Middle Lake

Barry County; T4N/R8W/Sec. 28, 29, 32, 33
Grand River Watershed; 2022

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Environment

Middle Lake is a 134-acre inland lake located in the northern one-third of Barry County in Michigan's Lower Peninsula. The lake is approximately 5 miles north and slightly east of the village of Hastings. Middle Lake has 4.3 miles of shoreline with one island. The northern and eastern sides of the lake are heavily developed with residences, whereas the southern and western sides of the lake are predominantly natural shorelines with wetland and forest. The landscape around Middle Lake is dominated by tilled agricultural lands (52%), forest (25%), and wetland (15%; Figures 1 and 2).

Middle Lake has a maximum depth of 36 feet and over 50% of the lake is at least 20 feet deep. It is connected to Leach Lake through a channel in its far southwestern lobe. One small unnamed tributary flows into Middle Lake just north of the connection to Leach Lake. The substrate of Middle Lake is predominantly pulpy peat, with muck in the areas deeper than 30 feet and a mix of sand and marl closer to the shorelines.

The Michigan Department of Natural Resources (DNR) maintains a public boating access site on the northeastern shore of Middle Lake. The boating access site has a hard surfaced ramp, a vault toilet, and parking for 16 vehicles with trailers.

History

Early fisheries management in Middle Lake included stocking of Largemouth Bass, Lake Trout, and Yellow Perch during 1895-1909 (Table 1). As with most other public lakes in southern Michigan, Middle Lake was stocked with Largemouth Bass, Bluegill, and Yellow Perch from 1933 through 1945. Throughout the state, stocking programs for these species were discontinued after research indicated that they were able to maintain fisheries solely through natural reproduction (Cooper 1948).

Middle Lake was initially surveyed and mapped in July 1957 by the Institute for Fisheries Research within the Michigan Department of Conservation (the precursor of the present-day Michigan DNR). This first fisheries survey was completed with seines and gill nets. Fish species captured in the gill nets included: Northern Pike, Yellow Perch, Largemouth Bass, Warmouth, Bluegill, Longear Sunfish, Pumpkinseed, Black Crappie, White Sucker, Lake Chubsucker, Black Bullhead, Brown Bullhead, Yellow Bullhead, Longnose Gar, and Golden Shiner. Additional fish species captured in the seines included: Green Sunfish, Blackchin Shiner, Bluntnose Minnow, Banded Killifish, Brook Silverside, and Blackstripe Topminnow. Age and growth analysis was completed on a sample of gamefish species captured during the 1957 survey. Remarks from the 1957 survey were that the fishery had "no particular issues", with abundant Bluegill, common Northern Pike, and low numbers of Yellow Perch and Pumpkinseed. A temperature and dissolved oxygen profile was also recorded during the 1957 survey, which showed the lake had less than 3 parts per million (ppm) of dissolved oxygen after 7.5 feet of water.

This was surprising given the depth of the lake. Heavy aquatic vegetation consisting of many plant species was observed along the shoreline.

The next fisheries survey was completed in May 1961. A 1,600-foot seine was used to sample the fish community of Middle Lake. Many of the same fish species found in the 1957 survey were captured as well as "mud pickerel" (which were most likely Grass Pickerel). A designated public boating access site was developed in February 1967. Prior to 1967, access to Middle Lake was limited to two road ends.

In October 1979, an electrofishing survey was completed around the shoreline of Middle Lake. No new fish species were captured compared to the previous two surveys. A few Bowfin were observed but not captured during the survey. Growth rates were good for Bluegill but poor for Largemouth Bass and Yellow Perch.

The next survey of Middle Lake was completed in June 2002. This survey used a variety of gear types including trap nets, gill nets, seines, and nighttime electrofishing to sample the entire fish community. Bluegills were the dominant fish species captured (1,486 individuals). Other species included Black Crappie, Largemouth Bass, Pumpkinseed, Warmouth, and Yellow Perch. Age and growth structures were collected from Black Crappies, Bluegills, Largemouth Bass, and Pumpkinseeds. Growth of Black Crappies, Bluegills, and Pumpkinseeds was similar to the statewide average growth rate for each species, while Largemouth Bass were growing much slower than the statewide average. The August 2002 survey also included a temperature and dissolved oxygen profile and water quality analyses. Dissolved oxygen began to rapidly decline after 14 feet of water with very low oxygen (hypoxia) from 18 feet of water to the bottom. Total alkalinity was 168 mg/L, total nitrogen was 0.706 mg/L, total phosphorus was 0.015 mg/L, and the Secchi depth was 9.5 feet.

Current Status

In May 2022, Middle Lake was surveyed as part of the DNR's Status and Trends Program (STP). The STP uses standardized protocols and a variety of sampling gear including small-mesh fyke nets, large-mesh fyke nets, experimental gill nets, seines, and electrofishing to assess fish populations in lakes across the state (Wehrly et al. 2010). This allows the DNR to develop benchmarks for fish abundance and growth that can be compared to other similar lakes within fisheries management units, Great Lakes basins, and across the state. Effort in the 2022 survey consisted of 4 net nights of small-mesh fyke nets, 9 net nights of large-mesh fyke nets, 4 net nights of experimental gill nets, 4 seine hauls, and 30 minutes of nighttime electrofishing (Figure 3). All fish captured in Middle Lake were measured for total length, and spine or scale samples for age and growth analysis were collected from the first 10 individuals per gamefish species per inch group. Weights, mean length-at-age, and age frequency were estimated using the procedures described by Schneider (2000a). Mean lengths-at-age for Middle Lake game species were compared to statewide averages presented in Schneider et al. (2000b). Water quality, shoreline development, and nearshore habitat were assessed in August 2022 following STP methods (Wehrly et al. 2010).

A total of 2,864 fish representing 18 species and one hybrid were captured during the 2022 STP survey of Middle Lake (Table 2). Panfish were common; Bluegill was the most abundant fish species captured with 2,465 individuals representing 86% of the overall catch by number and 36% by weight. Bluegills varied in length from 0.8 inches to 9.0 inches; 56% of all the Bluegills captured were 1-2 inches long. Only 16% of the Bluegills collected were larger than 6 inches in length (Figure 4) which is considered

acceptable for harvest by most Bluegill anglers (Gabelhouse 1984; Figure 4). Ten age classes (ages 1-10) of Bluegills were captured in Middle Lake, and their growth was similar to the statewide average (Figure 5; Table 3). The Schneider Index, which provides a score for the Bluegill fishery in a lake that ranges from 1 (very poor) to 7 (superior; Schneider 1990) was 4.3 (satisfactory) for electrofishing and 5.7 (good to excellent) for large-mesh fyke nets (between good and excellent). Note that when seines or electrofishing are the primary survey gear, the Schneider Index is typically lower than when fish are collected with trap nets and fyke nets. Black Crappie was the second most abundant fish species captured in Middle Lake with 97 individuals that ranged in length from 2-13 inches (Figure 6). Thirteen age classes (every age from 1-14 except age 12) were collected (Table 3). On average, Black Crappies in Middle Lake were growing similarly to Black Crappies statewide. Other panfish species captured included hybrid sunfish (n=11), Pumpkinseed (n=61), Warmouth (n=26), and Yellow Perch (n=6).

Fish species that are predators comprised approximately 32% of the total fish biomass in Middle Lake. Largemouth Bass was the most abundant predator with 87 individuals caught; of those, only 12 were larger than the 14-inch minimum length limit (Figure 7). The mean growth index for the nine age classes captured (ages 1-9) was -0.7 (Table 3), indicating that bass in Middle Lake were growing slightly slower than the average for Largemouth Bass in lakes across Michigan. Other predator species collected included Northern Pike and Bowfin.

The remaining fish species captured included prey species such as Blackchin Shiner, Banded Killifish, Brook Silverside, Blackstripe Topminnow, Golden Shiner, Lake Chubsucker, and White Sucker and other warmwater fishes such as Grass Pickerel, Brown Bullhead, and Yellow Bullhead.

On August 4, 2022, the water quality and shoreline sampling were completed on Middle Lake. A dissolved oxygen and temperature profile was taken in 36 feet of water. The epilimnion consisted of the top 10 feet of the water column. Water temperatures in the epilimnion were warm and varied from 76.2°F to 77.7°F (Figure 8). Dissolved oxygen in the epilimnion was between 7.16 ppm to 5.36 ppm. The metalimnion (zone of thermal change) began at 11 feet and continued to a depth of 20 feet. Water temperatures dropped from 73.9°F at 10 feet to 49.9°F at 20 feet. Dissolved oxygen concentrations declined quickly within the metalimnion, starting at 3.61 ppm at 11 feet and falling to 1.22 ppm by 13 feet. From 14 feet to the bottom, Middle Lake was hypoxic with no dissolved oxygen present. The hypolimnion extended from 21 feet to the lake bottom, with water temperatures gradually dropping from 49.1°F at 21 feet to 45.6°F at 36 feet. Water chemistry sampling was completed at the same location as the temperature and dissolved oxygen profile. Total alkalinity was 154 mg/L, total nitrogen was 0.685 mg/L, total phosphorus was 0.010 mg/L, chlorophyll a was 0.0040 mg/L, and the Secchi depth was 9.0 feet. A total of 64 docks and 81 dwellings were counted on Middle Lake. Eighteen percent of the shoreline was armored. The estimated density of large woody material along the shoreline was 23.6 logs per kilometer of shoreline.

Analysis and Discussion

Catch-per-unit-effort (CPUE; the number of fish captured per net night, seine haul, or minutes of electrofishing) provides an index of relative abundance that facilitates comparisons across lakes and sampling years. Bluegill CPUE from the 2022 Middle Lake survey was compared to CPUE data from other STP surveys in the DNR Southern Lake Michigan Management Unit (SLMMU) and statewide from 2002-2021. For each gear type, surveys with a CPUE of zero were excluded from the analysis. Average CPUE in large-mesh fyke nets (49 fish per net night) and nighttime electrofishing (9 fish per

minute) were between the median and 75th percentile when compared to other similar lakes in SLMMU and above the 75th percentile when compared to lakes across the state. Bluegill electrofishing CPUE over time tripled from 3 Bluegills per minute in 2002 to 9 Bluegills per minute in 2022. Large-mesh fyke nets were not used in the 2002 survey, prohibiting comparisons across years.

The Bluegill population in Middle Lake appears to be dominated by young fish. Two-thirds of the Bluegills captured were less than 3 inches in length, and age 1 fish composed 61% of the catch. The Bluegill CPUE in all four small mesh fyke net lifts and two of the seine hauls were above the 75th percentile for lakes in SLMMU and statewide. The abundance of young Bluegills indicates there is not a barrier to Bluegill reproduction in Middle Lake. The high abundance of young Bluegills could be related to favorable weather conditions during 2021, as well as a high density of aquatic plants which provide excellent nursery and rearing habitat for fry and early juvenile Bluegills and other fish species during early to mid-summer.

Despite the high abundance of juveniles, stunting of Bluegills does not appear to be a serious problem in Middle Lake. Mean lengths-at-age were slightly below statewide averages for age 1-4 fish, but mean lengths-at-age for ages 5-6 fish were comparable to or above statewide averages. Furthermore, Bluegills in the 6-9-inch range are available for angler harvest.

Black Crappies also are relatively abundant in Middle Lake. Black Crappie CPUE in large-mesh fyke nets in 2022 was 9 fish per net night which is above the 75th percentile when compared to lakes within SLMMU and across the state. The number of individual Black Crappies captured in 2022 was only 97 fish, but the majority were at least 8 inches in length making them desirable for anglers. Large-mesh fyke nets are not the optimum sampling gear for Black Crappie. The population may have been underrepresented without the use of trap nets, which have a slightly deeper sampling range than fyke nets.

Largemouth Bass are often the keystone predator on Bluegills in southwest Michigan lakes. During the 2022 survey on Middle Lake, nearly 84% of the Largemouth Bass were captured by nighttime electrofishing with a CPUE of 2.4 fish per minute of electrofishing. This value is between the median and 75th percentile when compared to other lakes in SLMMU and above the 75th percentile for lakes statewide. The Largemouth Bass CPUE was 1.8 fish per minute of electrofishing during the 2002 survey, which was similar to the catch rate in 2022. Largemouth Bass growth rates were very poor in 2002 with a mean growth index of -2.2. In 2022, the Largemouth Bass mean growth index had greatly improved to -0.7.

In 2016, the DNR began requiring all Smallmouth Bass and Largemouth Bass tournament directors to register their tournaments. As part of the registration and reporting process, tournament directors also must submit data on bass catches and angler participation. Since the initiation of this program, Middle Lake has had the 94th highest number of tournament days in Michigan between 2016 and 2022. Fifty-five tournament days were scheduled during this period, and an average of 7.9 tournament days are conducted on Middle Lake annually. The mean tournament size was 22.3 anglers fishing from 12.0 boats. An average of 24 bass were weighed at each tournament. The mean weight of bass weighed at Middle Lake tournaments was 1.93 pounds and the average heaviest bass weighed was 3.62 pounds. All of these statistics regarding tournament size, number of fish per tournament, and fish weight are lower than the average numbers reported for bass tournaments held in Michigan in 2022.

The overall predator population within Middle Lake was moderate with only Bowfin (n=10), Largemouth Bass (n=87) and Northern Pike (n=1) present. In total, these predators accounted for approximately 32% of the total fish biomass in Middle Lake. This is well within the suggested range of 20-50% of the total fish biomass from Schneider (2000a). The timing of the 2022 STP survey was not conducive to sampling Northern Pike; however, it is clear that Northern Pike abundance in Middle Lake is low. The CPUE was zero with every gear type except large-mesh fyke nets. The large-mesh fyke net CPUE of 0.11 fish per net night was below the 25th percentile for SLMMU lakes and lakes statewide. Given the high diversity of prey fish species and the moderate predator biomass, adding an additional predator into Middle Lake at low levels could improve the panfish community size structure and create an additional sport fishing opportunity. Middle Lake is a strong candidate for Walleye stocking due to its geographic location and presence of a public access site. Currently, there is a scarcity of Walleye fishing opportunities in Barry, Calhoun, and Eaton counties. Walleye should be stocked at a density of 4 fall fingerlings per acre on an every third year basis. This stocking rate and timing has been successful in other lakes in southwestern Michigan at improving Bluegill size structure while also creating a sport fishery for Walleye.

The limnology and shoreline sampling on Middle Lake were compared to previous STP surveys and other surveys from SLMMU and statewide. A temperature and dissolved oxygen profile was completed in 2002. In 2002, there was dissolved oxygen with at least 3.0 ppm from the surface to 16 feet of water. In comparison, there was only dissolved oxygen with at least 3.0 ppm from the surface to 11 feet of water in 2022. This is a large reduction in habitat for fish in only 20 years of time. Water temperatures between the 2002 and 2022 profiles were much more similar. Shoreline sampling following the STP protocol was not completed in 2002, so comparisons can not be made. However, shoreline sampling at Middle Lake in 2022 can be compared to shoreline sampling to other STP surveys in SLMMU and statewide (Wehrly et al. 2015). The number of docks (9.3/km) and dwellings (11.7/km) were between the 25th and 50th percentile when compared to other lakes in SLMMU. The number of docks was between the 50th and 75th percentile when compared to lakes in SLMMU. The number of dwellings was between the 25th and 50th percentile when compared to lakes statewide. The number of logs per kilometer in Middle Lake (23.6) was greater than the 75th percentile compared to lakes in SLMMU and statewide. The Secchi depth, a measure of water clarity, was 9.0 feet in 2022 which was 1.5 feet deeper than in 2002. Based on the water chemistry measurements, Middle Lake is most likely a mesotrophic lake, which means it has moderate amounts of nutrients, stratifies in the summer and winter months, and is at risk for increased nutrification.

Management Direction

1. Protect the remaining natural shoreline around the lake. Natural shorelines act as filters to reduce inputs of sediment, nutrients, and other pollutants. They also provide habitat for amphibians and reptiles, while facilitating future recruitment of coarse woody habitat into the lake.
2. Protect native aquatic vegetation including submergent and emergent plants. Native plants serve as spawning habitat for Northern Pike and Yellow Perch, function as nurseries for a variety of fish species, stabilize sediments, and sequester nutrients. When invasive plant control is necessary, use the most selective methods available.
3. Begin a fall fingerling Walleye stocking program to increase the predator abundance in Middle Lake while providing a popular sport fishery for anglers.

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Tables and Figures

Table 1. Fish stocked in Middle Lake, Barry County, Carlton Township, from 1895 through 2022.

Species	Year	Number	Length (inches)	Life Stage
Largemouth Bass	1895	6,000	Unknown	Unknown
Lake Trout	1897	15,000	Unknown	Unknown
Largemouth Bass	1909	4,000	Unknown	Fry
Yellow Perch	1909	80,000	Unknown	Fry
Largemouth Bass	1933	600	Unknown	4 month
Bluegill	1934	2,500	Unknown	5 month
Largemouth Bass	1934	1,200	Unknown	4 month
Yellow Perch	1934	2,000	Unknown	7 month
Bluegill	1935	3,500	Unknown	3 month
Bluegill	1935	7,500	Unknown	4 month
Yellow Perch	1935	5,000	Unknown	8 month
Bluegill	1936	14,000	Unknown	4 month
Yellow Perch	1936	5,000	Unknown	8 month
Bluegill	1937	10,000	Unknown	3 month
Bluegill	1937	7,500	Unknown	4 month
Yellow Perch	1937	2,400	Unknown	8 month
Bluegill	1938	10,000	Unknown	4 month
Bluegill	1939	19,000	Unknown	4 month
Largemouth Bass	1939	1,200	Unknown	5 month
Yellow Perch	1939	2,500	Unknown	7 month
Bluegill	1941	2,300	Unknown	3 month
Bluegill	1941	8,000	Unknown	4 month
Bluegill	1942	4,000	Unknown	3 month
Bluegill	1942	8,000	Unknown	3 month
Largemouth Bass	1942	200	Unknown	3 month
Bluegill	1943	8,000	Unknown	3 month
Smallmouth Bass	1943	400	Unknown	3 month
Bluegill	1944	4,000	4.0	Yearling
Bluegill	1944	4,000	2.5	Yearling
Largemouth Bass	1944	800	3.0	4 month
Largemouth Bass	1944	800	4.0	4 month
Bluegill	1945	1,000	2.5	Yearling
Largemouth Bass	1945	1,000	3.25	3 month

Table 2. Number captured, estimated weight, total length range, and percentage legal or harvestable for all fish species collected from Middle Lake during the 2022 Status and Trends Program survey.

Species	Number	Percent by Number	Weight (lbs.)	Percent by Weight	Length Range (in.)	Percent Legal Size
Black Crappie	97	3.4	53.8	13.3	2.0-13.9	94
Blackchin Shiner	3	0.1	<0.1	<0.1	1.0-2.9	N/A
Banded Killifish	2	0.1	<0.1	<0.1	1.0-1.9	N/A
Bluegill	2,465	86.1	144.7	35.8	0.1-9.9	16
Bowfin	10	0.3	55.8	13.8	13.0-29.9	N/A
Brown Bullhead	17	0.6	17.6	4.4	6.0-14.9	N/A
Brook Silverside	4	0.1	<0.1	<0.1	3.0-3.9	N/A
Blackstripe Topminnow	6	0.2	<0.1	<0.1	1.0-2.9	N/A
White Sucker	1	<0.1	2.9	0.7	19.0-19.9	N/A
Golden Shiner	1	<0.1	0.3	0.1	9.0-9.9	N/A
Grass Pickerel	3	0.1	0.6	0.2	9.0-10.9	N/A
Hybrid Sunfish	11	0.4	2.2	0.5	5.0-7.9	55
Lake Chubsucker	2	0.1	0.9	0.2	8.0-9.9	N/A
Largemouth Bass	87	3.0	69.5	17.2	2.0-18.9	14
Northern Pike	1	<0.1	5.8	1.4	29.0-29.9	100
Pumpkinseed	61	2.1	13.4	3.3	3.0-7.9	69
Warmouth	26	0.9	3	0.8	2.0-7.9	27
Yellow Perch	6	0.2	1.4	0.3	5.0-9.9	67
Yellow Bullhead	61	2.1	32.7	8.1	60.-13.9	N/A

[1] Harvestable size is defined as 6 inches for Bluegill, Hybrid Sunfish, Pumpkinseed, and Warmouth and 7 inches for Black Crappie and Yellow Perch.

Table 3. Length range and mean length, by age, for select Middle Lake fish species collected during the 2022 Status and Trends Program survey. Statewide average length and growth index (Schneider et al. 2000a) are provided for comparison.

Species	Age	# Aged	Length Range (in.)	State Average Length (in.)	Weighted Mean Length (in.)	Mean Growth Index
Black Crappie	1	3	2.9-3.5	4.2	3.2	+0.1
	2	4	5.5-6.2	6	5.8	
	3	7	7.0-8.3	7.5	7.8	
	4	14	7.9-9.7	8.6	9	
	5	5	9.2-11.2	9.4	9.7	
	6	3	10.2-10.7	10.2	10.5	
	7	9	10.0-12.7	10.8	10.7	
	8	1	11.2	11.4	N/A	
	9	7	10.5-13.0	11.9	11.4	
	10	1	12.9	N/A	N/A	
	11	1	11.6	N/A	N/A	
	13	1	11.5	N/A	N/A	
	14	1	11.7	N/A	N/A	
Bluegill	1	19	0.8-2.3	1.8	1.6	-0.3
	2	15	2.6-4.4	3.8	3.1	
	3	14	3.5-5.3	5	4.3	
	4	10	5.0-6.6	5.9	5.5	
	5	10	6.0-8.0	6.7	7	
	6	13	6.2-8.6	7.3	7.4	
	7	1	8.5	7.8	N/A	
	8	2	8.3-8.5	8.2	N/A	
	9	1	9	8.6	N/A	
	10	1	8.4	8.9	N/A	
Largemouth Bass	1	4	2.2-3.8	4.2	3.2	-0.7
	2	10	5.6-7.7	7.1	6.4	
	3	26	7.1-10.3	9.4	8.8	
	4	14	10.2-13.6	11.6	11.2	
	5	12	11.2-14.3	13.2	12.6	
	6	14	11.2-15.3	14.7	13.7	
	7	5	14.5-18.6	16.3	16.3	
	8	1	15.4	17.4	N/A	
	9	1	18.6	18.3	N/A	

Figure 1. Middle Lake, Barry County, Carlton Township watershed boundary.

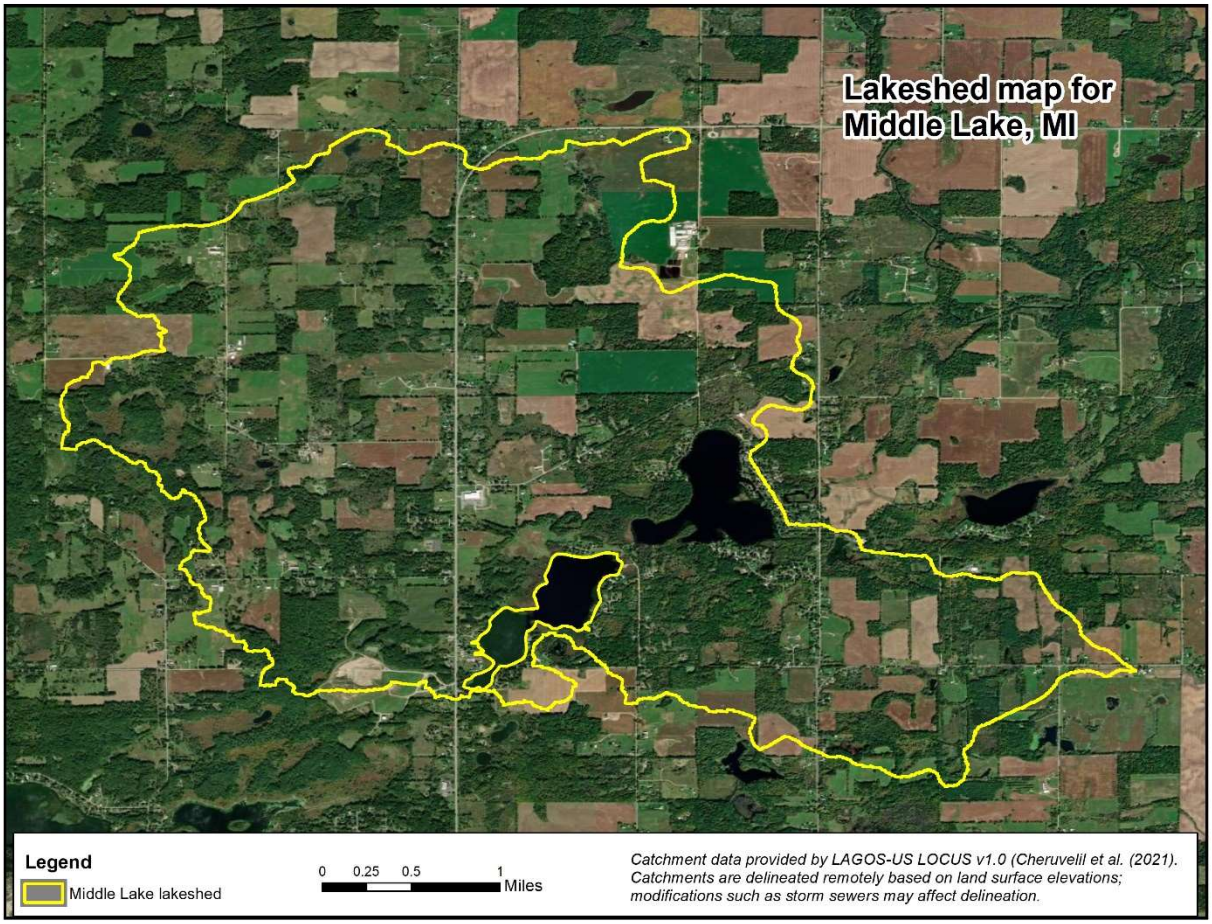


Figure 2. Land cover usage within the Middle Lake, Barry County, Carlton Township watershed (solid line), 2016.

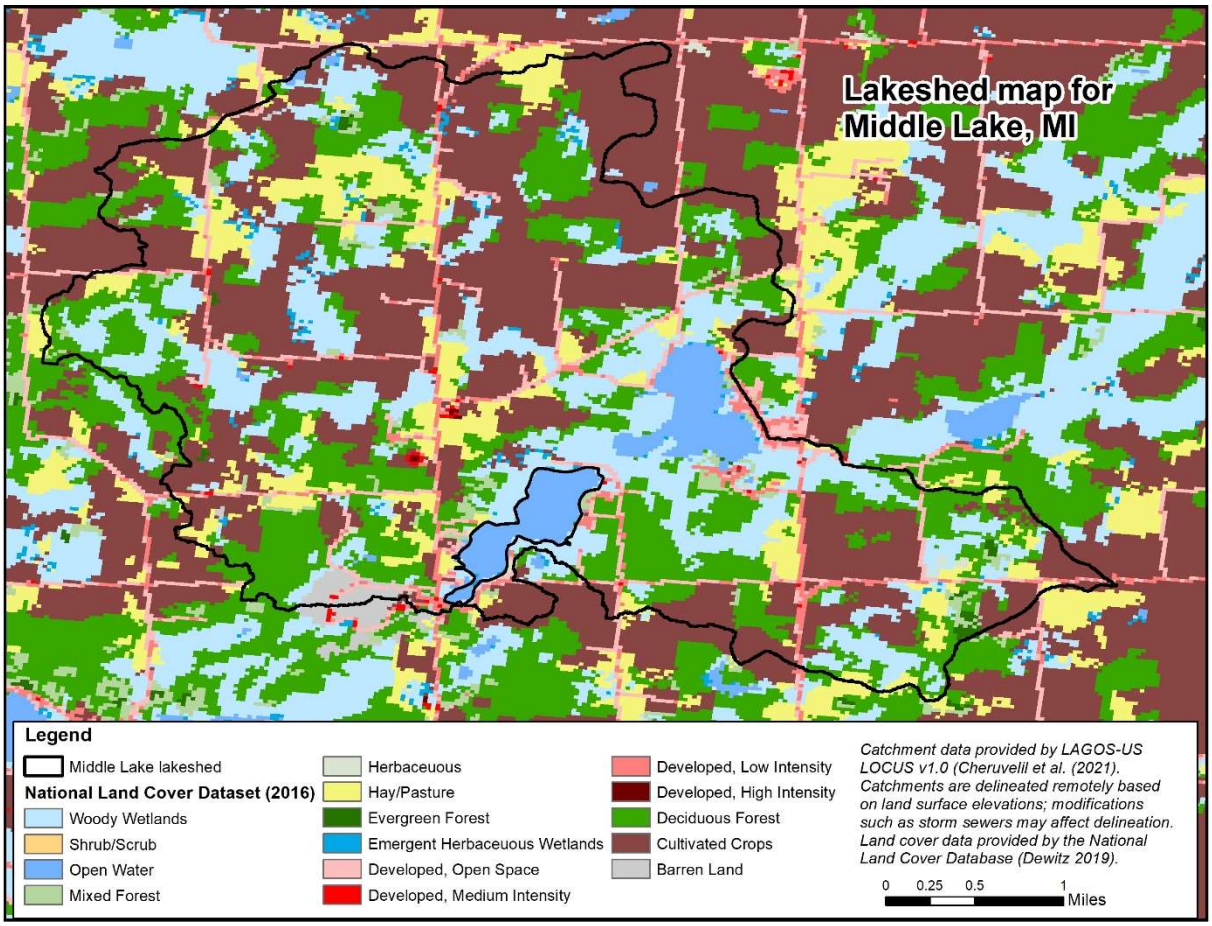


Figure 3. Map of Middle Lake with locations of different gear types used during the 2022 Status and Trends Program survey.

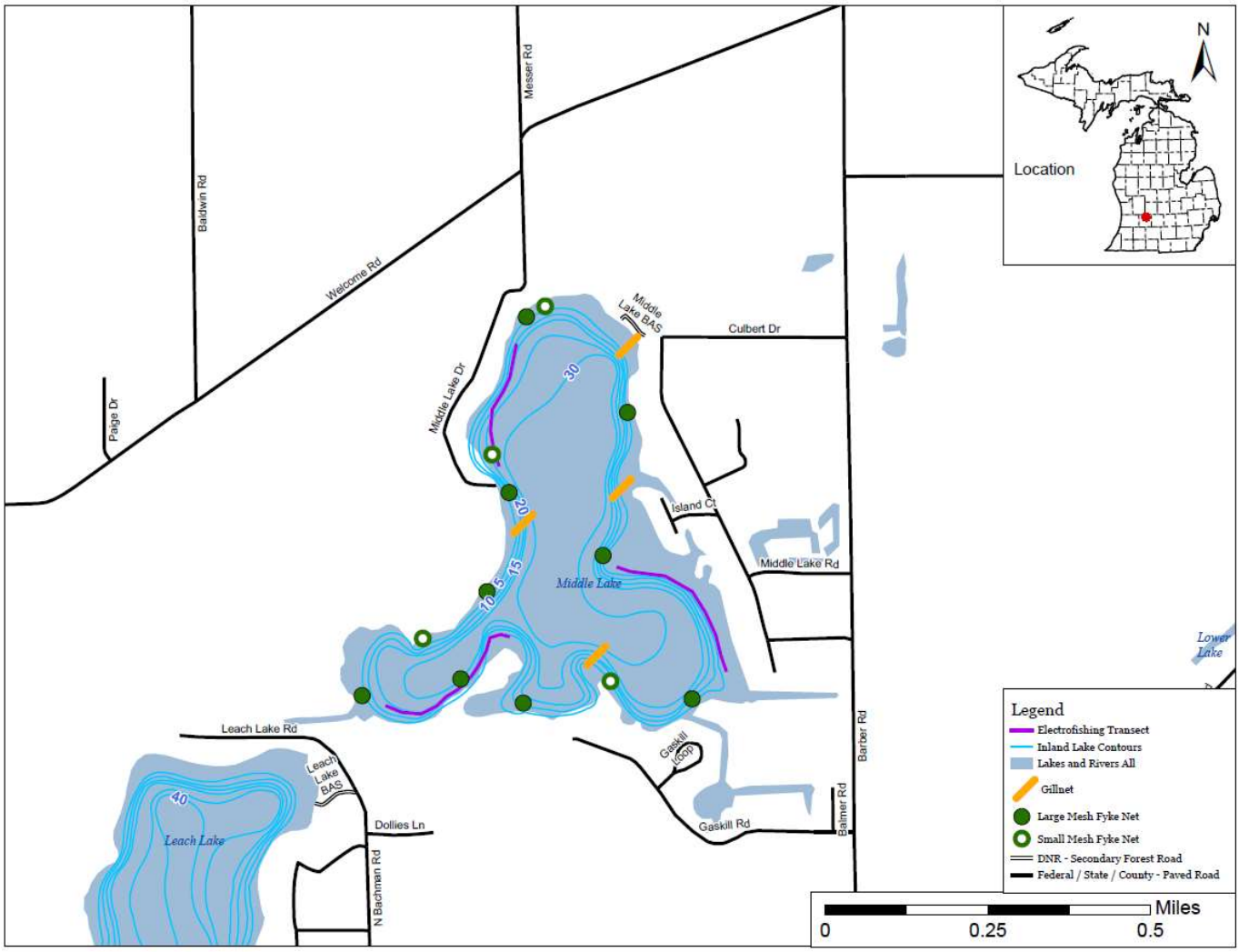


Figure 4. Length frequency distribution for Bluegills captured in Middle Lake during the 2022 Status and Trends Program survey.

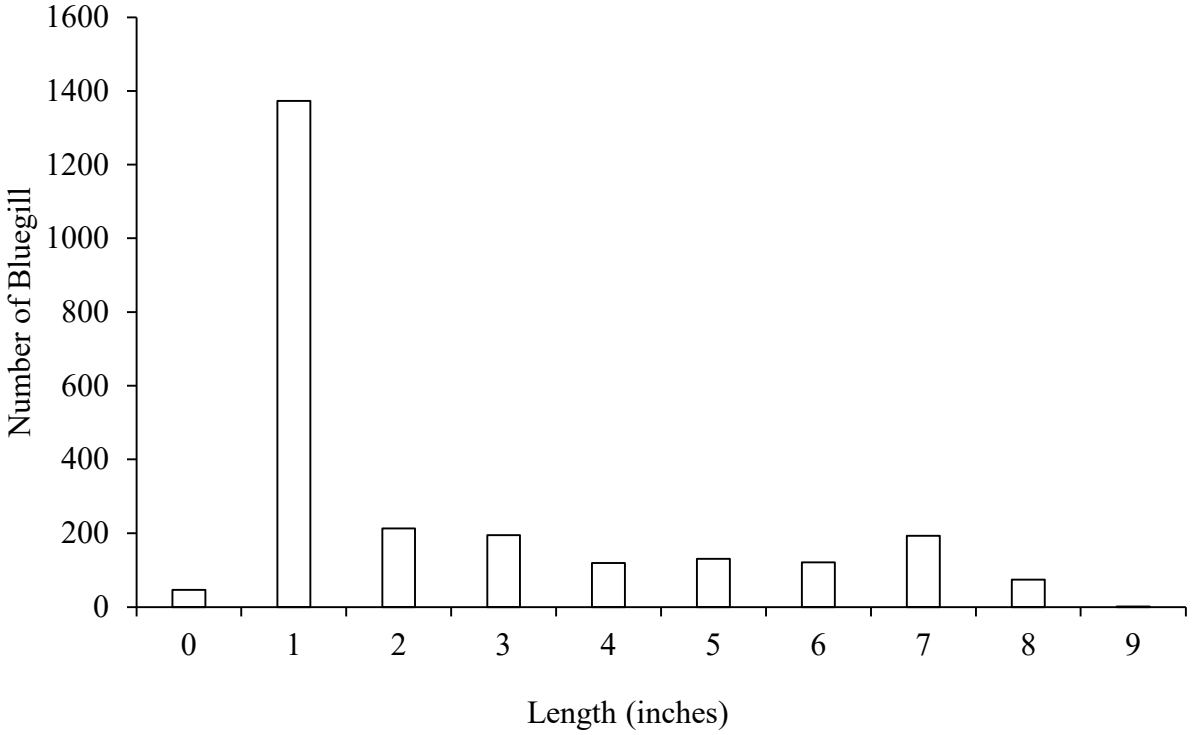


Figure 5. Mean length-at-age of Bluegill captured in Middle Lake during 2022 compared to statewide average Bluegill mean length-at-age (Schneider 2000a).

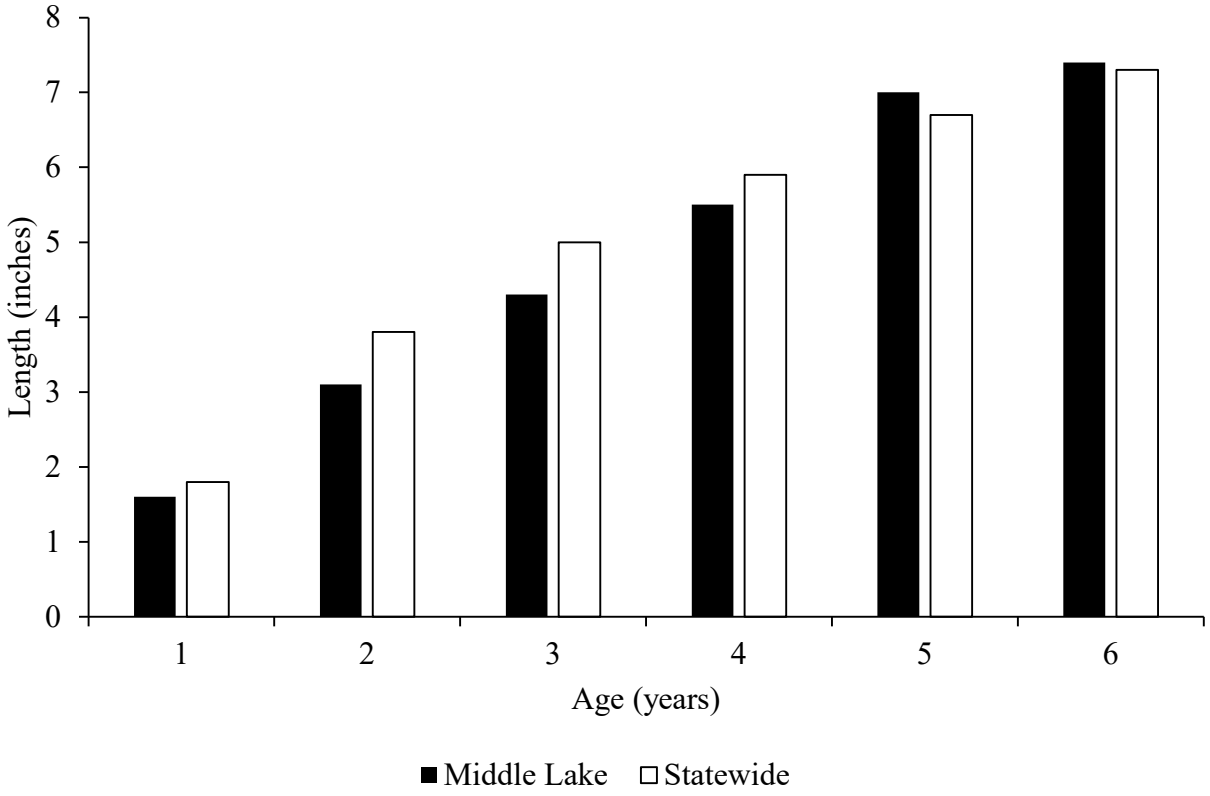


Figure 6. Length frequency distribution for Black Crappies captured in Middle Lake during the 2022 Status and Trends Program survey.

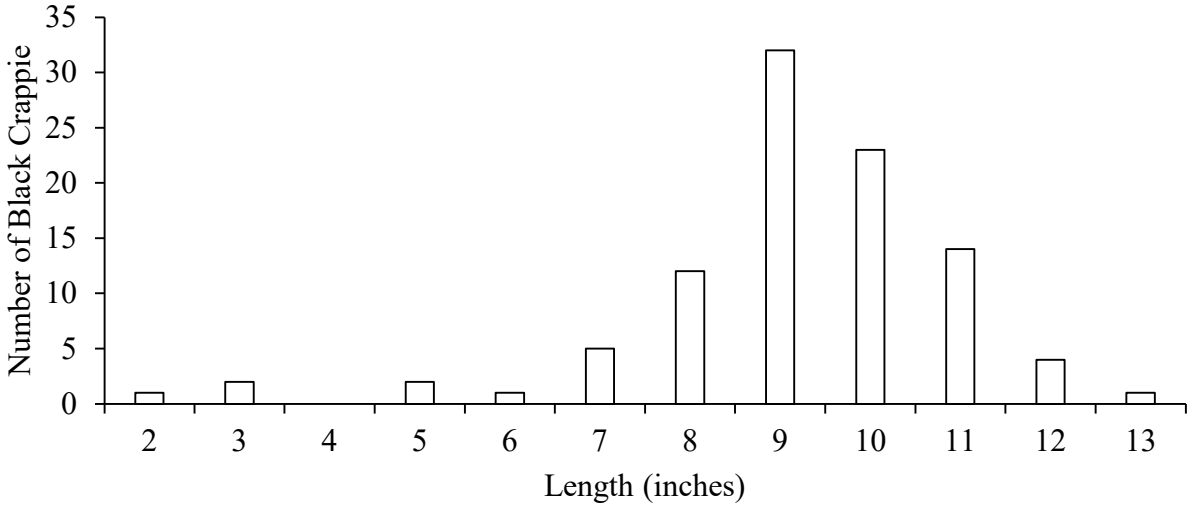


Figure 7. Length frequency distribution for Largemouth Bass captured in Middle Lake during the 2022 Status and Trends Program survey.

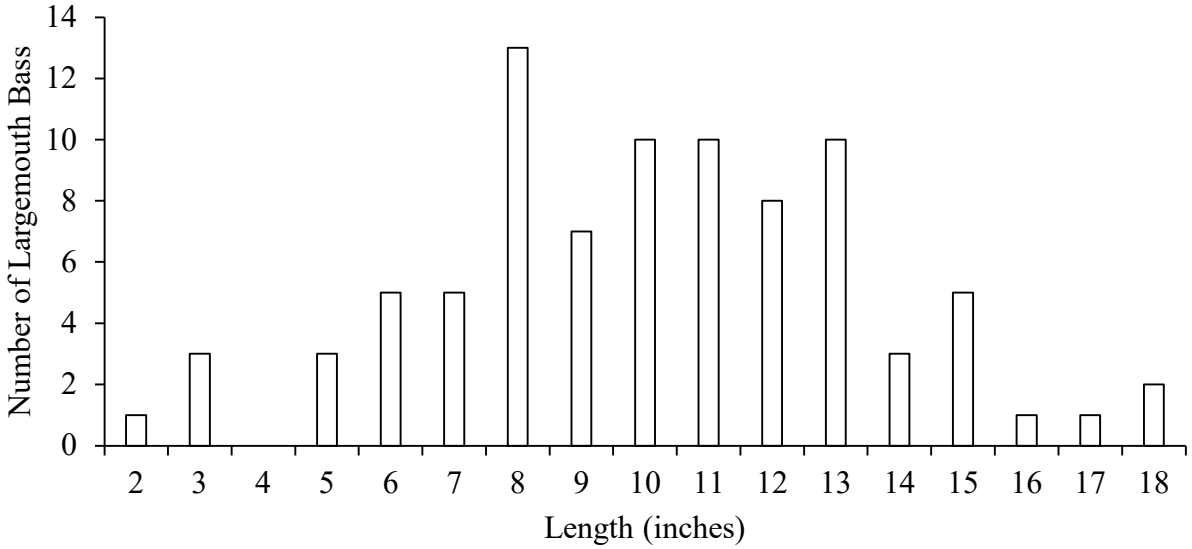
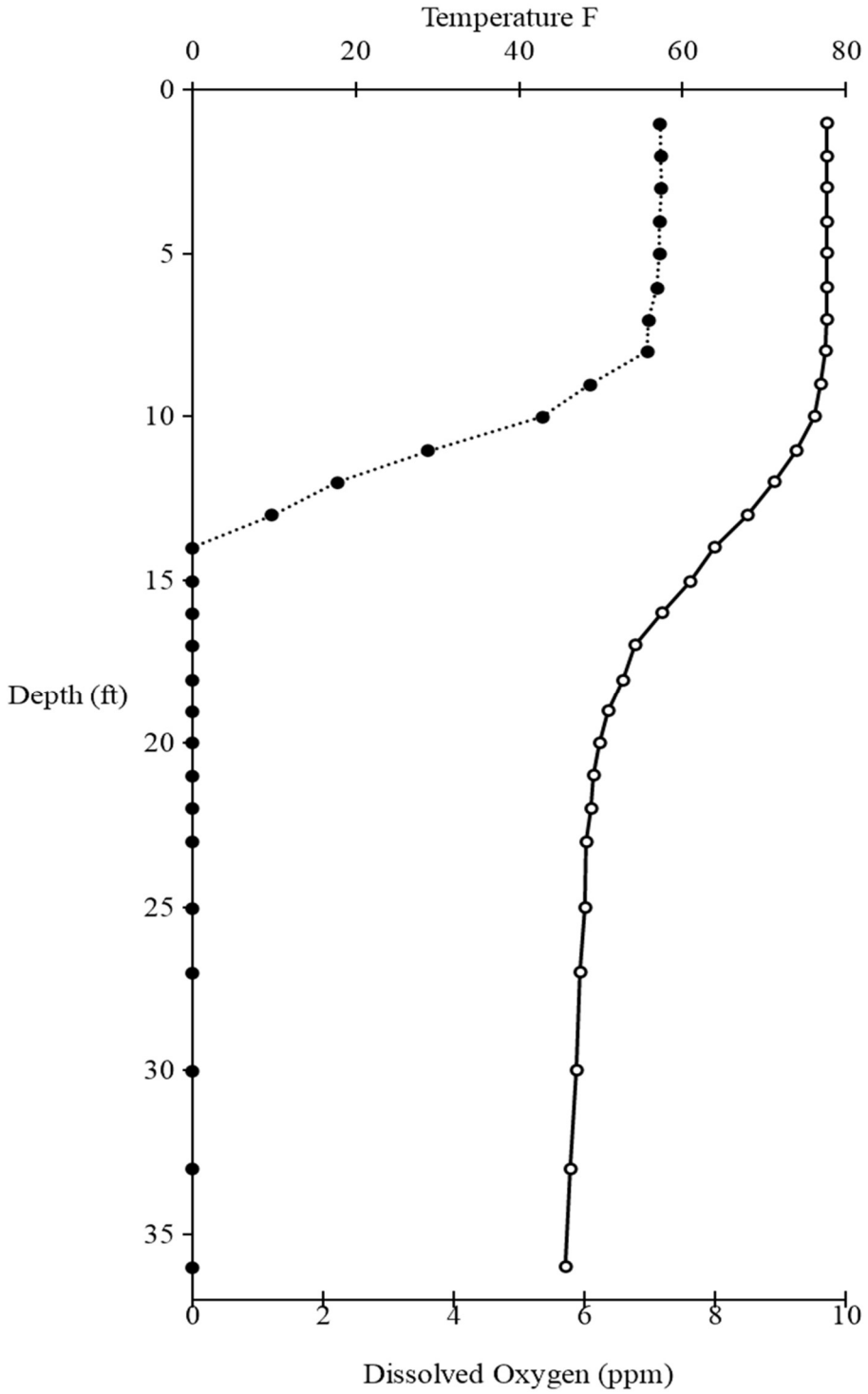


Figure 8. Water temperature and dissolved oxygen profiles for the deepest basin in Middle Lake on August 4, 2022. The hollow circles with solid line represent temperature and the sold circles with dashed line represent the dissolved oxygen concentration.



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