Big Trout Lake

Marquette County, T46N, R24W, Section 32
Chocolay River Watershed, Last Surveyed 2021

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Environment

Big Trout Lake is a 27-acre natural lake located in West Branch Township in Marquette County (T46N/R24W/Section 32) in Michigan's Upper Peninsula (Figure 1). Gwinn is the nearest community located approximately 6 miles to the southwest while Marquette, the largest populated city in the Upper Peninsula is located approximately 14 miles to the north.

The public can access Big Trout Lake from Sporley Lake Road which runs north and south connecting to M-94. The Michigan Department of Natural Resources (MDNR) Parks and Recreation Division maintains a Boating Access Site (BAS) in the southwest corner of the lake (GPS 46.344279, -87.345745) with a gravel parking lot with four parking spaces, a hard surfaced boat launch, and a vault toilet. Approximately 60% of the Big Trout Lake shoreline is held in private ownership, while the remaining 40% is owned by the State of Michigan (western shoreline).

Big Trout Lake lies at the origin of the West Branch Chocolay River and has an intermittent inlet from Sporley Lake. According to historical office files, the inlet flows underground most of the distance between Sporley and Big Trout lakes and is then supplied with nearby hillside springs as it approaches the connection with Big Trout Lake. In 1938, a beaver dam located at the Big Trout Lake outlet was removed to allow free passage for Brook Trout to drop down to the river, spawn, and return. As a result, the lake level dropped a reported 7-8 inches. Shortly after removal, four railroad ties were installed by locals to help maintain the previous observed lake level. In 1974, this structure was assessed and estimated to raise the lake level by 6-8 inches. Today, the outlet structure is a compilation of earthen material, logs, and other debris. It is believed that under normal conditions fish passage is unlikely. The outlet drains under Sporley Lake Road to converge with Silver Lead Creek forming the West Branch Chocolay River, ultimately reaching Lake Superior through the Chocolay River.

In 1949, a fish barrier was constructed on the Big Trout Lake outlet by the Michigan Department of Conservation (today MDNR) to block movement of undesirable species into Big Trout Lake for maintaining a desirable trout fishery. In-office files are unclear on whether this structure is the existing structure at the outlet.

Then in 1979, the Big Trout Lake Fish Barrier was constructed by MDNR. This concrete structure is located 155 feet below Sporley Lake Road and does not influence the water level of Big Trout Lake. The primary purpose was to stop passage of Common White Sucker from moving upstream to Big Trout Lake. The structure is 3 feet wide and has a 20-inch drop with a steel basket to prevent jumping fish from passing. The structure was built using habitat improvement funds through Fisheries Division.

Using Wehrly et al. (2015), Big Trout Lake is classified as a small-deep lake (depth greater than 15 feet) with a maximum depth of 18 feet. Approximately 55% of the lake is deeper than 10 feet. The shoreline perimeter is 1.1 miles. Big Trout Lake has a lakeshed (catchment area) of about 304 acres (Figure 2).

The surrounding surficial geology of Big Trout Lake consists of coarse textured materials with Garlic-Alcona-Voelker, Garlic-Fence, and Loxly, Dawson, and Greenwood soils (USDA 2023). The surrounding land cover type is dominated by forests (78%), wetlands (19%), water (2%), and urban development (1%; Figure 2).

On August 8, 2022, a limnological survey was conducted in Big Trout Lake at its deepest point (18 feet), to measure dissolved oxygen (DO; mg/L), water temperature (°F), water transparency (Secchi depth), and pH (Figure 3). At the water surface, pH was 8.5 and near the bottom, pH was 7. Dissolved oxygen is a critical component to suitable habitat in aquatic ecosystems. Dissolved oxygen in lakes derives from the atmosphere as well as from aquatic plants during photosynthesis. Concentration of DO in lakes can limit the distribution and growth of fish as well as the size composition and biomass of zooplankton, which is a primary food resource for juvenile and prey fishes. Concentrations of DO begin to limit fish populations at approximately 4.0 mg/L (hypoxic) and are often lethal below 0.5 mg/L (anoxic; Wehrly et al. 2015). The August 2022 profile survey recorded suitable DO down to 15 feet. Dissolved oxygen became zero at 16 feet. Water temperatures began at 71.5°F at the water surface and remained above 70°F down to 11 feet of water. At 12 feet, water temperatures began to decrease steadily and reached 54°F at 17.5 feet. A profile of the Big Trout Lake water column was also conducted in March 2020 (Figure 4). This profile found hypoxic conditions immediately below the ice down to 5 feet and anoxic conditions in water depths below 5 feet. Data from the winter 2020 profile suggests Big Trout Lake enters hypoxic conditions high in the water column and becomes anoxic quickly as you move deeper. These conditions indicate that fish kills may be likely and DO levels are limiting to aquatic life during winter months. The summer 2022 profile data indicate a small window (about 3 feet) of suitable conditions for trout species. These data also suggest Big Trout Lake is most suitable for cool and warmwater species, but could offer some opportunity to a tolerant coldwater species.

In addition, Secchi disk readings are a measure of water transparency and are an excellent indicator for primary production occurring in the water column. Secchi depth is often used to index the level of phytoplankton production and overall lake productivity (Wehrly et al. 2015). A Secchi disk reading was taken on August 8, 2022 and was reported at 10.5 feet. Water transparency for Big Trout Lake is higher (more transparent) than other small-deep lakes in the Lake Superior Basin (9.0 feet) and just below similar waterbodies across the State of Michigan (Wehrly et al. 2015).

On October 18, 2021, a visual shoreline habitat assessment was conducted to quantify the amount of residential development (dwellings per mile), dock density (docks per mile), large woody habitat (submerged logs per mile), and percent of shoreline armored. When comparing these shoreline habitat parameters to waterbodies of similar size across Michigan, Big Trout Lake has moderate residential development (11 dwellings), moderate dock density (11 small docks), and no shoreline armoring. Large woody debris in Big Trout Lake was 119 submerged logs per mile. This density matches the mean density for all small-deep lakes in Michigan according to Wehrly et al. (2015).

History

Fisheries management in Big Trout Lake over the last century has been very intensive for a variety of trout species, while using longstanding techniques and methodology. The earliest record of fisheries management in Big Trout Lake was a survey conducted by Dr. John Lowe, a fisheries biologist who taught at Northern State Teachers College (now Northern Michigan University). In June 1926, Dr. Lowe

used a seine to conduct the first recorded inventory of the Big Trout Lake fish community. Near the outlet, Dr. Lowe collected Yellow Perch, Common White Sucker, Blacknose Shiner, Golden Shiner, Fathead Minnow, and Iowa Darter (Table 1).

Later in June 1926, the Michigan Department of Conservation (MDOC; MDNR today) was exploring and experimenting with restocking Arctic Grayling. Due to logging practices and overharvest, the Michigan Grayling was extirpated from the state by the early 1900's. In 1926, MDOC made reintroduction attempts in various locations across the state using Montana Grayling fry (MDNR, 1974). That same year, Big Trout Lake received 25,000 Montana Grayling fry (state or private facility source unknown; Table 2). No official evaluation is documented on this stocking event other than a brief seine survey by Dr. Lowe in June 1927, in which no Grayling were captured. This reintroduction attempt for Grayling was considered a failure.

Management of Big Trout Lake in the 1930s came with shifting directions and decisions. In 1936 Bluegill were stocked with the belief that Big Trout Lake would simply provide a panfish fishery. In 1937 Brook Trout were stocked with hopes of keeping trout in Big Trout Lake. A 1938 netting survey was conducted using a seine and gill nets that captured Golden Shiner, Common White Sucker, Yellow Perch, and Creek Chub. As part of this survey, a limnological profile was also conducted and found suitable DO and water temperatures for trout species (Figure 3). These results triggered management staff to recommend the following four actions: 1) manage the lake for Brook Trout by removing beaver dam at outlet to permit trout movement for spawning; 2) dam removal would lower water level and make lake more attractive and accessible; 3) treat the lake with rotenone (piscicide) to remove all fish life; 4) restock with Brook Trout following the lake treatment. The 1938 lake treatment commenced and was considered a complete eradication. Brook Trout stocking began annually in fall 1938. However, surveys conducted from 1942-1944 captured increasing numbers of Common White Sucker and Yellow Perch.

As previously discussed in the above Environment Section, in 1949 a fish barrier was constructed to block movement of undesirable fish species into Big Trout Lake. This was followed by a second lake treatment that took place in fall 1949 to again, remove Common White Sucker and Yellow Perch to manage for Brook Trout. By 1950, fisheries managers believed the 1949 lake treatment was ineffective and a third treatment took place. Brook Trout stocking resumed that fall and were stocked annually through 1957.

Gill net surveys conducted in 1951 and 1952 captured Brook Trout up to 9.4 inches and were said to be "surviving in good numbers." A few Common White Sucker were captured in both surveys, but a lake treatment was not ordered at this time. In 1953, Rainbow Trout were added to the stocking plan to serve as an additional predator offering control on Common White Sucker and minnow populations.

In 1957, five experimental gill nets were fished for a total of 10 net nights and three fyke nets for a total of six net nights. This survey removed 321 pounds of Common White Sucker. Also captured in the survey were Rainbow Trout up to 14 inches and Brook Trout ranging 9-12.1 inches. The ratio of trout species to Common White Suckers was 7 to 103. Following this survey, Brown Trout replaced Brook Trout as the target trout species for management in Big Trout Lake. Fisheries managers hoped Brown Trout would help provide control on the Common White Sucker population due to their vigorous nature of being a top predator.

Netting surveys using gill nets in 1960 and 1962 were conducted to evaluate the trout to Common White Sucker ratio. A total of 13 Brown Trout and 76 Common White Sucker were captured in 1960 and in 1962, one Brook Trout, six Brown Trout, 10 Yellow Perch, and 193 Common White Sucker were captured. Immediately following the review of these survey results, a fourth lake treatment was conducted in September 1962. Rainbow Trout were stocked the following spring (April 1963). Through 1964 excellent Rainbow Trout fishing was reported by anglers. By 1965, very poor catches of Rainbow Trout were reported so Big Trout Lake was evaluated with a netting survey in June. The netting survey only captured 22 Common White Sucker. In 1965, legal Brown Trout (>7 inches) were stocked. In 1966, a netting survey using trap and gill nets captured Brown Trout up to 16 inches, but again found a high abundance of Common White Sucker. In response to these findings, fisheries managers doubled the Brown Trout stocking density for 1968, a turning point in the management for Big Trout Lake.

In June 1968, using two experimental mesh gill nets and two trap nets, a netting survey was conducted to assess the status of the Brown Trout population and to act as a manual removal for Common White Sucker and Yellow Perch. A total of two Brown Trout were captured in the three-night effort. A total of 292 Common White Sucker at weighing 231 pounds, in addition to 90 Yellow Perch totaling 21 pounds were removed. Following this survey fisheries managers recommended discontinuing trout management to focus on warmwater species and promote the Yellow Perch fishery. Justification for this shift in management was stated as the lake was too shallow for trout, too eutrophic, and subject to continual reintroductions of undesirable species via its outlet (and inlet from Sporley Lake). It was suggested that if Yellow Perch became stunted, management should then be directed toward a Bluegill and Largemouth Bass fishery. Fisheries managers desired a more effective barrier on the outlet to prevent the reintroduction of undesirable species. No stocking or active fisheries management occurred from 1969-1979.

In 1974 conversations began for installation of a fish barrier on the outlet creek. The fish barrier was proposed to be approximately a quarter mile downstream of the lake and about 155 feet below the Sporley Lake Road crossing. Ahead of the construction of the fish barrier structure, a netting survey to inventory the fish community was completed in the summer of 1976. The netting survey using experimental mesh gill nets and fyke nets captured Pumpkinseed Sunfish, Common White Sucker, Yellow Perch, Black Bullhead, Northern Pearl Dace, Northern Redbelly Dace, Johnny Darter, Iowa Darter, Mimic Shiner, and Fathead Minnow. Once the fish barrier structure was completed, fisheries managers desired to treat the lake and restock a species preferred by the public. Correspondence letters requesting public input were sent out in the winter of 1978. Riparians and anglers responded with support for constructing the fish barrier and restocking the lake with Rainbow Trout. After securing permits and funding for the fish barrier, the structure was constructed and completed in August 1979. A lake reclamation took place in September 1979 and Rainbow Trout stocking was reinstated in spring 1980. Rainbow Trout stocking continued annually through 1993 and in most years thereafter.

In 1985, four experimental gill nets were set for one night. Thirty-four Rainbow Trout were captured ranging in length 10-13 inches. No age 2 or age 3 fish were captured in the survey and Common White Sucker and Yellow Perch were present in low numbers. A follow up netting survey was conducted in 1989 using experimental gill nets. This effort captured two year classes of Rainbow Trout (ages 0 and 1), three Brook Trout ranging in length 11-14 inches, and 51 Common White Sucker. The results from the 1985 and 1989 surveys suggested an increasing abundance of Common White Sucker and a manual

removal was then scheduled for 1990. A total of 703 pounds of Common White Sucker were removed (26 pounds per acre).

In 1994, a spring netting survey captured 39 Rainbow Trout with only five fish greater than 10 inches. The survey also captured 50 Common White Sucker, 23 Yellow Perch, and one Splake at 21 inches. Fisheries managers still desired to continue trout management, therefore a sixth lake treatment was scheduled for 1995 to eradicate Common White Sucker and Yellow Perch from Big Trout Lake. Rainbow Trout stocking was continued in spring 1996 and was increased from 100 to 150 fall fingerlings per acre. Brown Trout yearlings were also added for diversity in the fishery and were stocked every third year. Brook Trout were stocked in 1999 and 2000.

In 2001, angler reports of Yellow Perch triggered a netting survey in October. Four fyke nets were set and captured one Brown Trout at 24 inches, 20 Rainbow Trout ranging in length 4-14 inches, two Smallmouth Bass, and 19 Yellow Perch. In response, manual removals were conducted in 2002 and 2004 to eradicate Yellow Perch and black bass species. In 2002, crews removed a total of 611 pounds of Yellow Perch along with 70 Largemouth and Smallmouth Bass and one 32-inch Northern Pike. This effort also captured and returned 110 Rainbow Trout ranging 10-16 inches and two 15-inch Brown Trout. The 2004 manual removal effort eradicated 223 pounds of Yellow Perch, 265 Smallmouth Bass, and eight Largemouth Bass. The 2004 survey also captured and returned 18 Rainbow Trout ranging 15-19 inches and 14 Brown Trout ranging 6-18 inches.

Rainbow Trout and Brown Trout stocking continued through the 2000's. In 2008, as part of the randomized list for Status and Trends (S&T) lakes in the Eastern Lake Superior Management Unit, Big Trout Lake was surveyed. Fisheries Division's S&T monitoring program is designed to randomly sample various sized lakes, using similar protocol to identify spatial and temporal trends among waters statewide (Wehrly et al. (2010)).

The S&T survey was conducted in June 2008. The fish community assessment captured Bluegill (n=31), Smallmouth Bass (n=23), Brown Trout (n=14), Yellow Perch (n=9), Pumpkinseed Sunfish (n=3), and Painted Turtle (n=2). Growth identified through scales and spines found Bluegill and Yellow Perch growing above statewide average with older fish present and Smallmouth Bass growing below statewide average. Yellow Perch density seemed lower than before the manual removals completed in 2002 and 2004. This was also confirmed by local anglers from their fishing experiences as reported during the survey. However, local anglers did indicate that Rainbow Trout were difficult to catch and were caught up to 24 inches and Brown Trout were caught most often and up to 20 inches.

A limnological profile conducted on August 25, 2008 found relatively uniform water temperatures throughout the water column with 72.7°F at the surface and 69.7°F near the bottom (Figure 3). The DO level was good at 9.2 mg/L at the surface and 5.0 mg/L at 17 feet of water. Unfortunately, the lake did not stratify (thermal layering of the water column into three layers (epilimnion, metalimnion (thermocline), and hypolimnion) in 2008. Therefore, the temperature and DO overlap/window was not favorable for trout.

In 2009, a management prescription requested 1,200 Brown Trout yearlings and 1,800 Rainbow Trout fall fingerlings. The Brown Trout request was being fulfilled. However, due to the long distance between the source hatchery and Big Trout Lake and because this was the only request in the area for Rainbow

Trout fall fingerlings, Rainbow Trout were not being stocked. In 2013, a netting survey was conducted to help support decisions for the stocking strategy for Big Trout Lake. The netting survey captured Brown Trout (n=5) in poor physical condition, Bluegill, Pumpkinseed Sunfish, Largemouth Bass, Smallmouth Bass, and Yellow Perch. Catch per effort (fish per net night) for all species increased (from 2008) except for Brown Trout. A meeting with the Big Trout Lake riparians in June 2014 resulted in a decision to attempt to resurrect the Rainbow Trout fishery. Research from Caroffino and Nuhfer (2014), suggested that overwinter survival to be slightly better for Michigan strain Steelhead (Rainbow Trout) than the Eagle Lake strain. As an experiment, fall fingerling Michigan strain Steelhead were stocked 2014 and 2015 and then yearlings were stocked 2016-2019. Since it would have been too restrictive for anglers to harvest these smaller Rainbow Trout and to encourage a put and take fishery, the Type-E (15-inch minimum size limit) regulation was removed (effective 2015).

To evaluate the success of the stocked Rainbow Trout, a netting survey was conducted in October 2017 using large and small mesh fyke nets and experimental mesh gill nets. The survey captured only one Rainbow Trout at 10.5 inches and a total of 903 fish species comprised of Bluegill, Pumpkinseed Sunfish, Largemouth Bass, Yellow Perch, Brown Trout, and Black Crappie. Brown Trout averaged 19 inches. Age and growth analysis from fin rays confirmed Brown Trout from the 2012 and 2010 stocking cohorts. Reports from riparians indicated no Rainbow Trout caught, but a few Brown Trout were occasionally caught. The survey results combined with angler reports, suggested Rainbow Trout may not be well suited for the fish community and that Brown Trout have marginal success.

Current Status

The Big Trout Lake fish community was assessed in the fall of 2021 with the primary purpose to evaluate the stocked Rainbow Trout. The netting survey was conducted for three nights using four large mesh fyke nets, a small mesh fyke net, and two experimental gill nets. Steelhead were stocked from 2014 to 2019 (not in 2020 and 2021 due to the Covid-19 pandemic) in Big Trout Lake and the expectation was that multiple year classes would be subject to the netting gear deployed.

The netting survey captured a total of 1,111 fish comprised of six species (Table 3). Predators or gamefish species (Black Crappie, Largemouth Bass, Yellow Perch) comprised 5% of the total catch by number and 8% of the total biomass. Pelagic species (Bluegill and Pumpkinseed Sunfish) comprised 95% of the total catch by number and 91% of the total biomass. One Rainbow Trout was captured at 15 inches.

Bluegill total catch was 931 with an average total length of 5.7 inches and a length range of 1-7 inches. Bluegill growth estimated by scales and anal fin rays was determined to be 1.3 inches below statewide average. Age classes represented in the catch were ages 2-9.

Pumpkinseed Sunfish represented 11 percent of the total catch (n=124) and had an average total length of 6.6 inches and a length range of 3-9 inches. Length frequency analysis found 82% of Pumpkinseed Sunfish to be greater than harvestable size (≥6 inches; preferred harvestable by anglers). Pumpkinseed Sunfish growth estimated using scales and anal fin rays was determined to be 0.2 inches below statewide average. Age classes for Pumpkinseed Sunfish represented in the catch were ages 2-10.

Black Crappie catch totaled 27. The average total length for Black Crappie was 6.6 inches and the length range was 3-12 inches. Eighteen percent of Black Crappie were greater than harvestable size (≥7 inches).

Growth estimation from scales found Black Crappie to be growth 0.2 inches below statewide average. Age classes represented in the catch for Black Crappie were ages 0-5 and 8.

Yellow Perch catch totaled 16 and had an average total length of 8.4 inches and a length range of 6-10 inches. Yellow Perch growth estimated from scales and fin rays was found to be 0.1 inches above statewide average. Age analysis found six age classes (ages 3,4,5,7,8, and 9).

Largemouth Bass catch totaled 12 and had an average total length of 7.8 inches and a length range of 3-12 inches. Largemouth Bass growth estimated from scales and spines was found to be 0.4 inches above statewide average.

In December 2021, a riparian/landowner meeting was organized with the MDNR to discuss results of the netting survey and overall assessment of the Steelhead experiment. In discussion with the meeting attendees, it was determined that Rainbow Trout (either strain) would not work with the existing fish community of Big Trout Lake. Despite the numerous attempts to control the lake for trout management, the fish community continues to revert to a cool and warmwater composition. Meeting attendees understanding that chances for Brown Trout success is poor, although better than that for other trout species in Big Trout Lake, their preference was to try to maintain a trout option. In a final effort to maintain a trout component, a management prescription was approved in 2022 requesting 800 Brown Trout yearlings to be stocked annually. Brown Trout are believed to be capable of preying on early life stages of Centrarchids and Yellow Perch, while being a more tolerant trout species for chemical and physical conditions of Big Trout Lake. A reinstatement of the Type-E regulation was recommended to protect Brown Trout to 15 inches, allowing adequate time for their growth and predation of Centrarchids and Yellow Perch.

Analysis and Discussion

Big Trout Lake, described as a small-deep inland lake, has a lightly developed shoreline and a fish community typically found in other inland lakes in the Upper Peninsula. The BAS provides adequate access to the public for fishing, trapping, and hunting opportunities.

For nearly a century, fisheries management in Big Trout Lake has focused on maintaining a trout fishery. These efforts included six lake reclamations, three manual removals, and construction of a fish barrier (Table 4). Despite these efforts, trout species have not fared well with only variable success for short periods of time. The fish community and physical and chemical conditions of Big Trout Lake appears to be mostly suitable for cool and warmwater species. Recognizing some chance of success, Brown Trout are being stocked by request of the Big Trout Lake riparians and in agreement with Eastern Lake Superior Management Unit staff. Brown Trout are the most tolerant trout species reared by MDNR Hatcheries (Eaton et al. 1995) and DO and water temperature data from the summer limnological profiles suggest a suitable window exists (Figure 3). The most challenging period and likely limiting factor for trout success is during the winter months when DO is <3 mg/L just below the ice surface and reaches 0 mg/L at about 5 feet of water depth (Figure 4). This condition creates limited habitat for Brown Trout (all trout species) and likely higher mortality during this period.

Lake reclamation with chemicals and manual removals were methods commonly used by fisheries staff last century. Reductions in staff resources and funding have significantly limited the use of these actions today, and any future use of these actions will be heavily scrutinized for purpose and efficacy in

managing fisheries. At the time of the completion of this document, the cost for reclamation chemical (liquid rotenone) was approximately $100.00 per gallon. The cost for chemical needed to treat Big Trout Lake one time, would be approximately $24,000. This type of management action should be considered only when there is a significant resource to protect or when there is presence of an invasive fish species needing eradication.

A highlight for the fishery of Big Trout Lake could be the panfish populations. Schneider (1990) developed a scoring system to interpret Michigan Bluegill populations and their size structure. Using length-frequency to determine average length and proportion of the population within size classes (%>6, 7, and 8 inches) along with mean growth index, Bluegill in Big Trout Lake scored a 5.0. Using the Schneider Index, the Bluegill population in Big Trout Lake would be considered "good" (scale: 1=very poor and 7= superior). Additionally, Bluegill in Big Trout Lake were evaluated using Proportional Stock Density (PSD), which is the percentage of "stock-length" fish that also were equal to or longer than a specified length and where a value falling between 20-60 is considered acceptable (Anderson 1985). Bluegill PSD from the 2021 survey was 34. Although on the lower side of this range, Bluegill in Big Trout Lake would be considered a balanced population with a high likelihood of catching fish 6 inches or greater. No Master Angler Bluegill have been reported from Big Trout Lake since the inception of the program. While in juvenile stages, Bluegill along with Pumpkinseed Sunfish can provide an excellent forage base for the larger predators in Big Trout Lake and for Brown Trout. In addition to the Bluegill population, Black Crappie have appeared to find a niche in the fish community with acceptable growth and favorable size structure. Black Crappie will likely provide future angler opportunity in Big Trout Lake.

The Big Trout Lake Fish Barrier is an aging structure that served the purpose to block the passage of Common White Sucker into Big Trout Lake. In 2022, the Fisheries Division Dam Evaluation Task Group was charged to provide recommendations and guidance for Division-managed dams when considering repair or removal. The Big Trout Lake Fish Barrier was prioritized for removal as a dam no longer serving useful purpose and ready for demolition. Although the Big Trout Lake Fish Barrier is in satisfactory condition, Fisheries Division wishes to remove it to reduce risk and provide ecological benefits to the tributary of the West Branch Chocolay River. In 2022, Michigan DNR was awarded funding from the National Fish and Wildlife Foundation's American the Beautiful Challenge. This award is to fund the removal of 27 stream barriers, one of which is the Big Trout Lake Fish Barrier, to restore fish passage and other aquatic organisms. Collaborating with a local conservation organization to complete the removal will ensure project efficiency and strengthen partnerships.

Coarse woody habitat around the shoreline provides food, refuge, spawning substrate, and nursery and rearing habitat for fishes. O'Neal and Soulliere (2006) recommend managing inland lakes with appropriate levels of large (coarse) woody debris. They suggested natural levels of 2-inch and larger logs should have a density of 470-1,545 logs per mile of shoreline. Christensen et al. (1996) found that undeveloped "north temperate" Michigan and Wisconsin lakes possessed a higher log density of 344 per mile than developed lakes (235 logs per mile). The shoreline assessment on Big Trout Lake in 2021 recorded a log density of 119 per shoreline mile. For the benefit of the fish community, an increase in shoreline coarse woody habitat is recommended for Big Trout Lake. Considering the recommended densities for coarse woody habitat in natural "undeveloped" lakes, Big Trout Lake would need an addition of nearly 200 logs per shoreline mile.

Management Direction

1. Continue Brown Trout stocking per the existing management prescription (expiration 2032). Monitor Brown Trout fishery by gathering angler reports. Once four cohorts are stocked, schedule a netting survey to evaluate Brown Trout success. Following netting evaluation results and pending angler reporting, determination of trout management should be made.

2. Continue the Type-E regulation so Brown Trout can be protected from harvest until they achieve 15 inches. This will also allow Brown Trout to prey on the early life stages of Bluegill, Pumpkinseed Sunfish, and Yellow Perch.

3. Remove the Big Trout Lake fish barrier on outlet creek. Work with local conservation partner(s) to complete project. Funding sourced from America the Beautiful Challenge secured in 2022 by Fisheries Division.

4. Increase amount of woody habitat around shoreline. Work with riparian owners, conservation partner, and Forest Resources Division-Gwinn Management Unit to install tree drops using guidelines from Wisconsin DNR Fish Sticks guidance document (2014). End goal for Big Trout Lake coarse woody habitat should be a density of >300 trees per shoreline mile.

5. Monitor aquatic invasive species with education and outreach to slow and hopefully prevent introductions. Early detection can be accomplished through periodic fish community surveys and continued communication with riparians and local law enforcement staff.

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Table 1.-Historical capture occurrence by species and year for Big Trout Lake, Marquette County. Bolded years represent lake reclamations. Nonbolded years are surveys conducted with netting gear, but not all survey efforts were equitable. No species summary available for a lake reclamation conducted in 1950.

	Black Bullhead	Black Crappie	Blacknose Shiner	Bluegill	Bluntnose Minnow	Brassy Minnow	Brook Stickleback	Brook Trout	Brown Trout	Central Mudminnow	Common White Sucker	Creek Chub	Fathead Minnow	Fine-scaled Dace	Golden Shiner	Iowa Darter	Johnny Darter	Largemouth Bass	Mimic Shiner	Northern Pearl Dace	Northern Pike	Northern Redbelly Dace	Pumpkinseed Sunfish	Rainbow Trout	Smallmouth Bass	Splake	Yellow Perch
1926			X								X		X		X	X											X
1938			X			X	X	X		X	X		X	X	X	X						X					X
1939								X				X															
1942								X			X																
1943								X			X																X
1944								X			X																X
1949								X			X																X
1951											X																
1952								X			X																
1957								X			X													X			
1960								X	X		X	X															X
1962					X		X	X		X	X	X					X					X		X			X
1965											X																
1966									X		X																X
1968									X		X																X
1976	X										X		X			X	X		X	X			X				X
1979	X				X					X	X				X		X			X			X				X
1985											X													X			X
1989								X			X													X			

Table 1.-Continued.

	Black Bullhead	Black Crappie	Blacknose Shiner	Bluegill	Bluntnose Minnow	Brassy Minnow	Brook Stickleback	Brook Trout	Brown Trout	Central Mudminnow	Common White Sucker	Creek Chub	Fathead Minnow	Fine-scaled Dace	Golden Shiner	Iowa Darter	Johnny Darter	Largemouth Bass	Mimic Shiner	Northern Pearl Dace	Northern Pike	Northern Redbelly Dace	Pumpkinseed Sunfish	Rainbow Trout	Smallmouth Bass	Splake	Yellow Perch
1994											X													X		X	X
1995											X																X
2002									X				X					X			X			X	X		X
2004				X					X									X						X	X		X
2008				X					X														X		X		X
2013				X					X									X					X		X		X
2017		X		X					X									X					X	X			X
2021		X		X														X					X	X			X

Table 2.-Stocking history for Big Trout Lake, Marquette County.

Year	Species	Age	Average Length (inches)	Number
1926	Grayling (Montana)	Fry	-	25,000
1936	Bluegill	5 months	-	4,000
1937	Brook Trout	9 months	-	1,000
1938	Brook Trout	Adult	-	600
1939	Brook Trout	Adult	-	475
1939	Brook Trout	Yearling	-	4,125
1943	Brook Trout	Adult	-	1,600
1946	Brook Trout	Legal	7.2	700
1946	Brook Trout	Fingerling	-	7000
1950	Brook Trout	-	6.6	3,500
1950	Brook Trout	-	7.4	700
1951	Brook Trout	Legal	7.9	1,700
1951	Brook Trout	Sub-legal	3.5	7,000
1952	Brook Trout	Fingerling	3	12,000
1953	Brook Trout	Legal	7.3	1,000
1953	Rainbow Trout	-	8.9	1,000
1954	Brook Trout	Sub-legal	5.7	2,000
1954	Rainbow Trout	-	6.8	2,000
1955	Brook Trout	Sub-legal	-	2,000
1955	Rainbow Trout	Sub-legal	-	2,000
1956	Brook Trout	Sub-legal	-	2,000
1956	Rainbow Trout	Sub-legal	-	2,000
1957	Brook Trout	Sub-legal	-	2,000
1957	Brown Trout	Sub-legal	-	2,000
1958	Rainbow Trout	Sub-legal	-	2,000
1958	Brown Trout	Sub-legal	-	2,000
1959	Rainbow Trout	Legal	-	2,000
1959	Brown Trout	Sub-legal	-	2,000
1960	Rainbow Trout	Sub-legal	-	1,000
1960	Brown Trout	Sub-legal	-	2,000
1961	Brown Trout	Legal	-	1,000
1963	Rainbow Trout	Legal	-	2,500
1963	Rainbow Trout	Sub-legal	-	5,000
1964	Rainbow Trout	Sub-legal	-	5,000
1965	Brown Trout	Yearling	7.4	1,000
1968	Brown Trout	Yearling	7.3	2,000
1980	Rainbow Trout	Yearling	7.6	1,150

Table 2.-Continued

Year	Species	Age	Average Length (inches)	Number
1980	Rainbow Trout	Fall fingerling	5.5	2,300
1981	Rainbow Trout	Fall fingerling	6.7	2,300
1982	Rainbow Trout	Fall fingerling	4.4	2,500
1983	Rainbow Trout	Fall fingerling	6.4	2,300
1984	Rainbow Trout	Fall fingerling	3.6	2,300
1985	Rainbow Trout	Fall fingerling	4.4	2,300
1986	Rainbow Trout	Fall fingerling	3.6	2,070
1987	Rainbow Trout	Fall fingerling	4.6	2,300
1988	Rainbow Trout	Fall fingerling	3.9	2,301
1989	Rainbow Trout	Fall fingerling	4.8	2,300
1990	Rainbow Trout	Fall fingerling	4.9	2,300
1991	Rainbow Trout	Fall fingerling	4.5	2,300
1992	Rainbow Trout	Fall fingerling	3.8	2,300
1993	Rainbow Trout	Fall fingerling	3.9	2,300
1996	Brown Trout	Yearling	7.5	2,275
1996	Rainbow Trout	Yearling	8.1	7,350
1997	Rainbow Trout	Fall fingerling	3.3	4,500
1999	Brook Trout	Yearling	8.4	300
1999	Rainbow Trout	Fall fingerling	4.3	4500
1999	Rainbow Trout	Yearling	8.5	2,000
2000	Brook Trout	Adult	11.2	200
2000	Brook Trout	Fall fingerling	2.9	2,500
2000	Rainbow Trout	Fall fingerling	3.8	5,500
2001	Brown Trout	Yearling	4.8	1,530
2001	Rainbow Trout	Fall fingerling	3.7	2,500
2002	Rainbow Trout	Fall fingerling	3.5	20,946
2003	Rainbow Trout	Fall fingerling	4.8	3,188
2004	Brown Trout	Yearling	5.2	1,200
2004	Rainbow Trout	Fall fingerling	4	5,081
2005	Rainbow Trout	Fall fingerling	4.7	2,886
2006	Brown Trout	Yearling	7.2	1,300
2006	Rainbow Trout	Fall fingerling	5.7	2,587
2007	Rainbow Trout	Fall fingerling	5.6	2,495
2008	Brown Trout	Yearling	7	1,100
2008	Rainbow Trout	Yearling	5.4	3,449
2010	Brown Trout	Yearling	7	1,300
2012	Brown Trout	Yearling	5.5	1,300

Table 2.-Continued.

Year	Species	Age	Average Length (inches)	Number
2014	Rainbow Trout (MI)	Fall fingerling	2.9	1,800
2015	Rainbow Trout (MI)	Fall fingerling	2.9	2,000
2016	Rainbow Trout (MI)	Yearling	7.9	700
2017	Rainbow Trout (MI)	Yearling	8.2	700
2018	Rainbow Trout (MI)	Yearling	7.9	700
2019	Rainbow Trout (MI)	Yearling	6.9	700
2022	Brown Trout	Yearling	7.2	800
2023	Brown Trout	Yearling	6.9	720

Table 3.-Numbers, weights, lengths, and mean growth indices for fish species collected during the general netting survey on Big Trout Lake, Marquette County on October 18–21, 2021. Fish were captured using fyke nets and experimental gill nets. Not enough fish were captured to estimate a growth index for Rainbow Trout.

Species	Number	Percent by number	Weight (lb)	Percent by weight	Length range (inches)	Average Length (inches)	Percent legal or harvestable[1]	Growth Index[2]
Bluegill	931	83.8	127.0	72.8	1-7	5.7	34	-1.3
Pumpkinseed Sunfish	124	11.2	32.0	18.3	3-9	6.6	82	-0.2
Black Crappie	27	2.4	6.0	3.4	3-12	6.6	18	-0.2
Yellow Perch	16	1.4	4.2	2.4	6-10	8.4	87.5	0.1
Largemouth Bass	12	1.1	3.9	2.3	3-12	7.8	0	0.4
Rainbow Trout	1	0.1	1.3	0.7	15-15	15.5	100	-
Total	1,111	100	174.4	100				

[1] Harvestable size is 6 inches for Bluegill and Pumpkinseed Sunfish and 7 inches for Black Crappie and Yellow Perch. Legal size for Rainbow Trout is 8 inches. All other game species based on statewide regulations.

[2] Average deviation from the statewide average length at age. Mean growth indices <-1 indicate below average growth, indices between -1 and +1 indicate average growth, and indices >+1 indicate growth is faster than statewide average.

Table 4.-History of intensive management actions conducted on Big Trout Lake, Marquette County.

Year	Management Action	Target Species
1938	Lake Reclamation	Common White Sucker and Yellow Perch
1949	Fish barrier constructed	Common White Sucker
1949	Lake Reclamation	Common White Sucker and Yellow Perch
1950	Lake Reclamation	Common White Sucker and Yellow Perch
1962	Lake Reclamation	Common White Sucker
1968	Manual Removal	Common White Sucker and Yellow Perch
1979	Fish barrier constructed	Common White Sucker
1979	Lake Reclamation	Common White Sucker and Yellow Perch
1995	Lake Reclamation	Common White Sucker and Yellow Perch
2002	Manual Removal	Common White Sucker and Yellow Perch
2004	Manual Removal	Common White Sucker and Yellow Perch

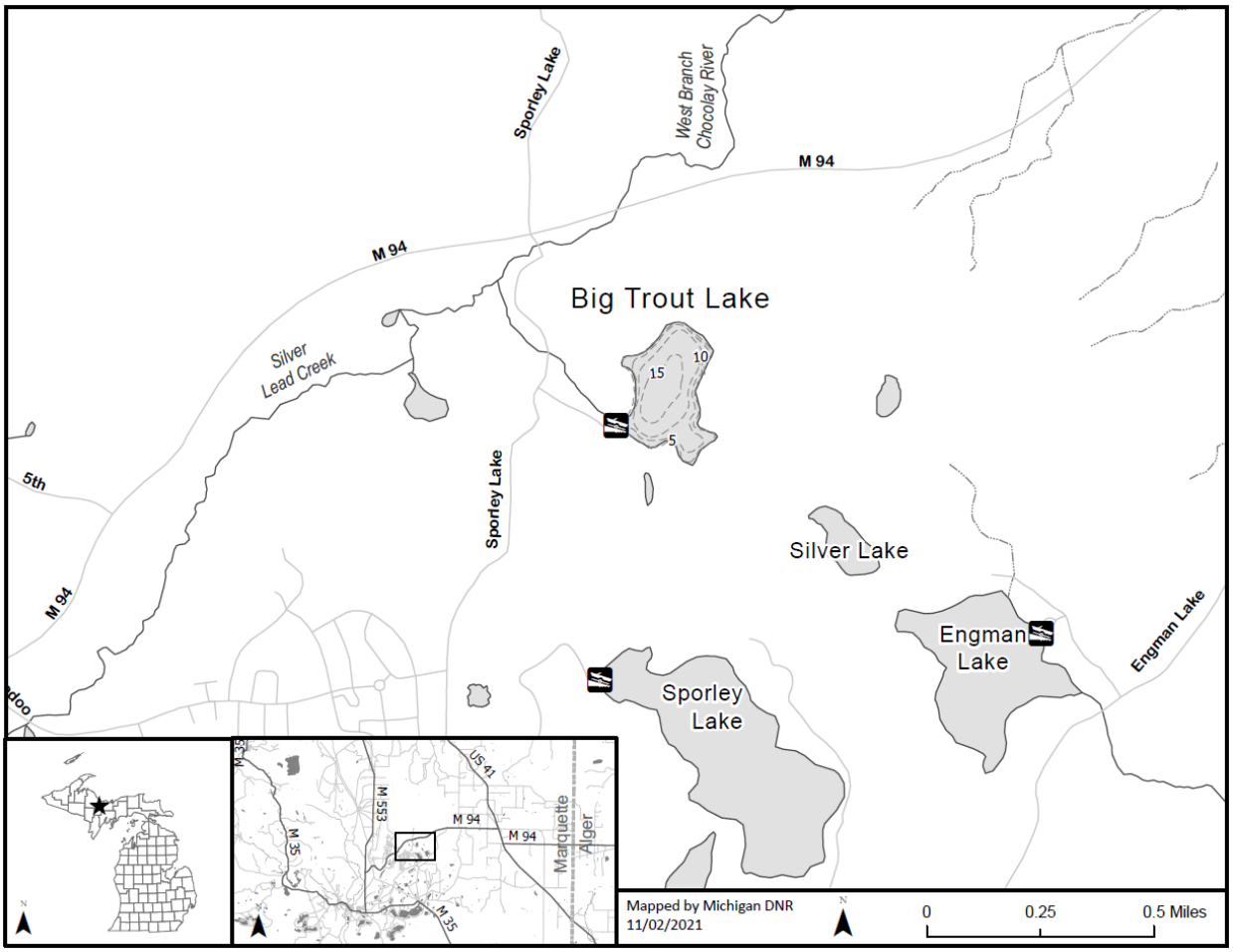

Figure 1.-Map of Big Trout Lake, Marquette County, Michigan.

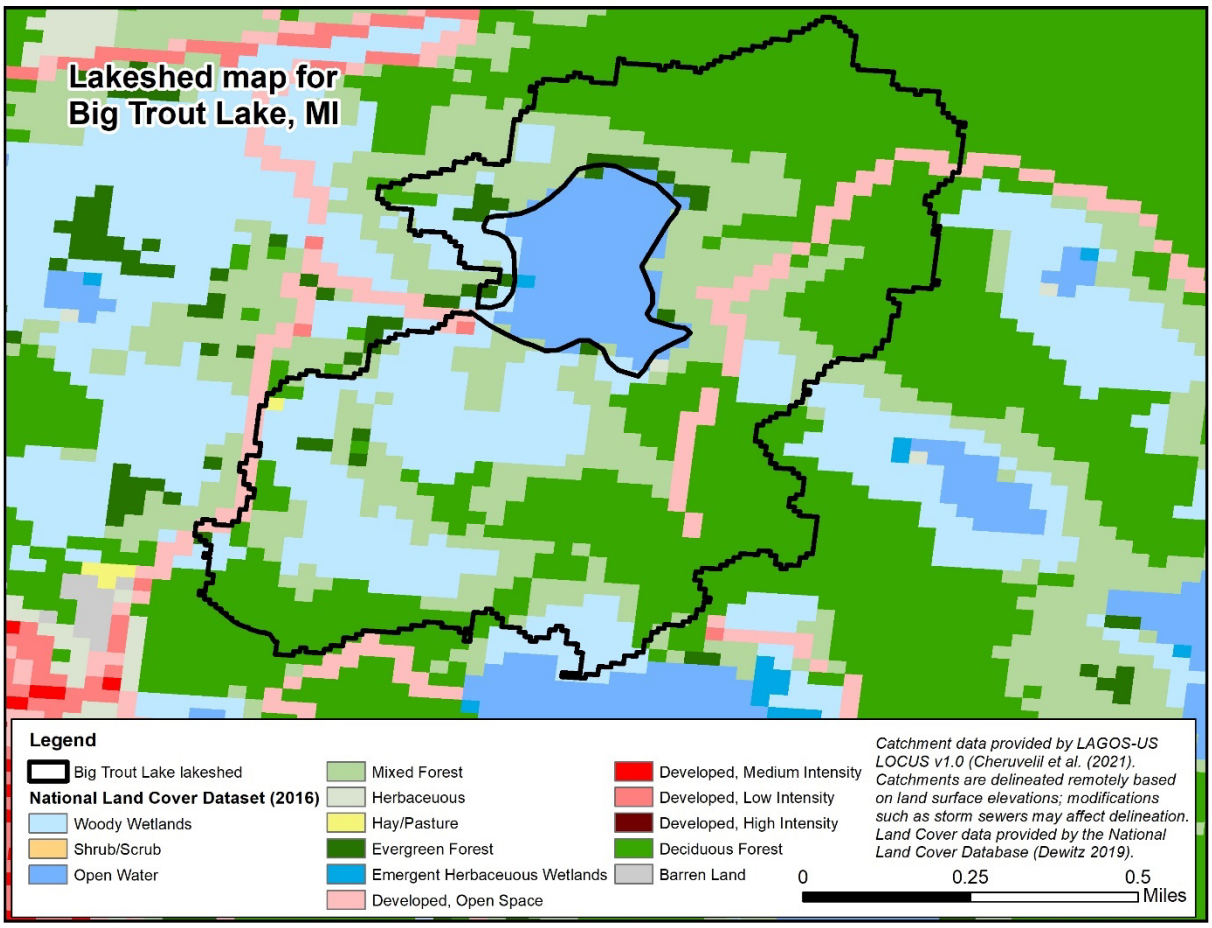

Figure 2.-Lakeshed (catchment) map for Big Trout Lake, Marquette County, with land cover imagery.

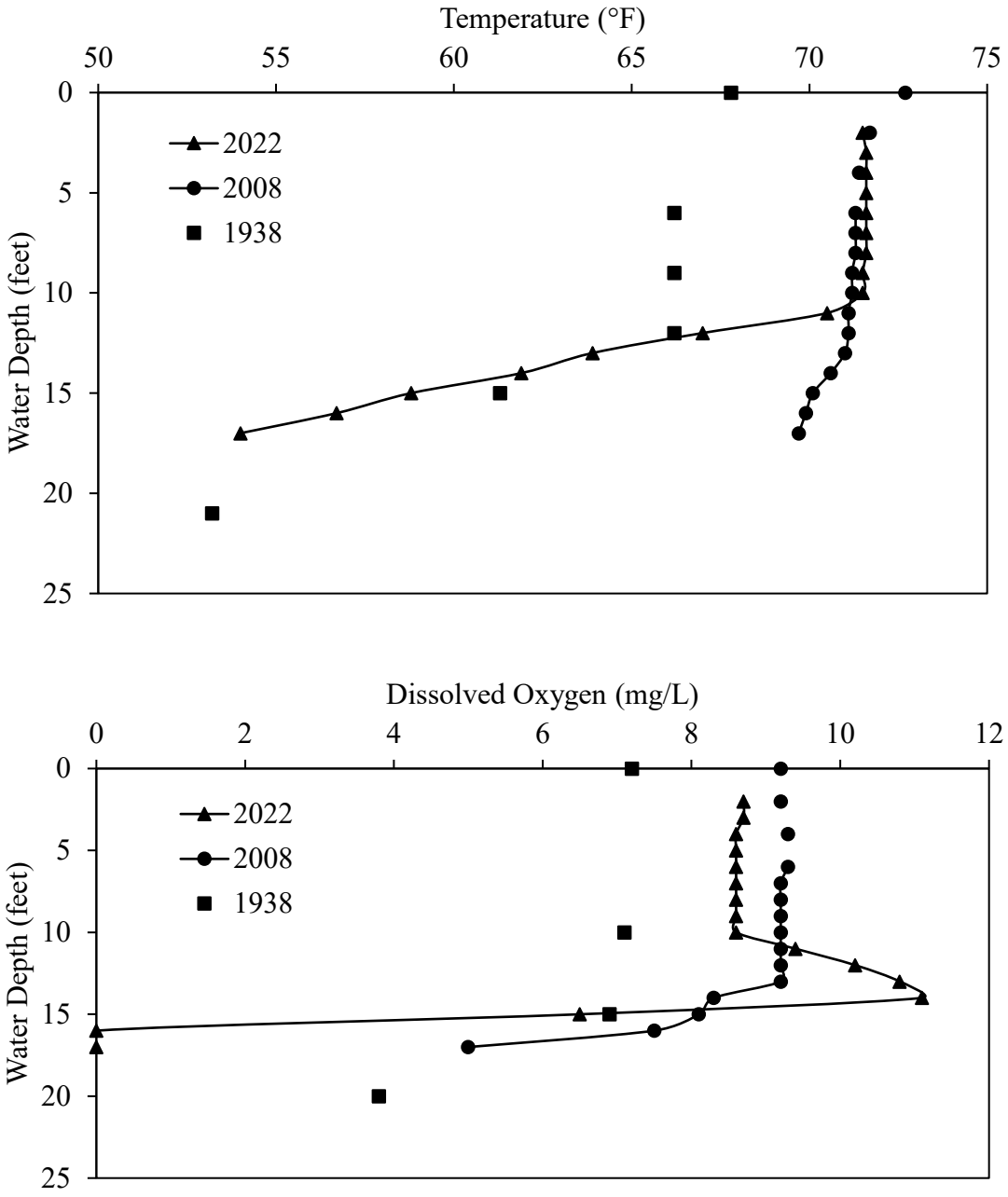

Figure 3.-Limnological profiles for Big Trout Lake, Marquette County conducted in August 1938, 2008, and 2022.

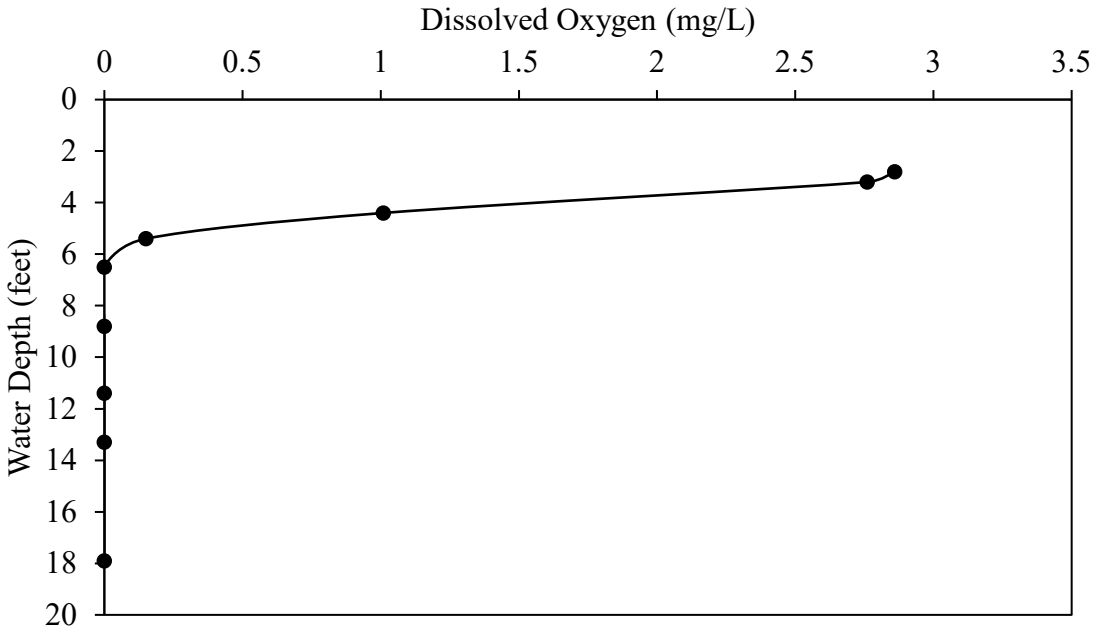

Figure 4.-Limnological profile for Big Trout Lake, Marquette County conducted in March 2020.