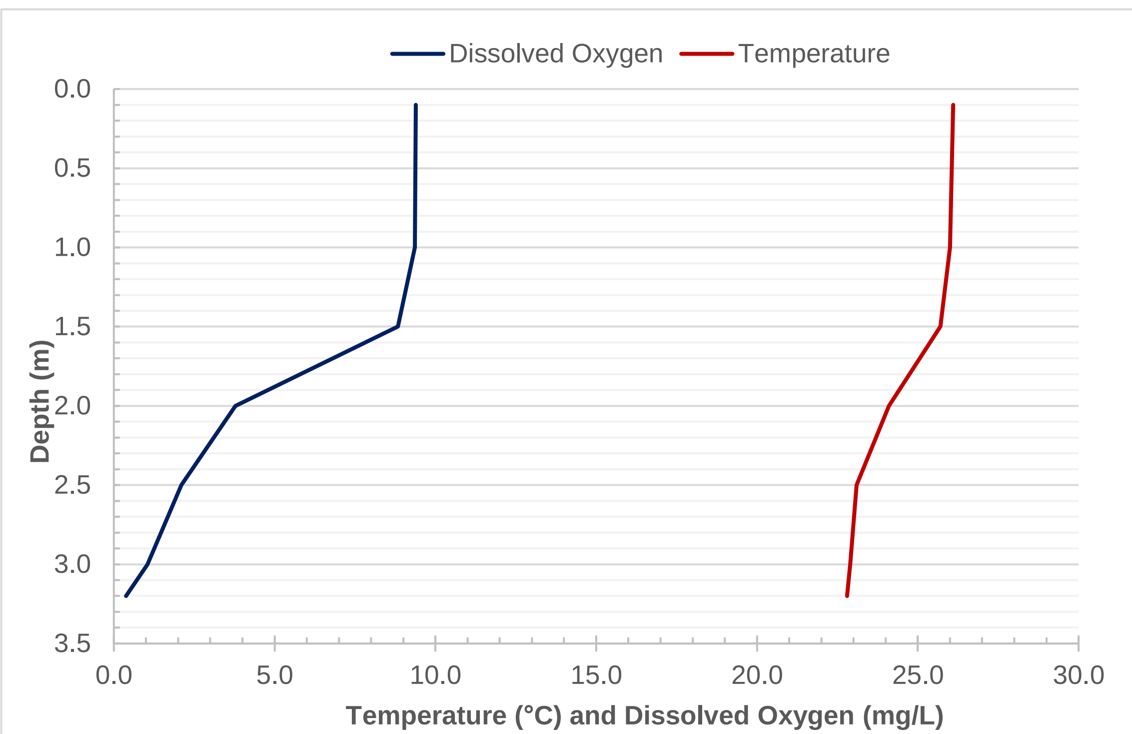

Figure 3.1 Vertical Depth Profiles for Temperature and Dissolved Oxygen – Loch Erin, Onsted, MI, 2022

3.2 SECCHI DISK TRANSPARENCY

Secchi disk transparency measurements were collected at the deepest part of the Lake. The results are presented in Table 3.2.

Table 3.2 Secchi Disk Transparency - Loch Erin, Onsted, MI, 2022

Water Depth (m)	Disappearance (m)	Reappearance (m)
3.7	0.9	0.6

3.3 ELECTROFISHING

Loch Erin was surveyed by ES biologists on June 14 - 16, 2022. The plan developed with LEPOA was to sample in the late spring after Largemouth Bass were mostly done spawning as to avoid any disturbance to spawning fish. Water temperatures increased rapidly at this time and sampling occurred just after the best temperature range for Largemouth Bass surveys of 55 – 65 degrees Fahrenheit (°F) suggested by Schneider (2000). Sampling was less efficient due to increased turbidity of the Lake and reduced water clarity from recent rainfall in the area. The weather during sampling at night was generally clear to partly cloudy, with ambient temperatures ranging from the 70s°F to low 80s°F.

3.3.1 Fisheries Survey Results

The fisheries survey at Loch Erin consisted of 8683 seconds of total effort and resulted in the collection of nine species, totaling 698 individuals. The species composition and catch count included: Bluegill – 476 total, Channel Catfish – 96 total, Green Sunfish (*Lepomis cyanellus*) – 7 total, Largemouth Bass – 53 total, Pumpkinseed – 36 total, Smallmouth Bass – 14 total, Walleye – 7 total, Yellow Bullhead (*Ameiurus natalis*) – 3 total and Yellow Perch (*Perca flavescens*) – 6 total. Two additional species, Gizzard Shad (*Dorosoma cepedianum*) and Common Carp (*Cyprinus carpio*), were observed at all sampling zones at high abundances but were not collected per suggestion by LEPOA. The majority of fish collected were Bluegill (68.2% of total catch) followed by Channel Catfish (13.8% of total catch) and then Largemouth Bass (7.6% of total catch).

A species of interest for LEPOA expressed during planning and the survey was Largemouth Bass. The length of the longest Largemouth Bass collected was 495 millimeters (mm) and weighed 1,975 grams (g). The heaviest Largemouth Bass collected weighed 1,996 g and measured 490 mm. The average length and weight for all Largemouth Bass was 356 mm and 829 g, respectively. The largest individuals for other selected species included: a Bluegill that measured 185 mm and 108 g, a Channel Catfish that measured 691 mm and 3255 g, a Smallmouth Bass that measured 440 mm and 1275 g, and a Walleye that measured 521 mm and 1480 g.

A summary of catch data for Loch Erin by sampling zone is presented in Table 3.3. A summary of statistical data for selected sport fish species collected from Loch Erin is presented in Table 3.4. Length frequency distributions of selected sport fish species including Bluegill, Channel Catfish, Largemouth Bass, Smallmouth Bass, and Walleye are presented in Figures 3.2, 3.3, 3.4, 3.5, and 3.6, respectively. The fish data sheets are included in Appendix B.

Table 3.3 Summary of Catch Data by Sampling Zone - Loch Erin, Onsted, MI, 2022

Species	LE1	LE2	LE3	LE4	LE5	Total Catch	% Total Catch
Bluegill	116	46	139	97	78	476	68.2%
Channel Catfish	9	11	43	10	23	96	13.8%
Green Sunfish	1	0	2	2	2	7	1.0%
Largemouth Bass	9	7	11	13	13	53	7.6%
Pumpkinseed	4	0	10	16	6	36	5.2%
Smallmouth Bass	0	2	8	1	3	14	2.0%
Walleye	2	2	3	0	0	7	1.0%
Yellow Bullhead	0	0	0	2	1	3	0.4%
Yellow Perch	0	0	3	0	3	6	0.9%
Total	**141**	**68**	**219**	**141**	**129**	**698**	**100%**

Table 3.4 Summary of Statistical Data for Selected Sport Fish - Loch Erin, Onsted, MI, 2022

Species	Total Catch	% Total Catch	No. Individuals Measured	No. Individuals Weighed	Average Total Length (mm)	Average Weight of Measured Ind. (g)	Total Weight of Measured Ind. (g)
Bluegill	476	68.2%	75	75	136	52	3,878
Channel Catfish	96	13.8%	67	67	457	1,099	73,633
Largemouth Bass	53	7.6%	53	53	356	829	43,954
Smallmouth Bass	14	2.0%	14	14	270	369	5,162
Walleye	7	1.0%	7	7	368	681	4,766
Total	**646**	**92.6%**	**216**	**216**	*NA*	**3,030**	*NA*

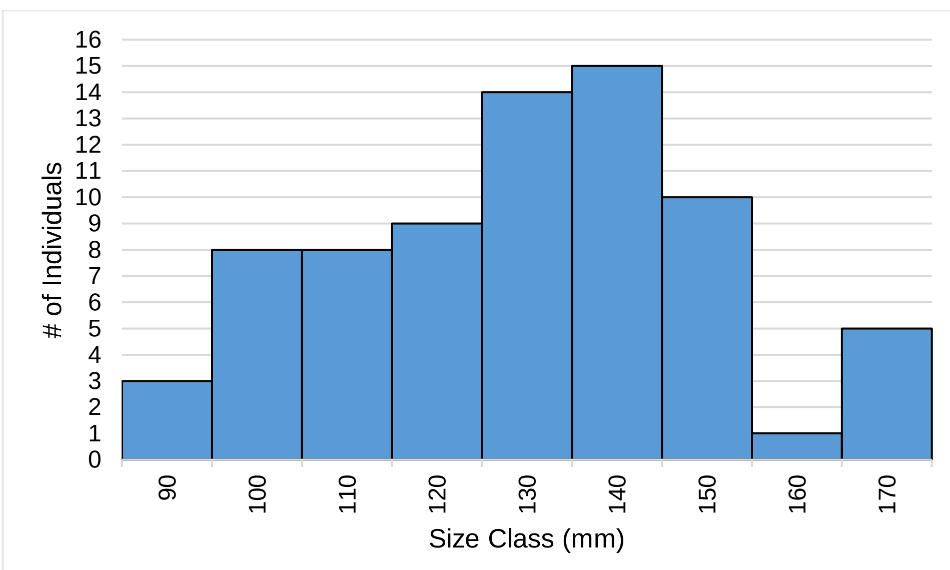

Figure 3.2 Length Frequency Distribution for Bluegill – Loch Erin, Onsted, MI, 2022

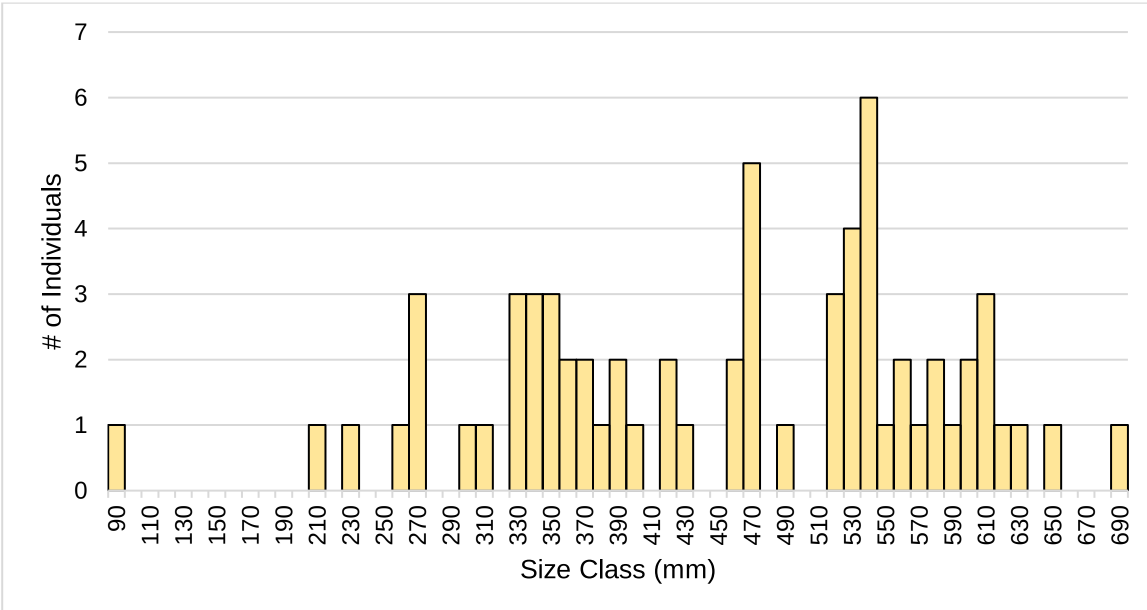

Figure 3.3 Length Frequency Distribution for Channel Catfish – Loch Erin, Onsted, MI, 2022

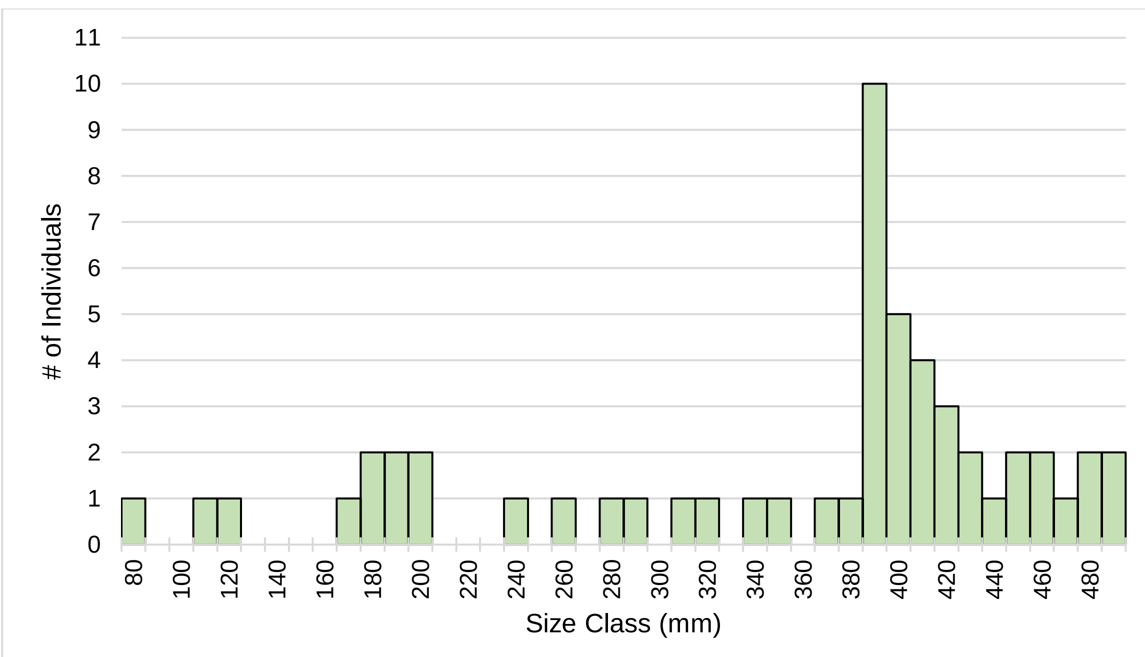

Figure 3.4 Length Frequency Distribution for Largemouth Bass – Loch Erin, Onsted, MI, 2022

Figure 3.5 Length Frequency Distribution for Smallmouth Bass – Loch Erin, Onsted, MI, 2022

Figure 3.6 Length Frequency Distribution for Walleye – Loch Erin, Onsted, MI, 2022

3.3.2 Catch Per Unit Effort

CPUE values were calculated for each collected species by zone and are displayed in Table 3.5.

Table 3.5 Summary of CPUE - Loch Erin, Onsted, MI, 2022

Species	CPUE (No. Fish/Hour)					
	LE1	LE2	LE3	LE4	LE5	All Sites
Bluegill	267.7	98.2	302.5	186.7	146.9	**197.4**
Channel Catfish	20.8	23.5	93.6	19.3	43.3	**39.8**
Green Sunfish	2.3	0.0	4.4	3.9	3.8	**2.9**
Largemouth Bass	20.8	14.9	23.9	25.0	24.5	**22.0**
Pumpkinseed	9.2	0.0	21.8	30.8	11.3	**14.9**
Smallmouth Bass	0.0	4.3	17.4	1.9	5.6	**5.8**
Walleye	4.6	4.3	6.5	0.0	0.0	**2.9**
Yellow Bullhead	0.0	0.0	0.0	3.9	1.9	**1.2**
Yellow Perch	0.0	0.0	6.5	0.0	5.6	**2.5**
Total	**325.4**	**145.1**	**476.7**	**271.4**	**242.9**	**289.4**

3.3.3 Proportional Stock Density

A representative subsample of 75 Bluegill were measured from Loch Erin; all 75 were of stock size and 16 were of quality size, resulting in a PSD value of 21.3. A total of 53 Largemouth Bass were collected and measured from the Lake; 45 were of stock size and 39 were of quality size, resulting in a PSD value of 86.7. A total of 7 Walleye were collected and measured from the Lake; 5 were of stock size and 4 were of quality size, resulting in a PSD value of 80.0. A summary of PSD results for Bluegill, Largemouth Bass, and Walleye collected at Loch Erin is displayed in Table 3.6.

3.3.4 Relative Condition

Wr values were calculated for selected species that were collected and measured from the Lake: Bluegill – 0.97, Largemouth Bass – 0.98, and Walleye – 0.95. Wr values for Bluegill, Largemouth Bass, and Walleye collected and measured from Loch Erin are displayed in Table 3.6.

Table 3.6 Summary of Community Analysis for Selected Sport Fish - Loch Erin, Onsted, MI, 2022

Species	No. Individuals Measured	No. Stock Size	No. Quality Size	PSD	Wr
Bluegill	75	75	16	21.3	0.97
Largemouth Bass	53	45	39	86.7	0.98
Walleye	7	5	4	80.0	0.95

3.4 AGE ASSESSMENT OF SELECTED SPORT FISH

Fish scale approximate age determination was completed using a subsample of 15 Largemouth Bass. The approximate ages of Largemouth Bass ranged from 4 – 12 years. The oldest fish (12 years) measured 495 mm and weighed 1,975 g. Growth rates of Largemouth Bass in Loch Erin were examined by determining the relationship between age and average length for each represented age class. These results were compared to published averages for Michigan from a dataset of Largemouth Bass collected in June – July (Schneider, 2000). A comparison of Largemouth Bass average growth rates by age class in Loch Erin and Michigan is presented in Figure 3.7.

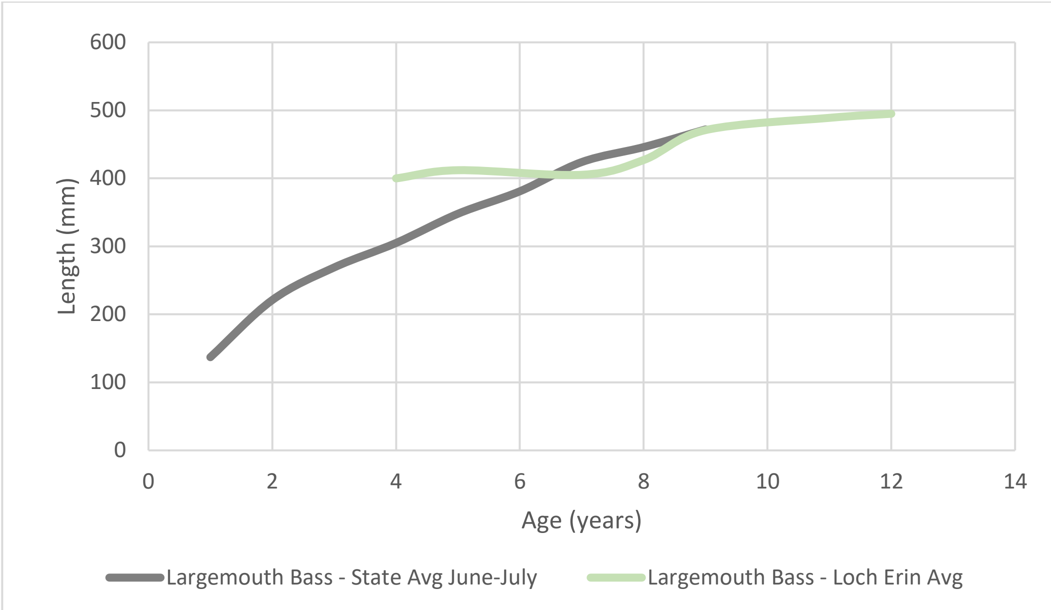

Figure 3.7 Comparison of Largemouth Bass Average Growth Rates by Age Class in Loch Erin and Michigan – Loch Erin, Onsted, MI, 2022

Fish scale approximate age determination was completed using a subsample of five Walleye. The approximate ages of Walleye ranged from 6 – 12 years. The oldest fish (12 years) measured 521 mm and weighed 1,480 g. Growth rates of Walleye in Loch Erin were examined by determining the relationship between age and average length for each represented age class. These results were compared to published averages for Michigan from a dataset of Walleye collected in June – July (Schneider, 2000). A comparison of Walleye average growth rates by age class in Loch Erin and Michigan is presented in Figure 3.8. The age frequency distribution of subsampled Largemouth Bass and Walleye is displayed in Figure 3.9.

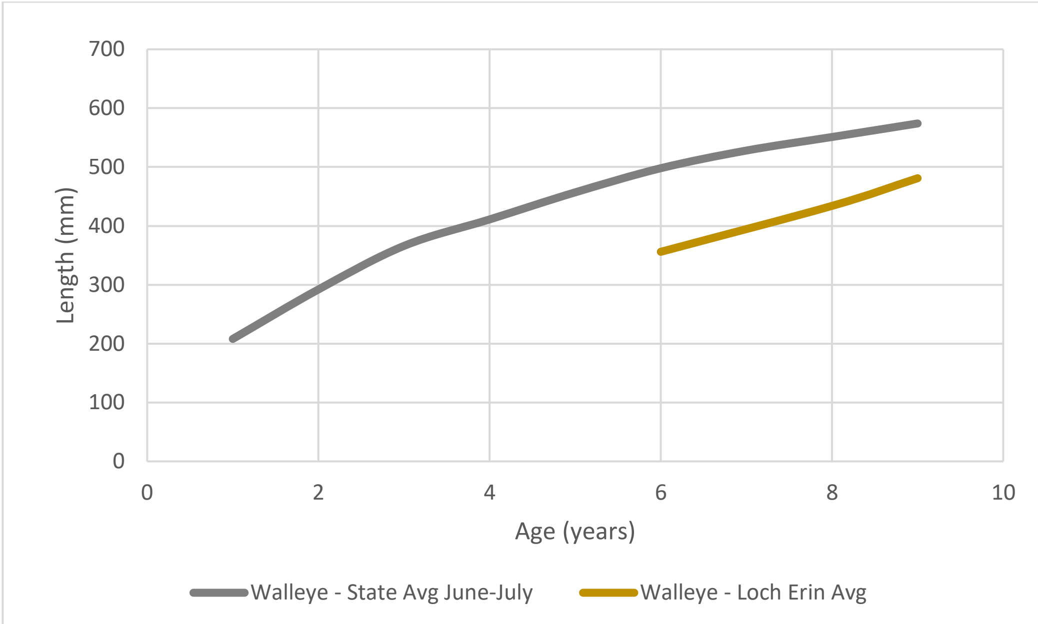

Figure 3.8 Comparison of Walleye Average Growth Rates by Age Class in Loch Erin and Michigan – Loch Erin, Onsted, MI, 2022

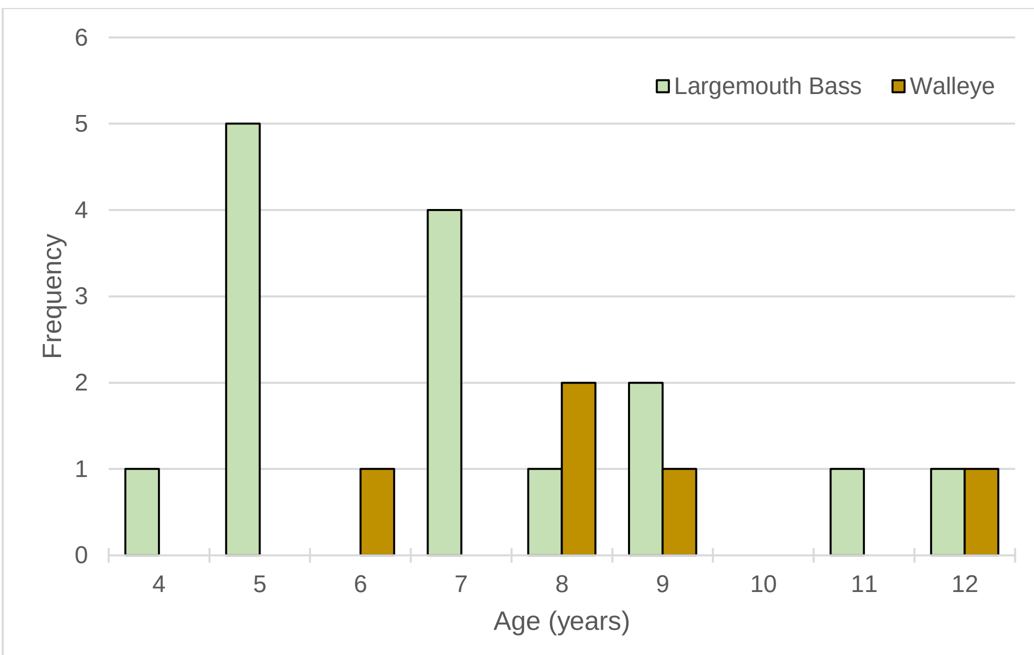

Figure 3.9 Age Frequency Distribution of Subsampled Largemouth Bass and Walleye – Loch Erin, Onsted, MI, 2022

4.0 DISCUSSION AND CONCLUSION

The results of the vertical depth profile show that Loch Erin is a thermally stratified lake. While the differences in temperatures are seemingly not that broad (26.1°C at 0.1 m deep to 22.8°C at 3.2 m deep, or 0.5 m above the bottom), this level of temperature stratification creates significant limitations for usage of the water column by fish species because DO is not able to mix between thermally stratified layers. This is evident based on the significant range of DO results throughout the water column (9.39 mg/L at 0.1 m deep to only 3.78 mg/L at 2.0 m deep). Because Walleye can tolerate DO levels of 2.0 mg/L for only a short time and most inhabit waters where DO concentrations are greater than 3 – 5 mg/L (McMahon et al., 1984), these results suggest that during the summer, Walleye must spend most of their time in the Lake in waters 2.0 m deep, or less. However, the water in this upper layer, the epilimnion, is between 26.1°C and 25.7°C. McMahon et al. (1984) indicated that preferred temperatures for adult Walleye growth are 20.0 - 24°C, and that adults tend to avoid water temperatures greater than 24°C.

The conditions present in the Lake present a situation where most Walleye do not have the ability to remain in the top layer of the water column that has suitable DO concentrations for extended amounts of time because temperatures are above the optimal range for fish growth. They also cannot remain in the bottom layer of the water column that has optimal temperature ranges for growth for extended amounts of time because DO concentrations are below suitable levels. These conditions reduce the ability for Walleye to grow and the effect is that Walleye of Loch Erin take longer to grow to a given length compared to Michigan averages. This is evident by the comparison of growth rates in Loch Erin and Michigan averages. For example, the average Michigan Walleye reaches 400 mm in length at about 4 years old whereas an average Loch Erin Walleye might not reach 400 mm until approximately 7 years old. However, a high PSD value (80.0) and acceptable Wr value (0.95) were calculated for collected fish, which indicated they are healthy and of quality size. Overall, these numbers suggest that Loch Erin Walleye are healthy but exist in low numbers and take longer than average to grow to quality size. Because Loch Erin was previously stocked with Walleye, and also due to the previously mentioned lake conditions, it is not believed that the Walleye are reproducing.

The conditions of Loch Erin are much better suited for centrarchid (sunfish) species, such as Largemouth Bass and Bluegill. Largemouth Bass are in healthy condition as evident by the acceptable Wr value (0.98). Growth rates for Largemouth Bass were above state averages for collected fish from 4 – 6 years old and very similar for fish from 7 – 12 years old. An average Michigan Largemouth Bass is 300 mm at four years old, whereas a fish from Loch Erin is approximately 400 mm at four years old.

In terms of numbers of quality size fish (300 mm), Loch Erin boasts an excellent population of Largemouth Bass (PSD 86.7). However, the PSD value is above the generally accepted range for balanced fish populations (40-70) because very few smaller sized Largemouth Bass were collected. The presence of larger-sized Largemouth Bass could be attributed to the high abundance of Gizzard Shad and small-sized Bluegill observed in the Lake, and the lack of aquatic vegetation which provides cover for these prey species. This leaves these prey species very vulnerable to Largemouth Bass predation and enables them to grow very quickly at a young age, as evident by the above average growth rates at ages 4 – 6 years. Smaller size classes of Largemouth Bass that are normally represented by younger fish were not represented from this survey because those fish are larger than the average fish at that age. The above average growth rates of younger Largemouth Bass could be skewing the interpreted results of the size distribution of Largemouth Bass. This means that the present population of Largemouth Bass will continue to grow well and provide excellent angling with opportunities for very large fish due to the availability of Bluegill and Gizzard Shad as prey.

Another explanation for the lack of small Largemouth Bass could be because of the abundant small Bluegill population which can reduce the number of juvenile Largemouth Bass produced in the lake, as hungry Bluegills typically raid Largemouth Bass nests and eat eggs and larvae (Garling, 2002). Largemouth Bass that survive past larval stage then must compete for resources, such as food, from small Bluegill. However, once Largemouth Bass are large enough to prey upon small Bluegill and Gizzard Shad, they have an abundance of easily accessible food.

The abundance of small Bluegill may be because of a direct and indirect relationship with the abundant Gizzard Shad population of the Lake. Aday et al. found that Bluegill have higher densities, but reduced growth rates and adult sizes, when Gizzard Shad are present (2003). The results of the Loch Erin study found that Bluegill were the most abundant species collected by a large margin (68.2% of the total catch followed by Channel Catfish at 13.8%). However, the low PSD (21.3) indicates that the proportion of smaller fish to larger fish is too high according to generally accepted ranges. These results suggest small Bluegill are overpopulated, which directly correlates to the results observed by Aday et al. An example of the indirect relationship that exists between Bluegill and Gizzard Shad is that Gizzard Shad are a more preferred prey than Bluegill for several piscivores, including Largemouth Bass and Walleye (Aday et al., 2003). Because Bluegill are not targeted as much as Gizzard Shad by predators, Bluegill are able to become more abundant, stunting their own population by limiting their own resources.

Excellent angling opportunities in Loch Erin also exist for Channel Catfish, which is an often-overlooked sport fish. Channel Catfish (96 individuals) were almost twice as abundant as Largemouth Bass (53 individuals) and consisted of a relatively good size distribution with some very large fish. The Channel Catfish population is also likely preying on the abundant Gizzard Shad and smaller-sized Bluegill. Populations can increase rapidly and numbers of Channel Catfish should be maintained through occasional angler harvest and monitored to ensure fish remain healthy.

Other commonly targeted sport fish collected at relatively low numbers were Pumpkinseed, Smallmouth Bass, and Yellow Perch. Smallmouth Bass and Yellow Perch populations may not be appropriately represented by this study as individuals might have been present in waters that were too deep to be effectively sampled using electrofishing methods. However, the Smallmouth Bass collected were of respectable size. Although none were collected, Crappie species (*Pomoxis spp*.) are known to occur in Loch Erin based on anecdotal evidence provided by LEPOA and other survey volunteers.

An overall assessment of Loch Erin based on the results of this study is that the Lake has a healthy fish community and offers excellent angling opportunities for quality size predatory sport fish. Largemouth Bass are growing at above-average rates, particularly among fish in the low and middle range size classes, likely due to the high abundance of available forage fish in Bluegill and Gizzard Shad. Quality sized Walleye are also present but likely in low numbers as the habitat is not preferential for that species. Quality sized Channel Catfish are abundant and may be an underutilized species for anglers. Small Bluegill are abundant and the proportion of smaller individuals is higher than what is generally accepted for balanced fish populations. The panfish population (a collective group of species commonly harvested by anglers – Pumpkinseed, Yellow Perch, and Crappie) [excluding Bluegill] is below average but results may be skewed based on the methods utilized in this study. Gizzard Shad are very abundant and their presence and population size has direct and indirect effects on other species in the Lake. Common Carp are also abundant and were observed throughout the entire lake but likely do not cause much harm to other species.

A general observation from the study was that most fish were collected along shorelines of the main lake and islands that were undeveloped and had a natural riparian buffer. These areas were especially productive for large predator sport fish and should be targeted by anglers. The mid-lake shoals were also very productive, as noted by LEPOA, and would also provide quality angling opportunities. Fish also seemed to congregate in areas that had diverse habitat with access to deeper water.

5.0 RECOMMENDATIONS

EnviroScience, Inc. recommends the following management practices to support a healthy, sustained fishery at Loch Erin:

- Continue to monitor trends in fish populations in the lake. This will allow LEPOA to identify changes, take corrective actions, and determine the effectiveness of management efforts. The frequency for monitoring is recommended to be at least every five years unless changes in the fishery are observed.
- Fish scale age determinations for 30 individual Largemouth Bass distributed across the full range of collected age classes to determine average growth rates for all represented ages.
- Perform regular monitoring to ensure that lake nutrient levels are within appropriate ranges to prevent over-nutrification which can lead to excessive aquatic plant and algae growth.
- Suspend herbicide treatment of aquatic vegetation to allow a healthy vegetation community to become established. Many species within the lake would benefit from the additional aquatic habitat and the input of dissolved oxygen through photosynthesis.
- Harvest of Bluegill in 3 – 5-inch range to improve recruitment of egg, larval, and juvenile Largemouth Bass.
- Occasional harvest of small - medium sized Channel Catfish to prevent a stunted population from becoming established.
- Install an aeration system in the deepest parts of Loch Erin. This will help reduce temperature stratification and increase oxygen levels in deep water, thereby making more habitat available to Walleye in the summertime. Increasing oxygen in deep, cool portions of the Lake helps increase growth, survival, and the chance of successful reproduction for this species.

6.0 LITERATURE CITED

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Appendix A

Field Data Sheet for Vertical Depth Profile

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Loch Erin
Vertical Depth Profile

Station ID:	LE-Index	**Date:**	6/16/2022
Waterbody Name:	Loch Erin	**City, State:**	Onsted, MI
Coordinates:	42.00592, 84.13907	**County:**	Lenawee
Water Chemistry Instrument:	ProDSS1	**Secchi Readings (m):**	Disappear 0.90, Reappear 0.60
Weather:	sunny, 80s, breezy, recent storms		
Samplers:	David Burton, Caleb Green	**Water Depth (m):**	3.7

Depth (m)	DO (mg/L)	Temp (°C)	pH (su)	SpC (µS/cm)	Metalimnion (T/B)	Comments
0.1	9.39	26.10	8.49	468.60		
1.0	9.36	26.00	8.49	468.70		
1.5	8.83	25.70	8.44	471.00	T	
2.0	3.78	24.10	7.87	478.60		
2.5	2.10	23.10	7.67	479.20	B	
3.0	1.05	22.90	7.65	480.50		
3.2	0.38	22.80	7.57	481.00		

Measurement Protocol:

~ First measurement just below surface (0.1m)

~ Last measurement 0.5m from the bottom

~ If depth is < 3m, take readings at surface, every 0.5m, and 0.5m from the bottom

~ If depth is between 3-20m, take readings at surface, every 1m, and 0.5m from the bottom

~ If depth is > 20m, take readings at surface, every 1m up to 20m, then every 2m until 0.5m from the bottom

~ If the metalimnion is encountered (change of ≥ 1 °C per meter of depth), take readings at least every meter within the metalimnion

~ Note the top (T) and bottom (B) of the metalimnion in the appropriate column

Appendix B

Fish Data Sheets for Loch Erin 2022 Fisheries Assessment

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Loch Erin
Fish Community Assessment

Station ID:	LE-1	**Date**:	6/14/2022
Sampling Gear:	Boat - Nighttime	**City, State**:	Onsted, MI
Start Time:	20:57	**County**:	Lenawee
End Time:	21:56	**Seconds Fished**:	1650
Weather:	Clear, 70s		
Samplers:	Kevin Reed, David Burton, Caleb Green		

Notes:
Sampled shoreline habitat in northwest corner of lake, including along two islands. High abundance of Common Carp and Gizzard Shad observed but not collected. Increased water turbidity decreased visibilty.

Species	Length (mm) / Weight (g)					# Individuals / Weight (g)		Counts	Totals	Anomaly Count	
Walleye	521	437							**Individual Count**	Deformities	
	1480	800								Erosions	
									2	Lesions	
									Weight (g)	Tumors	
										Multiple	
									2280	**Total**	0
Largemouth Bass	427	410	395	390	416				**Individual Count**	Deformities	
	1120	950	910	840	1100					Erosions	
	483	450	188	397					9	Lesions	
	1830	1380	84	835					**Weight (g)**	Tumors	
										Multiple	
									9049	**Total**	0
Bluegill	174	115	128	141	112	8	3	25	**Individual Count**	Deformities	
	84	28	42	50	27	440	80	33		Erosions	
	125	145	115	144	128	6	9	1	116	Lesions	
	34	65	29	57	36	345	316		**Weight (g)**	Tumors	
	124	128	159	124	154	11	5			Multiple	
	32	38	83	40	74	472	335		2704	**Total**	0
Green Sunfish	151								**Individual Count**	Deformities	
	81									Erosions	
									1	Lesions	
									Weight (g)	Tumors	
										Multiple	
									81	**Total**	0
Pumpkinseed	165	155	160	165					**Individual Count**	Deformities	
	88	63	82	105						Erosions	
									4	Lesions	
									Weight (g)	Tumors	
										Multiple	
									338	**Total**	0
Channel Catfish	569	474	525	550	460				**Individual Count**	Deformities	
	2183	1085	1295	1917	936					Erosions	
	540	371	378	275					9	Lesions	2
	1536	433	502	155					**Weight (g)**	Tumors	
										Multiple	
									10042	**Total**	2

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Loch Erin
Fish Community Assessment

Station ID: LE-2
Sampling Gear: Boat - Nighttime
Start Time: 23:28
End Time: 0:16
Weather: Clear, upper 60s
Samplers: Kevin Reed, David Burton, Caleb Green

Date: 6/14/2022 - 6/15/2022
City, State: Onsted, MI
County: Lenawee
Seconds Fished: 1687

Notes:
High abundance of Gizzard Shad observed but not collected. Increased water turbidity decreased visibilty.Sampled two rock islands. Multiple passes at each island. Focused on collecting predators, large sport fish.

Species	Length (mm) Weight (g)					# Individuals Weight (g)		Counts	Totals	Anomaly Count	
Largemouth Bass	450	475	405	390	430				Individual	Deformities	
	1150	1570	990	770	1250				Count	Erosions	
	489	465							7	Lesions	
	1470	1560							Weight (g)	Tumors	
										Multiple	
									8760	**Total**	0
Walleye	481	356							Individual	Deformities	
	1112	447							Count	Erosions	
									2	Lesions	
									Weight (g)	Tumors	
										Multiple	
									1559	**Total**	0
Smallmouth Bass	440	306							Individual	Deformities	
	1275	445							Count	Erosions	
									2	Lesions	
									Weight (g)	Tumors	
										Multiple	
									1720	**Total**	0
Channel Catfish	380	231	600	584	650				Individual	Deformities	
	432	87	2190	2115	2605				Count	Erosions	
	530	548	353	330	420				11	Lesions	
	1294	1360	316	280	656				Weight (g)	Tumors	
	349									Multiple	
	343								11678	**Total**	0
Bluegill	149	159	185	155	160	5	10		Individual	Deformities	
	57	85	108	68	76	263	679		Count	Erosions	
	158	119	175	180	140	14			46	Lesions	
	73	27	101	91	50	700			Weight (g)	Tumors	
	130	135	145	130	159					Multiple	
	42	47	56	40	71				2634	**Total**	0

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Loch Erin
Fish Community Assessment

Station ID:	LE-3	**Date:**	6/15/2022
Sampling Gear:	Boat - Nighttime	**City, State:**	Onsted, MI
Start Time:	1:34	**County:**	Lenawee
End Time:	2:12	**Seconds Fished:**	1654
Weather:	Clear, 60s		
Samplers:	Kevin Reed, David Burton, Caleb Green		

Notes:
Sampled shoreline habitat in vicinity of dam. Missed several walleye, bluegill, catfish, bass. Common Carp and smaller Gizzard Shad were abundant. Increased water turbidity decreased visibilty.

Species	Length (mm) / Weight (g)					# Individuals / Weight (g)		Counts	Totals	Anomaly Count	
Walleye	185	431	164						Individual	Deformities	
	52	839	36						Count	Erosions	
									3	Lesions	
									Weight (g)	Tumors	
										Multiple	
									927	**Total**	0
Smallmouth Bass	370	193	294	292	275				Individual	Deformities	
	739	115	370	377	347				Count	Erosions	
	190	170	190						8	Lesions	
	104	72	105						Weight (g)	Tumors	
										Multiple	
									2229	**Total**	0
Largemouth Bass	400	269	199	400	467				Individual	Deformities	
	990	286	94	914	1585				Count	Erosions	
	241	310	120	183	86				11	Lesions	
	186	461	22	84	8				Weight (g)	Tumors	
	113									Multiple	
	18								4648	**Total**	0
Yellow Perch	120	95	125						Individual	Deformities	
	21	11	26						Count	Erosions	
									3	Lesions	
									Weight (g)	Tumors	
										Multiple	
									58	**Total**	0
Bluegill	145	140	134	144	106	11	7	14	Individual	Deformities	
	53	47	49	61	24	450	307		Count	Erosions	
	105	100	103	130	140	17	40		139	Lesions	
	22	18	20	45	97	949	1801		Weight (g)	Tumors	
	114	170	139	132	115	14	21			Multiple	
	30	99	51	45	30	1814	1040		7052	**Total**	0
Pumpkinseed	121	108	150	145	136				Individual	Deformities	
	35	27	73	70	56				Count	Erosions	
	150	114	144	110	110				10	Lesions	
	62	32	66	30	26				Weight (g)	Tumors	
										Multiple	
									477	**Total**	0

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Loch Erin
Fish Community Assessment

Species	Length (mm) / Weight (g)					# Individuals / Weight (g)		Counts	Totals	Anomaly Count	
Green Sunfish	84	105							Individual Count	Deformities	
	12	28								Erosions	
									2	Lesions	
									Weight (g)	Tumors	
										Multiple	
									40	**Total**	0
Channel Catfish	330	470	475	545	352			14	Individual Count	Deformities	
	294	1227	1337	2145	333			13		Erosions	
	525	475	535	340	300			1	43	Lesions	
	1627	905	1320	425	70				Weight (g)	Tumors	
	330	430	571	350	212					Multiple	
	342	936	1773	414	88				13236	**Total**	0

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Loch Erin
Fish Community Assessment

Station ID: LE-4
Sampling Gear: Boat - Nighttime
Start Time: 21:46
End Time: 22:34
Weather: Clear, 70s
Samplers: Kevin Reed, David Burton, Caleb Green

Date: 6/15/2022
City, State: Onsted, MI
County: Lenawee
Seconds Fished: 1870

Notes:
Sampled shoreline habitat in bay extending north from northeast corner of lake and at island where bay opens into lake. High abundance of Common Carp and Gizzard Shad observed but not collected. Increased water turbidity decreased visibilty. Christian Malcom of LEPOA assisted with sampling.

Species	Length (mm) Weight (g)					# Individuals Weight (g)		Counts	Totals	Anomaly Count	
Largemouth Bass	425	495	415	398	340				Individual Count	Deformities	
	1083	1975	1050	1031	564					Erosions	
	201	199	401	435	350				13	Lesions	
	104	90	952	1056	674				Weight (g)	Tumors	
	390	372	444							Multiple	
	839	693	1251						11362	Total	0
Bluegill	173	150	139	137	148	6	7	52	Individual Count	Deformities	
	102	76	54	45	96	351	429			Erosions	
	105	110	96	98	90	6	5		97	Lesions	
	21	34	17	18	17	236	216		Weight (g)	Tumors	
	145	157	170	149	158	4	2			Multiple	
	63	78	104	62	91	287	130		2527	Total	0
Pumpkinseed	140	100	113	119	141	1			Individual Count	Deformities	
	59	23	29	34	60	14				Erosions	
	80	108	96	107	65				16	Lesions	
	5	24	16	24	5				Weight (g)	Tumors	
	134	103	120	104	124					Multiple	
	59	21	35	23	35				466	Total	0
Channel Catfish	273	269	465	615	691				Individual Count	Deformities	
	171	151	1232	2150	3255					Erosions	
	270	590	545	365	580				10	Lesions	
	80	1246	1526	388	1920				Weight (g)	Tumors	
										Multiple	
									12119	Total	0
Smallmouth Bass	281								Individual Count	Deformities	
	328									Erosions	
									1	Lesions	
									Weight (g)	Tumors	
										Multiple	
									328	Total	0
Yellow Bullhead	259	235							Individual Count	Deformities	
	256	203								Erosions	
									2	Lesions	
									Weight (g)	Tumors	
										Multiple	
									459	Total	0

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Loch Erin
Fish Community Assessment

Species	Length (mm) / Weight (g)					# Individuals / Weight (g)		Counts	Totals	Anomaly Count	
Green Sunfish	79 / 11	147 / 70							Individual Count	Deformities	
										Erosions	
									2	Lesions	
									Weight (g)	Tumors	
										Multiple	
									81	**Total**	0

Loch Erin
Fish Community Assessment

Station ID: LE-5
Sampling Gear: Boat - Nighttime
Start Time: 0:15
End Time: 1:20
Weather: Partly cloudy, Low 80s, light breeze
Samplers: Kevin Reed, David Burton, Caleb Green
Date: 6/16/2022
City, State: Onsted, MI
County: Lenawee
Seconds Fished: 1912

Notes:
Sampled shoreline habitat of bay in northwest corner of lake, two islands along southcentral shoreline, and bay in southcentral part of lake. High abundance of Common Carp and Gizzard Shad observed but not collected. Increased water turbidity decreased visibilty. Best fishing was along undisturbed shoreline with good cover

Species	Length (mm) / Weight (g)					# Individuals / Weight (g)		Counts	Totals	Anomaly Count	
Largemouth Bass	380	404	399	179	298				**Individual**	Deformities	
	766	1052	796	70	431				**Count**	Erosions	
	391	329	490	390	288				13	Lesions	
	949	505	1996	996	339				**Weight (g)**	Tumors	
	207	395	425							Multiple	
	118	990	1127						10135	**Total**	0
Channel Catfish	636	521	615	497	545				**Individual**	Deformities	
	2860	1580	1535	1187	1944				**Count**	Erosions	
	536	420	566	625	390				15	Lesions	2
	1448	517	1753	2235	479				**Weight (g)**	Tumors	
	540	533	614	90	600					Multiple	
	1656	1712	2395	8	1945				23254	**Total**	2
Bluegill	134	119	141	130	124	25	18	3	**Individual**	Deformities	
	49	31	50	40	35	966	683		**Count**	Erosions	
	138	128	103	106	133	10	7		78	Lesions	
	50	43	16	26	51	462	189		**Weight (g)**	Tumors	
	139	147	109	129	150					Multiple	
	40	49	21	39	61				2901	**Total**	0
Pumpkinseed	113	121	111	93	120				**Individual**	Deformities	
	34	41	30	16	35				**Count**	Erosions	
	122								6	Lesions	
	39								**Weight (g)**	Tumors	
										Multiple	
									195	**Total**	0
Green Sunfish	129	79							**Individual**	Deformities	
	48	10							**Count**	Erosions	
									2	Lesions	
									Weight (g)	Tumors	
										Multiple	
									58	**Total**	0
Yellow Perch	116	112	144						**Individual**	Deformities	
	20	17	30						**Count**	Erosions	
									3	Lesions	
									Weight (g)	Tumors	
										Multiple	
									67	**Total**	0

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Species	Length (mm) Weight (g)					# Individuals Weight (g)		Counts	Totals	Anomaly Count	
Smallmouth Bass	295 418	290 379	192 88						Individual Count	Deformities	
										Erosions	
									3	Lesions	
									Weight (g)	Tumors	
										Multiple	
									885	**Total**	0
Yellow Bullhead	211 132								Individual Count	Deformities	
										Erosions	
									1	Lesions	
									Weight (g)	Tumors	
										Multiple	
									132	**Total**	0
Channel Catfish	390 480	473 882	340 330	317 240	278 175				Individual Count	Deformities	
										Erosions	
	365 363	401 458	370 384						8	Lesions	
									Weight (g)	Tumors	
										Multiple	
									3312	**Total**	0