Duck Lake

Clarence Township, Calhoun County
Battle Creek Watershed

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Environment

Duck Lake is a 628 acre headwater lake located in Clarence Township, Calhoun County. The lake is located three miles east of the village of Partello. The basin shape is rather complex (Figure 1) with shoals, "sunken islands", weed beds, and drop-offs. The lake basin is mostly large flat shoals comprised of marl with some sand and silt. Duck Lake creek is the only outlet from the lake flowing in a north direction into Narrow Lake where these waters form the source of the Battle Creek River. The outlet has a water control structure, originally constructed in 1944, to establish a legal lake level with a spillway elevation at 929 feet. Approximately, 58% of the lake area and 44% of the lake volume is less than ten feet deep (Figure 2). The total volume of water is 6,900 acre-ft with a maximum depth of 51 feet. The longest unobstructed distance across the lake, often referred to as the fetch, is 1.70 miles. The day of year that water temperature reaches its maximum, based on a long term average, was late July (210 day of the calendar year). The lake is classified as warmwater because the average July water temperature was 82.7 degrees Fahrenheit (Figure 3). There is a state owned public access ramp located on the west side of the lake at the intersection of T Dr. North and 27 ½ Mile Road.

History

Much of the fishery management of Duck Lake in the past has centered on attempts to develop a substantial walleye population. Walleye were stocked from 1934 through 1942 and then several times from 1955 to 1988. Recently walleye spring fingerlings have been stocked every other year starting in 2000. Walleye have also been stocked as fall fingerlings through a private stocking permit issued by the MDNR. The 1992 Status of the Fishery Report (92-11) found year classes of walleye that were not consistent with years that the DNR stocked walleye; an indication that natural reproduction may have been occurring, however, this was later determined to be unrecorded walleye stockings from local anglers. Natural reproduction of walleye is very unusual for an inland lake in southern Michigan and recent evaluations have not observed any natural reproduction.

Redear sunfish, also referred to as shellcrackers because of their preference for snails as food, were stocked in this lake in 1984, 1986, 1988, and 1995 by Fisheries Division, MDNR. Redear sunfish were stocked to provide a quality sized panfish fishery and not to replace bluegill or pumpkinseed (MDNR, 92-11). Redears are not hybrids, but a distinct species in the sunfish family (Centrarchidae). Redears are not indigenous to Michigan, but seem to survive in limited numbers when stocked as fingerlings. They typically grow very rapidly and usually attain larger sizes than native bluegill and pumpkinseed. In 1996, Fisheries Division surveyed Duck Lake to evaluate the survival and growth of Redear sunfish. This survey found natural reproduction that could sustain the Redear sunfish population without stocking.

The first complete inventory of the fish community in Duck Lake was described in the Fish Collection Report for Duck Lake written in April 20, 1987. Historically, largemouth bass in Duck Lake have been slow growing, nearly one inch below the state average growth rate. Survey catches have always indicated a large bass population with good recruitment. In 2003, Largemouth Bass Virus (LMBV) was confirmed in Duck Lake and influenced a fish kill during the summer of 2002. The objectives of this survey were to evaluate the population dynamics of largemouth bass in Duck Lake and four other populations in the southwest region of Michigan. The 1992 Status of the Fishery Report provides a detailed summary on the fish community of Duck Lake.

Current Status

Largemouth bass were collected using a modified Michigan DNR boat with Smith-Root electrofishing gear. The electrofishing gear was set to deliver pulsed direct current (30% cycle duty) on low range (250 volts and 60 pulses per second) at 5 to 7 amps. Nine 0.5 mile long electrofishing transects were established around the perimeter of the lake and each night all transects were surveyed; however, each night the direction of sampling alternated between a clock-wise or counter-clockwise rotation. Sampling duration varied with each transect but was either 1,440 or 1,260 seconds each night of sampling. A second crew was used to record biological data and tag fish. Largemouth bass were measured to the nearest tenth of an inch; dorsal spines were removed for age estimation on 20 fish per inch group. Largemouth bass equal to and larger than 12 inches were tagged with a Monel butt-end band (size 10 or 12) applied to the upper mandible. Tags were sequentially numbered to allow for identification of individual fish. All largemouth bass collected received a left pelvic fin clip to evaluate tag loss and record recaptures for population estimates.

Differences in length frequency data were assessed by comparing the distribution of lengths obtained in Duck Lake with average values from four other lakes in the region, using a Kruskal-Wallis test and nonparametric multiple comparison test which assumes unequal sample sizes (Zar 1999). Weighted Mean lengths at age and age length keys were used for growth analysis. Differences in mean length at age were tested using a two-way analysis of variance, controlling for age as a covariate. Mean growth index was computed to compare data to Michigan state averages as described in Schneider (2000). The mean growth index is the average difference between the observed mean lengths and statewide seasonal (October) average lengths for each age class of the species where five or more fish were collected. Catch at age for all largemouth bass was estimated from a length at age key for use in the catch-curve analysis. A minimum age of one and maximum age of nine were used because fish were represented in proportion to their abundance, except for fish of older age classes. The oldest age groups were not included in the analysis because less than five representatives were sampled and the linear fit of the estimate appeared more indicative of the general trend in declining catch with age when the analysis was truncated at age nine.

Estimates of population size for largemouth bass were made for fish 10 inches and larger using recaptures of tagged fish during subsequent electrofishing efforts. Closed population estimates within the program Capture were used to evaluate equal catchability. Program CAPTURE examines the encounter history of each fish, and then chooses a model that best suits the variability in catchability (Lancia et al. 1994). CAPTURE chooses from the following models: M0, where catchability is equal for the population, Mh, where each fish has a unique capture probability that remains constant during the sample period, Mb, which allows a change in capture probabilities caused by a response to trapping, Mt, where each fish is assumed to have equal catchability during the sample period (Schnabel method), and Mbh, Mth, Mtb, Mtbh, which are combinations of these previous models (Lancia et al.

1994). The most appropriate model is determined by CAPTURE based on goodness-of-fit tests and tests between models (Lancia et al. 1994). Estimates were based on a minimum of four nights of sampling unless the standard error of the estimate was within 10% after the third night. Because sampling took place over a relatively short period of time, no adjustments were made in the estimates to compensate for growth or mortality. Catch-per-unit-effort (CPUE) was calculated for bass as a secondary method of evaluating abundance trends. Effort was defined as rate based on the time to sample a one half mile transect. Catch-per-unit effort is a measure of relative abundance that can be used to make temporal or spatial comparisons of fish density around the lake.

Catches at age were calculated for all fish in the sample, excluding recaptures. Instantaneous mortality rates (the death rate of the largemouth bass population) were estimated by using a catch-curve regression (Ricker 1975). Only age groups that were recruited to the gear in proportion to their abundance in the population were used for mortality estimates. Relative year class strength was used as an index of recruitment. Only population data from one year was collected, therefore properties of the catch curve regression were examined as in Maceina (1997) where residuals of the catch-curve regression were used as indices of year-class strength.

Analysis and Discussion

A total of 1,173 largemouth bass, excluding recaptures, was collected during 55,800 seconds of sampling effort. Relative abundance of the largemouth bass population was 1.3 bass per minute. The population estimate for all sizes of bass was 13,223 (95% CI 9,700-19,138) while the estimate for stock-sized (8 inches or larger) bass was 5,573 (95% CI 3,555-10,036). Density of all sized bass is 21 fish per acre and higher than other regional lakes with acceptable growth of largemouth bass. Corey Lake had a largemouth bass density of 13.8/acre while Gull Lake had a density of 5.3/acre (DNR, Status of the Fishery Resource Report 2012-145). Growth of bass in Corey and Gull Lake were both at the statewide average. In comparison, the density of largemouth bass in Pleasant Lake was 22.7 fish per acre and were growing one year slower than the state average rate. Density dependent factors have been limiting growth of largemouth bass in Duck Lake. Density dependent factors are those that are responsible for regulating the population in proportion to its density such as competition, predation, and diseases. The 2002 LMBV related fish kill may have reduced the population slightly, but no apparent improvements in growth have occurred.

For largemouth bass in Duck Lake, the catch curve regressions produced total instantaneous mortality rates of 0.39 corresponding to annual survival rates of 67% and annual mortality rates of 33% (Figure 4). Variability in year class strength was moderate in Duck Lake as represented by the amount of variation explained by the age variable (R2 = 0.79) in the catch-curve regression. Year class strength appears to be variable, the residual values showed strong year classes from age 5 to age 8 with a weak year class for age 3. Residual values below the regression line for older than age 9 are likely due to angler harvest more than a weak year class.

Largemouth bass growth was slow in Duck Lake. The average length at age for all year classes was well below the statewide average length at age (Figure 5). Largemouth bass achieved the legal size limit of 14 inches at age 8, which is three years later than the statewide average length at legal size. Population mean length was 8.0 inches (se 0.87) in Duck Lake (Table 1). Size distributions of bass by inch group were erratic with the catch strongly comprised of fish from within the six and seven inch groups. The difference in largemouth bass mean lengths between Duck Lake and Gull Lake was statistically significant (t= 7.57, P=0.001). The distribution of largemouth bass length frequency data yielded significantly smaller values in Duck Lake compared to fish size in four other regional lakes (Figure 6 and 7). Proportional stock density was calculated as 0.29 for largemouth bass in Duck Lake, which indicates a poor size structure where typically values greater than 40% indicate an acceptable size structure. Mean state growth index was -3.6 which indicates slower growth rates compared to statewide averages. The largest fish captured measured 20.2 inches in total length therefore the ability to grow larger is possible; however few individuals larger than quality stock size are available to anglers.

Multiple pairwise comparisons of CPUE data between transects around the lake showed an interesting spatial trend based on body size of largemouth bass. Generally, smaller sized bass were captured at higher numbers in the northern transects of the lake where the extensive shoals are located. Fewer individual bass were captured in the southern and eastern transects, but these individuals were generally larger in body size.

Management Direction

Largemouth bass in Duck Lake have a high survival rate and a moderate rate of recruitment. Dynamics of these fish populations typically result in high density populations with poor growth as is the case in Duck Lake. Extensive shoals and spawning habitat within Duck Lake provide for the environment necessary to maintain a high density and recruitment in the lake. Typically, high populations of small body sized predators will excessively crop young prey. This can in most cases create a good fishery for bluegill and pumpkinseed in the presence of poor fishing for largemouth bass. Previous fish surveys of Duck Lake have verified the good size structure and growth of panfish (DNR, Status of the Fishery Report 92-11).

Management of fish stocks generally requires knowledge of the fraction of the stock harvested by anglers. The estimation of fishing mortality is a critical component of modern fisheries stock assessment. These rates measure the impact of a fishery on the stock, and fisheries management biologist use target and threshold levels of fishing mortality as reference points to evaluate regulations. We did not have a creel clerk dedicated to this lake to assess the number of tag returns or harvest of fish; therefore the assumption that all tags are reported may have been violated and interpretation of this information should be used cautiously. However, voluntary tag returns were provided through the DNR website and telephone calls made to the DNR office in Plainwell, Michigan during the year. Exploitation rate is commonly determined from tag returns or total catch relative to population size. The estimated rate is then used in conjunction with an estimate of survival to determine total annual mortality. Of the 546 legal size tagged largemouth bass, 37 fish were reported, resulting in an annual fishing mortality of 7%. This information, although biased low, indicates that fishing mortality was negligible. Despite the limitations of this analysis, the estimates of high survival and poor growth indicate that not many anglers are harvesting largemouth bass, primarily because few individuals reach the legal size limit of greater than 14 inches in length. Size based regulations for this population may need to consider a harvest slot limit or reducing the minimum size limit to promote more harvest while maintaining adequate predation on panfish populations. In conjunction with this needed exploitation rate, walleye have been stocked to provide additional predatory pressures on the largemouth bass population. Duck Lake should be surveyed in another five years to evaluate age (cohort) specific mortality rates and to assess trends in population size structure.

References

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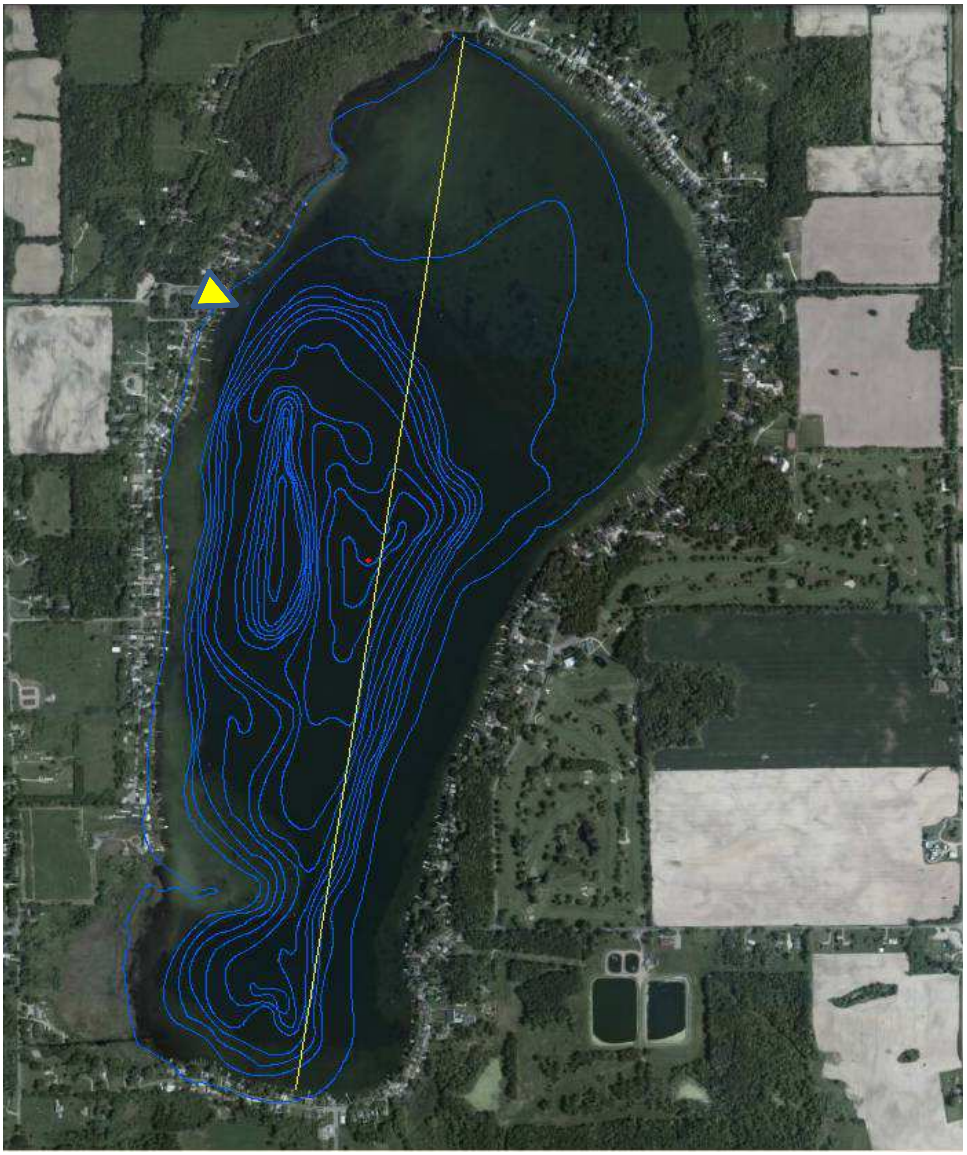


Figure 1. Bathymetric map of Duck Lake, Calhoun County. Contour lines represent five foot depth intervals. The yellow line represents the fetch and the yellow triangle indicates the location of the public access site. The red dot in the center of the lake marks the deepest depth in Duck Lake.

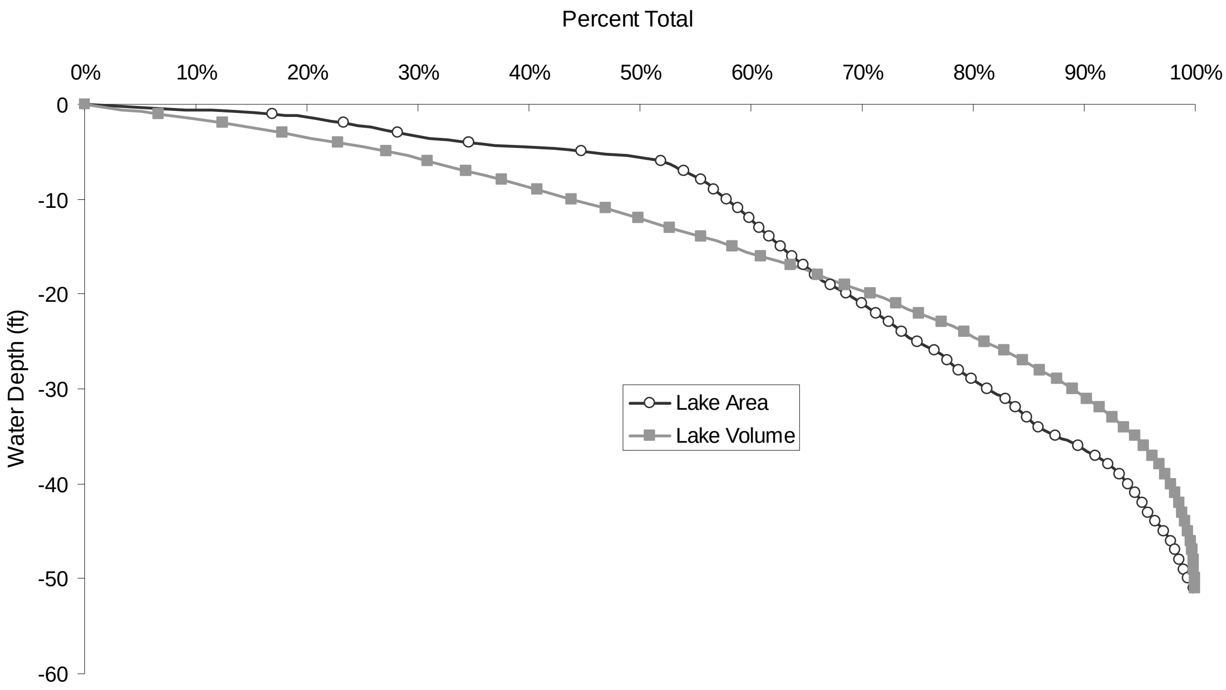


Figure 2. Hypsographic curve (Lake Area/Volume) of Duck Lake, Calhoun County. The horizontal scale represents the area or volume of the lake as a percentage of the entire area. The vertical scale represents the depth. Points in the graph represent the area or volume shallower than the corresponding depth.

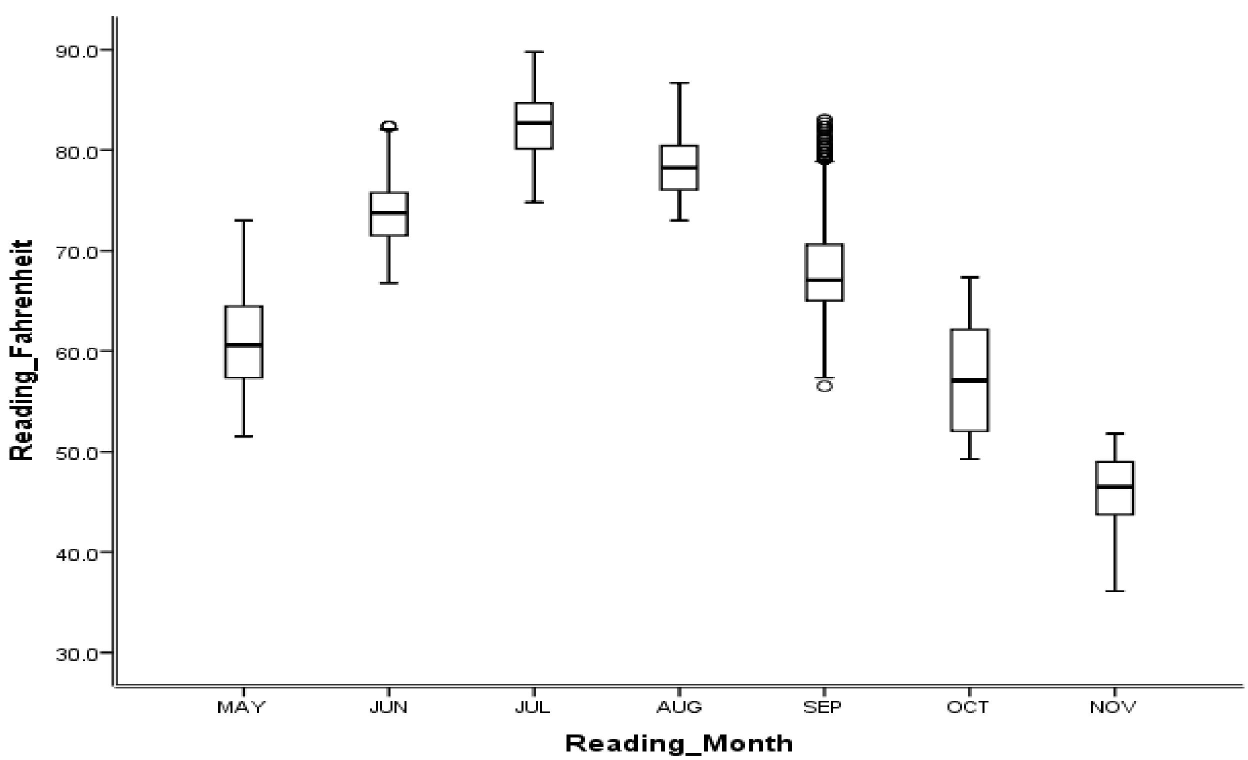


Figure 3. Monthly water temperature data in the Littoral Zone of Duck Lake, Calhoun County in 2011.

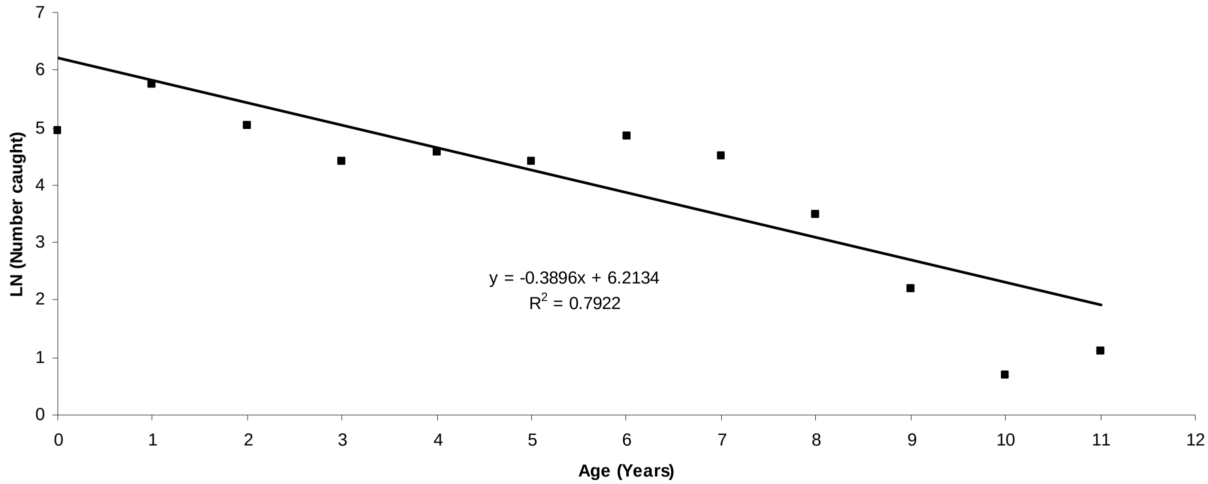


Figure 4. Catch Curve regression of Largemouth bass in Duck Lake, Calhoun County.

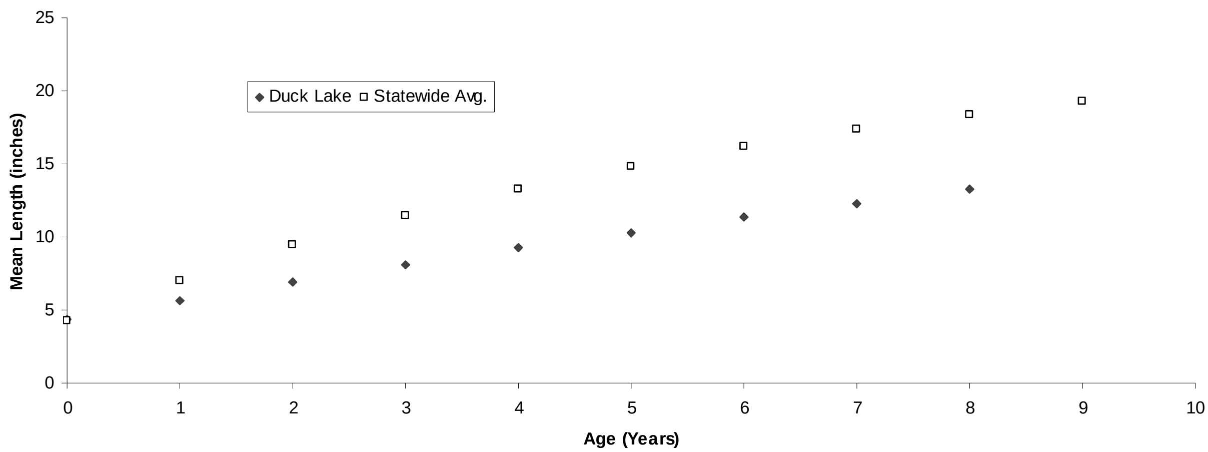
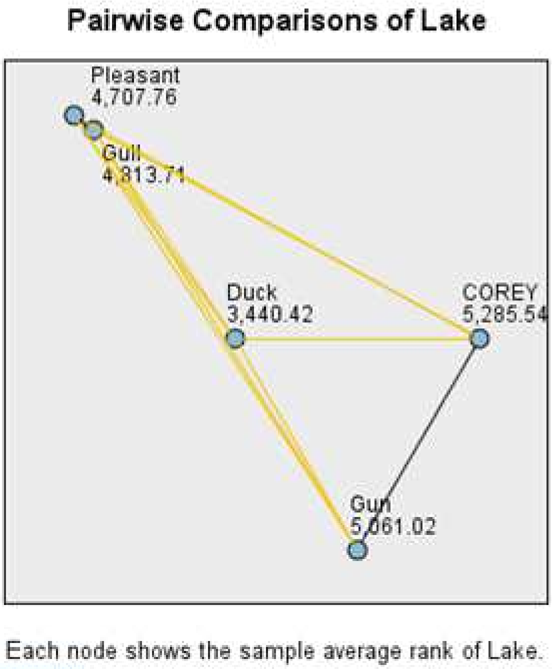


Figure 5. Mean length at age for largemouth bass in Duck Lake, Calhoun County compared to the statewide average length at age.



Sample1-Sample2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj.Sig.
Duck-Pleasant	-1,267.340	105.655	-11.995	.000	.000
Duck-Gull	-1,373.288	99.157	-13.850	.000	.000
Duck-Gun	-1,620.598	95.929	-16.894	.000	.000
Duck-COREY	1,845.124	107.345	17.189	.000	.000

Figure 6. Multiple comparisons of largemouth bass length-frequency data between Duck Lake, Calhoun County and four other largemouth bass populations in southwest Michigan. Results of a Kruskal-Wallis test and nonparametric multiple comparisons test assuming unequal sample sizes (Zar 1999). Size distribution of bass in Duck Lake was significantly different from 4 other lakes in the region.

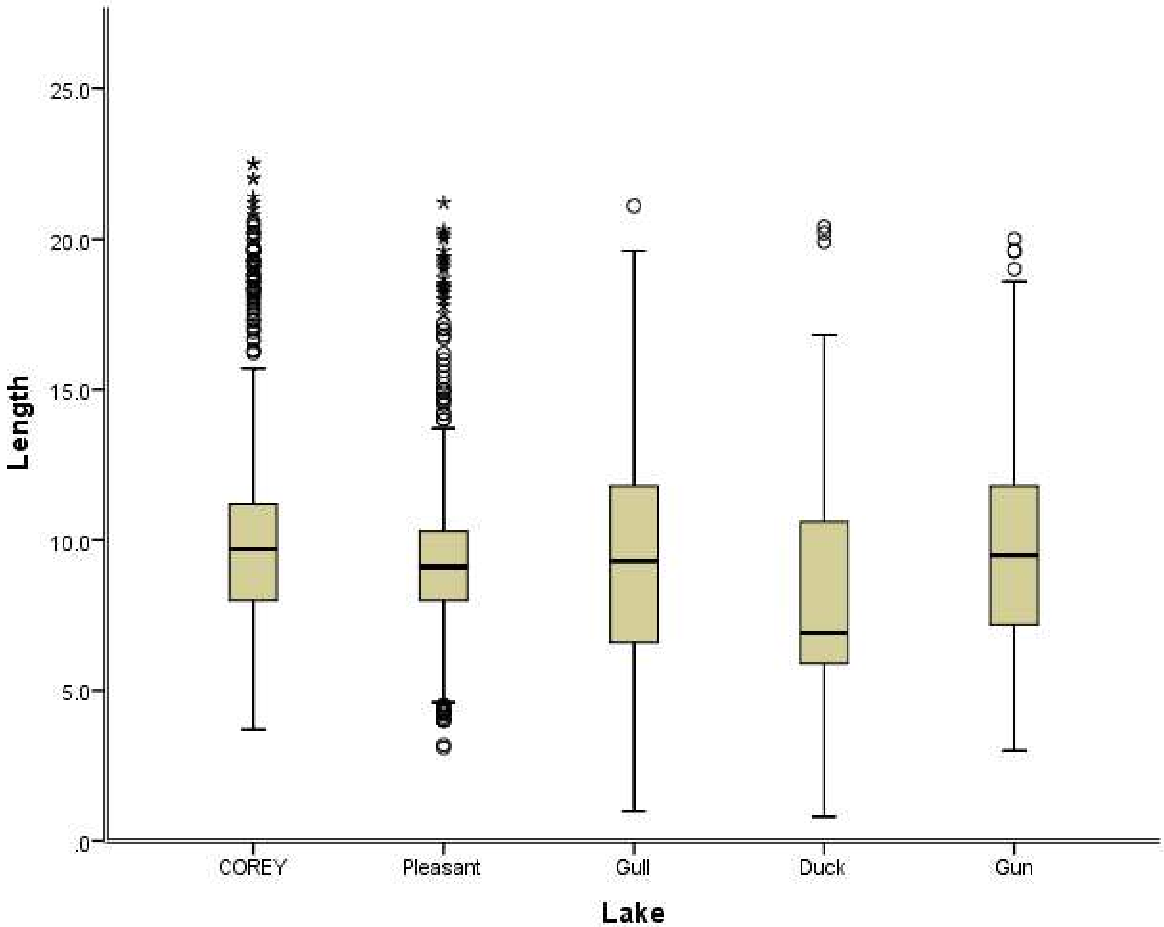


Figure 7. Length frequency distributions of largemouth bass from five different inland lakes in Michigan. The box represents 50% of the measured lengths were found within that range, and the black band inside the box represents the median length. The whisker bars represent the 5th and 95th percentile values while the circles and stars represent values that are outliers (rare lengths) from the dataset.

Table 1. Largemouth bass population length estimates from Duck Lake and compared to four other regional lakes.

Lake	N	Mean	Median	Std. Error of Mean	Minimum	Maximum	Std. Deviation	Variance
COREY	1534	9.958	9.700	.0724	3.7	22.5	2.8340	8.032
Duck	1160	8.022	6.900	.0870	.8	20.4	2.9642	8.786
Gull	2327	9.312	9.300	.0652	1.0	21.1	3.1456	9.895
Gun	2882	9.695	9.500	.0541	3.0	20.0	2.9057	8.443
Pleasant	1654	9.257	9.100	.0524	3.1	21.2	2.1327	4.549
Total	9557	9.365	9.200	.0297	.8	22.5	2.8993	8.406