Higgins Lake

Roscommon and Crawford Counties
Muskegon River Watershed; last surveyed fall 2020

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Environment

Higgins Lake is a 10,186-acre natural lake (the 10th largest in Michigan) that is in the central Lower Peninsula of Michigan. Higgins Lake lies mostly in Lyon and Gerrish Townships of Roscommon County, although a small sliver of the northern part of the lake lies in Beaver Creek Township of Crawford County. Higgins Lake is a deep, oligotrophic lake of glacial origin with a maximum depth of approximately 135 feet and an average depth of 30.4 feet (Jermalowicz-Jones 2020). Substrates consist primarily of sand and marl. Higgins Lake is essentially the headwaters of the Muskegon River watershed. An outlet stream flows out of the south shore of Higgins Lake and into Marl Lake, a shallow, 237-acre natural lake. The outflow from Marl Lake forms a stream known as "the Cut" or "the Cut River", which eventually flows into Houghton Lake.

There is a lake-level control dam on the outlet of Higgins Lake. The dam is operated by the Roscommon County Board of Commissioners. The average discharge for the outlet is approximately 44.2 cubic feet per second (cfs; Jermalowicz-Jones 2020). Although crude structures to aid in the harvest and transport of harvest timber were likely built earlier, the first lake level control dam on the Higgins Lake outlet was built in 1926. The most recent structure was built in 1950 and the current lake level was established in 1982 (Anonymous 2010). The court-ordered summer level is 1154.11, and the winter level is 1153.61.

There are only a few small tributaries to Higgins Lake. The largest is Big Creek, which flows into the western end of the lake. Big Creek is a Designated Trout Stream that supports a resident population of Brook Trout and possibly natural reproduction for Rainbow Trout as well. Big Creek was recently surveyed by MDNR (Tonello 2020). A perched culvert at Dewey Road (the lowest crossing in the Big Creek subwatershed) was replaced by the Roscommon County Road Commission in the summer of 2021. Many partners contributed to the project, including the Higgins Lake Foundation, the Higgins Lake Property Owners Association, the Morley Foundation, and Huron Pines.

Higgins Lake has a relatively small watershed for a lake of its size, at 27,783 acres (Jermalowicz-Jones 2020). The surrounding landscape is mostly flat and mostly forested with northern hardwoods and conifers, although there is a large wetland complex located directly west of the lake that drains into Big Creek. According to the Midwest Glacial Lakes Partnership (MGLP; 2019), landcover in the Higgins Lake watershed consists of 38.3% forest, 35.7% open water, 10.1% urban, 7.9% wetland, 5.3% grassland, 2.5% other, and 0.1% agricultural. The shoreline of Higgins Lake (approximately 22.2 miles, including the island; Jermalowicz-Jones 2020) is heavily developed with homes and cottages. Higgins Lake is an extremely popular tourist destination, with fishing, boating, sailing, and swimming all being popular activities. The local economies of the Village of Roscommon and several townships all benefit significantly from Higgins Lake-based tourism.

Access to Higgins Lake can be gained at numerous locations around the lake. According to the Roscommon County Road Commission, there are a total of 86 road-end access points on Higgins Lake. While all provide legal access to the lake, they have varying amenities ranging from no development of any kind to public docks and paved boat launches. Another very popular access point is the public boat launch on the west shore that is administered by MDNR. This launch has a large parking area capable of hosting 82 vehicles with trailers.

There are also two State Parks on Higgins Lake- North Higgins Lake State Park and South Higgins Lake State Park. Both offer boat launches with large parking lots and camping facilities. The North Higgins Lake State Park has nearly _ mile of Higgins Lake frontage and covers 449 acres of mostly forested land, and offers hiking, cross country skiing, and biking trails. The boat launch at North Higgins Lake State Park has parking for 54 vehicles and trailers. South Higgins Lake State Park covers approximately 1,364 acres and has approximately 1 mile of Higgins Lake frontage. The boat launch at South Higgins Lake State Park hosts parking for approximately 174 vehicles and trailers. South Higgins Lake State Park also encompasses the entire perimeter of Marl Lake (including a boat launch) and has 5.5 miles of hiking trails. Both parks are extremely popular with campers and are heavily booked between Memorial Day and Labor Day.

The first citizen-led group for Higgins Lake was the Higgins Lake Property Owners Association (HLPOA), which formed in 1935. The HLPOA exists to "protect, preserve and enhance the quality of Higgins Lake and its surrounding watershed" (https://hlpoa.org/). According to their website, "the purpose of the HLPOA, in accordance with its Articles of Incorporation, is to represent the interests of the lakefront property owners on Higgins Lake, and engage in activities to preserve and enhance the water quality of Higgins Lake, and work with local and state government officials on issues that affect the environment and water quality of Higgins Lake, and inform the HLPOA membership and the community of activities performed for the preservation and enhancement of Higgins Lake for future generations."

Another citizen-led group that advocates for Higgins Lake is the Higgins Lake Foundation (HLF), established in 1989. The HLF mission statement is: "promoting ecologically sound programs and practices for the protection of Higgins Lake and the surrounding watershed." HLF is not a membership organization; instead, it is supported by donations and grants. HLF has funded two boat wash stations at Higgins Lake state park boat launch sites in cooperation with MDNR and HLPOA. HLF also owns and operates the DASH (Diver-Assisted Suction Harvesting) boat. The HLF DASH boat is currently permitted by EGLE to remove Eurasian water milfoil and Starry stonewort, both aggressive aquatic invasive species in Higgins Lake. HLF also helps conduct educational projects in local schools and hosts an annual one-day environmental camp for local fourth graders (Vicki Springstead, HLF, personal communication). HLF has hosted various "State of the Lake" presentations by Dr. Mark Luttenton from Grand Valley State University. Dr. Luttenton has worked with HLF for several years as a consultant and advisor on best management practices for Higgins Lake.

The final citizen-led group that exists for the benefit of Higgins Lake is the Higgins Lake Land Conservancy (HLLC), which was formed in 2001. According to their website (http://www.higginslakelandconservancy.com/), "the Higgins Lake Land Conservancy is a not-for-profit corporation formed to acquire, sell and otherwise manage lands solely within the Higgins Lake

watershed and surrounding areas in a manner which promotes prudent environmental use and conservation of the Higgins Lake area".

History

The first records of fish stocking in Higgins Lake date back to 1874 when Atlantic Salmon were stocked by the Michigan Fishery Commission (MFC; Table 1). Lake Whitefish were then stocked 1879, and Atlantic Salmon were stocked again in 1880. Lake Trout were first stocked in 1902, followed by the first stocking of Rainbow Trout in 1905. Numerous other species were also stocked in the early 1900s, including Walleye (first stocked in 1909), Largemouth Bass (1911), Bluegill (1913), Yellow Perch (1914), and Smallmouth Bass (1919). Arctic Grayling were also stocked three times, in 1926-1928. Lake Whitefish were again stocked in 1927. Emerald Shiners (known then as "Great Lakes Shiners") were stocked once, in 1933 (Taube 1951). Stocking of non-salmonid species ceased in the mid-1940s, and only coldwater species (salmonids) have been stocked since. Between 1945 and 1964, only Lake Trout and Rainbow Trout were stocked. Kokanee Salmon were then stocked four times between 1965 and 1970. Splake were first stocked in 1966 and were stocked sporadically over the years, with the last stocking in 1994. Rainbow Trout were not stocked into Higgins Lake between 1974 and 1985, but they were stocked again in 1986 and have been regularly stocked since then. Brown Trout were first stocked into Higgins Lake in 1974 and have been stocked on a fairly regular basis since then. Atlantic Salmon were again stocked in 1982, 1986, and 1990. Since 1994, the only species stocked into Higgins Lake have been Brown Trout, Lake Trout, and Rainbow Trout.

Historical Fisheries Issues

Detailed descriptions of the 1800s Higgins Lake fish community simply do not exist. A note in Michigan Department of Natural Resources (MDNR) files (Cadillac office) from 1887 mentions Walleye, Yellow Perch, "Grass Pike" (probably referring to Northern Pike), Whitefish, and "Herring" (probably referring to Cisco or Lake Herring) as being present in Higgins Lake. It is unknown if the Lake Whitefish were native, or if their population began with the 1879 stocking effort.

Observations by MDOC (Michigan Department of Conservation; the precursor to the MDNR of today) staff from the 1920s include mentions of Smallmouth Bass, White Suckers, Rock Bass, Yellow Perch "small ones abundant, no large ones present" (MDNR files, Cadillac office). Walleye (referred to then as "Wall-eyed pike") were also mentioned, with the comment being "few present". Northern Pike were also mentioned as "few, some of them very large". Big Lake Trout were also reported as being caught by anglers. Due to the lack of Lake Trout spawning habitat in Higgins Lake, it is unlikely that the Lake Trout were native to the lake. Instead, the population discussed in the 1920s had probably been established through stocking. Lake Whitefish and Cisco were also both discussed, and it was noted that the Lake Whitefish spawned in the shallows, and that the "natives" had speared them for years. Other species mentioned included "dogfish" (likely Bowfin), "calico bass" (likely Black Crappie, although they likely weren't very abundant due to a lack of habitat for that species). Various other small, non-game fish species were also mentioned.

Another note (MDNR files, Cadillac office) from 1939 mentioned that Rock Bass, Smallmouth Bass, and Yellow Perch were abundant, but that the Yellow Perch are typically only 6-7 inches in length. Lake Whitefish and Cisco were mentioned as present, as were Walleye. Northern Pike, Muskellunge, and "gar" were listed as "reported". This note represents the only mention of Muskellunge or gar in the

file, and neither species has ever been caught in a fisheries survey. It is likely that neither of these species was ever present in Higgins Lake.

A report by Taube (1951) mentions unsuccessful stockings "in earlier years" of Atlantic Salmon, "landlocked salmon", "California Salmon", and "Montana Grayling". The "landlocked salmon" Taube referred to are likely Atlantic Salmon. What he meant by "California Salmon" is unknown. The report also mentions that numerous brush shelters had been installed previously in Higgins Lake, including 45 in 1933 and another 318 installed in 1949.

During the period from 1952-1954 there was much discussion within MDOC about the possibility of intentionally stocking Rainbow Smelt into Higgins Lake. Not all MDOC Fisheries staff agreed with the idea, and the discussion even reached the level of then- MDOC Director Gerald Eddy. HLPOA discussed the issue as well, with some members in favor of the idea, and others against. Eventually, the decision was made to forgo stocking of Rainbow Smelt into Higgins Lake. However, in 1975, an angler reported that there were Rainbow Smelt in the stomachs of Lake Trout he had caught from Higgins Lake (MDNR files, Cadillac office). MDNR Fisheries Biologist Jerry Manz responded that he suspected that the Rainbow Smelt had been stocked into Higgins Lake illegally by anglers. In 1985, MDNR Fisheries Biologist Jan Fenske wrote that she believed the Rainbow Smelt had been stocked illegally by anglers in the late 1960s. She was responding to an angler who was concerned about the Rainbow Smelt possibly suppressing or negatively affecting the Yellow Perch population (MDNR files, Cadillac office). Since their introduction to the lake, Rainbow Smelt have created a very popular ice fishery on Higgins Lake, with thousands of angler-hours accrued each winter by anglers pursuing them through the ice.

For three years from 1958 to 1960, MDOC personnel conducted egg takes for Lake Trout from Higgins Lake. The fish were caught using gill nets. Fisheries Biologist Buddy Jacob wrote informal reports about each of these efforts (MDNR files, Cadillac office). After 1947, all the Lake Trout stocked into Higgins Lake had been marked with differing fin clips to determine whether or not natural reproduction was occurring, and also to differentiate age groups and allow for decisive aging of the fish. Seven different fins were clipped in subsequent years, but after the seventh year the process started again, meaning that fish from different stocking years had the same fin clip. Biologist Jacob noted that "the great variation of growth among the Lake Trout of Higgins Lake makes the separation of these fish, even with a difference in age of seven years, less than obvious". In each report, he concluded that natural reproduction of Lake Trout in Higgins Lake was virtually non-existent or very low. He also noted that Lake Trout that had been stocked at smaller sizes had not done as well as those stocked at larger sizes. Most of the Lake Trout caught in these efforts were from gill net sets on several reefs/bars in the vicinity of Flynn's Island.

In the summer of 1962, with the assistance of Michigan United Conservation Clubs (MUCC), an artificial spawning reef was constructed by MDOC personnel in 20 feet of water on the south end of the sunken island in the north basin of Higgins Lake. The reef was built with a total of 170 cubic yards of broken concrete for the purpose of fostering natural reproduction of Lake Trout. Gill netting in the fall of 1962 documented mature Lake Trout in the vicinity of the reef at the time spawning would have occurred. A follow up survey with divers in the fall of 1963 and winter of 1964 documented Lake Trout eggs on the reef. The divers also observed a small number of recently hatched sac fry in the winter diving survey.

In several correspondences with anglers in late 1968/early 1969, Fisheries Biologist Gary Schnicke stated that Splake were being stocked as a replacement for Lake Trout, which were last stocked in 1966. He believed that the Splake would be better for anglers than Lake Trout because of their faster growth rates. Schnicke also explained that Rainbow Trout stocking had been cut after 1965 because he felt they weren't being utilized enough by anglers. This stocking strategy didn't last long, as Rainbow Trout were again stocked in 1970, while Lake Trout were again stocked in 1971. In other correspondence from 1968, MDNR Fisheries Biologist Russ Lincoln echoed the previous sentiment from Buddy Jacob about natural reproduction of Lake Trout not being successful (MDNR files, Cadillac office).

Kokanee Salmon were stocked into Higgins Lake four times, including in 1965, 1966, 1967, and 1970. In November 1968 an effort was made to collect adult Kokanee Salmon for an egg take. Around 1,000 adult Kokanee Salmon were captured, resulting in around 250,000 eggs. Egg takes were also conducted in 1971 and 1972. For these efforts, the fish were taken in trap nets along the shoreline near the creek mouths, by electrofishing from the creeks, and by hand netting in the creeks. Further sampling of spawning Kokanee Salmon was conducted in the fall of 1973, although not for egg take purposes. Another egg take was conducted in the fall of 1974. MDNR Fisheries Biologist William Buc (1974) hypothesized that at least some of the Kokanee Salmon caught in the fall of 1973 were from natural reproduction and that the fish might establish a self-sustaining population in Higgins Lake. Ultimately this did not happen and eventually the Kokanee Salmon faded from Higgins Lake. One drawback to the adult Kokanee Salmon was their small size. The adult salmon typically ranged from 12 to 16 inches, with few ever getting larger than that. Although they could clearly survive in Higgins Lake, they failed to create a fishery that excited anglers.

In March of 1974, MDNR Fisheries Biologist Gary Schnicke wrote a lengthy correspondence about the fishery of Higgins Lake (MDNR files, Cadillac office). Among other issues, he mentioned that the stocked Splake have experienced variable survival, with some years having virtually no survival, for reasons unknown. He recommended stocking Brown Trout in addition to the Splake, Rainbow Trout, and Lake Trout already being stocked. He also brought up a concern regarding potential overharvest of Lake Whitefish by ice anglers using chum to attract the fish.

Higgins Lake was featured in a 1976 MDNR report on the twenty largest lakes in Michigan (Laarman 1976). The author basically echoed the sentiments of the other Biologists from the previous 20 years. Laarman mentioned the variable survival of the stocked Splake, and that the stocked Rainbow Trout were only creating a token fishery. He also mentioned concern about potential Lake Whitefish overharvest. He also noted a general lack of robust fisheries survey data for Higgins Lake and recommended that a comprehensive fisheries survey be conducted.

A series of newspaper articles from 2003 to 2005 report excellent ice fishing for Rainbow Smelt, Lake Whitefish, and Lake Trout (MDNR files, Cadillac office). The presence of professional ice fishing guides on Higgins Lake is also discussed. In the winter of 2005, MDNR Fisheries Biologist Steve Sendek reflected on his Higgins Lake ice fishing experiences so far that winter, mentioning that he was catching large numbers of smaller Yellow Perch. He also mentioned that the few larger Yellow Perch he was catching were very skinny. He also noted what he believed to be a large upcoming year class of Rainbow Smelt that were 5-6 inches in length (MDNR files, Cadillac office).

Since 1994, a total of 312 exceptional fish caught from Higgins Lake have been entered in the MDNR Fisheries Division Master Angler program. A total of 14 different species have been entered for Higgins Lake (Table 2). Rock Bass was the most numerous species entered, with 112 entries, followed by Lake Trout with 75 entries, and Lake Whitefish with 52 entries.

Lake Management Issues

In 1990, a research team from Central Michigan University (CMU) studied multiple aspects of Higgins Lake (King et al. 1991). The study was funded by the HLF. One part of the study focused on cladophora (algae) issues, which had been reportedly becoming worse in recent years. The researchers determined that phosphorous levels were too high and were likely contributing to the problem. While Higgins Lake is a deep, cold, oligotrophic lake, the researchers found that phosphorous levels spiked in the summer to levels more comparable with eutrophic (highly productive) lakes. They attributed this to nutrient inputs from lawn fertilizers and leaking septic systems. At that time, most of the dwellings around Higgins Lake were not occupied during the winter, and the researchers believed the summer spikes in phosphorous levels were due to the dramatic increase in the human population around Higgins Lake in the summer.

Another water quality survey of Higgins Lake was conducted from 1995-1999 (Minnerick 2001). This study was cooperative in nature, with participants including Gerrish and Lyon Townships, HLPOA, and HLF. The study was in response to concerns regarding the water quality of Higgins Lake due to a 246% increase in population surrounding the lake from 1970 to 1990. In the study, Minnerick noted that nutrient concentrations were much higher near more heavily developed areas. He also found that E. coli bacteria counts were also much higher near more developed areas. He concluded that faulty septic systems were the most likely source for both the excess nutrients and the high bacteria counts. Another study by Martin et al. (2014) found similar results, but also found that water quality in the northwest portion of the lake greatly improved with the installation of the Camp Curnalia wastewater treatment plant. Dr. Mark Luttenton from Grand Valley State University has also studied the limnology of Higgins Lake in recent years and has also concluded that nutrient enrichment from septic systems is a major threat to the water quality of Higgins Lake (personal communication).

In the 1990 study, the CMU researchers also studied the aquatic plants of Higgins Lake (King et al. 1991). Not surprisingly, they found low abundances of aquatic plants and low diversity of species. This is typical of large, deep, inland lakes. The most abundant plant was Chara spp. No Eurasian Watermilfoil (EWM) was encountered during the plant surveys conducted by the researchers (King et al. 1991). Unfortunately, EWM was discovered to be covering approximately 17 acres of Higgins Lake bottomland in the summer of 1994 (MDNR files, Cadillac). Since then, there has been a concerted effort by the Higgins Lake community to control the EWM on Higgins Lake to keep it from spreading.

Other invasive species have been introduced into Higgins Lake. Zebra mussels were first discovered in 2000 (Vicki Springstead, HLF, personal communication). Starry Stonewort was first identified in Higgins Lake in 2018, and quagga mussels were found in 2020 (Dr. Mark Luttenton, Grand Valley State University, personal communication).

In July 2002, a document produced by Huron Pines (a local conservation-based non-profit organization) and the HLF discussed potential treatment options for EWM on Higgins Lake. The

report mentioned that EWM was present on approximately 12 acres of Higgins Lake. Potential treatment options discussed in the report included biological control with weevils (aquatic insects known to eat EWM), bottom barriers, chemical applications, and hand-removal. Subsequently, bottom barriers were installed in 2002, weevils were stocked in 2004, chemicals were used at DNR access sites, and hand-removal was conducted by some private landowners. In 2012, the HLF purchased a boat with Diver-Assisted Suction Harvesting (DASH) capabilities, and since then that has been the primary method of invasive aquatic plant removal, although chemicals have still been used occasionally.

The first boat wash station was installed at a Higgins Lake boat launch site in 2014, with three of the busiest launches on the lake now having them. Unfortunately, Starry Stonewort, another invasive aquatic plant, was discovered in Higgins Lake in 2018. In 2019, Jermalowicz-Jones found a total of 20 native aquatic plant species in Higgins Lake (2020) and found 21.1 acres of EWM and 2.5 acres of starry stonewort. The report also recommends using the DASH boats to remove invasive aquatic plants from Higgins Lake and only using chemicals if the distribution of the invasive plants exceeds the ability of the DASH crews.

Lake levels have long been a hot topic on Higgins Lake, with an often-heated debate between those who want lower lake levels (typically because their properties are damaged by erosion with higher lake levels), and those who prefer higher lake levels (typically because their properties have extensive shallow shoals, making boat access difficult under lower lake levels). The topic first shows up in MDNR files (Cadillac office) in 1954. That file entry included discussion about high water levels on Higgins Lake creating damage for property owners. In 1982, during the court proceedings regarding the legal lake level for Higgins Lake, MDNR submitted a position statement that recommended upgrading the lake level control facility (since it was in poor condition) and maintaining a minimum flow from the lake so as not to dramatically reduce flows in the Cut River. The Houghton Lake Walleye population is supported entirely by natural reproduction, much of which takes place in the Cut River. Dramatically reducing flows in the Cut River could impact spawning success of Houghton Lake Walleye.

Since 1982, MDNR has repeatedly advocated for maintaining a minimum flow in the Cut River. MDNR Fisheries Biologist Rich O'Neal wrote a letter in January of 2005 to the Roscommon County Board of Commissioners (BOC) discussing lake levels and advocating for robust flows released into the Cut River during the April walleye spawning season. O'Neal wrote another letter in December 2006 to MDEQ (Michigan Department of Environmental Quality, the precursor to the Michigan Department of Environment, Great Lakes, and Energy or EGLE of today) requesting denial of a permit application to alter the dam at the outlet. In September of 2010, O'Neal wrote another letter to the Roscommon County BOC discussing the erosion damage to the lakeshore that was resulting from too-high lake levels.

An engineering report by the Spicer Group (Anonymous 2010) on the Higgins Lake level control structure found that the lake is typically below the legal lake level by late summer. The report states that to be able to meet the legal summer lake level in late summer, the dam operators would have to hold the lake level higher in early summer and not release as much water. The report also mentioned that the 2007 alteration to the dam (the addition of a low flow cut that sends a minimum of 33 cfs downstream) makes it harder to maintain the summer level. The report recommended closing the dam

during summer and filling in the low flow channel. Unfortunately, the report failed to mention the request from MDNR to maintain adequate flows in the Cut River, particularly during the spring Walleye spawning and rearing period.

Swimmer's itch has long been a topic of discussion on Higgins Lake. Swimmer's itch (also known as cercarial dermatitis) is a skin rash that is caused by microscopic parasites that are released from snails as part of their life cycle. Another part of the life cycle involves waterfowl. Over the years, complaints from lake users led to a number of different attempts at solving the problem. In particular, large amounts of copper sulfate were dumped into Higgins Lake to supposedly kill the host snails. Unfortunately, this was not effective, and studies have shown that copper sulfate can have long-term negative effects on the invertebrate populations of inland lakes (Wisconsin Department of Natural Resources 2012; Warnick and Bell 1969). Correspondence from 1995 (MDNR files, Cadillac office) discusses the work of Dr. Harvey Blankespoor from Hope College. Dr. Blankespoor identified common mergansers as being the primary waterfowl host on Higgins Lake, and efforts were undertaken to discourage them from mating and developing broods on the lake. However, the problem persisted for many years. In the early 2010s, a non-profit group called the Higgins Lake Swimmer's Itch Organization (HLSIO) was formed. The group worked with a company called Swimmer's Itch Solutions to relocate common merganser broods off Higgins Lake. This strategy has been very successful, and since 2015, complaints of swimmer's itch have fallen to very low levels (Blankespoor and DeJong 2020).

Historical Fisheries Surveys

The first fisheries survey of Higgins Lake was conducted by the MDOC in 1935. The survey was conducted with seines, and a total of 16 species were caught (Table 3). More seining was conducted by MDOC in 1938 and 1941. In the winter of 1936-1937, the lake was mapped by MDOC personnel from the Institute for Fisheries Research. Further seining was conducted in in August 1939 (Moffett and Brown 1940), in addition to the first gill net and fyke net survey of Higgins Lake. A total of 18 species were caught, although some were identified with names that are unknown today. In the report, Moffett and Brown mention that Higgins Lake "has never had much of a reputation for fishing", and that the Yellow Perch and Northern Pike populations were "in decline". The authors recommended managing Higgins Lake for Lake Trout and increasing the stocking accordingly.

A creel census study was conducted on Higgins Lake during the winter of 1935-36 (Eschmeyer 1936). Only six species were recorded in the survey, including Yellow Perch, "Grass Pike" (likely Northern Pike), Bullhead, Lake Whitefish, White Sucker, and Cisco. The vast majority of the fish caught in the survey were Yellow Perch. Another gill net survey was conducted in the fall of 1943, with eight species recorded (Table 3). Late-fall gill net efforts were conducted in 1952 and 1954. While no reports were produced for these efforts, it is believed that that they were attempts to gather ripe Lake Trout for egg-take purposes (MDNR files, Cadillac office).

After that, no fisheries surveys were conducted on Higgins Lake until a comprehensive survey was conducted in the fall of 1987 by MDNR. The notes for that survey indicate that the survey was conducted in preparation for a Status of the Fishery Report, but it does not appear that one was ever written. A total of 13 species were caught in the survey (Table 3), which consisted of fyke nets, trap nets, and gill nets (both experimental and straight run with 1.5-inch mesh). The 1987 survey

represented the only time that Atlantic Salmon were caught in an MDNR fisheries survey of Higgins Lake.

Another fisheries survey of Higgins Lake was conducted by MDNR in the fall of 1997 (O'Neal 2001). The survey was conducted in similar fashion to the 1987 survey. By this time, combined stocking rates for salmonids in Higgins Lake had crept up to over 100,000 per year (over 11/acre). Due to decreased catch rates for Lake Trout and Brown Trout and reduced growth rates in several species in the 1997 survey, O'Neal recommended a reduction in salmonid stocking to conserve the available forage base. He recommended a combined salmonid stocking rate of no more than 75,000 per year (approximately 8/acre). O'Neal also mentioned that angler reports from this period regarding the Rainbow Smelt fishery indicated a poor fishery in the winter of 1998, but then good recovery in 2000 and 2001.

Creel surveys of Higgins Lake were conducted by MDNR in the summer of 2001 and the winter of 2002 (O'Neal 2008). In the two surveys, a total of 250,962 angler hours were generated. Nearly 700,000 fish were harvested, with the majority of those being Yellow Perch and Rainbow Smelt. Harvest was much higher in the winter. Other common species that were caught by anglers surveyed included Rainbow Trout, Brown Trout, Lake Trout, Lake Whitefish, Northern Pike, Rock Bass, Smallmouth Bass, and White Sucker. Species such as Splake, Cisco, Pumpkinseed, and Largemouth Bass were represented in the creel survey, but in very low numbers. O'Neal estimated the economic value of the Higgins Lake fishery to be worth at least $1.6 million annually to the local economy.

Another comprehensive fisheries survey was conducted by MDNR in the fall of 2011 and the summer of 2012. Netting was conducted in September and late October/early November, including trap nets, minnow seines, inland gill nets, and Great Lakes gill nets. The 2012 portion of the survey only included electrofishing, which was conducted in July. In the 2011 netting survey, a total of 3,911 fish were caught, representing 18 species (Tables 4 and 5). Another 177 fish representing 9 species were caught in the 2012 electrofishing portion of the survey (Table 6). Age and growth analysis was conducted on all gamefish collected in the netting portions of the survey (Tables 7 and 8).

Current Status

The most recent fisheries survey of Higgins Lake was conducted in the fall of 2020. The target species for the survey were Lake Trout and Lake Whitefish. Species such as Yellow Perch and Rock Bass were specifically not targeted. This was accomplished by selecting sampling gear that does not target smaller species, including Great Lakes gill nets and straight-run gill nets with mesh sizes of 2.5, 4.0, and 5.0 inches. The survey was conducted in two periods, from September 21-24 and October 26-29. A total of 398 fish were caught, representing 13 species (Tables 3, 9, and 10). Age and growth analysis was conducted on gamefish species caught in the 2020 surveys (Tables 11 and 12). A total of 79 Lake Trout were caught in the 2020 survey, ranging from 8 to 33 inches, and representing 12 different age classes. The Lake Trout caught in September were growing 4.1 inches above the state average, while those caught in October were growing 3.5 inches above the state average. A total of 22 Lake Whitefish were caught in the 2020 survey, ranging from 21 to 25 inches in length, and representing 17 different age classes. Not enough Lake Whitefish from any one age class were caught to make statistical inferences regarding growth rates compared to the state average.

Analysis and Discussion

The 2020 MDNR fisheries survey of Higgins Lake should be viewed as a success, as it provided current information on the population levels of Lake Trout and Lake Whitefish in particular. The Lake Trout population of Higgins Lake remains robust, with individuals from many different year classes present in the catch. Since natural reproduction likely does not contribute much to the overall Lake Trout population of Higgins Lake, the 2020 survey provided evidence that the stocked Lake Trout are surviving and growing well in Higgins Lake. Catch per unit effort (CPUE) levels were somewhat lower for Lake Trout in Great Lakes gill nets in 2020 when compared to 2011 (Table 13), although fewer Great Lakes gill net lifts were conducted in 2020. Regardless, angler reports regarding the Lake Trout fishery on Higgins Lake remain highly positive.

Conversely, the Lake Whitefish population seems to have declined since the 2011 survey. Lake Whitefish CPUE levels for Great Lakes gill nets were substantially lower than in 2011. Also, younger age classes were much better represented in the 2011 survey than in the 2020 survey. This corresponds with recent angler reports that smaller, younger Lake Whitefish have been absent from the sport catch. While not conclusive, the 2020 survey data may indicate that Lake Whitefish have not been overly successful in reproducing in recent years. Angler harvest also may play a role. As early as the 1970s, MDNR Biologists expressed concern over possible overharvest of Lake Whitefish from Higgins Lake. The winter 2002 creel census had an estimated harvest of 1,147 Lake Whitefish (O'Neal 2008). Also, in the 2000s and 2010s, social media reports with pictures showed large angler harvests of Lake Whitefish from Higgins Lake through the ice, with professional fishing guides playing at least a partial role in the heavy take of Lake Whitefish.

Other popular species like Yellow Perch, Rock Bass, and Rainbow Smelt were not targeted in the 2020 survey. The 2011 survey showed a robust catch of Yellow Perch, although most were smaller than 7 inches. Angler reports continue to tell of good fishing for Rainbow Smelt on Higgins Lake, and of numerous Yellow Perch. While many angler reports tell of small Yellow Perch, there continue to be occasional reports of limit catches of Yellow Perch up to 12 inches in length.

Only a few Rainbow and Brown Trout were caught in either the 2011 or 2020 surveys. Historically it has been difficult to consistently catch these species with any kind of traditional fisheries survey gear. Creel surveys and angler reports have always been a much better indicator of survival and contribution to the fishery of these species to the Higgins Lake fishery.

Although they were not specifically targeted, other gamefish species like Northern Pike and Smallmouth Bass were present in the catch of both the 2011 and 2020 surveys. While the catch for these species was not overly numerous for either species, some large individuals were caught. This echoes the reports received by anglers regarding these species. While no Walleye were caught in the 2011 survey, several were caught in the 2020 survey. There have been sporadic reports of Walleye in Higgins Lake over the past century, including some very large individuals.

Cisco (also known as Lake Herring) are classified as a State-Threatened species in Michigan (Latta 1995). They are a native species in Higgins Lake and have been caught in most historical fisheries surveys of Higgins Lake (Table 3). In the 2020 survey, a total of 30 Cisco were caught, ranging from 8 to 9 inches in length, and representing four different year classes (Tables 10 and 11). Most of those were caught in Great Lakes gill nets (Table 13).

Management Direction

Higgins Lake has a long, successful history of popular salmonid fisheries being supported by stocking (Table 1). Over the years, Lake Trout have been by far the most popular stocked salmonid, and have created an outstanding fishery for anglers, including both open-water and ice fishing opportunities. Large numbers of Lake Trout were caught in both the 2011 and 2020 surveys, and growth rates were well above the state average in both surveys (Tables 7-8 and 11-12). While it is possible that some Lake Trout natural reproduction occurs at a low level in Higgins Lake, it would not be nearly enough to support the level of fishery desired by Higgins Lake anglers. Therefore, yearling Lake Trout should continue to be stocked into Higgins Lake on an annual basis.

Rainbow and Brown Trout have also been stocked into Higgins Lake on a regular basis, although Brown Trout were not stocked from 2012-2017. At the request of Higgins Lake anglers, they were stocked again in 2018 and have been stocked annually since then. Since Rainbow and Brown Trout are very difficult to catch in fisheries surveys, we have requested that anglers notify us and send pictures when they catch Rainbow and Brown Trout from Higgins Lake. This has been successful- since 2018 we have received many positive reports and pictures from anglers regarding their catches of Rainbow and Brown Trout (MDNR files, Cadillac office). While reports of Rainbow Trout are more numerous, Brown Trout are also being caught and are contributing to the fishery. Therefore, the stocking of yearling Rainbow and Brown Trout into Higgins Lake should continue on an annual basis.

O'Neal (2001) recommended keeping overall yearling salmonid stocking rates below 8/acre on Higgins Lake. In recent years, the prescribed total yearling salmonid stocking rate for Higgins Lake has been 8.9/acre, including 40,000 Lake Trout, 25,000 Rainbow Trout and 25,000 Brown Trout. Growth rates (at least for Lake Trout) have continued to be good, so this stocking strategy should be continued. These recommendations and stocking rates are very similar to those for other large oligotrophic lakes in the northern Lower Peninsula of Michigan, including Crystal Lake in Benzie County (Tonello 2015) and Glen Lake in Leelanau County (Seites et al. 2010). Occasional stockings of surplus fall fingerling salmonids from Michigan hatcheries have also been conducted, but survival of these fish is likely low.

Walleye remain present but rare in Higgins Lake. While some anglers have requested that Walleye be stocked into Higgins Lake, we disagree. It is very difficult to manage both Walleye and salmonids in the same lake since Walleye are known to be highly effective predators on stocked salmonids (particularly Rainbow and/or Brown Trout). Higgins Lake provides a unique salmonid fishery for the region, which would be threatened by stocked Walleye. An excellent option for Walleye anglers already exists on Houghton Lake only a few miles south of Higgins Lake. Therefore, Walleye should not be stocked into Higgins Lake.

The fisheries for Yellow Perch and Rainbow Smelt should continue to provide excellent angling opportunities on Higgins Lake. Previous creel census studies have shown that the Yellow Perch and Rainbow Smelt fisheries are extremely popular and generate most of the angler hours accrued on Higgins Lake, particularly for ice anglers in the winter. These fisheries have been somewhat cyclic in nature, with some years being better than others. While it is possible that competition exists between the two species, there are no direct management techniques that can affect these species, other than limiting predator stocking levels so that Rainbow Smelt are not overcropped. In some years, anglers observe smaller catches of Rainbow Smelt or fewer "keeper" sized Yellow Perch (typically over 7

inches). Observations of small Yellow Perch in Higgins Lake date back nearly 100 years (MDNR files, Cadillac office), and this likely will not change in the future. Fortunately, these species are expected to persist in Higgins Lake for many years, and they should provide good fishing opportunities in most years.

Other Higgins Lake native species, including Rock Bass, Smallmouth Bass, and Northern Pike, should continue to provide good fishing for many years. Rock Bass are abundant in Higgins Lake and typically reach the larger sizes preferred by anglers. They can provide an excellent alternative for anglers if "keeper" sized Yellow Perch cannot be found. Smallmouth Bass are an under-utilized resource on Higgins Lake. Several tournaments targeting Smallmouth Bass are held on Higgins Lake each year, with numerous fish over 4 lbs. reported being caught in those tournaments. While Northern Pike are not abundant in Higgins Lake, they do reach very large sizes, and Higgins Lake is known as one of the best lakes in the Lower Peninsula of Michigan for catching or spearing large Northern Pike over 40 inches. If the Northern Pike population of Higgins Lake were to expand, this could create issues for the stocked Rainbow and Brown Trout fisheries, since Northern Pike are known to prey heavily on them.

While the 2020 survey results seemed to indicate a decline in the Lake Whitefish population of Higgins Lake, the survey was limited in nature. However, angler reports in recent years have also told of a decline in the Lake Whitefish fishery on Higgins Lake. For many years prior to 2020, the daily harvest limit for Lake Whitefish (in combination with Cisco) was 12. In 2020, MDNR reduced the harvest limit for Lake Whitefish (in combination with Cisco) to 5 per day on inland lakes. While this was no doubt a positive step, whether it is enough to have any impact remains to be seen. Angler reports from the last few years indicate that catching even a few Lake Whitefish on any given day has become rare, let alone a limit of 5. Further study of the Lake Whitefish population of Higgins Lake would be difficult and require a large amount of effort to catch enough to make strong conclusions. It is possible that lower catch rates will lead to lower angler effort targeting Lake Whitefish and therefore lower harvest levels. This may allow Lake Whitefish population levels to recover, as long as natural reproduction continues to occur. Voluntary reduced harvest by anglers could also help the population recover.

We recognize the concerns of both those landowners who struggle with erosion and property damage during periods of higher water levels, and those landowners with extensive, shallow shoals who struggle to access the lake during periods of lower water levels. From a lake ecosystem perspective, Layman's model of Higgins Lake water levels (2015) did not predict significant changes to submerged aquatic vegetation distribution for any of the lake level management scenarios that were being discussed at the time. He also stated that any potential changes would likely be insufficient to produce measurable changes in the fisheries habitat of Higgins Lake. Wiley and Layman (2016) suggest maintaining flows of at least 50 cfs through the dam to protect fish populations in the Cut River. They also suggested that during the critical spring Walleye spawning time, flows of 100-150 cfs should be maintained to ensure that walleye spawning, and hatching can be successfully completed. O'Neal (2017) also recommended maintaining flows of at least 50 cfs through the dam to protect fisheries in the Cut River. This will require leaving at least some gates open all the time. We continue to advocate for this. The Cut River provides critical habitat for Walleye on their annual spawning run from Houghton Lake. The Houghton Lake Walleye population is dependent on natural reproduction, and the

Cut River has been shown to be a critical source of naturally reproduced Walleye. Cutting off all or even most of the flow to the Cut River should not be permitted by EGLE.

We commend the Higgins Lake community for moving away from copper sulfate for the treatment of swimmer's itch. This strategy has never been successful on Higgins Lake. Instead, it is likely harmful to the invertebrate population, and therefore the ecosystem and food chain of Higgins Lake. We support the current strategy of relocating broods of common mergansers off the lake in the summer. This strategy seems to have been successful in the last few years while not doing any overall harm to the Higgins Lake ecosystem. The mergansers that are removed from Higgins Lake are relocated to Lake Huron, so the effect on Michigan merganser populations is negligible.

Nutrient enrichment has been a very hot topic among the Higgins Lake community in recent years, although it has been a documented, ongoing problem for decades (King et al. 1991; Minnerick 2001; Martin et al. 2014; Jermalowicz-Jones 2020). There is no doubt that nutrient enrichment of Higgins Lake is occurring, and that a significant amount of the nutrients come from septic system effluent leaching into the lake through the groundwater. If the nutrient enrichment continues at this pace, much of the deeper areas of the lake will become hypoxic, and therefore unusable for fishes. In other words, within a few decades, it could become impossible for species like Lake Trout, Rainbow Trout, Brown Trout, Lake Whitefish, Rainbow Smelt, and Cisco to thrive or perhaps even survive, in the deeper parts of Higgins Lake (Dr. Mark Luttenton, Grand Valley State University, personal communication). In addition, algal blooms could continue to get worse in Higgins Lake, potentially including blooms that are toxic to humans and their pets. The warmer water temperatures seen in recent years (attributed to climate change) may also serve to exacerbate algae bloom issues. Jermalowicz-Jones recommended the installation of a lake-wide sewer system to reduce nutrient inputs into the lake (2020). We agree with that recommendation, and therefore, we wholeheartedly support the efforts of the Gerrish Lyon Utility Authority (GLUA) to install a sanitary sewer system in the Higgins Lake watershed. If this effort is not successful, we will also support any other efforts to keep nutrients from human waste out of Higgins Lake.

We commend the Higgins Lake community for the use of DASH to control aquatic invasive plants in Higgins Lake. While chemical treatments of invasives may be necessary at times, these should only be conducted when EWM or Starry Stonewort levels exceed the capabilities of DASH.

Improved shoreline management would benefit the fish populations and the overall ecosystem of Higgins Lake. Seawalls, developed shorelines, and manicured lawns do not provide the appropriate habitat for the Higgins Lake ecosystem. The Michigan Natural Shoreline Partnership, an organization dedicated to promoting natural shoreline landscaping to protect Michigan's inland lakes (http://www.mishorelinepartnership.org/), can provide guidance and training on how best to manage the land/water interface for the benefit of Higgins Lake. Also, downed trees in the shallows of the lake provide excellent habitat for Rock Bass, Smallmouth Bass, and Yellow Perch. Any trees that fall into the lake should be left alone as fisheries habitat. In addition, trees could be intentionally placed in appropriate shallow water areas of Higgins Lake to provide cover and habitat for desirable fish species.

If future fisheries surveys are scheduled for Higgins Lake, survey goals should determine the techniques and gear to be used. For example, straight run and Great Lakes gill nets should be used to scrutinize Lake Trout and Lake Whitefish populations. For Yellow Perch and Rock Bass, inland gill

nets with graded mesh should be used. For surveys targeting Cisco, monofilament straight-run vertical gill nets should be utilized (Mike Wilson, MDNR, personal communication). If those are not available, then Great Lakes gill nets would be the best alternative. For nearshore and non-game species, shore nets like trap nets, fyke nets, and seines could be used, along with electrofishing. Creel surveys are also important tools for fisheries management of heavily fished lakes like Higgins. Since the last creel census study was conducted more than 20 years ago, a modern creel census study would provide information on the amount of angling effort that currently takes place on Higgins Lake and the survival and contribution of stocked fish to the fishery. The angler effort data provided by a creel survey would also allow for calculation of the current economic benefit that the Higgins Lake fishery provides to the local economy.

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Table 1. Fish stocked in Higgins Lake, Crawford and Roscommon Counties, 1874-2021.

Year	Species	Number	Size	Strain
1874	Atlantic Salmon	7,000	fry	Penobscot
1879	Lake Whitefish	200,000	fry	Detroit River
1880	Atlantic Salmon	20,000	fry	Landlocked
1902	Lake Trout	50,000		
1903	Lake Trout	50,000		
1905	Rainbow Trout	3,000	fry	
1909	Walleye	400,000	fry	
1911	Lake Trout	40,000	fry	
	Largemouth Bass	9,400	fingerlings	
1912	Largemouth Bass	5,000	fingerlings	
1913	Bluegill	6,000	fingerlings and yearlings	
	Largemouth Bass	1,200	fingerlings	
	Walleye	150,000	fry	
1914	Lake Trout	20,000	fry	
	Largemouth Bass	12,000	fingerlings	
	Walleye	120,000	fry	
	Yellow Perch	5,000	fingerlings	
1919	Smallmouth Bass	700		
1920	Smallmouth Bass	12,000		
	Walleye	180,000	fry	
1921	Smallmouth Bass	3,500		
1923	Smallmouth Bass	1,500		
1926	Arctic Grayling	unknown	fry	
1927	Arctic Grayling	unknown	fry	
	Lake Whitefish	750,000	fry	
1928	Arctic Grayling	unknown	fry	
1934	Rainbow Trout	750	6 mo.	
	Yellow Perch	50,000	7 mo.	
	Walleye	2,100,00	fry	
1935	Rainbow Trout	6,600	4 mo.	
	Yellow Perch	60,000	7 mo.	
	Walleye	900,000	fry	
1936	Yellow Perch	30,000	9 mo.	
	Walleye	1,000,000	fry	
1937	Rainbow Trout	9,000	3 mo.	
	Yellow Perch	20,000	7 mo.	
	Walleye	2,000,000	fry	
1938	Largemouth Bass	400	5 mo.	
	Yellow Perch	60,000	6 mo.	
	Walleye	2,000,000	fry	
1939	Bluegill	3,000	4 mo.	
	Yellow Perch	477,000	7 mo.	
	Walleye	2,400,000	fry	
1940	Bluegill	9,440	3 mo.	
	Yellow Perch	60,000	7 mo.	

Table 1. Cont.

1941	Lake Trout	4,165	adults
	Rainbow Trout	2,480	yearlings
	Yellow Perch	2,000	7 mo.
1943	Rainbow Trout	5,000	yearlings
1944	Rainbow Trout	5,050	yearlings
	Smallmouth Bass	800	fingerlings and yearlings
1945	Rainbow Trout	5,000	yearlings
1946	Lake Trout	4,000	yearlings
1947	Lake Trout	8,000	yearlings
1948	Lake Trout	3,600	yearlings
1949	Lake Trout	8,000	yearlings
1950	Lake Trout	10,300	yearlings
	Rainbow Trout	3,500	3 inch
1951	Lake Trout	10,000	yearlings
	Rainbow Trout	35,000	spring fingerlings
1952	Lake Trout	10,000	fingerlings, yearlings
	Rainbow Trout	100,000	spring fingerlings
1953	Lake Trout	10,000	yearlings
	Rainbow Trout	10,000	yearlings
1954	Lake Trout	10,000	yearlings
	Rainbow Trout	10,000	yearlings
1955	Lake Trout	10,000	yearlings
	Rainbow Trout	10,000	yearlings
1956	Lake Trout	10,000	yearlings
	Lake Trout	20,000	sublegal
	Rainbow Trout	10,000	yearlings
1957	Lake Trout	10,000	yearlings
	Rainbow Trout	10,000	yearlings
	Rainbow Trout	20,000	sublegal
	Rainbow Trout	70,000	fingerlings
1958	Lake Trout	13,000	yearlings
	Rainbow Trout	27,501	sublegal
1959	Lake Trout	15,000	yearlings
	Rainbow Trout	5,000	yearlings
1960	Lake Trout	5,000	yearlings
	Lake Trout	9,000	sublegal
	Rainbow Trout	15,000	yearlings
1961	Rainbow Trout	10,000	yearlings
	Lake Trout	5,000	yearlings
	Lake Trout	5,000	sublegal
1962	Lake Trout	10,000	yearlings
	Rainbow Trout	10,000	yearlings
1963	Lake Trout	9,310	yearlings
	Rainbow Trout	10,000	yearlings
1964	Lake Trout	10,441	yearlings
	Rainbow Trout	10,750	yearlings

Table 1. Cont.

1965	Kokanee Salmon	717,740	fingerlings	
	Lake Trout	12,000	Fingerlings	
	Lake Trout	18,151	yearlings	
	Rainbow Trout	20,000	fingerlings	
1966	Kokanee Salmon	466,276	spring fingerlings	
	Lake Trout	709	adults	
	Splake	92,720	fall fingerlings	
1967	Kokanee Salmon	722,800	spring fingerlings	
1968	Splake	99,550	yearlings	
1969	Splake	54,000	yearlings	
1970	Kokanee Salmon	36,624	spring fingerlings	
	Rainbow Trout	20,001	yearlings	
	Splake	51,492	yearlings	
1971	Lake Trout	10,360	yearlings	
	Rainbow Trout	25,000	yearlings	
	Rainbow Trout	25,000	fall fingerlings	
	Splake	101,160	yearlings	
1972	Lake Trout	20,000	yearlings	
	Splake	50,200	yearlings	
1973	Lake Trout	25,000	yearlings	
	Lake Trout	130	fingerlings	
	Rainbow Trout	24,830	yearlings	
	Rainbow Trout	13,630	fingerlings	Steel-MI
	Splake	22,000	yearlings	
1974	Brown Trout	35,636	yearlings	
	Lake Trout	45,000	yearlings	
	Splake	25,000	yearlings	
1975	Brown Trout	25,019	yearlings	
	Lake Trout	50,000	yearlings	
	Splake	50,000	fall fingerlings	
1976	Brown Trout	24,008	yearlings	
	Lake Trout	50,000	yearlings	
	Splake	27,796	yearlings	
1977	Brown Trout	25,000	yearlings	
	Lake Trout	25,000	yearlings	
	Splake	30,000	yearlings	
1978	Brown Trout	25,000	yearlings	
	Lake Trout	35,000	yearlings	
1979	Brown Trout	17,000	yearlings	
	Lake Trout	50,000	yearlings	
1980	Brown Trout	25,000	yearlings	Harrietta
	Lake Trout	50,000	yearlings	Marquette
1981	Brown Trout	25,000	yearlings	
	Lake Trout	25,000	yearlings	
	Splake	22,000	yearlings	

Table 1. Cont.

1982	Atlantic Salmon	1,629	yearlings	Landlocked
	Brown Trout	20,000	Yearlings	Harrietta
	Lake Trout	25,000	yearlings	
	Splake	25,000	yearlings	
1983	Brown Trout	26,900	yearlings	Harrietta
	Lake Trout	25,000	yearlings	Marquette
	Splake	25,000	yearlings	
1984	Brown Trout	25,000	yearlings	Harrietta
	Brown Trout	25,000	fall fingerlings	Plymouth Rock
	Lake Trout	100,000	fall fingerlings	Marquette
	Lake Trout	798	adults	Marquette
	Splake	25,000	yearlings	
1985	Brown Trout	20,330	yearlings	Harrietta
	Lake Trout	25,000	yearlings	
	Splake	25,000	fall fingerlings	
	Splake	25,000	yearlings	
1986	Atlantic Salmon	25,000	fall fingerlings	Landlocked
	Brown Trout	25,000	yearlings	Plymouth Rock, Wild Rose
	Rainbow Trout	8,000	yearlings	Shasta
	Splake	23,400	yearlings	
1987	Brown Trout	23,274	yearlings	Plymouth Rock
	Lake Trout	1,550	adults	
	Lake Trout	20,330	yearlings	
	Splake	34,975	yearlings	
1988	Brown Trout	35,010	yearlings	Plymouth Rock
	Lake Trout	150,000	spring fingerlings	Marquette
	Rainbow Trout	17,651	yearlings	Eagle Lake
	Splake	23,000	yearlings	
1989	Brown Trout	35,000	yearlings	Plymouth Rock
	Lake Trout	600	yearlings	
	Rainbow Trout	58,678	yearlings	Shasta
	Rainbow Trout	25,051	fall fingerlings	Arlee
1990	Atlantic Salmon	20,007	yearlings	Landlocked
	Atlantic Salmon	20,000	fall fingerlings	Penobscot
	Brown Trout	10,000	yearlings	Plymouth Rock
	Lake Trout	29,500	yearlings	Marquette
	Rainbow Trout	10,000	yearlings	Eagle Lake
	Splake	30,000	yearlings	
1991	Brown Trout	49,395	yearlings	Seeforellen
	Brown Trout	15,605	yearlings	Plymouth Rock
	Rainbow Trout	33,000	yearlings	Arlee
1992	Brown Trout	6,347	yearlings	Soda Lake
	Brown Trout	27,952	yearlings	Wild Rose
	Lake Trout	34,900	yearlings	Lake Superior
	Rainbow Trout	150	adults	
	Rainbow Trout	10,000	yearlings	

Table 1. Cont.

1993	Brown Trout	34,700	yearlings	Wild Rose
	Lake Trout	34,900	Yearlings	Marquette
	Rainbow Trout	10,000	yearlings	Eagle Lake
1994	Lake Trout	27,200	yearlings	Marquette
	Rainbow Trout	10,000	yearlings	Eagle Lake
	Splake	19,994	yearlings	
1995	Brown Trout	17,493	yearlings	Seeforellen
	Brown Trout	17,488	yearlings	Wild Rose
	Rainbow Trout	34,980	yearlings	Eagle Lake
	Rainbow Trout	81,644	fall fingerlings	Steel-MI
1996	Brown Trout	16,624	yearlings	Seeforellen
	Brown Trout	17,497	yearlings	Wild Rose
	Brown Trout	58,769	fall fingerlings	Wild Rose
	Lake Trout	35,000	yearlings	Marquette
	Rainbow Trout	17,494	yearlings	Gerrard Kamloops
	Rainbow Trout	17,500	yearlings	Eagle Lake
	Rainbow Trout	47,500	fall fingerlings	Steel-Ska
1997	Brown Trout	16,134	yearlings	Seeforellen
	Brown Trout	7,495	yearlings	Wild Rose
	Lake Trout	4,832	yearlings	Isle Royale
	Lake Trout	23,616	yearlings	Marquette
	Rainbow Trout	34,979	yearlings	Eagle Lake
	Rainbow Trout	104,000	fall fingerlings	Eagle Lake
1998	Brown Trout	16,400	yearlings	Seeforellen
	Brown Trout	17,000	yearlings	Wild Rose
	Brown Trout	22,342	fall fingerlings	Seeforellen
	Lake Trout	34,500	yearlings	Marquette
	Rainbow Trout	34,455	yearlings	Eagle Lake
	Rainbow Trout	150	adults	
1999	Brown Trout	24,980	yearlings	Seeforellen
	Lake Trout	35,000	yearlings	Marquette
	Rainbow Trout	34,780	yearlings	Eagle Lake
2000	Brown Trout	17,500	yearlings	Seeforellen
	Brown Trout	17,500	yearlings	Wild Rose
	Lake Trout	30,402	yearlings	Marquette
	Rainbow Trout	34,905	yearlings	Eagle Lake
2001	Brown Trout	17,500	yearlings	Seeforellen
	Brown Trout	17,500	yearlings	Wild Rose
	Lake Trout	35,000	yearlings	Marquette
	Rainbow Trout	30,550	yearlings	Eagle Lake
2002	Brown Trout	14,973	yearlings	Wild Rose
	Lake Trout	35,000	yearlings	Marquette
	Rainbow Trout	25,000	yearlings	Eagle Lake
2003	Brown Trout	15,000	yearlings	Wild Rose
	Lake Trout	35,000	yearlings	Marquette
	Rainbow Trout	25,001	yearlings	Eagle Lake

Table 1. Cont.

2004	Brown Trout	15,000	yearlings	Wild Rose
	Lake Trout	35,001	Yearlings	Marquette
	Rainbow Trout	23,750	yearlings	Eagle Lake
	Rainbow Trout	3,186	adults	Eagle Lake
2005	Brown Trout	15,000	yearlings	Wild Rose
	Lake Trout	35,001	yearlings	Marquette
	Rainbow Trout	27,500	yearlings	Eagle Lake
2006	Brown Trout	15,009	yearlings	Wild Rose
	Lake Trout	35,000	yearlings	Marquette
	Lake Trout	1,400	adults	Lake Superior
	Rainbow Trout	26,800	yearlings	Eagle Lake
2007	Brown Trout	13,630	yearlings	Wild Rose
	Lake Trout	31,626	yearlings	Marquette
	Rainbow Trout	25,000	yearlings	Eagle Lake
2008	Brown Trout	15,000	yearlings	Gilchrist Creek
	Lake Trout	35,000	yearlings	Lewis Lake
	Rainbow Trout	27,400	yearlings	Eagle Lake
2009	Lake Trout	49,470	yearlings	Lewis Lake
	Rainbow Trout	32,300	yearlings	Eagle Lake
2010	Brown Trout	12,008	yearlings	Sturgeon River
	Lake Trout	32,093	yearlings	Lake Superior
	Rainbow Trout	25,528	yearlings	Eagle Lake
2011	Brown Trout	15,000	yearlings	Sturgeon River
	Lake Trout	35,650	yearlings	Lake Superior
	Rainbow Trout	17,267	yearlings	Eagle Lake
2012	Lake Trout	40,000	yearlings	Lake Superior
	Rainbow Trout	30,000	yearlings	Eagle Lake
2013	Lake Trout	29,624	yearlings	Lake Superior
	Lake Trout	15,376	yearlings	Seneca Lake
	Rainbow Trout	30,498	yearlings	Eagle Lake
2014	Lake Trout	39,388	yearlings	Lake Superior
	Rainbow Trout	31,000	yearlings	Eagle Lake
2015	Lake Trout	31,300	yearlings	Lake Superior
	Rainbow Trout	31,000	yearlings	Eagle Lake
2016	Lake Trout	35,944	yearlings	Lake Superior
	Rainbow Trout	30,000	yearlings	Eagle Lake
2017	Lake Trout	40,158	yearlings	Lake Superior
	Rainbow Trout	40,377	yearlings	Eagle Lake
2018	Brown Trout	25,000	yearlings	Wild Rose
	Lake Trout	40,500	yearlings	Seneca Lake
	Rainbow Trout	30,000	yearlings	Eagle Lake
	Rainbow Trout	30,000	fall fingerlings	Eagle Lake
2019	Brown Trout	35,000	yearlings	Wild Rose
	Lake Trout	31,973	yearlings	Lake Superior
	Rainbow Trout	27,500	yearlings	Eagle Lake

Table 1. Cont.

2020	Brown Trout	26,180	yearlings	Wild Rose
	Brown Trout	844	Adults	Sturgeon River
	Brown Trout	440	adults	Wild Rose
	Lake Trout	34,755	yearlings	Lake Superior
	Rainbow Trout	24,100	yearlings	Eagle Lake
	Rainbow Trout	1,200	adults	Eagle Lake
2021	Brown Trout	25,000	yearlings	Wild Rose
	Lake Trout	11,867	yearlings	Lake Superior
	Lake Trout	55,150	fall fingerlings	Seneca Lake
	Rainbow Trout	25,000	yearlings	Eagle Lake

Table 2. Michigan DNR Master Angler awards issued for fish caught from Higgins Lake, Crawford and Roscommon Counties, Michigan, 1994-2020.

Species	Number of Master Angler awards issued
Rock Bass	112
Lake Trout	75
Lake Whitefish	52
Northern Pike	28
Smallmouth Bass	12
Brown Trout	10
Yellow Perch	6
White Sucker	5
Bowfin	3
Lake Herring	3
Rainbow Smelt	3
Bluegill	1
Largemouth Bass	1
Splake	1
Total:	312

Table 3. Presence/absence of fish species in historical fisheries surveys of Higgins Lake, Crawford and Roscommon Counties.

Species	1935	1938	1939	1941	1943	1952	1954	1987	1993	1995	1997	2011	2012	2020
Atlantic Salmon								x						
Black Bullhead												x		
Black Crappie												x		
Bluntnose Minnow	x	x	x	x									x	
Bowfin					x		x				x	x		
Brook Stickleback			x											
Brook Trout	x													
Brown Trout								x	x		x			x
Cisco			x		x	x		x	x		x	x		x
Common Carp											x			
Common Shiner	x		x	x										
Emerald Shiner	x							x						
Golden Shiner				x										
Green Sunfish												x		
Johnny Darter	x	x	x									x	x	
Lake Trout					x	x	x	x	x	x	x	x		x
Lake Whitefish			x		x	x	x	x	x	x	x	x		x
Largemouth Bass											x	x		
Long Eared Sunfish				x										
Mimic Shiner	x	x	x										x	
Northern Dace*	x													
Northern Redfin Shiner			x											
Northern Pike						x	x	x	x	x	x	x		x
Pumpkinseed											x	x	x	x
Rainbow Smelt								x				x		x
Rainbow Trout	x						x			x	x	x		x
Rock Bass	x		x		x		x	x	x		x	x	x	x
Rosyface Shiner	x		x	x										
Sand Shiner													x	
Satin-fin Minnow*	x													
Sculpin spp.	x													
Smallmouth Bass		x	x			x	x	x			x	x	x	x
Splake								x						
Spotfin Shiner			x	x										
Spottail Shiner	x	x	x	x								x	x	
Steel-Colored Shiner*		x	x											
Straw-colored Shiner*	x	x	x	x										
Walleye			x		x	x				x				x
White Sucker	x		x		x	x	x	x		x	x	x		x
Yellow Bullhead							x							
Yellow Perch	x	x	x	x	x	x	x	x	x	x	x	x	x	x

*No fish species in Michigan is known by that name today. Exactly what species they were referring to is unknown.

Table 4. Number, weight, and length of fish collected from Higgins Lake with trap nets, minnow seine, inland gillnets, and Great Lakes gillnets, September 12-23 and October 31 to November 3, 2011.

Species	Number	Percent by number	Weight (pounds)	Percent by weight	Length range (inches)[1]	Average length	Percent legal size[2]
Black Crappie	1	0.0	1.1	0.0	12-12	12.5	100 (7")
Black Bullhead	1	0.0	0.9	0.0	12-12	12.5	100 (7")
Bowfin	20	0.5	80.1	3.6	16-28	21.5	
Green Sunfish	1	0.0	0.2	0.0	6-6	6.5	
Johnny Darter	1	0.0	0.0	0.0	1-1	1.5	
Lake Trout	147	3.8	782.1	35.3	7-38	24.3	85 (15")
Lake Herring	11	0.3	5.0	0.2	9-15	11.9	
Largemouth Bass	7	0.2	1.7	0.1	7-8	7.4	0 (14")
Lake Whitefish	122	3.1	463.5	20.9	11-26	20.9	
Northern Pike	23	0.6	165.8	7.5	21-41	30.3	91 (24")
Pumpkinseed	2	0.1	0.1	0.0	3-4	3.5	0 (6")
Rainbow Trout	2	0.1	7.3	0.3	19-23	21.0	100 (15")
Rock Bass	2,274	58.1	342.6	15.5	2-11	6.3	29 (6")
Smallmouth Bass	43	1.1	33.1	1.5	6-17	10.1	21 (14")
Rainbow Smelt	105	2.7	5.0	0.2	5-6	5.5	
Spottail Shiner	19	0.5	0.0	0.0	1-2	1.1	
White Sucker	89	2.3	179.8	8.1	8-21	16.5	
Yellow Perch	1,043	26.7	147.6	6.7	4-12	6.3	(7")
Total	3,911	100	2215.9	100			

[1]Note some fish were measured to 0.1 inch, others to inch group: e.g., "5"=5.0 to 5.9 inch, "12"=12.0 to 12.9 inches; etc.

[2]Percent legal size or acceptable size for angling. Legal size or acceptable size for angling is given in parentheses.

Table 5. Length frequency distribution for fish caught from Higgins Lake with trap nets, minnow seine, inland gillnets, and Great Lakes gillnets, in September and November, 2011.

Inch Class	Black Crappie	Black Bull-head	Bowfin	Cisco	Green Sunfish	Johnny Darter	Lake Trout	Lake White-fish	Large-mouth Bass	Northern Pike	Pumpkin-seed	Rainbow Trout	Rock Bass	Rain-bow Smelt	Small-mouth Bass	Spot-tail Shiner	White Sucker	Yellow Perch
1						1										18		
2													1			1		
3											1		58					
4											1		614					5
5													937	56				120
6					1								436	49	1			663
7							8		4				141		11			146
8							5		3				44		8		1	65
9				1									21		2			11
10				1									16		2		1	21
11				3			2	1					6		6		2	9
12	1	1		3			1	1							3		5	3
13				1			3								1		1	
14							3	2							5		4	
15				2			2	3							1		2	
16			1					1							2		18	
17			1				2	7							1		31	
18			1				2	15									12	
19			4				2	10				1					6	
20			1				8	7									4	
21			4				11	9		1							2	
22			1				10	22										
23			1				9	23		1		1						
24			2				10	13		1								
25							9	7										
26			3				13	1		2								
27							14			1								
28			1				7			4								
29							11			1								
30							8			3								
31							5			2								
32							1											
33										2								
36										1								
37										1								
38							1			1								
40										1								
41										1								
Total	1	1	20	11	1	1	147	122	7	23	2	2	2274	105	43	19	89	1043

Table 6. Number, weight, and length of fish collected from Higgins Lake with electrofishing, July 11, 2012.

Species	Number	Percent by number	Weight (pounds)	Percent by weight	Length range (inches)[1]	Average length	Percent legal size[2]
Bluntnose Minnow	2	1.1	0.0	0.0	2-3	3.0	
Johnny Darter	6	3.4	0.0	0.0	1-1	1.5	
Mimic Shiner	1	0.6	0.0	0.0	2-2	2.5	
Pumpkinseed Sunfish	1	0.6	0.1	1.1	4-4	4.5	0 (6")
Rock Bass	46	26.0	4.1	46.1	2-8	4.8	13 (6")
Sand Shiner	40	22.6	0.2	2.2	1-3	2.6	
Smallmouth Bass	5	2.8	0.4	4.5	4-5	5.3	0 (14")
Spottail Shiner	22	12.4	0.1	1.1	1-3	2.6	
Yellow Perch	54	30.5	4.0	44.9	1-8	4.2	35 (7")
Total	177	100	8.9	100			

[1]Note some fish were measured to 0.1 inch, others to inch group: e.g., "5"=5.0 to 5.9 inch, "12"=12.0 to 12.9 inches; etc.

[2]Percent legal size or acceptable size for angling. Legal size or acceptable size for angling is given in parentheses.

Table 7. Average total weighted length (inches) at age, and growth relative to the state average, for fish sampled from Higgins Lake with trap nets, Great Lakes gillnets, inland gillnets, and seining, September 12-23, 2011. Number of fish aged is given in parenthesis. A minimum of five fish per age group is statistically necessary for calculating a Mean Growth Index, which is a comparison to the State of Michigan average.

	Age													Mean Growth
Species	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	Index
Black Crappie									12.0 (1)					--
Cisco		9.8 (2)	11.5 (2)	12.2 (1)	14.0 (2)	15.4 (1)								--
Lake Trout	7.9 (13)	14.2 (5)	19.4 (17)	23.5 (28)	27.1 (29)	29.5 (14)	31.6 (7)	30.9 (3)		38.5 (1)				+4.6
Lake Whitefish		13.4 (2)	11.3 (1)	18.1 (10)	22.0 (1)	23.5 (1)	24.0 (7)	24.4 (1)						--
Largemouth Bass	7.5 (3)	8.4 (4)												--
Northern Pike		23.3 (1)	25.1 (2)			34.3 (2)	38.3 (1)							--
Pumpkinseed	3.8 (1)	4.1 (1)												--
Rainbow Trout		19.5 (1)	23.5 (1)											--
Rock Bass		3.6 (2)	4.0 (14)	5.1 (6)	6.1 (13)	6.9 (8)	7.4 (7)	9.5 (1)	8.3 (4)	8.9 (7)	10.4 (14)	10.8 (2)	11.0 (1)	-1.7
Rainbow Smelt	5.6 (17)	6.1 (10)												-0.3
Smallmouth Bass	7.4 (11)	8.2 (11)	11.1 (8)	14.1 (10)	16.0 (1)		17.2 (1)							-0.6
Yellow Perch			5.8 (10)	6.9 (19)	8.3 (16)	10.0 (15)	10.9 (2)	12.0 (3)						-0.9

Table 8. Average total weighted length (inches) at age, and growth relative to the state average, for fish sampled from Higgins Lake with Great Lakes gillnets, October 31-November 3, 2011. Number of fish aged is given in parenthesis. A minimum of five fish per age group is statistically necessary for calculating a Mean Growth Index, which is a comparison to the State of Michigan average.

	Age												Mean Growth
Species	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	Index
Cisco				11.4 (1)	13.4 (1)									--
Lake Trout		13.2 (5)	19.1 (5)	24.7 (4)	26.1 (9)	27.9 (5)	28.1 (1)	30.0 (2)						+2.6
Lake Whitefish		15.1 (3)	17.0 (3)	18.9 (23)	21.3 (20)	22.5 (23)	23.6 (11)	24.6 (7)	25.4 (9)					--
Northern Pike		21.5 (1)	28.1 (5)	28.5 (3)	33.4 (3)	34.8 (4)		41.0 (1)						+4.7
Rock Bass										10.4 (2)	11.2 (1)	11.5 (1)	11.8 (1)	--
Rainbow Smelt	6.4 (1)													--
Smallmouth Bass					16.5 (1)									--
Yellow Perch					9.0 (1)	11.3 (1)		11.4 (2)	12.9 (1)					--

Table 9. Number, weight, and length of fish collected from Higgins Lake with straight-run and Great Lakes gillnets, September 21-24 and October 26-29, 2020.

Species	Number	Percent by number	Weight (pounds)	Percent by weight	Length range (inches)[1]	Average length	Percent legal size[2]
Brown Trout	2	0.5	9.9	1.0	21-23	22.5	100 (15")
Cisco	30	7.5	5.5	0.6	8-9	9.0	
Lake Trout	79	19.8	536.9	56.2	8-33	25.7	99 (15")
Lake Whitefish	22	5.5	109.5	11.5	21-25	23.6	
Northern Pike	11	2.8	98.3	10.3	25-40	33.0	100 (24")
Pumpkinseed	1	0.3	0.2	0.0	6-6	6.5	100 (6")
Rainbow Trout	1	0.3	3.6	0.4	21-21	21.5	100 (15")
Rock Bass	103	25.9	37.0	3.9	5-10	7.8	95 (6")
Smallmouth Bass	14	3.5	31.2	3.3	10-19	15.7	86 (14")
Rainbow Smelt	8	2.0	0.3	0.0	3-7	4.8	
Walleye	2	0.5	4.1	0.4	18-18	18.5	100 (15")
White Sucker	46	11.6	109.0	11.4	11-21	18.7	
Yellow Perch	79	19.8	9.9	1.0	5-10	7.0	15 (7")
Total	398	100	955.4	100			

[1]Note some fish were measured to 0.1 inch, others to inch group: e.g., "5"=5.0 to 5.9 inch, "12"=12.0 to 12.9 inches; etc.

[2]Percent legal size or acceptable size for angling. Legal size or acceptable size for angling is given in parentheses.

Table 10. Length frequency distribution for fish caught from Higgins Lake in September and October 2020.

Inch Class	Brown Trout	Cisco	Lake Trout	Lake Whitefish	Northern Pike	Pumpkinseed	Rainbow Trout	Rock Bass	Rainbow Smelt	Smallmouth Bass	Walleye	White Sucker	Yellow Perch
3									2				
4									2				
5								5	2				15
6						1		16	1				52
7								48	1				6
8		18	1					23					4
9		12						9					
10								2		1			2
11										1		3	
12												4	
14										4			
15			1							1		3	
16										2		1	
17										1		8	
18										2	2	12	
19										2		4	
20												6	
21	1		2	4			1					5	
22				2									
23	1		5	7									
24			9	6									
25			17	3	1								
26			9		1								
27			16		1								
28			7		1								
29			3										
30			4										
31			3		2								
33			2										
36					1								
37					1								
38					2								
40					1								
Total	2	30	79	22	11	1	1	103	8	14	2	46	79

Table 11. Average total weighted length (inches) at age, and growth relative to the state average, for fish sampled from Higgins Lake with trap nets, Great Lakes gillnets, inland gillnets, and seining, September 21-24, 2020. Number of fish aged is given in parenthesis. A minimum of five fish per age group is statistically necessary for calculating a Mean Growth Index, which is a comparison to the State of Michigan average.

	Age															Mean Growth
Species	I	II	III	IV	V	VI	VII	VIII	IX	X	XIII	XVI	XVIII	XIX	XX	Index
Brown Trout			22.7 (2)													--
Cisco		9.0 (6)	9.0 (6)	8.9 (7)	9.0 (1)											--
Lake Trout	8.6 (1)			23.7 (9)	26.0 (16)	26.9 (7)	28.0 (2)	29.7 (4)	29.3 (2)	31.0 (1)	29.7 (1)	33.0 (1)	33.4 (1)			+4.1
Lake Whitefish														24.9 (1)	24.8 (1)	--
Northern Pike			27.1 (3)			31.4 (1)	36.3 (5)									+5.6
Pumpkinseed						6.7 (1)										--
Rainbow Trout		21.0 (1)														--
Smallmouth Bass			14.6 (1)	14.3 (2)	16.9 (1)			18.6 (1)	19.2 (1)							--
Yellow Perch		6.1 (4)	6.4 (6)	6.5 (12)	6.5 (7)	8.2 (2)	8.0 (1)									-1.7

Table 12. Average total weighted length (inches) at age, and growth relative to the state average, for fish sampled from Higgins Lake with Great Lakes gillnets, October 26-29, 2020. Number of fish aged is given in parenthesis. A minimum of five fish per age group is statistically necessary for calculating a Mean Growth Index, which is a comparison to the State of Michigan average.

	Age																			Mean Growth
Species	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XV	XVII	XVIII	XIX	XXI	XXII	XXV	Index
Lake Trout		15.7		25.0	25.6	26.6	29.5	28.7		21.4											+3.5
		(1)		(7)	(6)	(8)	(7)	(4)		(1)											
Lake Whitefish					21.2	22.0	21.4	24.2	22.5	23.7	21.7	23.3	25.2	23.7	25.7	23.3	23.4	24.2	25.0	24.9	--
					(1)	(3)	(1)	(1)	(1)	(1)	(1)	(2)	(2)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	
Northern Pike							27.5	37.7													--
							(1)	(1)													
Smallmouth Bass			10.6	15.3	15.2	17.6		18.5	19.8												--
			(2)	(2)	(1)	(1)		(1)	(1)												
Walleye			18.6						18.5												--
			(1)						(1)												
Yellow Perch						10.7			10.4												--
						(1)			(1)												

Table 13. Comparison of CPUE (catch per unit effort or number of fish per net lift) for the different types of gillnets used in the 2011 and 2020 MDNR fisheries surveys of Higgins Lake.

Year	Gear type	# lifts	Cisco	Lake Trout	Lake Whitefish	Northern Pike	Yellow Perch	Rock Bass
2011	Inland gill net	22	0.18	0.82	0.23	0.23	23.18	13.41
2011	Great Lakes gill net	32	0.28	4.03	3.66	0.53	13.97	1.88
2020	Straight run gill net	14	0.07	2.86	0.5	0.43	0.07	4.43
2020	Great Lakes gill net	11	2.07	2.79	1.07	0.36	5.57	2.93

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