Goguac Lake

Calhoun County, T 2 S / R 8 W / Sec 22
Kalamazoo River Watershed; last surveyed May 13, 2019

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Environment

Goguac Lake is a 352-acre lake located near the City of Battle Creek (Figure 1). It has a maximum depth of 66 feet. There is a Department of Natural Resources (DNR) boating access site located on the north side of the lake that has a hard-surfaced ramp and 33 parking spaces. Because of the proximity to Battle Creek, the land use in the watershed is mostly urban (58%) with the remaining area comprised of forested (9%), agriculture (9%), wetland (8%), and water (14%) (Figure 2; MWGLP 2019). The substrate of the shoreline of Goguac Lake is characterized as sand and marl down to approximately 10 feet of depth. The deeper sections of the lake consist mainly of pulpy peat. There is an intact wetland complex on the southwest side of the lake that drains to a major tributary to Minges Brook. Minges Brook is a warm transitional stream that supports a Brown Trout population through natural reproduction. An artificial connection was created between Goguac Lake and Minges Brook that allowed half of the streams flow to enter the lake during low water years to maintain the legal lake level. This lake is heavily developed, and because of its proximity to Battle Creek, is heavily used by recreational boaters as well as anglers. Goguac Lake is also very popular with local bass tournament anglers.

History

Goguac Lake was first stocked in the late 1870s with a variety of fish in an attempt to diversify the fishery. Fish species stocked included American Eel, Arctic Grayling, Atlantic Salmon, Chinook Salmon, Lake Trout, Walleye, and Lake Whitefish (Table 1). The first fisheries survey on record was conducted in 1888 and none of these species were observed (despite reported sightings and catch of American Eel through the mid to late 1900s). The fishery consisted of Grass Pickerel, Largemouth and Smallmouth Bass, Yellow Perch, Bluegill, other sunfish species, and bullhead. Stocking of warmwater fish continued. Bluegill, Largemouth Bass, Smallmouth Bass, and Yellow Perch were stocked periodically from 1900 through 1932 and regularly from 1933 through 1943 (Table 1).

The DNR boating access site was purchased and developed in 1942, and mapping of the lake depth was conducted in 1951 (Figure 3). Northern Pike were stocked a single time in 1960. A large seine survey was conducted in June of 1964 which documented many of the same species found in 1888. Bluegills and Pumpkinseeds were abundant in the 4 to 7 inch range, with some 8 to 10 inch fish available making up only 5 percent of the 1,189 Bluegills captured. Bluegills averaged 5.5 inches in length. A total of 178 Yellow Perch were caught that averaged 6.1 inches. No Yellow Perch over 10 inches and only seven fish over 8 inches were observed. Seven Black Crappies were captured ranging from 4 to 10 inches. Largemouth Bass were the primary predator with 92 fish caught. Largemouth Bass averaged 7.7 inches with only one fish that was 14 inches in length. One Northern Pike was captured measuring 22.5 inches. The analysis assessed that the only remaining Northern Pike spawning habitat was in the two marches located on the southwest end of the lake. Common Carp

were also captured. Chemical removal of Common Carp through Rotenonec treatment was recommended as well as protection of the Northern Pike spawning areas.

The fish community was assessed again in September 1977 using electrofishing gear. The fishery was reported to be similar to what was observed in 1964. Of the 132 Bluegills caught, only 3 were over 8 inches. The condition of panfish was reported as poor. The Largemouth Bass fishery was somewhat improved with fish up to 20 inches being caught and 13 of the 71 fish captured being over 14 inches. The differences in bass size structure between the 1977 survey and the previous sampling effort likely were due to the better efficiency of electrofishing gear (relative to seining) for capturing adult Largemouth Bass. Only six Black Crappies were captured ranging from 4 to 10 inches. Yellow Perch remained abundant with 140 being captured that ranged from 4 to 10 inches. Northern Pike were not observed. An additional electrofishing survey was conducted in 1978 and age structures were collected. The catch rates and sizes were very similar to 1977. Despite only small Bluegills being captured, growth rate was average with a mean growth index score of -0.1. Largemouth Bass, Pumpkinseed, Black Crappie, and Yellow Perch populations were also exhibiting average growth.

A trap netting and electrofishing survey was conducted in June 1981. Species composition, size structure, and growth were reported to be poor. Bluegills dominated the catch with 1,958 being caught making up 72 percent of the fish by number. Average size of Bluegills was 5.8 inches, but most were between 4 and 7 inches and only 1 percent were 7 inches or larger. Bluegill growth was within the acceptable range with an index score of -0.5, but very few fish over 4 years old were captured. More Black Crappies were captured in 1981 compared to previous surveys (n = 198). These fish were generally small ranging from 4 to 9 inches. Black Crappies had a mean growth index of -0.7, which is considered poor (Schneider 2000a). Common Carp were caught in high numbers (n = 120) and made up a significant portion of the biomass (63 percent). Angling pressure was suggested as likely responsible for the poor fish community.

Another fish survey was conducted in June 1988 using gill and trap nets. The fishery looked similar to past years with small Bluegills dominating the catch. Bluegills averaged 5.8 inches and only 1 percent of the 1,648 Bluegills caught were longer than 7 inches. Angling pressure was again suggested to be the cause of the poor size structure. The Black Crappie population was somewhat improved in 1988 with a mean growth index ½ inch greater than in 1981. Average length of crappies increased to 7.1 inches. Nine Northern Pike were also collected, each over 28 inches in length. Growth rates for these fish were above average. Anglers that were interviewed still reported satisfaction with the fishery and had no problems with harvesting the 6-inch Bluegills present. One Northern Pike over 40 inches was reported being harvested. Goguac Lake continued to be popular for bass tournaments. One spring fingerling Walleye stocking was permitted by private plant in 1988 in an attempt to diversify fishing opportunities and increase predation on small panfish potentially improving size structure. Walleye were not expected to reproduce in Goguac Lake.

Another gill and trap net survey was conducted in May 1998. A total of 359 Bluegills were caught making up 59 percent of the catch. Bluegill size structure was much improved over past surveys. Bluegills 7 inches and larger were 66 percent of the fish captured and 8 and 9 inch fish were caught. The size structure was ranked "good" using the Schneider index (Schneider 2000a, Schneider 1990). Black Crappie catch was also high with 93 fish caught ranging from 5 to 12 inches. Larger Black Crappies were captured in 1998 compared to past surveys with fish up to 12 inches being collected.

Even though size structure was improved, growth of Black Crappie had declined in 1998 after the brief increase in 1988, and the mean growth index was again within the poor range at -0.8. Only four Yellow Perch were caught that were 5 to 8 inches in length. Fourteen Largemouth Bass averaging over 14 inches were captured, and they exhibited good growth rates (growth index +0.8). More Northern Pike were captured in 1998 than in past surveys. They began showing up in 1988, but 16 were captured in 1998 ranging from 17 to 38 inches. Northern Pike were again growing above the state average with a growth index score of +2.9 and the population had expanded and created a fishery. One Walleye was also captured that was 27 inches indicating potential survival from the 1988 stocking.

Current Status

The DNR conducted a fish survey in 2019 to evaluate the status of the fish community and the potential for Walleye stocking to diversify fishing opportunities in Calhoun County. The survey design followed standard methods for conducting a random lake survey as described in the DNR Status and Trends protocol (Wehrly et al. Draft). Netting efforts took place from May 13 through May 16, 2019. Two gill nets were set overnight on Goguac Lake for two nights for a total of four net nights. Three large mesh fyke nets were set overnight on three nights for a total of nine net nights. Two small mesh fyke nets were deployed for two nights (total of four net nights). One trap net was set for three nights resulting in a total of three net nights of effort. Four beach seine hauls were conducted to quantify minnow and inshore prey species abundance levels. Three 10-minute nighttime electrofishing transects were conducted on Goguac Lake on the evening of May 21, 2019 for a total of 30 minutes of effort. All fish were identified, counted, and measured (total length). Weights for all fish species were calculated using length-weight regression equations compiled by Schneider et al. (2000b).

The relative stock density for each fish species was assessed using catch-per-unit-effort (CPUE) calculated as the number of fish caught per net night (gill, fyke, and trap nets), per minute of electrofishing (boomshocker), or per seine haul. CPUE data from this survey were compared to a summary of CPUE data from lakes surveyed in the Status and Trend Program from 2001 through 2021 on a statewide and regional level for the Southern Lake Michigan Management Unit (SLMMU). Age structures (scales or spines) were collected from ten fish in each inch class for Largemouth Bass and Northern Pike. Weighted age compositions using length and age keys for each game fish species were calculated as described by Schneider (2000b). A growth index for each age class was calculated by subtracting the state average mean length from the mean length-at-age from the 2019 Goguac Lake survey. Growth indices for age classes represented by a minimum of five fish were averaged to provide a mean index of fish growth (Schneider et al. 2000a). Growth index scores between +1 and -1 are considered similar to the state average while scores less than -1 and greater than +1 are considered below or above the state average, respectively. Bluegill size structure was rated using an index based on the mean length, growth, and the proportion of fish >6 inches, >7 inches, and >8 inches and rated for different gear types and using growth index score (Schneider 2000a, Schneider 1990).

A fish habitat assessment of Goguac Lake was conducted on August 27, 2019. Shoreline surveys of the lake included 24 transects of 1,000 feet each for a total of approximately 24,000 feet. An additional four transects were assessed along the islands that totaled 4,000 feet. The number of docks (large and small), dwellings, submerged trees, and the percent of the shoreline that was armored (riprap or seawalls) were recorded for each transect. A temperature and dissolved oxygen profile was

collected for 1-foot increments at the deepest spot in Goguac Lake. Detailed methods for limnological, shoreline, and fish sampling can be found in Wehrly et al. (Draft).

The limnology survey was conducted on August 27, 2019. The Secchi depth was 10 feet and light was penetrating to 20 feet of depth. Surface water was relatively cool at approximately 74 degrees F (Figure 4). The temperatures decreased at the thermocline at 21 feet and dropped to below 56 at 30 feet. Dissolved oxygen was 7.98 ppm just below the surface and began to decline at a depth of 16 feet. Dissolved oxygen dropped below 5 ppm at 20 feet and below 3 ppm at 21 feet. Deep cool water habitat is limited in Goguac Lake, but cooler surface waters result in some habitat for cool water species. The shoreline was heavily armored with 79% being seawall or riprap. There are a few wetland shorelines where armoring is not present.

A total of 1,694 fish were caught across all gears in the 2019 DNR survey of Goguac Lake (Table 2). Bluegill was the most abundant species captured making up 51% of the catch by number. Bluegill catch rates were high at 10.6 fish per minute, 15.8 fish per net night, and 120 fish per net night for electrofishing, large mesh fyke nets, and trap nets respectively. CPUE was above the statewide 75th percentile for electrofishing (7.4 fish per minute) and trap nets (54.7 fish per net night), but near the median for large mesh fyke nets (13.4 fish per net night). CPUE was also above the SLMMU 75th percentile for electrofishing (9.5 fish per minute) and trap nets (94.3 fish per net night), but below the 25th percentile for large mesh fyke nets (22.1 fish per net night). It is unclear why large mesh fyke net catch rate was lower than other gears, but when evaluating results across gears, the Bluegill population density appears to be at least somewhat high. Bluegills averaged 5.7 inches and ranged from 1 to 9 inches. Fish in the 7-inch and 8-inch size classes were the most abundant, and fish 7 inches and larger comprised 50 percent of the total catch (Figure 5). There was also an abundance of smaller sized Bluegills (1 and 2 inches) captured while electrofishing, indicating strong natural recruitment. Size structure was rated as superior and excellent by trap net and large mesh fyke net catch respectively, but only acceptable by electrofishing catch. This is likely due to the abundance of juvenile Bluegills captured in the electrofishing run. Generally, the abundance of smaller fish results in a lower rating, but 7-inch and 8-inch fish were so abundant in Goguac Lake in 2019, that panfish size structure was rated high quality. Bluegills are providing an excellent fishery in Goguac Lake with good numbers of larger fish.

Largemouth Bass was the most abundant predator species, with 149 individuals caught making up 9% of the catch by number. Bass ranged from 3.1 to 19.3 inches. Fish from age 1 through age 10 were captured. Only 2 fish were over 14 inches making up only 1% of the total Largemouth Bass captured. Growth rates were acceptable for Largemouth Bass with a growth index score of -0.5. Largemouth bass CPUE from electrofishing was 2.2 fish per minute, which is higher than the statewide 75th percentile (1.7 fish per minute) and just below the 75th percentile for SLMMU lakes (2.5 fish per minute). Additional electrofishing was conducted for collection of fish for contaminant analysis, and several large Largemouth Bass were observed in shallow bays that had warmed faster than the rest of the lake.

Goguac Lake is a popular lake for bass tournaments. There were 18 bass tournaments scheduled in 2022. From 2016 through 2021 an average of 11 tournaments were held each year ranging from a high of 19 in 2020 to a low of 5 in 2019. The tournament participation averaged 21.6 anglers and 11.8 boats per tournament. The average number of fish weighed in at each tournament was 17.2 fish. The

average bag weight was 3.2 pounds per angler. The average weight of fish caught in a tournament was 1.9 pounds with the big bass averaging 3.8 pounds. Goguac continues to provide a good venue for bass tournaments with a boating access site that can accommodate larger tournaments and an acceptable Largemouth Bass fishery.

A total of 12 Northern Pike were also captured in the 2019 survey. Fish ages 3 to 13 were captured in low numbers. Only enough age 3 fish were collected to evaluate growth. These fish had a growth index of +1.9, which is considered above average. CPUE of Northern Pike was average at 2.8 fish per net night in gill nets which is near the median CPUE for statewide and SLMMU lakes (2.5 fish per net night for both).

Black Crappies were abundant with 165 individuals captured. Crappies averaged 9.7 inches with fish up to 13 inches present. Surveys were conducted early, and large spawning Black Crappie were inshore and vulnerable to larger netting gears making for a good evaluation of this species. As a result, trap nets fished well capturing 49.7 fish per net night, well above the 75th percentile for statewide surveys (9.9 fish per net night) and SLMMU surveys (17.1 fish per net night). The large mesh fyke net catch rates were not as high, only capturing nine Black Crappies for a CPUE of one fish per net night. This would rank below the 25th percentile for statewide (1.5 fish per net night) and SLMMU surveys (2.5 fish per net night). Crappies can be difficult to net in the spring as they spawn earlier than other sunfish targeted by May surveys. Crappie spawn in shallow bays, but generally close to deep water. While staging, they tend to shift from drop offs to shallows and catch rates can fluctuate. Often large fish start to move in and out early as well. Deploying additional gears to the standard status and trends requirements for this survey resulted in a better evaluation for crappies which would have been deemed low density and small if only large mesh fyke nets were deployed. Although fish were not aged, growth was adequate for fish to reach large sizes that are preferred by anglers. Based on the size structure of the catch and the CPUEs for all gear types, the Black Crappie fishery in Goguac Lake appears to be very good.

Yellow Perch were also present in good numbers with 87 fish captured. Yellow Perch were small and averaged 4.7 inches and ranged from 2 to 8 inches. Gill nets captured only five Yellow Perch for a CPUE of 1.3 fish per net night. This is below the 25th percentile for statewide (1.5 fish per net night) and SLMMU surveys (1.6 fish per net night). More Yellow Perch were captured in the electrofishing gear (81 fish). CPUE was 2.7 fish per minute which is above the 75th percentile for statewide (2.6 fish per minute) and SLMMU surveys (1.4 fish per minute). These fish were small averaging only 4.5 inches and 78% were below 4 inches in length. Across gears, very few large Yellow Perch were captured, but catch rates were high for smaller fish. No growth data was collected for Yellow Perch, so it is difficult to determine if the small size structure is due to slow growth or high annual mortality. We could also be observing a few strong year classes of younger fish still recruiting to the fishery. However, at this time, these sizes are not preferable to anglers and Yellow Perch do not provide much of a fishery in Goguac Lake.

There was a good diversity and number of prey species captured in Goguac Lake. These fish included Banded Killifish, Blacknose Shiner, Bluntnose Minnow, Brook Silverside, Golden Shiner, Logperch, and White Sucker. Largemouth Bass, Grass Pickerel, and Northern Pike were the only predators in Goguac Lake. Cumulatively their biomass was 144.3 pounds which was 27% of the total biomass captured. This is within the range of 20-50% of the biomass reported in lakes with desirable fish

communities (Schneider 2000a). Thus, the predator:prey ratio in Goguac Lake appears to be on the low end of a balanced population.

Yellow and Brown Bullhead also are present in Goguac Lake providing an additional fishery if targeted. Common Carp were present, but not observed in high numbers with only two fish being captured. Only a few turtles were captured during the 2019 survey, including four Musk Turtles, two Painted Turtles, and two Map Turtles. No threatened or endangered species have been reported for this water body. Vegetation species observed included Yellow and White Water Lily, Chara, native milfoil species, Narrow-leaf pondweeds, Eurasian Milfoil, Curly-Leaf Pondweed, Eelgrass (spp.), and Elodea. Vegetation was generally sparse with some pockets of dense vegetation. Goguac Lake has a long history of weed treatments.

Analysis and Discussion

Habitat degradation likely impacts fisheries in Goguac Lake. There is very little shoreline that is not developed or hardened by seawalls. Remaining natural shorelines should be a priority to protect as they likely are habitat for much of the Northern Pike spawning as well as other fish. Vegetation has been chemically treated for both invasive and nuisance species control. Native vegetation should be protected in this lake as it provides refuge for juvenile fish and substrate for invertebrates and other food resources. Connected wetlands and vegetated coves are a priority for protection and crucial for spawning and recruitment of sportfish.

Goguac Lake provides a quality fishery for several species. Good sizes and numbers of Bluegills and Black Crappies are present, and Largemouth Bass populations are adequate. The Yellow Perch fishery is limited and dominated by small individuals resulting in a poor fishery for this species. Northern Pike provide a fishery with average density and good growth resulting in the potential for catching larger fish. Northern Pike up to 33 inches were caught in this survey and anglers reported fish over 40 inches in the past. The 2019 survey did not occur at an ideal time to capture Northern Pike, and early spring netting would be needed to more rigorously assess the status of this species in Goguac Lake.

The Panfish population is much improved from that observed in past surveys. The size structure was rated excellent-superior for the large mesh fyke net and trap net samples, and the proportion of fish 7 inches and greater was much higher than past surveys. Overharvest was commonly identified as contributing to the poor size structure in the past and could continue to be an issue today. The Bluegill fishery is supported by good numbers of 7- and 8-inch fish, but few medium sized fish (4-6 inches) were present. A large year class of small fish was observed (1 and 2 inches). This could be the result of fast growth with small fish growing through middle size classes and reaching 7 and 8 inches quickly but is more likely a result of variable recruitment with strong year classes cycled with poor recruitment. Bluegills were not aged in this survey, so it is difficult to determine year class strength and growth. Larger fish can easily be exploited and fished out in high pressure lakes. With few medium fish to replace them the population could cycle back to an abundance of smaller fish. Goguac Lake could be a good candidate lake for reduced bag limits for panfish. Reducing harvest of larger fish could result in larger fish remaining in the population longer and shifting biomass towards older fish. This could reduce boom year classes resulting in overabundant recruits and competition for resources. Reduced bag limits are not a management tool being used in Michigan, but there is a proposal to implement experimental regulations on a suit of lakes. If the regulations are successful at promoting better panfish size structure, then they could be considered on Goguac Lake in the future.

Water temperatures were somewhat cold during the 2019 survey ranging in the mid-50s and only reaching 60 degrees by the last day. These cool temperatures could have influenced catch rates with the various gear types as fish likely were staging near drop-offs to prepare for spawning. Bluegill CPUE was below average for large mesh fyke nets (which are limited to sampling water depths of 4 feet or less), whereas CPUEs were well above average with electrofishing and trap net gear that can catch fish in slightly deeper water. When viewed across gear types, abundance of Bluegills seems to be average or above average. Few big Largemouth Bass were also collected inshore, despite being observed in other locations and in tournament catches. A higher number of legal sized Largemouth Bass (> 14 inches) are likely present than indicated by the survey data. This hypothesis is supported by the bass tournament data and visual observations during supplemental electrofishing conducted in 2019.

A potential action being considered by DNR-Fisheries managers are to stock fall fingerling Walleye in Goguac Lake. This would diversify fisheries in the region by potentially creating a Walleye fishery in a popular lake in a part of the state with few Walleye fishing opportunities. The optimal temperature range for Walleye is 64 to 72 F (Christie and Regier 1988; Hasnain et al. 2010). The surface temperature of Goguac Lake was 74 F on August 27, 2019. The temperature remained above 72 F until a depth of 22 feet. It was at this depth that dissolved oxygen declined to 3 ppm. This results in optimal thermal habitat being just below oxygenated water. It is likely that cooler oxygenated water is available much of the summer but becomes suboptimal in late summer. This is not uncommon in southern Michigan waters and often growth of Walleye stops during summer heat. However, due to the longer growing season, even with summer growth checks, Walleye tend to grow faster in southern Michigan waters than in northern regions of the state. The surface water temperature in Goguac Lake was relatively low for a southern Michigan lake at this time of year and was only slightly above optimal temperatures for Walleye. Thus, Goguac Lake provides better thermal habitat than many regional lakes where surface water temperatures approach or exceed 80 F. Not only would Walleye survive summers in Goguac Lake, but they should also have access to optimal thermal habitat for much of the season.

SLMMU is recommends fall fingerling Walleye stocking in Goguac Lake for multiple reasons. Walleye stocking in Goguac Lake meets objectives outlined in the Walleye management plan of creating diverse fisheries, creating fisheries in areas of the state with limited Walleye fishing opportunities, and creating fishing opportunities close to large human population centers. Stocking fish in waters where natural recruitment is limited also is preferred over stocking on top of naturally reproducing fish. Fall fingerling Walleye have performed well in southwest Michigan inland lakes. SLMMU has increased fall fingerling Walleye production in recent years and has the capacity to stock a few additional lakes. Fall fingerlings are released in October and are larger than the spring fingerlings traditionally used for stocking programs. As a result, the fall fingerlings are less vulnerable to predation by panfish, bass, and other predators. These fish also perform well in smaller warm lakes, as evidenced by recent SLMMU surveys on Osterhout and Selkirk lakes. Goguac Lake is a class 1 lake as identified in the Management Plan for Walleye in Michigan's Inland Waters (Herbst et al. 2021). This is primarily due to the small size of the lake, lack of historic natural reproduction of Walleye, and temperature regime as the lake is located in southern Michigan. Almost all lakes in SLMMU fall into the class 1 designation. Class 1 lakes are not recommended as priorities for spring fingerling stocking. The success of the fall fingerling stocking program in SLMMU supports stocking

fall fingerlings in Goguac Lake. This will continue the adaptive management approach SLMMU has taken with fall fingerling Walleye stocking. SLMMU actively monitors the success of stocking to determine the success each effort. This allows for management changes based on the survival of stocked fish and utilization of the fishery.

Walleye stocking would increase the number of predators in Goguac Lake. This scenario could lead to competition with native predators if prey becomes limited. Largemouth Bass had average growth while Northern Pike had above average growth. The predator and prey populations are within acceptable balance, but with predator abundance being near the low end of the desirable range. There are additional indicators that increasing predation may benefit some species. Bluegills and Yellow Perch are a preferred prey for Walleye. Small Bluegills and Yellow Perch are abundant in Goguac Lake. These fish may be competing for resources resulting in slow growth, especially for Yellow Perch. Predation would thin overabundant year classes for both species. Under the current growth conditions, few Yellow Perch are surviving long enough to achieve preferred size for anglers. As a result, there is little risk to the Yellow Perch fishery if predation on Yellow Perch increases. Reducing densities could reduce competition for food and increase growth. There is also an abundance of different minnows and sucker species in Goguac Lake that would provide suitable prey for Walleye.

Goguac Lake would likely be a popular destination for Walleye anglers due to its proximity to Battle Creek and accessibility to a large human population. The lake is highly used by recreational boaters, but Walleye can be targeted in the evening and at night allowing for angling use that can avoid peak boating hours on the lake. Calhoun County has limited Walleye fishing opportunities and few public water bodies accessible to fishing. Stocking Walleye in Goguac Lake would diversify angling options in the county. In addition to the DNR boating access site, there is good shore and ice fishing access through the City Park along much of the eastern shoreline. Walleye stocking would initially be evaluated through angler reports and eventually through early spring surveys with nets and nighttime electrofishing gear.

Management Direction

Stock fall fingerling Walleye in Goguac Lake to potentially create a new fishery. Fish would be stocked biennially at a rate of 4 fish per acre (1,408 fish). This program will create a new fishery close to the population of Battle Creek in an area where few Walleye fishing opportunities currently exist.

Continue to manage Goguac Lake as a warm water fishery. Bluegills, Black Crappies, and Largemouth Bass provide acceptable fisheries. These populations should be monitored to ensure continued recreational opportunities. The Michigan Fishing Tournament Information System is one potential source of information regarding bass fishing activity on the lake. Recommend evaluating potential regulation changes to promote better quality panfish fisheries. This effort depends on changes in panfish size structure that may occur due to Walleye stocking.

Continue to protect the water quality of Goguac Lake through partnerships with the City of Battle Creek and local organizations. This objective will be accomplished by supporting grant applications for watershed projects and continuing to participate in Michigan Department of Environment, Great Lakes, and Energy (EGLE) permit review to avoid or minimize negative impacts of proposed projects on the lake ecosystem. DNR will continue to comment on weed treatment permits and advocate for

protection of native vegetation, especially in the wetland habitats associated with the southwestern part of the lake.

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Table 1. Fish species and number stocked in Goguac Lake from 1877 to present.

Species	Year	Number Stocked	Life Stage
American Eel	1877	10,000	Spring Fingerling
American Eel	1878	15,000	Spring Fingerling
Arctic Grayling	1877	75	Swim-up Fry
Atlantic Salmon	1876	3,000	Spring Fingerling
Atlantic Salmon	1878	4,000	Swim-up Fry
Chinook Salmon	1875	7,000	Swim-up Fry
Chinook Salmon	1878	3,500	Spring Fingerling
Lake Trout	1897	15,000	Unknown
Lake Whitefish	1874	10,000	Swim-up Fry
Lake Whitefish	1875	12,500	Swim-up Fry
Lake Whitefish	1876	10,000	Swim-up Fry
Bluegill	1933	2,250	4 month
Bluegill	1934	5,000	5 month
Bluegill	1936	8,000	4 month
Bluegill	1937	24,400	3-4 month
Bluegill	1938	50,000	4 month
Bluegill	1939	35,000	4 month
Bluegill	1940	150,000	4 month
Bluegill	1941	150,000	4 month
Bluegill	1942	6,000	3 month
Bluegill	1943	80,000	3 month
Bluegill	1945	2,000	Yearling
Largemouth Bass	1905	4,000	Advanced Fingerling
Largemouth Bass	1909	3,000	Fingerling
Largemouth Bass	1933	3,800	4-5 month
Largemouth Bass	1934	1,000	4 month
Largemouth Bass	1935	2,800	4 month
Largemouth Bass	1937	3,500	3 month
Largemouth Bass	1939	1,000	5 month
Largemouth Bass	1940	1,800	4 month
Largemouth Bass	1941	2,400	5 month
Largemouth Bass	1942	7,000	3 month
Largemouth Bass	1943	1,000	4 month
Largemouth Bass	1944	1,000	3 month
Largemouth Bass	1945	2,000	4 month
Northern Pike	1960	5,500	Fingerling
Smallmouth Bass	1880	1,500	Swim-up Fry
Smallmouth Bass	1881	3,000	Swim-up Fry

Table 1. Continued

Species	Year	Number Stocked	Life Stage
Smallmouth Bass	1910	6,000	Fry
Smallmouth Bass	1910	6,000	Fry
Smallmouth Bass	1936	1,500	4 month
Smallmouth Bass	1939	2,000	4 month
Smallmouth Bass	1940	2,500	4 month
Smallmouth Bass	1941	2,400	5 month
Smallmouth Bass	1943	500	3 month
Smallmouth Bass	1944	500	4 month
Walleye	1896	120,000	Fry
Walleye	1988	1,024	Spring Fingerlings
Yellow Perch	1910	80,000	Fry
Yellow Perch	1933	2,700	6 month
Yellow Perch	1935	4,500	8 month
Yellow Perch	1936	7,500	8 month
Yellow Perch	1937	4,000	8 month
Yellow Perch	1938	4,000	6 month
Yellow Perch	1939	2,700	7 month

Table 2. Fish captured in the 2019 DNR Fisheries survey of Goguac Lake across all gears.

Species	Total Number	Total Weight (lbs)	Mean Length (Inches)	Length Range (Inches)
Banded Killifish	3	0.0	2.2	1 - 2
Black Crappie	165	92.4	9.7	4 - 13
Blacknose Shiner	32	0.1	2.3	1 - 2
Bluegill	861	181.3	5.7	1 - 9
Bluntnose Minnow	64	0.3	2.2	1 - 3
Brook Silverside	3	-	3.8	3 - 4
Brown Bullhead	7	5.5	11.8	9 - 13
Common Carp	2	10.9	19.0	9 - 28
Golden Shiner	1	0.1	7.5	7 - 7
Grass Pickerel	4	0.5	8.5	7 - 10
Green Sunfish	14	1.4	4.8	3 - 7
Hybrid Sunfish	28	10.3	7.7	5 - 9
Largemouth Bass	149	95.4	10.3	3 - 19
Logperch	1	0.0	3.5	3 - 3
Northern Pike	12	48.4	25.7	20 - 33
Pumpkinseed	79	22.3	6.8	3 - 8
Rock Bass	52	11.4	6.1	2 - 12
Warmouth	45	6.7	5.5	2 - 7
White Sucker	2	6.3	20.0	19 - 20
Yellow Bullhead	83	40.5	10.0	7 - 12
Yellow Perch	87	5.0	4.7	2 - 8
Grand Total	1,694	539.0	6.8	1 - 33

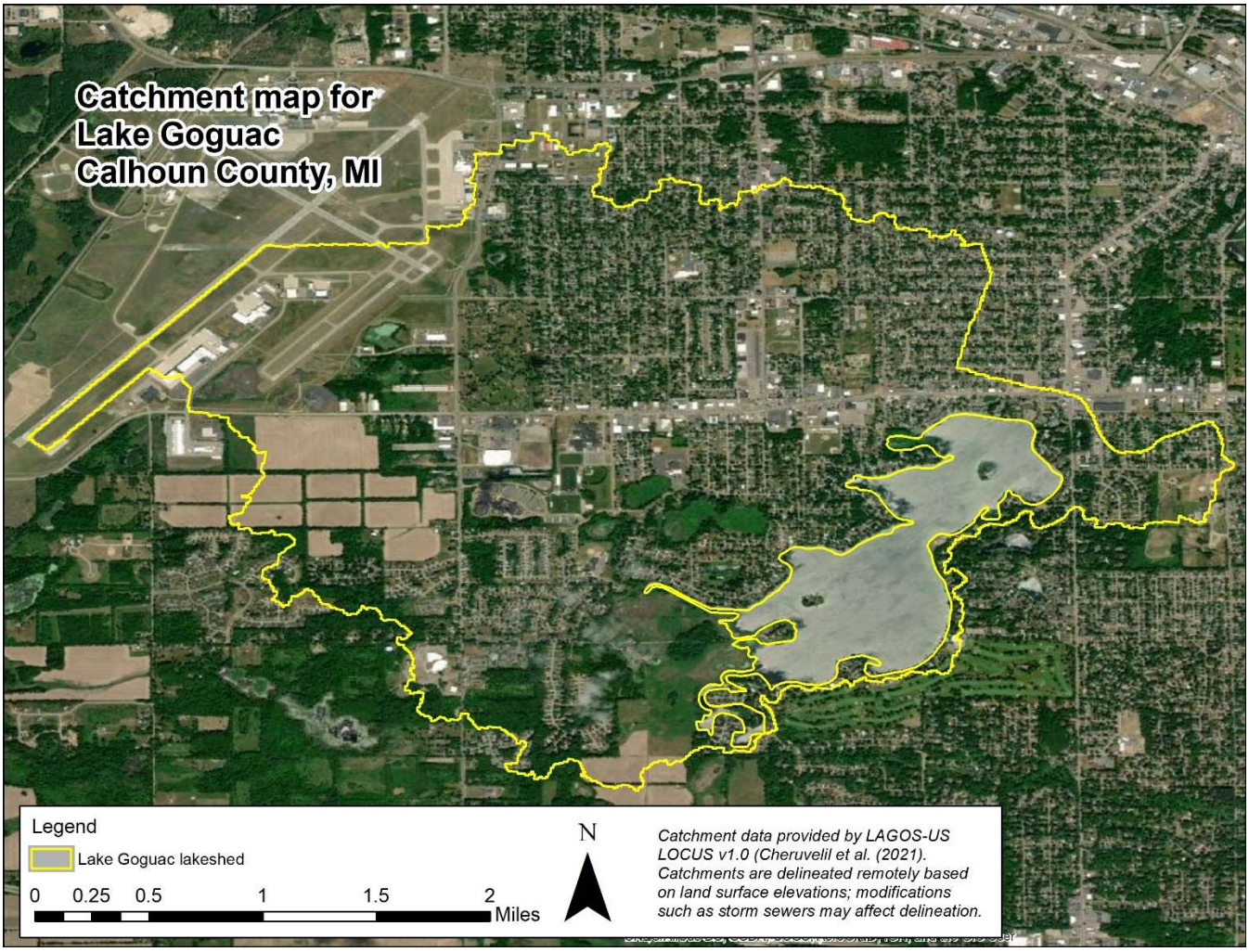

Figure 1. Catchment map and satellite imagery of the Goguac Lake Watershed. Catchment data delineated by Cheruvelil (2021).

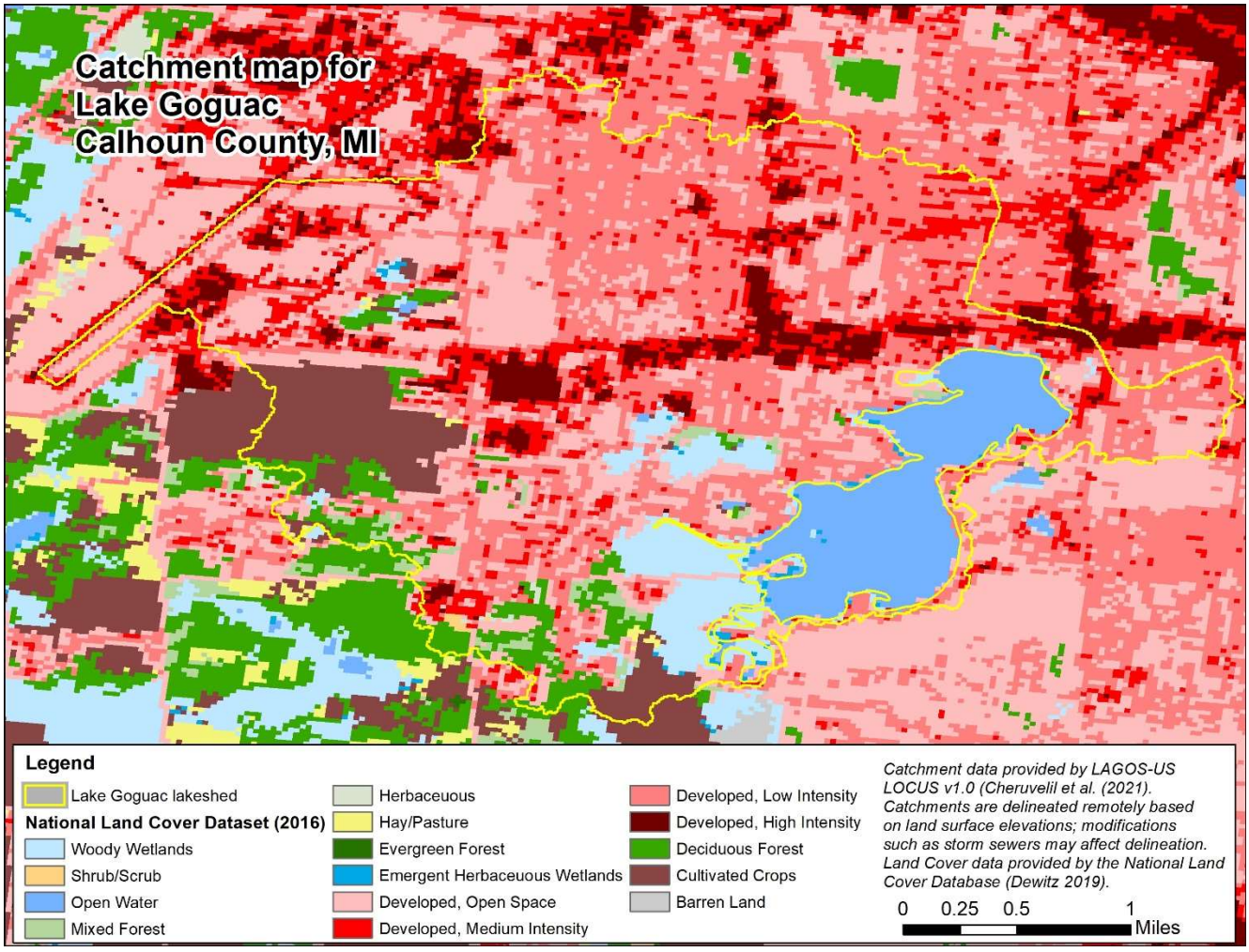

Figure 2. Catchment map and land use of the Goguac Lake Watershed. Catchment data delineated by Cheruvelil (2021) and land use data provided by the National Landcover Database (Dewitz 2021).

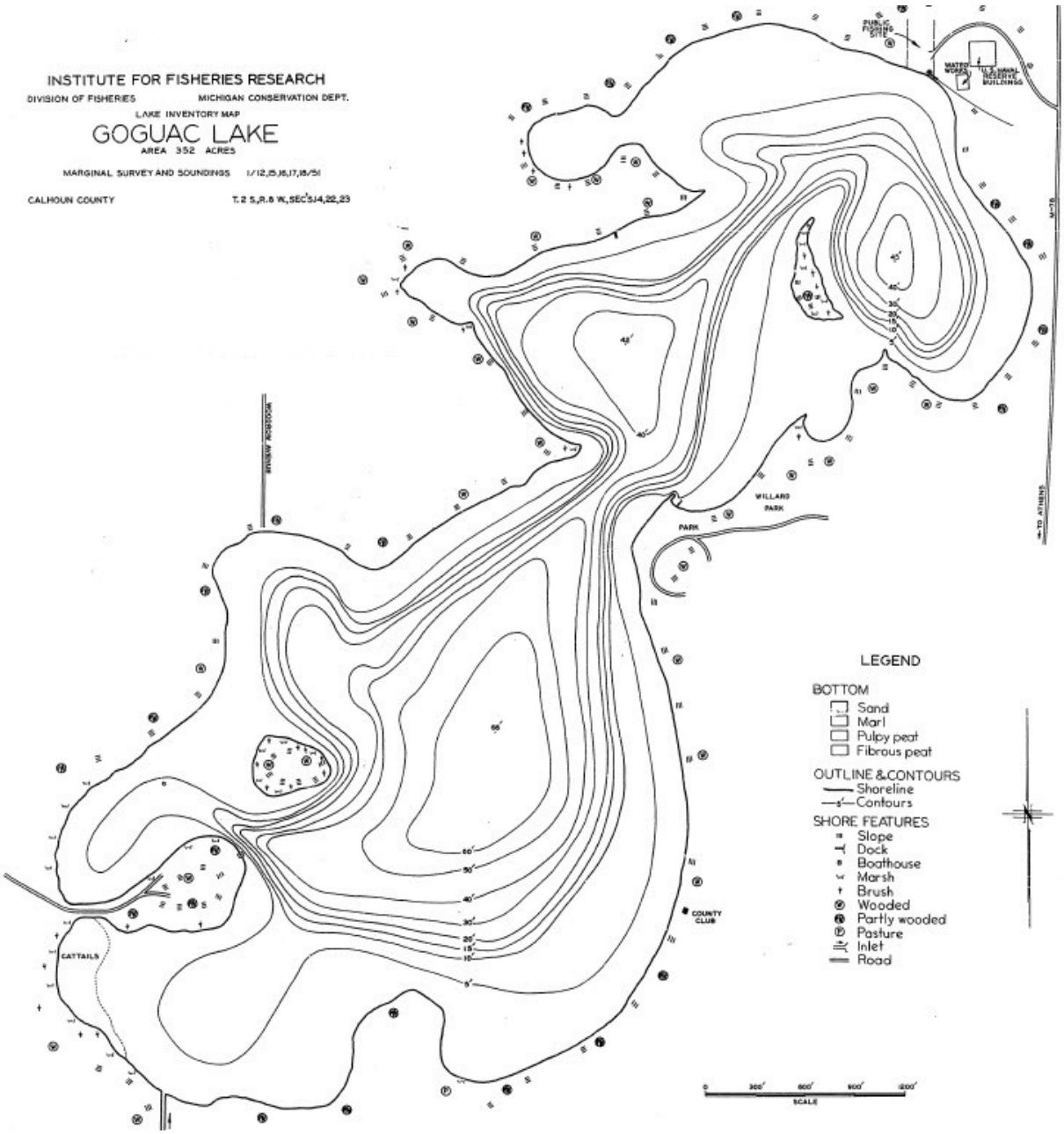

Figure 3. Depth map of Goguac Lake created from a 1951 survey.

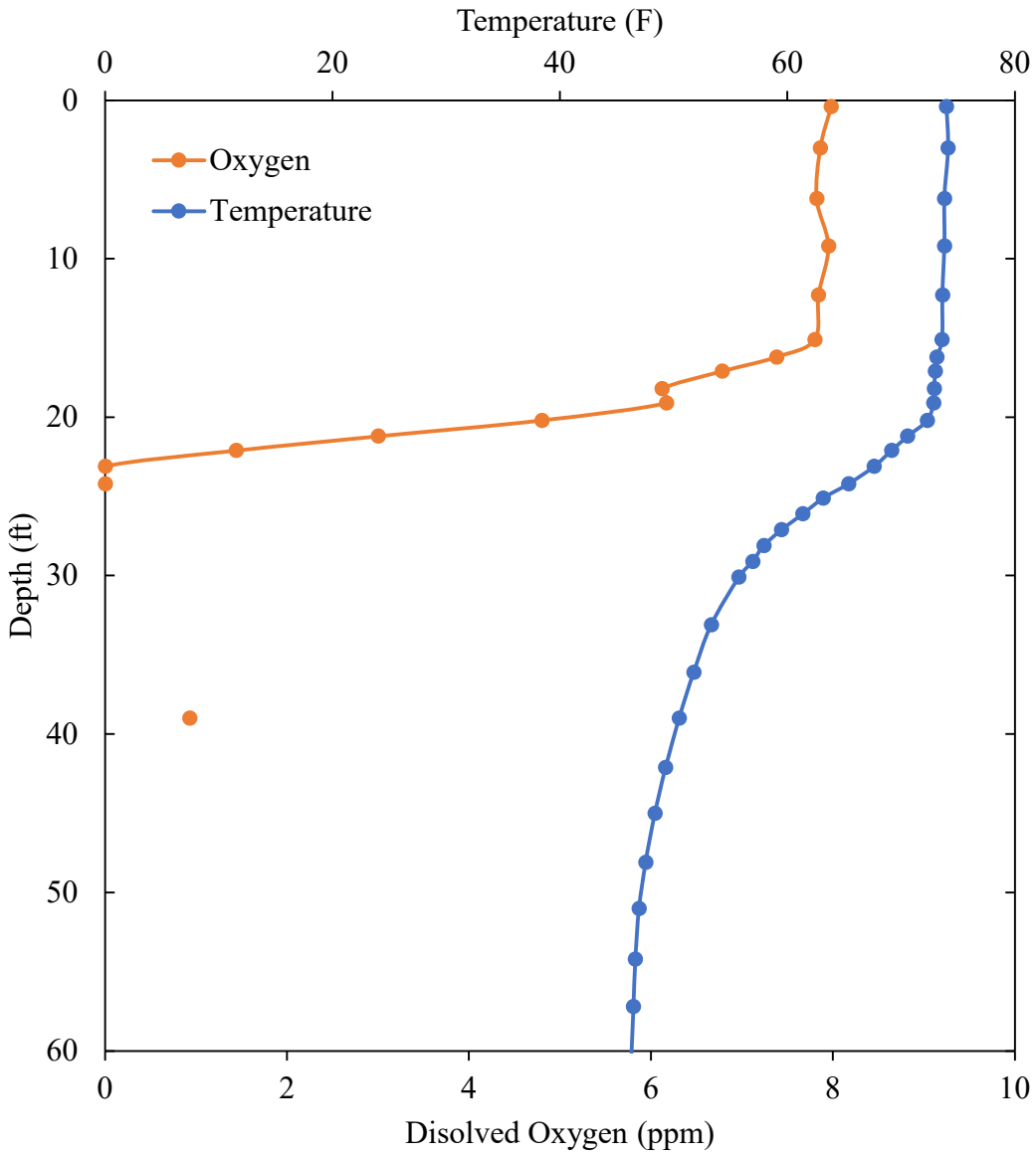

Figure 4. Temperature and dissolved oxygen profile for Goguac Lake surveyed on August 27, 2019.

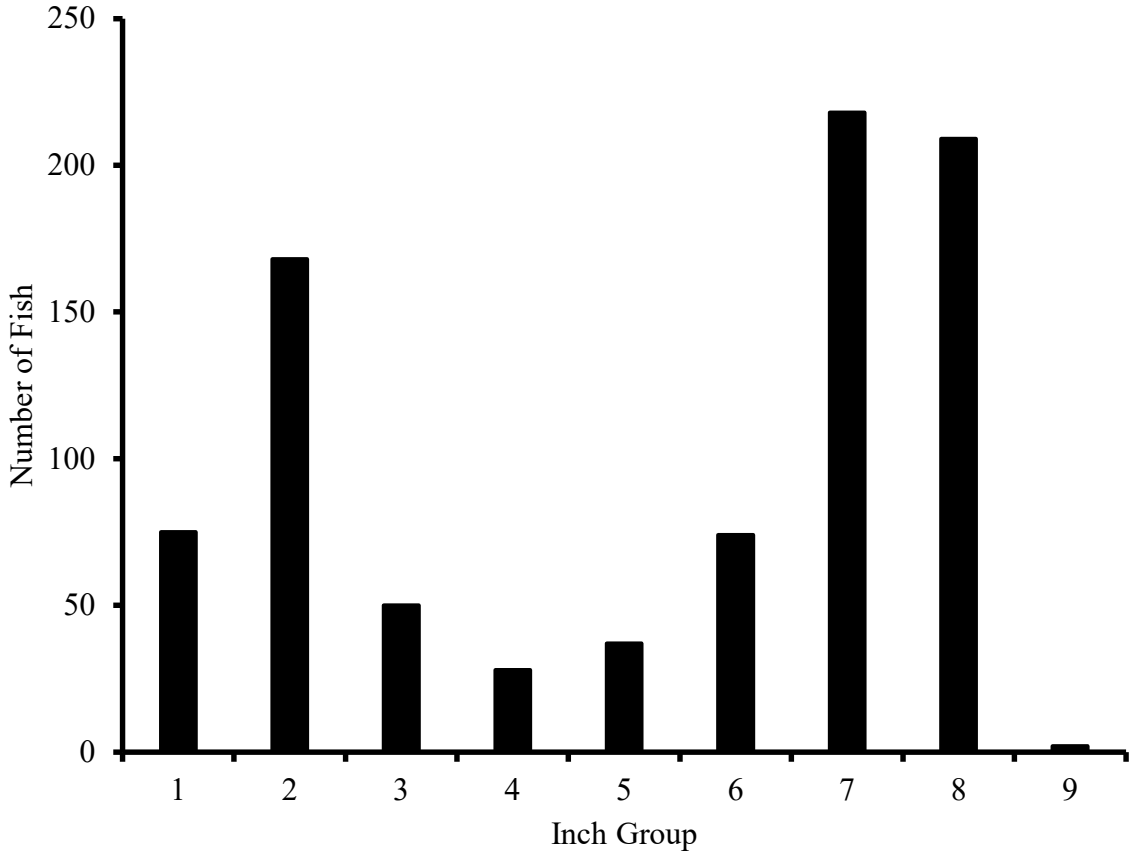

Figure 5. Length frequency of Bluegills caught across all gears in Goguac Lake during the 2019 fish survey.

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