Grand Lake
Presque Isle County
Lake Huron watershed, last surveyed 2019

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Environment

Grand Lake is located in eastern Presque Isle County of the northern Lower Peninsula of Michigan (Figure 1), and at 5,823 acres (Hanchin 2011), is one of the larger inland lakes in Michigan. It is located about fifteen miles north of the town of Alpena and drains a watershed of approximately 21,650 acres (Laarman 1976). Grand Lake is fed by three small creeks on the west shore known as Warren, Schaut, and Schalks creeks. A Northern Pike spawning marsh and manmade control structure was built on Schalks Creek in the 1960s to enhance pike abundance for Grand Lake (Photo 1). A small outlet from Lotus Lake drains into Grand Lake on the east shore. The outlet of Grand Lake is called Grand Lake Outlet and flows directly to Lake Huron. The outlet control structure is approximately 4 feet high and 40-foot long and was built in 1956 (Photo 2). It establishes a legal lake level of 594.24 feet and is maintained by the county. The outlet allows some fish passage, particularly at high flows.

There are two primary boat launching sites on Grand Lake. Department of Natural Resources (DNR) operates and maintains the Metzelaar Bay launch on the south side of Grand Lake (Figure 2). There is also a township launch on the north side of the lake. Both are paved launch sites with ample parking and toilet facilities. There are a number of other access points to Grand Lake which are unimproved (road endings, private launches).

The shoreline of Grand Lake is moderately developed and dominated by private residences. DNR statistics from 2004 showed the lake had 989 dwellings along its shoreline, 847 small docks, and 12 large docks. It was also estimated that 36% of the shoreline was armored. There are nineteen islands on Grand Lake, which is quite unique for lakes in Michigan's northern Lower Peninsula. The islands range in size from less than an acre to 263 acres. Prominent bays include Black Bass Bay and Metzelaar Bay. Grand Lake generally has clear water, yet due to the long profile of the lake and shallow water, the lake can become slightly turbid following wind action. A secchi disk measurement of 6 feet was measured in 2004. Maximim depth of Grand Lake is 25 feet, with approximately 78% of the lake area less than 15 feet deep, and approximately 59% of the lake volume in water less than 15 feet deep (Figure 2) (Hanchin 2011).

A thermocline is rarely established in Grand Lake in the summer and high dissolved oxygen levels can be found throughout most of the water column as was observed on August 8, 2004 in 24 feet of water (Table 1). The lake does not possess a cold water refuge since temperatures in the summer will range from the high 60's to low 70's Fahrenheit throughout the water column. The substrate of the littoral zone consists largely of sand, gravel, and rock. The deeper water substrate is marl and organic matter. Submergent and emergent aquatic vegetation are sparse throughout the lake, though some shallow areas and bays have abundant vegetation, particularly chara (Hanchin 2011). The lake is moderately alkaline, with a value of 111ppm in 2004. However, it is considered mesotrophic and relatively sterile with a chlorophyll-a measurement of less than 1 microgram/liter.

Known invasive species to the Grand Lake environment are Round Goby, zebra mussels, and rusty crayfish, all of which are believed to have entered the lake in the last 20-30 years. The mussel species are thought to have a profound impact on the lake through their ability to reduce the amount of food (plankton) in the water column through filter feeding. Other non-native species that periodically may enter the lake are Sea Lamprey, salmon species, and Steelhead. The primary native species of Grand Lake include Yellow Perch, Walleye, Rock Bass, Smallmouth Bass, and Northern Pike, to name a few. These are species typical for a cool- to warmwater fish community.

Standard State of Michigan fishing regulations currently apply for all species in Grand Lake (see Michigan Fishing Guide), which includes a 15 inch minimum size limit on Walleye. From 1990 through 1996, the minimum size limit on Walleye at Grand Lake was 13 inches.

To summarize, Grand Lake is a large natural inland lake that does not stratify thermally with high dissolved oxygen levels throughout the water column. Water clarity is often high, and productivity is considered low. It has a relatively small drainage area and is connected directly to Lake Huron by a small outlet. A control structure on the lake prevents easy fish passage from Lake Huron to Grand Lake, although fish passage is possible in high flow events. The fish communities of Grand Lake consist of mostly native species. Most attractive to anglers are the cool water fish species such as Yellow Perch, Walleye, and Smallmouth Bass. There is no permanent coldwater species community of fish in Grand Lake. Smallmouth Bass fishing tournaments are known to occur frequently at Grand Lake, but tournaments have declined in recent years. Bass tournaments that were registered with the DNR have been 7 in 2016, 10 in 2017, and 2 each in 2018 and 2019. There have been 48 State of Michigan Master Angler awards registered for fish from Grand Lake since 1996. Species registered included Rock Bass, Smallmouth Bass, Yellow Perch, Bowfin, Bluegill, Pumpkinseed, and bullhead species.

History

Fisheries and aquatic habitat management can be broken down into five categories at Grand Lake, dating back to the early twentieth century. These are: 1) historical and recent fish stocking practices, 2) rough fish removal through commercial trap netting, 3) angler census methods, 4) special lake assessments, 5) cormorant control and hazing efforts, and 6) fish community assessment through surveys.

Stocking

Known stocking records for Grand Lake date back to 1910; and are incomplete. This was a period in the early days of the Michigan Department of Conservation (MDOC) when regional stocking of warm- and cool water species was normal. Stocking was infrequently done in lakes and streams prior to 1945, and often with little consideration for the need to stock. This was true for Grand Lake when various species such as bass and Walleye were stocked prior to 1950 (Table 3). Many of the species stocked would have been endemic to Grand Lake and likely at acceptable population levels. Supplemental stocking of Northern Pike was initiated by MDOC and eventually the DNR by the 1960s with the development of a pike marsh. A small control structure was built on the upper reaches of Schaulks Creek on the northwest side of the lake that flooded a small wetland (Photo 2). The pike marsh is still operated today, but management has changed considerably through the decades. In the early decades of pike management (Table 3), pike fry were typically stocked into the marsh and held there to grow to

fingerling size and then released to Schaulks Creek and back to Grand Lake. Obtaining and transporting pike fry or fingerlings was no longer cost beneficial, so over time, the control structure was operated so that Northern Pike adults from Grand Lake enter the marsh, spawn, and return to Grand Lake. The surviving fingerlings are released to the creek and lake with the receding water levels. This marsh has been operated by one member of the Grand Lake Sportsmans Club for a many decades. The DNR Fisheries Division also experimented with stocking Tiger Muskellunge at a number of Michigan lakes in the 1970s through 1990s. Although these fish did well and were popular in some locations, the stocking program was discontinued in the 1990s. Grand Lake was stocked with fall fingerling Tiger Muskellunge a small number of times in the late 1970s and early 1980s (Table 3).

Commerical Trap Netting to Remove Rough Fish

Less is known about this past management practice at Grand Lake, but it did occur from 1944-46. Crowe (1946) states that the MDOC at the time approved a permit for the take of certain species by Harold Lamb of Rogers City, Michigan. It can be speculated that the goal was to remove the abundance of non-game species by netting while allowing for the take of a small percentage of game fish. During this period, nearly 6,000 White Sucker dominated the harvest (Table 4). Walleye and Rock Bass comprised a significant portion of the harvest as well. A similar management strategy was developed between the DNR and Grand Lake Sportsmans Club in the 1980s and 1990s. The club and area anglers wished to reduce the White Sucker (and likely other species) population through spring netting efforts. The club borrowed DNR fyke nets for a number of years to remove non-game species. This management practice faded in the 1990s over concerns of game fish removal, gear logistics, and overall efficacy of the activity.

Angler Census

A variety of angler censuses have been done at Grand Lake. A special creel census (Laarman 1976) (Eschmeyer 1936) was made at Grand Lake in the winter months of 1935. They found that Yellow Perch made 81% of the total catch, Northern Pike 18%, and Walleye less than 1%. General creel censuses were conducted at many regional lakes, including Grand Lake, from 1939 through 1964 (Laarman 1976). The MDOC utilized conservation officers to formally ask anglers about catch and effort. Results showed that Yellow Perch were the species that most Grand Lake anglers fished for (Table 5). From 1939-1950, Smallmouth Bass, Walleye, and Northern Pike combined catch was only 7% of total harvest, and slightly higher (12%) from 1951-1964. Statewide mail surveys to anglers in 1970 and 1973 showed that Grand Lake produced over 19,000 and 24,000 angler days for those years, respectively (Laarman 1976).

A random sampling creel census for Grand Lake was completed by DNR in the summer of 1976. This was part of a program initiated by the public to have the DNR better understand the fish community and angler desires. This included boat and angler counts to determine fishing pressure and angler interviews to quantify catch. The survey was made from mid-May (Walleye opener) through August. Angler hours for this period were over 40,000, while angler trips were over 13,000. Over 23,000 fish were caught during this period, with Yellow Perch comprising 60% of the catch, followed by Rock Bass (17%), Walleye (9%), Northern Pike (4%), Smallmouth Bass (3%), and Bluegill/sunfish (3%). The catch rate per hour of Walleye was 0.06.

A modern, stratified design creel census was completed at Grand Lake in 2004 and 2005. The creel census followed a netting and tagging effort for Walleye, Smallmouth Bass, and Northern Pike in spring 2004. Details of the creel census can be found in Hanchin (2011). A modified table from that survey shows that a nearly year-long creel at Grand Lake documented over 33,000 angler hours and 10,000 angler trips (Table 6). In addition, it demonstrated that over 46,000 fish were caught in that period. Total catch was dominated by Yellow Perch (87%), followed by Smallmouth Bass (7%), and Rock Bass (2%). Walleye total catch composition was only 1% (Table 6). This is believed to be a period when Walleye numbers were thought to be relatively lower in Grand Lake. The majority of the Yellow Perch were harvested in winter. Regardless, anglers of this period still relied heavily on perch for fishing at Grand Lake, just like a half-century earlier (Table 5). Hanchin (2011) found that the ice-cover period of fishing during this survey accounted for greater effort than the entire summer period. From angler interviews, it was found that species fishing preferences by fishing period were the following: spring through fall (any species 47%, Walleye 31%, bass 12%, Yellow Perch 8%); winter (Yellow Perch 60%, any species 24%, Walleye 13%). This shows the importance of a diverse fishery in the open water period, and the importance of Yellow Perch to the winter fishery. This is likely still true today.

Special Assessments

Special assessments of Grand Lake or its watershed were completed in 1994 and 2007. The Grand Lake Sportsmans Club and Grand Lake Association hired TMI Analytical Services to assess the water quality of the lake and surrounding shoreline areas (TMI 1994). Procedures for the collections followed the DNR suggestions for the EPA Clean Lakes Program. Parameters such as dissolved oxygen, temperature, pH, total alkalinity, and nutrients were collected both in the spring and summer, as well as plankton, benthos, and analysis of aquatic vegetation. The authors found a lake that did not stratify and had oxygen levels and temperatures adequate for warm-water fish populations. There are multiple best management practices laid out by the authors for Grand Lake and its watershed (TMI 1994).

A management plan for Grand Lake and its neighboring watersheds was developed by the Northeast Michigan Council of Governments (NEMCOG) in 2007. The purpose of the plan was to "protect the water and natural resources in the Grand Lake watershed and adjacent coastal watersheds in Alpena and Presque Isle counties". The plan (NEMCOG 2007) summarized existing conditions in the watershed, identified the overall resource, provided summaries of land planning, zoning, and water quality, then identified goals, strategies, and action items for improving the lake and watershed.

Cormorant Control and Hazing Efforts

Populations of double-crested cormorants had significantly increased in the Great Lakes region by the 1980's, and particularly in northern Michigan (DNR Briefing, 2019). Concerns also increased that congregating cormorants during spring migration were having considerable impacts on free-swimming fish populations through predation. Management agencies and stakeholder groups expressed concerns over the impacts, including at Grand Lake. The U.S. Fish and Wildlife Service (USFWS) developed a Public Resource Depredation Order (PRDO) to provide for state level management to address impacts on free-swimming fishes in 24 northern states, including Michigan. During the late 1990s and early 2000s, anglers and residents of Grand Lake expressed concerns about the impacts that the spring

cormorants were having on Grand Lake fish populations, often correlating reduced fish catches with bird predation on fish. Volunteers worked with U.S. Department of Agriculture (USDA) Animal Plant Health Inspection Service (APHIS) personnel to organize efforts to harass cormorants at Grand Lake during the spring migration. This included some limited lethal efforts on birds. This organized activity occurred for Grand Lake from 2005 through 2016, and along with bird hazing, included the killing of 478 cormorants. The PRDO, however, was rescinded in 2016 by the U.S. District Court until the USFWS could reissue an Environmental Assessment that more adequately took in to account the effects of such orders on the double-crested cormorant population. Thus, no lethal means of control has occurred at Grand Lake and most other northern Michigan waterbodies since 2016. Harrassment, or hazing, is still an option of management from volunteers, but without some lethal take these efforts have much lower effectiveness.

Fisheries Surveys

Grand Lake was stocked with low numbers of cool- and warm water fish species in the first half of the twentieth-century. It wasn't until 1950 when personnel from the MDOC and local sportsman actually surveyed the entire aquatic community of Grand Lake. This was preceded by lake mapping efforts in the winter of 1949-50, as well as a period when over 200 brush shelters were installed in the lake by the local sportsman club in cooperation with MDOC. In 1950, there were approximately 300 cottages on the shores of Grand Lake, 6 hotels/resorts, and a livery. The lake was noted to be a shallow lake, with extensive shoals and a maximum depth of 25 feet. The lake had a normal alkanity value of 125ppm, a typical pH range over 8, and did not have any thermocline or significant summer temperature stratification (Table 7). Aquatic vegetation was noted as sparse, although nineteen species of plant were documented in 1950 (Table 8). The most common species being chara and bulrush. Lake residents suggested that the Northern Pike numbers were low compared to past years, and that one could still find good catches of Smallmouth Bass, Walleye, Yellow Perch, and Rock Bass.

In June and July of 1950, MDOC personnel used lakewide shoreline seining and gill netting to sample the Grand Lake fish community. Northern Pike, Yellow Perch, and Rock Bass were considered abundant, while Walleye, Smallmouth Bass, and Pumpkinseed were common in the survey catches (Table 9). Other species collected in varying numbers were Longnose Gar, Bowfin, Common Carp, White Sucker, shiners, minnows, darters, chubs, killifish, Logperch, bullheads, and mudminnow. Also caught were adult Cisco, a cold water species that needs cold water habitat and high dissolved oxygen levels. This type of habitat was not found in Grand Lake in the summer, though Cisco were present.

It would be nearly 10 years later before MDOC personnel would be back at Grand Lake examining the fish community. Small numbers of gill nets were used in September 1959 to capture a small number of fish. Reasons behind the survey are unknown. The usual larger species from the 1950 survey were also collected in 1959, with the exception of Cisco.

A two year fish community survey was completed by MDOC with shoreline seining in 1961 and fyke/trap netting in 1962. The purpose was to capture up to date information on Walleye and Smallmouth Bass at Grand Lake, both abundance and age and growth estimates. Both species were collected in good numbers during the survey period, with most in the 10-14 inch size range (Table 10). High densities of larger bass and Walleye were not found. In addition, it was noted that very few Northern Pike were collected. Rock Bass and White Sucker were prolific in the catch (Table 10).

It was following the survey of the early 1960s that MDOC personnel cooperatively built a small control structure on Schaulks Creek and established a pike spawning marsh. The spawning marsh went into operation in 1965 and is still present today, although serves a less critical purpose. MDOC conducted spring trap netting or electrofishing on a number of occasions in or near the marsh from 1968 through 1973 to document pike numbers and utilization of the marsh. Laarman (1976) suggested great variability in pike catches during this period.

Another low intensity fisheries survey was made by MDOC at Grand Lake in June of 1970. Surveyors used electrofishing to document pike relative abundance, particularly near the pike marsh outlet and in Black Bass Bay. Many species were found again to be common, such as Smallmouth Bass, Rock Bass, Walleye, Yellow Perch, and White Sucker. Northern Pike, however, were considered scarce.

In the spring of both 1976 and 1977, DNR Fisheries Division netted Grand Lake with the goal of tagging Walleye and Smallmouth Bass. This was following complaints from anglers over poor fishing. Extensive trap netting was done both years to tag 1,043 Walleye and 600 Smallmouth Bass. A creel census took place in the spring and summer of 1976 and allowed biologists to estimate Walleye exploitation through angler tag returns. From the spring trapping efforts in 1976, a total of 363 Walleye were tagged but only 16 (4%) of those tags were returned by anglers. This was considered a low exploitation rate after one year, and much lower than from a similar study done at Burt Lake the year prior (17% tag return) (Shouder 1977). Biologists noted that Walleye were abundant from all year classes and that reproduction was sufficient to provide a fishery. Walleye, just like Yellow Perch, however, were considered very slow growing (Table 11). Age and growth data suggested that it took 5-6 years for a Walleye to reach legal size of 15 inches. Smallmouth Bass were considered abundant, average growing, and underutilized. Few Northern Pike were collected during the two year netting effort, but pike growth was considered good. Based on the low catch rates of pike and high densities of White Sucker, managers recommended stocking Tiger Muskellunge in Grand Lake (via the pike marsh). This stocking program began in 1978.

Efforts were made by DNR in 1981 to assess the recent Tiger Muskellunge stocking efforts. Personnel used 41 trap net lifts in early to mid-April on the north end of Grand Lake. Only two Tiger Muskellunge were collected, a 19 and 24 inch fish, age 2 and 3. Stocking efforts were discontinued for this species after 1982 for the following reasons: 1) lack of approval for the managers to stock the species at higher stocking rates (4/acre), 2) poor catches in the 1981 survey, 3) intense dissatisfaction of program by some Grand Lake anglers, and 4) limited hatchery production and higher priority stocking locations statewide.

The 1981 trap netting effort did produce quality numbers of other game fish. Northern Pike were better represented in the catch, but most fish were less than 24 inches in length. Growth rates were exceptional for pike, and they were represented by seven year classes. Walleye ranged in length from 10-24 inches (Table 12) in the 1981 survey, but again most were less than the legal size of 15 inches. The average size of Walleye based on the catch distribution was 14.2 inches. Growth was still considered very poor for Walleye at Grand Lake, and two-inches slower than average Walleye growth across Michigan. Legal size (15 inches) was reached around age 5, likely quicker for females, and slower for males.

The 1981 survey catch of Smallmouth Bass ranged in size from 8-18 inches (Table 13), with an average size of 13.3 inches. The oldest bass was age 8, and Smallmouth Bass growth was slightly below the statewide average for this species. Also collected in good numbers during the survey were Rock Bass and White Sucker. Very few Yellow Perch were collected, yet this species would likely not be as vulnerable to the large mesh trap nets as other species noted.

The next fish survey netting of Grand Lake was done in May 1995 by DNR. The survey was done in regards to angler complaints about Walleye fishing, and the lack of "good" Yellow Perch fishing. The minimum size limit of 15 inches for Walleye was changed to 13 inches in 1990 to address stunting and to allow for additional harvest opportunity. The current size structure of Walleye could be evaluated with this survey following five years of the reduced size limit. Anglers of the time were also concerned with the abundant White Sucker and Carp population. Ironically, this survey followed a period when DNR and locals attempted to reduce the rough fish population through spring removal efforts of the late 1980s and early 1990s.

Trap netting was used in the 1995 survey, with 75 net lifts and 129 net nights of large mesh trap nets. It was noted that the survey was following the Walleye spawning run, which may have influenced catches. However, Smallmouth Bass were noted as plentiful in the shallows. The catch rate of Walleye in the nets was 2.9/net. This was not considered a poor catch rate, but neither was it considered outstanding. Walleye exhibited a fair size distribution with the bulk of the catch in the 15-17 inch size range (Table 12). The mean length of Walleye in the survey was 16.7 inches, much higher than 14.2 inches demonstrated in 1981. Growth, however, was still considered to be slow for this species, but reproduction was considered to be excellent based on the abundance of year classes collected. Despite the larger mean size of Walleye in the catch, it was suggested that the 13-inch minimum size limit exception for Walleye on Grand Lake be returned to the statewide standard of 15 inches. This was accomplished for the 1997 fishing season.

Smallmouth Bass were abundant in the survey efforts (Table 13). This species also had a higher mean length of 14.8 inches in the survey, compared to 13.3 inches in the 1981 survey. Bass appeared to be robust and in excellent condition according to managers. It was believed that Smallmouth Bass exhibited low exploitation rates at Grand Lake, with higher exploitation exhibited on Walleye.

Northern Pike had an acceptable size distribution, good growth rates, and offered a good number of large fish to the sportfishery. Rock Bass, White Sucker, and bullhead species were captured in good numbers in the 1995 survey along with smaller numbers of other typical species of the Grand Lake fish community. Two species, Black Crappie and Channel Catfish, were documented in low numbers for the first time in a survey.

Previous surveys routinely demonstrated good natural reproduction of Walleye and Smallmouth Bass at Grand Lake. Despite this, DNR heard concerns from Grand Lake anglers regarding poor Walleye catches and the desire to stock Walleye. In the fall of 1996 and 1997, DNR conducted fall juvenile Walleye assessments at Grand Lake. This is done with boomshocking gear in the shallows at night. The catch rate (number per hour) of age 0 Walleye is a good indicator of annual production, especially when compared to other waterbodies, or one waterbody over time. The index is not a good indicator of the adult population since fewer adults are in shallow and vulnerable to the sampling gear (adult indices are typically done in the spring with trap or fyke nets). Both the 1996 and 1997 fall night

shocking efforts again documented strong year classes of Walleye and the lack of a need to stock (Table 14). Growth of young walleye was considered slow, a likely result of competition for resources with other small Walleye and Yellow Perch.

The most extensive three part examination of the Grand Lake fish community and fishery was completed by DNR in 2004 and 2005. The three phases included 1) a spring survey effort after ice-out 2004 with an emphasis on tagging Walleye, Northern Pike, and Smallmouth Bass for population estimation, 2) a general survey of the entire fish community in the summer of 2004, and 3) a stratified angler survey design for Grand Lake from April 24, 2004 through March 15, 2005 (summarized earlier). Detailed analysis of phase 1 and 3 can be found in Hanchin (2011). Phase 1 was part of the DNR Large Lakes Survey Program which was designed to improve assessment and monitoring of fish communities and fisheries in Michigan's largest inland lakes (Clark et al. 2004). In doing so, managers would have baseline data on the important game fish in these lakes and allow for statewide comparisons.

The spring survey effort was completed with 294 fyke net lifts and 163 trap net lifts after ice-out in 2004. Legal size Walleye, Northern Pike, and Smallmouth Bass were jaw tagged, and a population estimate was derived from the marked-unmarked ratios of catch of these three species during the nearly year long creel census (Hanchin 2011). A total of 20,906 fish were captured during the spring netting effort (Table 15) and represented by 16 species. Hanchin (2011) found that Walleye in Grand Lake displayed below average growth when compared to other lake Michigan lakes. This was consistent with past surveys as well. The size structure of the spring 2004 catch was skewed to smaller Walleye (Table 12 and 16) with a mean length of 14.2 inches. Hanchin (2011) found that female Walleye could reach legal size (15 inches) at Grand Lake by age 4, while males reached it at age 5. Many sub-legal Walleye captured during the survey were sexually mature males.

The population estimate of mature Walleye was estimated to be 4,641, or 0.8 mature fish per acre. This is a low estimate when compared to other Walleye populations in Michigan lakes surveyed under the same protocol (Hanchin 2017). The same is true for the estimate of legal (15 inches and larger) Walleye which was 3,308, or 0.6 legal fish per acre. Hanchin (2011) also suggested that the annual mortality of 43% for Walleye was relatively high, based on catch curve analysis and the lack of many older fish. The author suggested that the high natural mortality "is conceivable, given the high summer water temperatures and lack of a thermocline in Grand Lake." Although natural mortality was considered high, harvest or exploitation was considered to be low (approximately 10%) based on tag return data.

Northern Pike ranged in length from 10-42 inches during the netting effort, with a mean length of 23 inches. Age and growth data suggested that pike have a relatively short life span in Grand Lake, with no fish aged over age 10 and a total annual mortality of 49%. Hanchin (2011) found that female pike grew faster than males in Grand Lake, and attained legal size (24 inches) by age 3, where it was age 5 for the few males that made 24 inches. The adult pike estimate was 280 based on the single-census method (marking session from spring netting, recapture session was the creel census) (Hanchin 2011). Hanchin (2017) found that the density of adult and legal size Northern Pike was extremely low compared to other Michigan lakes surveyed in the Large Lakes Survey Program from 2001 through 2010. The total annual mortality rate of 49% was average compared to other lake pike populations, while growth was average.

The population estimate of mature Smallmouth Bass was 2,869 or 0.49 mature fish per acre. Hanchin (2017) found this estimate to be slightly higher than the mean estimate of bass density across lakes in the Large Lake Survey Program from 2001-2010. The total annual mortality of Smallmouth Bass was 36%, which was slightly higher compared to other large lake Smallmouth Bass densities. Growth rates for bass were considered average compared to other lakes.

An intensive follow-up survey was made on Grand Lake from June 28 through July 1, 2004. The intent of this follow-up survey was to gather information on other species in the lake, other than the primary targets of the earlier survey after ice-out (Walleye, Smallmouth Bass, Northern Pike). Effort over this four-day survey included 9 large mesh fyke net nights, 10 large mesh trap net nights, 3 small mesh fyke net nights, 12 experimental inland gill net nights, and 2 mini-fyke net nights. Water temperature ranged from 67-70 Fahrenheit during this summer survey.

Over 1,300 fish were captured during the summer survey (Table 17). The species composition was similar to all previous surveys and consisting of fish already known to inhabit Grand Lake. Yellow Perch were captured in higher proportions, likely due to the utilization of gill nets and small mesh nets deployed near shore. Most perch were in the 2-3 and 5-7 inch size ranges. Few Walleye were collected, but the prevalence of this species (as well as Northern Pike and Smallmouth Bass) was higher during the spring survey in 2004.

The next fish surveys were made in 2006 and 2014 to examine natural reproduction of Walleye. These were done each year with nighttime boomshocking gear in the shallow water. Four hours of shoreline were surveyed in 2006 and less than three hours in 2014 (Table 14). The catch rate of age 0 and age 1 Walleye is an index of year class strength. Catch rates of any young fish are evidence of natural reproduction since Walleye are not stocked in Grand Lake. Catch rates above 10/hour (of both age 0 or age 1 fish) indicate a strong wild year class. In 2006, DNR collected 16 age 0 Walleye per hour, and a fair number of both yearlings and adults (Table 14). Large catches of all sizes of Walleye were collected in 2014. Conclusions were the same in these years as for past years. Walleye consistently reproduce in Grand Lake and stocking is not necessary.

Current Status

DNR Fisheries Division began receiving phone calls from anglers reporting bass (Smallmouth and Largemouth bass) problems at a number of lakes in the northeastern Lower Peninsula of Michigan in 2017 and 2018. Complaints centered around one or a combination of concerns such as 1) reduced spawning numbers, 2) reduced bass densities, 3) dead bass, or 4) ailing bass. A number of reports came from Grand Lake anglers, riparians, and even bass tournament anglers.

Although DNR was unable to collect bass for disease testing during this period, we were able to survey the Grand Lake Smallmouth Bass and Walleye population specifically in the spring of 2019. The goal was to best mimic sampling conditions from a past survey (1995 and 2004) which would allow us comparisons of both species size and structure to past decades. We surveyed the lake with 63 trap net nights in 2019 from May 13-31 when water temperature ranged from 50-59 degrees Fahrenheit. Some comparisons can be made to catches from 2004, however, the survey in 2004 was done after ice out at much colder temperatures and 163 trap net nights. In 1995, DNR surveyed Grand Lake with 73 trap net nights in May when water temperatures were warmer. Thus, the best catch rate comparisons are

between the years 1995 and 2019. In addition, the invasive Round Goby had been documented in Grand Lake by the 2019 survey.

A total of 331 Smallmouth Bass were captured in the 2019 netting efforts and ranged from 7-20 inches. Bass continue to be represented by multiple age classes (11) and live between 10 and 15 years old (Table 11). Comparisons of Smallmouth Bass growth over the decades demonstrates that this species grows well in Grand Lake, and growth rates have changed very little over time (Figure 3). Bass appeared robust during the 2019 survey, and many collected were legal size (14 inches) or larger (Table 13). Comparisons of bass catch rate from the 1995 and 2004 surveys can be found in Figure 4. Legal Smallmouth Bass densities have declined slightly when comparing 1995 to 2019. The decline of sub-legal Smallmouth Bass has been more apparent among surveys (Figure 4).

In addition, we submitted 26 Smallmouth Bass samples for viral testing to the Michigan State University Fish Health Laboratory following the survey. The specimens were live captured and healthy looking. These samples were frozen and shipped for testing. Conclusions found "no evidence for fish-pathogenic viral infections were observed in the examined Smallmouth Bass, and no viruses were isolated during laboratory virological analyses".

A total of 955 Walleye were collected during the spring 2019 survey effort and ranged from 8-24 inches (Table 12). It was noted that the survey timing was after, or near the end, of the spawning period. The majority of Walleye collected were 12-15 inches and averaged 14.2 inches in length. Coincidentally, this was the same average length as measured during two other previous surveys (Table 12). Walleye growth remains below the statewide average for this species but very similar over time (Figure 5). This likely means that growth is dictated by lake morphology and water temperatures, rather than food supply. Catch rates of legal Walleye (15 inches and larger) have not changed when compared to the 1995 and 2004 surveys (Figure 6). However, catch rates of sub-legal Walleye were much higher in the recent surveys than when compared to the 1995 survey (Figure 6). This again is evidence of continued natural reproduction at high levels.

Analysis and Discussion

The current (2019) fish community of Grand Lake can be generally characterized as having the following: 1) a panfish community that is low in diversity, and dominated by Yellow Perch (particularly the fishery) and Rock Bass, 2) a perch size structure that we know very little about since they have not been collected in large numbers during past surveys; these species are not susceptible to typical predator sampling gear, and are often undersampled, 3) a predator population having moderate diversity and dominated by Walleye and Smallmouth Bass, and to a much lesser degree, Northern Pike, 4) a slow growing Walleye population supported by consistent natural reproduction, 5) a Walleye population with higher metabolic rates and higher natural mortality rates, 6) a non-game fish community typical for a large inland glaciated Michigan lake comprised primarily of suckers, bullheads, and gar, 7) a seasonal and low density cold water fish population that enters the lake from Grand Lake Outlet and Lake Huron, and 8) a once known Cisco population despite not having suitable cold water during the summer months (it is unknown if any Cisco still exist in Grand Lake, or if they were also once periodic migrants from Lake Huron). Grand Lake has a number of invasive species, some of which have been integrated into the aquatic community, others which have not. Zebra mussels, Round Goby, and rusty crayfish have invaded the lake in recent decades and it is unknown

what there impacts will be in coming years. The fishery of Grand Lake is dominated by anglers seeking Yellow Perch, Walleye, and Smallmouth Bass, and likely in this order.

The Grand Lake panfish community is low in diversity but can be high in quality. Yellow Perch are the main attraction for anglers at this lake year around. The lake receives considerable fishing pressure for this species. Yellow Perch attain large sizes through longevity rather than fast growth. The warm water and lack of a summer thermocline may reduce growth rates of perch. Abundance is usually good, although large perch are likely affected by high mortality rates and harvest. Rock Bass are very prolific at Grand Lake and attain large sizes. This species competes with other more desirable game fish for resources, but it does offer quality catches in the open water months. Pumpkinseed and Bluegill also inhabit Grand Lake, but in much lower numbers. Pumpkinseed are more abundant than Bluegill, and both do better with aquatic vegetation present. Aquatic vegetation is generally scarce in Grand Lake.

The predator base of Grand Lake is also low in diversity. Most anglers seek out Walleye and Smallmouth Bass during the open water season. Walleye numbers appear quite adequate in Grand Lake currently and continue to be sustained through natural reproduction. Since the lake is not stocked, there will be natural fluctuations in Walleye abundance, but they will be within the carrying capacity of the lake to sustain the species. Supplementing the strong, wild population through stocking would certainly hinder the wild population through competition. Walleye growth rates are historically and currently poor at Grand Lake. Having additional Walleye in the lake through stocking would only hinder these growth rates further.

Smallmouth Bass are a popular game fish at Grand Lake and throughout northern Michigan. They are less valuable from a consumption standpoint, and more as a catch and release sport fishery. It is believed that Smallmouth Bass populations had done well in many of the large northern Michigan lakes following the invasion of species such as Round Goby and zebra mussels. Mussels have cleared the water considerably over the last couple decades which may have been beneficial for a benthic, sight feeding species such as Smallmouth Bass. The recent invasion of Round Goby may add an additional benthic predator to the forage base for bass. However, more needs to be known about the competition effects between goby and small game fish such as perch and bass. In addition, goby are known predators on fish eggs and fry, possibly impacting population levels over a period of time. It certainly is too early to speculate currently on population effects. However, it is believed from angler reports and some survey data that Smallmouth Bass numbers, particularly for young fish, are lower.

Northern Pike are native to Grand Lake, but they are low in abundance. Grand Lake is naturally surrounded by rocky terrain and hills, with limited adjacent wetlands and near-shore aquatic vegetation. It is likely this species has always been lower in abundance in Grand Lake compared to other northern Michigan waterbodies. Growth rates of pike are good and they do offer an additional game fish for anglers. Pike densities are likely supported mainly from in-lake spawning on chara and pondweed flats. However, the pike marsh in some years may supplement the lake population significantly.

Other species such suckers, gar, Bowfin and bullheads are all native to Grand Lake and in normal population levels. There is some fish migration from Lake Huron into Grand Lake, but is relatively infrequent, only during extreme high- water periods. The Cisco population is likely extirpated from Grand Lake. This historic population may have been reliant on high densities of migrating fish from

Lake Huron. Current Cisco levels along the west shore of Lake Huron are likely too low to offer significant inland spawning runs.

Management Direction

Grand Lake is an important waterbody in northern Michigan. The fishery and the general recreational use it supports is important to the statewide and local economy. Below are some management recommendations for Grand Lake. These management recommendations were written following a review of recent surveys of the fish communities and fishery of the lake.

1) Water quality monitoring and limnological analysis should be implemented at Grand Lake. Long term monitoring of parameters such as phosphorus, chlorophyll, and water clarity allow insight into the changes of the fish community and base of the food chain. Invasives have greatly impacted such parameters at regional waterbodies, and it is likely that other invasive organisms will enter Grand Lake in the future. Having at least baseline data on these variables will be beneficial.

2) Aquatic vegetation is extremely important as spawning substrate and cover for various fish species, and it serves as the base of the food chain. This is particularly true at Grand Lake where aquatic vegetation is naturally limiting. Native vegetation should be protected throughout the lake. Submersed vegetation is important for Yellow Perch and Northern Pike populations for spawning and nursery habitat. Both species are important to the fish community and fishery.

3) Fisheries surveys at Grand Lake date back to 1950. Many surveys of a variety of types have occurred here since then. However, some of the surveys have been species or program specific. The 2004 summer fish community survey examined the overall fish community with a broad amount of gear types, providing a more accurate picture of the fish community. This effort should be duplicated periodically to allow for more direct comparisons over time. This should be done approximately every 20-30 years, or when need arises (e.g. new invasive species detected). Species specific surveys for Walleye and Smallmouth Bass have been used frequently, and likely will continue to be used in the future. Yellow Perch are the most important fish when considering the Grand Lake fishery, however, no past surveys of the lake have focused on this important fishery. A future baseline survey of the perch population could be used with experimental gill nets at index stations. Gathering this information now could be valuable decades from now if additional invasives enter the lake.

4) Anglers should provide catch reports for fish at Grand Lake more frequently to DNR biologists. Catch reports are a valuable tool for managers, and often considered in management plans for the lake.

5) Creel/angler surveys of Grand Lake are a very valuable tool for managers. These surveys provide critical information such as fishing pressure, catch, and angler preferences that also shape lake management principles. These types of surveys are done infrequently due to personnel shortages and costs. Partnerships for such efforts should be examined in the future.

6) Walleye year class strength should continue to periodically be examined at Grand Lake through fall shoreline electrofishing at night. Historical stations should be re-surveyed. Surveys are used to document continued natural reproduction. This lake has ample in-lake spawning substrate and it is likely that Walleye reproduction will continue. However, recruitment bottlenecks could occur from the fry to fingerling stage if the plankton community declines over time. We believe this is not occurring at

Grand Lake, as evidenced by the presence of multiple year classes of Walleye. However, it has occurred at a nearby regional lake.

7) Walleye growth rates are slow in Grand Lake when compared to Michigan Walleye populations. This is true for current and historical populations. Growth is slow likely as a result of water temperatures and metabolism. Currently, Walleye are regulated with the statewide standard of a 15 inch minimum size limit and 5 fish daily bag limit. There currently are few exceptions to this regulation across Michigan. However, it is possible in the future that Michigan creates an exception to this regulation for extremely slow growing (stunted), abundant populations. This could be a reduced minimum size limit with the same bag limit. This type of regulation existed on Grand Lake for Walleye from 1990-1996. It could be explored again. Such a regulation change would have pros and cons. Pros would include some harvest of 13-15 inch Walleye and alleviation of pressure on the forage base. A con could include social ramifications from anglers and perception of overharvest.

8) Smallmouth Bass are also an integral part of the fish community and fishery. They are a keystone species for controlling benthic invasive species such as rusty crayfish and Round Goby. Bass fishing and tournament fishing has increased in recent decades, especially with the well promoted bass fisheries of northern Michigan. Tournament organizers should continue to register bass (and Walleye) tournaments for Grand Lake. Results should be shared with fisheries managers. Bass numbers appear to be fluctuating in recent decades. High densities, and especially ones that are stressed, have been more susceptible to viruses or diseases as noted at some regional lakes. Managers will have to keep monitoring this at our regional lakes, and anglers can provide insight as they are on these waters frequently.

9) There was a perceived positive effectiveness about the cormorant control program during the years when hazing and lethal means were allowed. Anglers noted better catches and noted a rebound in the overall fishery. This cause and effect relationship has been well documented in other locations in Michigan, such as the Les Cheneaux Islands. If cormorant numbers remain high at Grand Lake during the spring, it is quite possible we will those fishery gains of the past eventually dissipate. It is recommended that the USFWS establishes a clear policy forward for permitting cormorant control measures which include necessary lethal means.

10) Continue to work with the Northern Inland Lakes Citizen Fisheries Advisory Committee on issues related to Mullett Lake and the Inland Waterway. This committee, created in 2010, acts as a bridge between MDNR and the public (local anglers, MAPS). Meetings are bi-annual as needed, and are a conduit of information sharing between managing agencies and the public. Members of the Grand Lake Sportmans' Club have been consistent members of this committee, and we urge this to continue into the future.

References

Clark, R.D., Jr., P.A. Hanchin, and R.N. Lockwood. 2004. The fish community and fishery of Houghton Lake, Roscommon County, Michigan with emphasis on Walleyes and Northern Pike. Michigan Department of Natural Resources, Fisheries Division Special Report 30, Ann Arbor.

Crowe, W.R. 1946. Coarse fish removal, Grand Lake, Presque Isle County, 1945-46. Report No. 1045, Ann Arbor.

DNR Briefing. 2019. Double-crested cormorant briefing, Lansing.

Eschmeyer, R.W. 1936. Creel census on 12 northern Michigan lakes, winter of 1935-36. Report No. 369, Ann Arbor.

Hanchin, P.A. 2011. The fish community and fishery of Grand Lake, Presque Isle County, Michigan in 2004-05 with emphasis on walleye, northern pike, and smallmouth bass. Michigan Department of Natural Resources, Fisheries Special Report 54, Lansing.

Hanchin, P.A. 2017. A summary and analysis of the Large Lakes Survey Program in Michigan in 2001-2010. Michigan Department of Natural Resources, Fisheries Report 25, Lansing.

Laarman, P. W. 1976. The sport fisheries of the twenty largest inland lakes in Michigan. Michigan Department of Natural Resources, Fisheries Research Report 1843, Ann Arbor.

Northeast Michigan Council of Governments. 2007. Grand Lake and coastal watersheds management plan. NEMCOG, Gaylord, MI.

Shouder, M.F. 1977. A progress report of 1976 Walleye survey, Grand Lake, Presque Isle County. Michigan Department of Natural Resources, Fisheries Division. Technical Report No. 76, Ann Arbor.

TMI Analytical Services. 1994. 1994 Biological, chemical, and physical limnological water quality surveys, Grand Lake, Presque Isle County, Michigan.

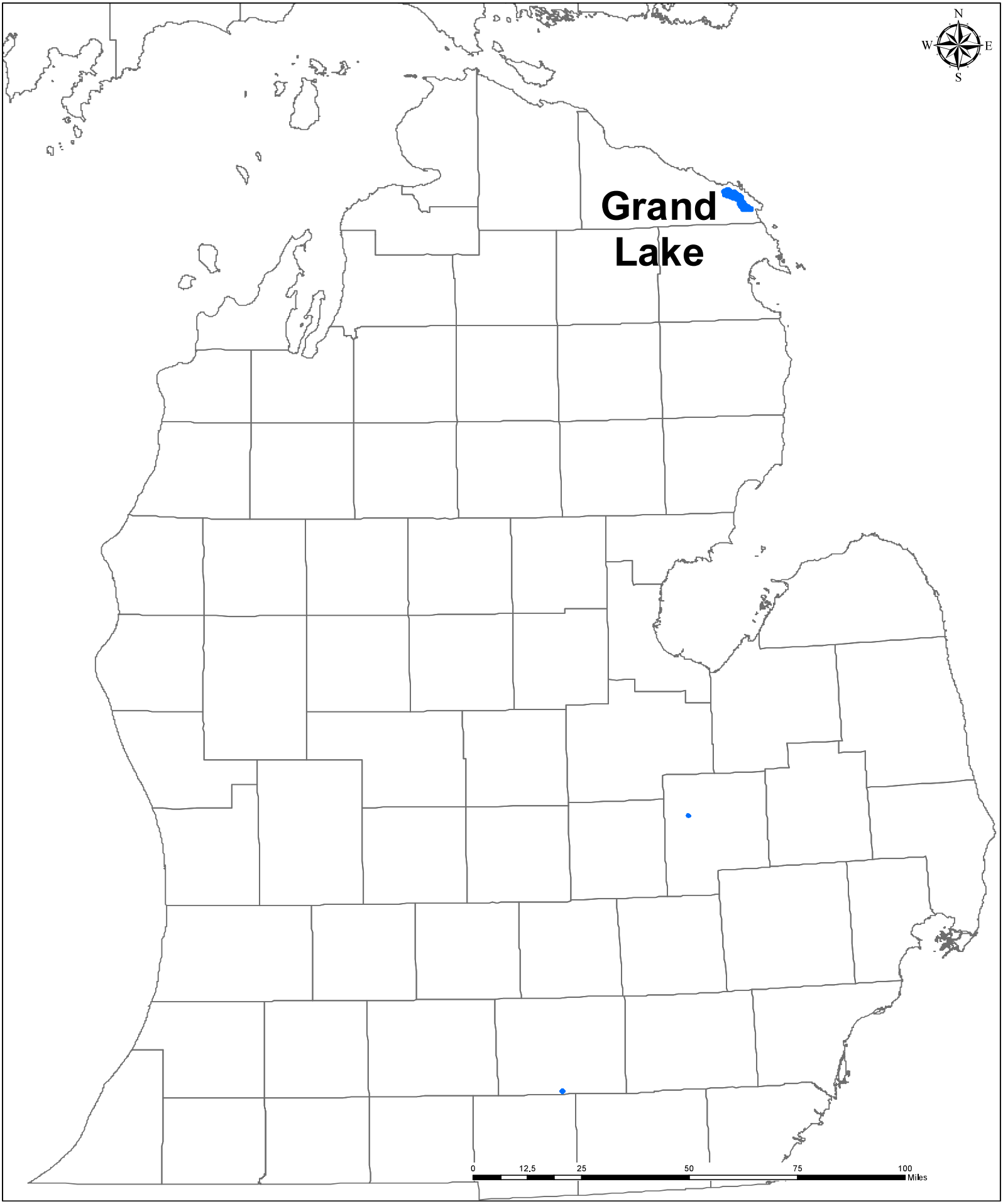

Figure 1.-Location of Grand Lake in Northern Michigan.

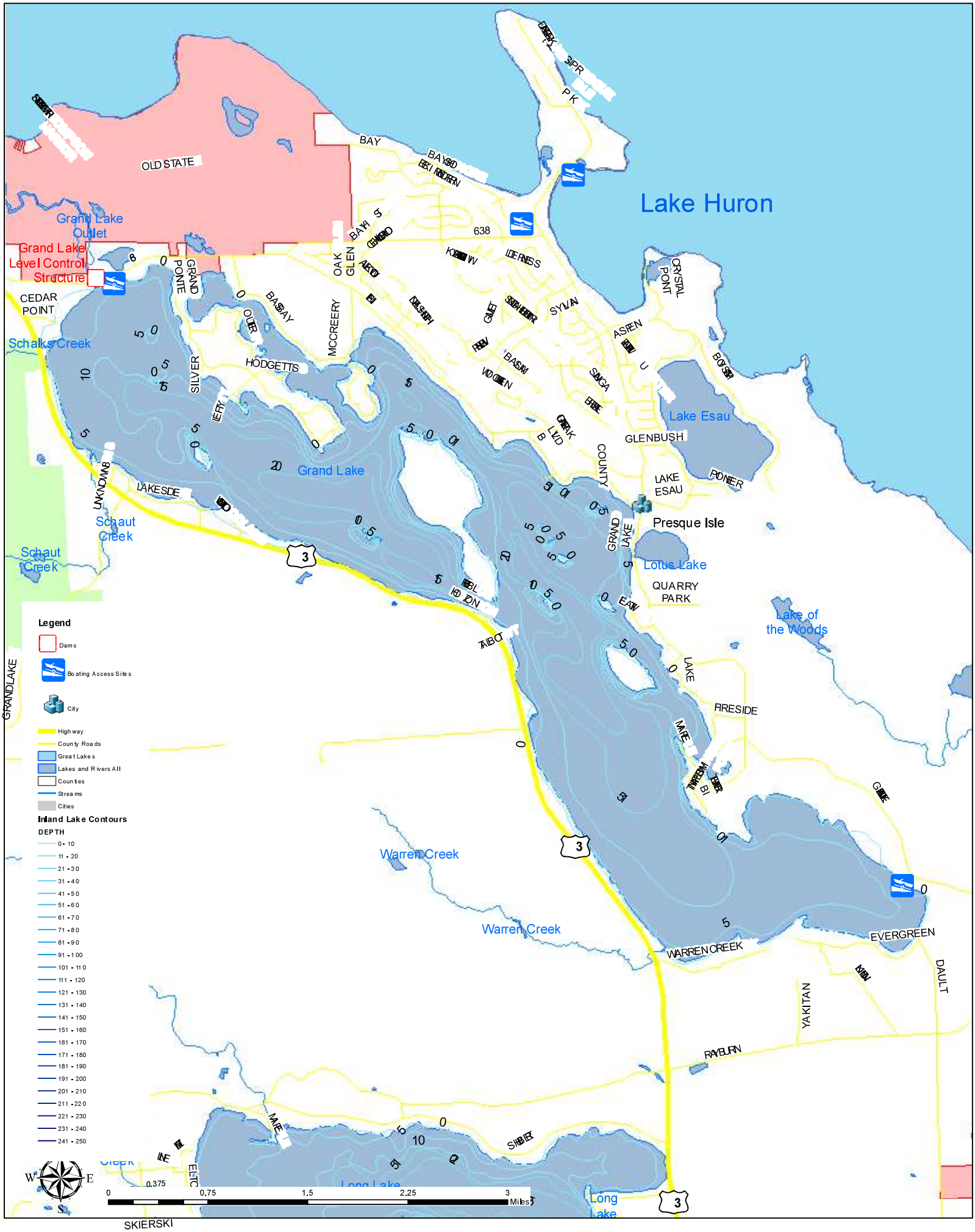

Figure 2.-Bathymetric map for Grand Lake.

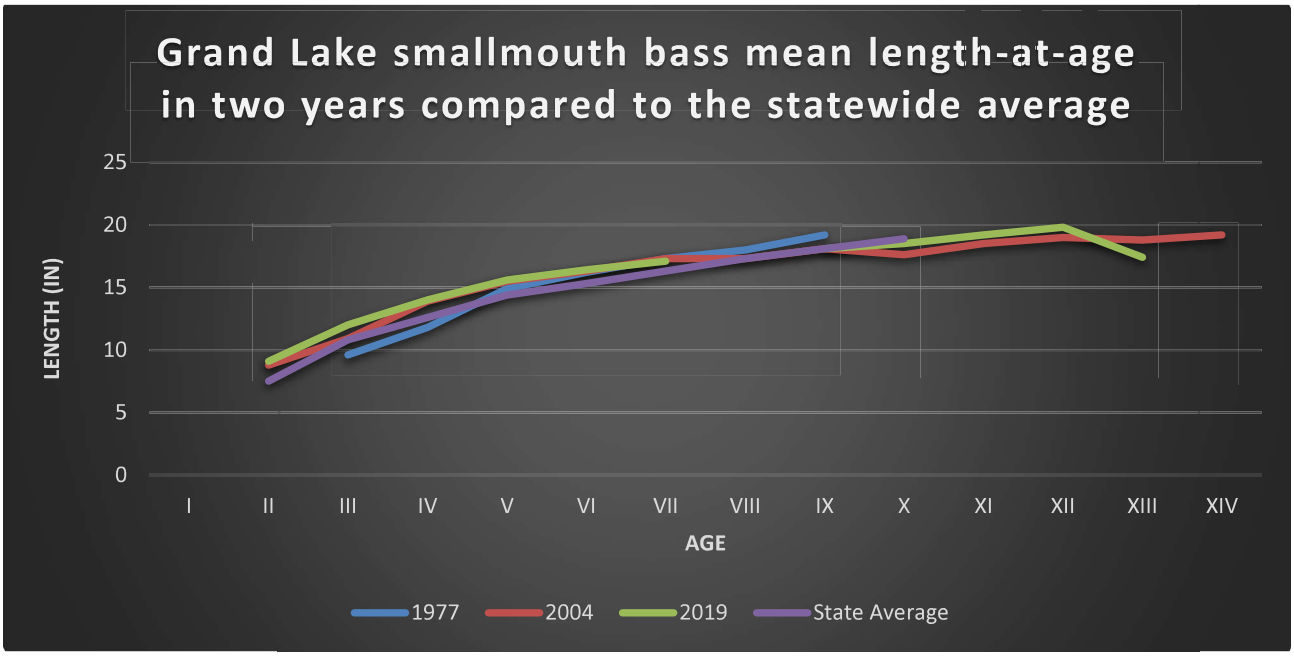

Figure 3.-Age and growth comparisons of Grand Lake Smallmouth Bass from different surveys over time.

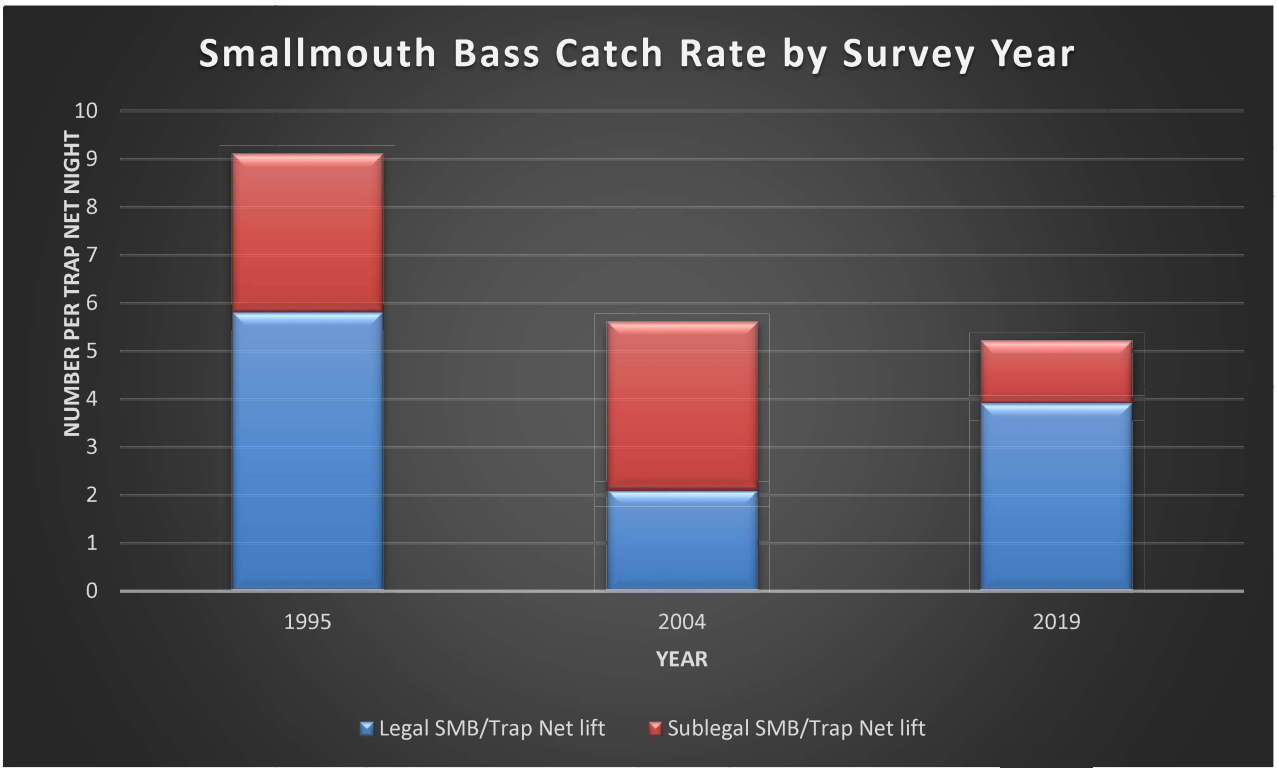

Figure 4.-Comparison of Smallmouth Bass catch rates from trap netting by year.

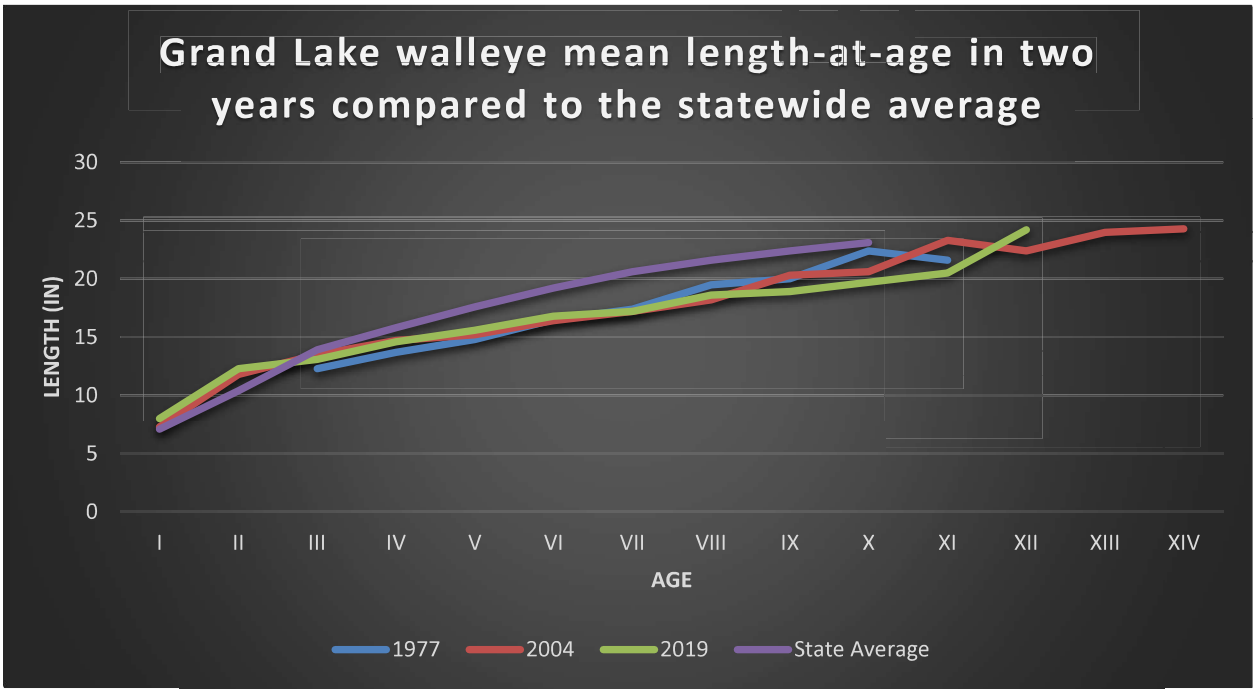

Figure 5.-Age and growth comparisons of Grand Lake Walleye from different surveys over time.

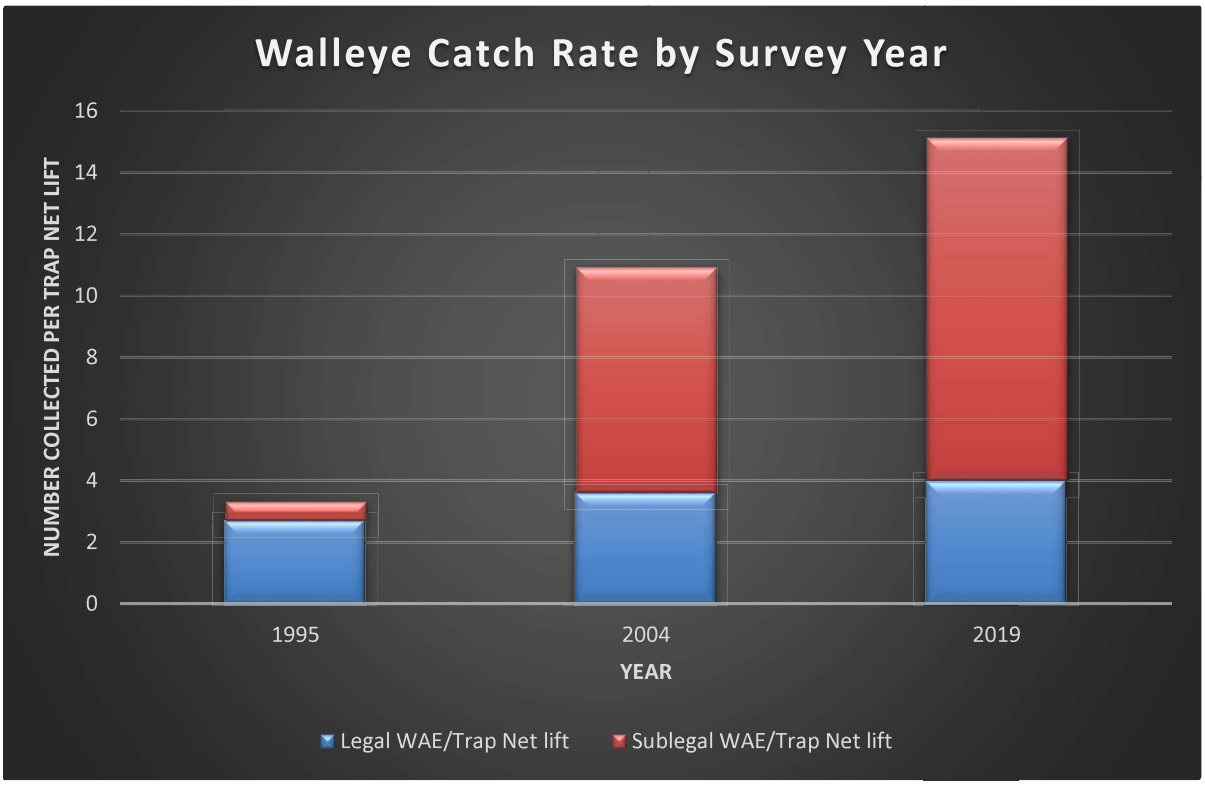

Figure 6.-Comparison of Smallmouth Bass catch rates from trap netting by year.

Photo 1.-Grand Lake water level control structure.

Photo 2. Schaulks Creek control structure and Northern Pike spawning marsh.

Table 1.-Water temperature and dissolved oxygen profile for Grand Lake, August 8, 2004.

Depth (ft)	Temperature (F)	Dissolved Oxygen (ppm)
1	72	8.9
2	72	8.9
3	72	8.9
4	72	8.8
5	71	8.8
6	71	8.8
7	71	8.8
8	71	8.8
9	71	8.8
12	71	8.8
13	71	8.8
15	71	8.7
16	71	8.7
17	71	8.6
18	70	8.6
20	70	8.6
22	70	8.6

Table 2.-History of known fisheries management or other important activities for Grand Lake.

Year	Month	Management Activity	Reason for the Activity
1906-45	Various	Warm and cool water fish species stocking	Bolster fish populations
1935-36	Winter	Creel census	Gather angler catch and effort information
1939-50	Various	General creel census	Gather angler catch and effort information
1944-46	Various	Commercial trap netting	Removal of rough fish species
1949-51	Various	Brush shelter installation	--
1950	June-July	Aquatic community survey	Gather baseline information on fish and habitat
1951-64	Various	General creel census	Gather angler catch and effort information
1955-56	Various	Lake level established/dam constructed	--
1959	September	Fish gill-netting	Gather fish community information
1961	June	Fish seining	Measure northern pike and walleye population
1962	June	Fish trap netting	Determine fish species composition and growth
1962	Various	Pike spawning marsh built	Bolster northern pike abundance through stocking
1970	--	Estimation of angler effort from mail survey	Determine Grand Lake angler days
1970	June	Electrofishing	General fish community survey
1973	--	Estimation of angler effort from mail survey	Determine Grand Lake angler days
1976	April-May	Fish trap netting	Evaluate fish community, particularly walleye and bass
1976	May-August	Creel census	Gather angler catch and effort information
1977	April	Fish trap netting	Evaluate fish community, particularly walleye and bass
1979	Various	Limnological sampling	Evaluate overall water quality
1990	--	Size limit of Walleye reduced to 13 inches	
1994	Various	Limnological sampling	Evaluate overall water quality
1995	May	Trap and fyke netting	General survey with emphasis on walleye
1996	September	Nighttime shoreline electrofishing	Walleye recruitment evaluation
1997	--	Size limit of Walleye increased to 15 inches	
1997	September	Nighttime shoreline electrofishing	Walleye recruitment evaluation
2004	April	Fyke and trap netting, electrofishing	Fish community evaluation with emphasis on walleye, pike, and smallmouth bass
2004-05	Various	Creel census	Gather angler catch and effort information
2004	June-July	Fyke and trap netting, electrofishing	General fish community evaluation
2006	September	Nighttime shoreline electrofishing	Walleye recruitment evaluation

Table 2.-Continued

Year	Month	Management Activity	Reason for the Activity
2007	--	Grand Lake and Coastal Watershed Plan	Regional planning
2014	September	Nighttime shoreline electrofishing	Walleye recruitment evaluation
2019	May	Submit 26 smallmouth bass to MSU health lab for virus testing	Regional bass mortality events
2019	May	Trap netting	Evaluate smallmouth bass and walleye population

Table 3.-Known number and size of fish stocked in Grand Lake from 1891 through 2017. Some of the data reproduced from Laarman (1976).

Species	Year(s)	Size	Number	Source
Yellow Perch	1910-14	Fingerlings	8,750	State
	1921	Fingerlings	15,750	State
	1933-39	Fingerlings	208,950	State
Bluegill	1933-45	Fingerlings	340,700	State
Sunfish spp.	1944	Fingerlings	5,160	State
Warmouth	1910	Yearlings	450	State
Largemouth Bass	1906-14	Fry and fingerlings	89,325	State
	1933	Fingerlings	1,800	State
	1938-45	Fingerlings	22,250	State
Smallmouth Bass	1911-14	Fingerlings	1,900	State
	1933-34	Adult	972	State
	1936-45	Fingerlings and adult	15,622	State
Bullhead spp.	1948	Adults	70	State
Walleye	1913	Fry	285,000	State
	1933-42	Fry	4,320,000	State
Tiger Muskellunge	1978-80, 1982	Fall fingerlings	36.000	State
Northern Pike*	1962-76	Spring fingerlings	5,000-50,000/yr	State/Public
	1978-86	Spring fingerlings	299,825	State/Public
	1987-2000	Spring fingerlings	129,000	State/Public
	1987-2000	Yearlings	4,000	State/Public
	1987-2000	Fall fingerlings	8,000	State/Public
	2001-2019	Fall fingerlings	Unknown	State/Public

*Northern pike fry were stocked into the Grand Lake pike marsh for a number of years, at least part of the 1980s, with the goal of stockout at fingerling size.

*The pike marsh in recent decades has not been stocked with fish, rather, small numbers of adult pike are allowed to enter the marsh from Grand Lake during spawning time. Fingerling production during this period is unknown, and likely small and highly variable.

Table 4.-Removal of rough fish by commercial trap netting, 1944-46. Table reproduced from Laarman (1976).

Species	**Number of fish caught**		**Percent of total catch**	
White Sucker	1,009	4,919	64.9	70.4
Walleye	303	1,151	19.5	16.5
Northern Pike	33	107	2.1	1.5
Rock Bass	189	563	12.2	8.1
Smallmouth Bass	10	62	0.6	0.9
Largemouth Bass	1	--	<0.1	--
Yellow Perch	4	160	0.3	2.3
Others*	5	21	0.3	0.3

*Included Bowfin, bullhead species, Cisco, sunfish species, and Bluegill.

Table 5.-Species composition of catch from the general creel census of Grand Lake from 1939-50 and 1951-64. Table reproduced from Laarman (1976).

Species	**Percent of catch**	
	1939-50	1951-64
Bluegill	0.7	0.3
Sunfish species	0.7	2.1
Rock Bass	4.8	18.4
Yellow Perch	85.2	66.6
Largemouth Bass	0.2	0.2
Smallmouth Bass	2.8	4.7
Walleye	3.0	6.4
Northern Pike	2.1	1.1
Cisco	0.4	--
Others	--	0.2

Table 6.-Angler survey estimates for summer and winter 2004-05 from Grand Lake. Angler survey period was April 24 through October 13, 2004 and December 17, 2004 through March 26, 2005. Data is reproduced from Hanchin (2011). Detailed variance estimates on harvest and species catch by month and period can be found in Hanchin (2011).

Species	Number Harvested	Number Released	Percent of Total Catch
Smallmouth Bass	606	2,953	7.7
Walleye	344	161	1.1
Yellow Perch	9,051	31,724	87.7
Northern Pike	59	38	<1
Rock Bass	492	591	2.3
Pumpkinseed	41	167	<1
Bluegill	28	60	<1
Cisco	--	12	<1
Largemouth Bass	--	6	<1
White Sucker	--	49	<1
Longnose Gar	--	18	<1
Brown Bullhead	--	77	<1
Angler Hours	33,037		
Angler Trips	10,350		

Table 7.-Temperature and chemical characteristics of Grand Lake, July 1950. Table reproduced from Rodeheffer and Day (1952).

Depth (ft)	Temperature (F)	Dissolved oxygen (ppm)	Alkalinity (ppm)	pH
Surface	70.0	7.8	127	8.2
12	68.7	7.8	125	8.4
15	68.7	--	--	--
20	68.2	--	--	--
22	66.9	7.8	129	8.4

Table 8.-A list of aquatic vegetation in Grand Lake and their relative abundance based on a 1950 survey by the Michigan Department of Conservation. Table reproduced from Rodeheffer and Day (1952). Some species names may have changed in modern day.

Common Name	Scientific Name	Relative Abundance
Waterweed	*Anacharis canadensis*	Sparse to common
Coontail	*Ceratophyllum demersum*	Sparse
Spike rush	*Elecharis sp.*	Sparse
Water milfoil	*Myriophyllum sp.*	Sparse to dense
Bushy pondweed	*Najas flexilis*	Sparse
White water lily	*Nymphaea odorata*	Sparse to common
Yellow water lily	*Nuphar advena*	Sparse to common
Reed grass	*Phragmites sp.*	Sparse to dense
Large-leaf pondweed	*Potamogeton amplifolius*	Sparse
Floating-leaf pondweed	*Potamogeton natans*	Sparse to common
Sago pondweed	*Potamogeton pectinatus*	Sparse to common
White-stem pondweed	*Potamogeton praelongus*	Sparse to common
Flat-stem pondweed	*Potamogeton zosteriformus*	Sparse
Robbin's pondweed	*Potamogeton Robbinsii*	Sparse to common
Soft-stem bulrush	*Scirpus Validus*	Sparse to dense
Cattail	*Typha lattifolia*	Sparse to dense
Bladderwort	*Utricularis purpurea*	Sparse to common
Wild celery	*Vallisneria spiralis*	Sparse to common
Muskgrass	*Chara*	Sparse to common

Table 9.-List of fish, taken or reported, and their relative abundance from the 1950 survey at Grand Lake. Table reproduced from Rodeheffer and Day (1952).

Common name	Scientific name	Relative abundance
Northern Pike	*Esox lucius*	Abundant
Yellow Perch	*Perca flavescens*	Abundant
Walleye	*Stizostedion vitreum*	Common
Smallmouth Bass	*Micropterus dolomieui*	Common
Pumpkinseed	*Lepomis gibbosus*	Common
Rock Bass	*Ambloplites rupestris*	Abundant
Longear sunfish	*Lepomis megalotis*	Few
Cisco	*Coregonus artedi*	Common
White Sucker	*Catastomus commersoni*	Abundant
Longnose Sucker	*Catastomus catastomus*	Reported
Brown Bullhead	*Ameiurus nebulosus*	Few
Longnose Gar	*Lepisosteus osseus*	Common
Bowfin	*Amia calva*	Few
Carp	*Cyprinus carpio*	Reported
Blacknose Shiner	*Notropis heterolepis*	Common
Mimic Shiner	*Notropis volucellus*	Abundant
Common Shiner	*Notropis cornutus*	Abundant
Bluntnose Minnow	*Pimephales notatus*	Abundant
Central Mudminnow	*Umbra limi*	Few
Banded Killifish	*Fundulus diaphanus*	Few
Logperch	*Percina caprodes*	Few
Johnny Darter	*Etheostoma nigrum*	Common
Hornyhead Chub	*Hybopsis biguttata*	Few
Creek Chub	*Semotilus atromaculatus*	Few

Table 10.-Catch by length of certain Grand Lake fish from seining, fyke-netting, and trap-netting in the summer of 1961 and 1962.

Length (in)	Walleye	Yellow Perch	Smallmouth Bass	Northern Pike	Rock Bass	Pumpkinseed	White Sucker
<6		86	1		626	18	
6.0 – 6.9		57	3		300	11	5
7.0 – 7.9	3	46	41		281	16	14
8.0 – 9.9	81	41	92		404	7	62
10.0 – 14.9	295	18	143	1	386		489
15.0 – 19.9	33		41	4			718
>=20	8			2			

Table 11.-Comparison of mean length (inches) at age for various game fishes of Grand Lake from 1977 to 2019. Number in parentheses represents number aged. Scales were used for game fish prior to 2004, while dorsal rays were used on larger game fish starting in 2004.

Species	Age group	April 1977	April 1981	May 1995	April 2004	April 2019
Yellow Perch	I	--	--	--	--	--
	II	4.2 (60)	3.9 (3)	--	--	--
	III	6.1 (35)	4.9 (2)	--	5.9 (16)	--
	IV	7.1 (19)	--	--	7.1 (12)	--
	V	8.2 (10)	8.8 (1)	8.3 (2)	8.0 (15)	--
	VI	9.7 (14)	8.9 (6)	--	9.7 (12)	--
	VII	10.7 (10)	--	10.9 (2)	10.0 (8)	--
	VIII	11.2 (15)	--	--	11.3 (6)	--
	IX	12.1 (3)	--	--	11.8 (8)	--
	X	12.4 (2)	--	--	12.9 (5)	--
	XI	--	--	--	--	--
	XII	--	--	--	13.6 (1)	--
Walleye	I	--	--	--	7.3 (15)	8.0 (1)
	II	--	10.9 (4)	11.3 (4)	11.8 (47)	12.3 (15)
	III	12.3 (57)	12.5 (19)	12.8 (5)	13.5 (26)	13.1 (21)
	IV	13.7 (68)	13.7 (16)	14.1 (21)	14.8 (29)	14.6 (9)
	V	14.8 (82)	15.0 (8)	15.3 (12)	15.2 (20)	15.6 (14)
	VI	16.5 (44)	15.7 (20)	16.3 (15)	16.5 (40)	16.8 (19)
	VII	17.4 (33)	17.2 (9)	17.2 (8)	17.2 (40)	17.2 (13)
	VIII	19.5 (14)	18.6 (12)	18.4 (32)	18.3 (54)	18.6 (4)
	IX	20.0 (1)	21.0 (1)	20.4 (9)	20.3 (14)	18.9 (2)
	X	22.4 (3)	22.2 (4)	--	20.5 (5)	19.7 (5)
	XI	21.6 (4)	--	--	23.4 (4)	20.5 (1)
	XII	--	--	25.1 (1)	--	24.2 (2)
	XIII	--	--	--	22.4 (8)	20.2 (1)
	XIV	--	--	--	24.2 (2)	--
	XV	--	--	--	24.4 (4)	--

Table 11.-Continued.

Species	Age group	April 1977	April 1981	May 1995	April 2004	April 2019
Northern	I	--	--	--	12.3 (9)	--
Pike	II	--	19.2 (49)	19.1 (16)	17.6 (26)	--
	III	--	22.4 (26)	20.7 (24)	23.5 (58)	--
	IV	--	26.0 (13)	24.4 (13)	25.0 (30)	--
	V	32.0 (1)	31.2 (6)	25.3 (4)	26.8 (20)	--
	VI	--	34.3 (1)	29.0 (2)	27.0 (11)	--
	VII	38.9 (7)	26.7 (1)	34.5 (2)	35.3 (3)	--
	VIII	--	38.2 (1)	37.7 (1)	27.4 (1)	--
	IX	--	--	39.2 (3)	28.1 (2)	--
	X	--	--	39.5 (1)	41.3 (2)	--
	XI	--	--			--
Smallmouth	I	--	--	--	--	--
Bass	II	--	--	7.7 (1)	8.8 (53)	9.1 (10)
	III	9.6 (15)	9.0 (7)	9.0 (1)	10.9 (73)	12.0 (21)
	IV	11.8 (106)	11.3 (9)	11.4 (47)	13.9 (32)	14.0 (23)
	V	14.9 (30)	12.5 (20)	13.4 (16)	15.6 (23)	15.6 (7)
	VI	16.2 (20)	14.3 (15)	14.7 (23)	16.3 (17)	16.4 (8)
	VII	17.3 (23)	15.8 (7)	16.0 (14)	17.3 (15)	17.1 (6)
	VIII	18.0 (10)	16.7 (4)	17.1 (18)	17.4 (6)	--
	IX	19.2 (3)	--	17.7 (9)	18.1 (9)	18.1 (9)
	X	--	--	18.5 (10)	17.6 (2)	18.5 (4)
	XI	--	--	19.0 (11)	18.5 (7)	19.2 (4)
	XII	--	--	--	19.0 (7)	19.8 (3)
	XIII	--	--	--	18.9 (5)	17.4 (9)
	XIV	--	--	--	19.2 (2)	--

Table 12.-Length-frequency distribution of Walleye at Grand Lake in various survey years. Sampling effort was highly variable between years, and in April or May.

Length (in)	1981	1996	2004	2019
1				
2				
3				
4			1	
5			8	
6			47	
7			122	
8			43	1
9			5	
10	2	1	100	3
11	14	4	433	47
12	110	1	360	240
13	142	12	126	234
14	96	23	270	178
15	64	33	319	117
16	19	58	353	61
17	19	66	225	28
18	5	22	128	22
19	4	12	51	9
20	2	7	25	5
21	1		15	4
22	1	1	11	3
23	1		9	2
24	1		4	1
25		1	2	
26			2	
27				
28			1	
29				
30				
31				
32				
33				
34				
35				
36				
37				
38				
39				
Mean Length (in)	14.2	16.7	14.2	14.2

Table 13.-Length-frequency distribution of Smallmouth Bass at Grand Lake in various survey years. Sampling effort was highly variable between years, and in April or May.

Length (in)	1981	1995	2004	2019
1				
2				
3			2	
4				
5				
6			22	
7		1	65	1
8	4		57	5
9	3	1	123	7
10	4	23	454	4
11	14	83	274	17
12	27	73	79	25
13	28	61	80	25
14	19	89	118	21
15	9	109	206	29
16	7	117	235	68
17	3	69	127	91
18	1	35	59	26
19		8	18	9
20			1	3
21				
22				
23				
24				
25				
26				
27				
28				
29				
30				
31				
32				
33				
34				
35				
36				
37				
38				
39				
40				
41				
42				
Mean Length (in)	13.3	14.8	12.9	15.7

Table 14.-Fall juvenile Walleye nighttime electrofishing assessments at Grand Lake.

Year	Date	Water Temp (F)	Hours	Miles Shocked	Age-0 walleye	No. age-0 per hour	Yearling walleye collected	Adults
1996	9/12	73	2.0	2.5	21	10.5	5	1
1997	9/8	63	--	2.0	39	--	22	0
2006	9/21	59	4.0	7.6	65	16.3	6	16
2014	9/23	59	2.7	6.8	152	56.3	32	53

Table 15.-Fish collected from Grand Lake using a total sampling effort of 163 trap net lifts and 294 fyke net lifts. Table reproduced from Hanchin (2011).

Species	Total Catch[a]	Percent by number	Length range (in)	Average length (in)[b]
White Sucker	7,586	36.3	6.0 – 20.9	12.4
Yellow Perch	3,848	18.4	4.3 – 13.5	7.1
Walleye	3,295	15.8	4.9 – 28.0	14.2
Rock Bass	2,451	11.7	3.1 – 12.0	6.9
Smallmouth Bass	2,125	10.2	3.0 – 20.2	12.8
Pumpkinseed	537	2.6	3.0 – 12.6	5.9
Brown Bullhead	377	1.8	6.2 – 17.0	13.8
Bluegill	309	1.5	2.8 – 9.8	6.2
Northern Pike	232	1.1	10.9 – 42.0	23.3
Bowfin	79	0.4	12.1 – 28.9	23.3
Common Shiner	38	0.2	5.1 – 7.3	6.3
Longnose Gar	15	0.1	12.7 – 41.5	29.6
Largemouth Bass	9	<0.1	8.2 – 21.1	14.2
Yellow Bullhead	3	<0.1	11.5 – 12.3	11.9
Green Sunfish	1	<0.1	3.7	3.7
Common Carp	1	<0.1	32.7	32.7
Total	20,906			

[a] Includes recaptured fish

[b] Does not include recaptures for Walleye, Northern Pike, or Smallmouth Bass

Table 16.-Number of fish per inch group of certain species caught and measured in Grand Lake during fyke and trap netting efforts April 9-23, 2004. Many of these are subsamples of the total catch for that species. Table reproduced from Hanchin (2011).

	Species													
Inch group	**White Sucker**	**Yellow Perch**	**Walleye**	**Rock Bass**	**Smallmouth Bass**	**Pumpkinseed**	**Brown Bullhead**	**Bluegill**	**Northern Pike**	**Bowfin**	**Longnose Gar**	**Yellow Bullhead**	**Carp**	**Largemouth Bass**
<5		12	1	167	2	79		60						
5		137	8	166		160		88						
6	8	322	47	186	22	160	1	46						
7	151	212	122	248	65	57		67						
8	214	67	43	236	57	13	1	42						2
9	28	38	5	71	123	4	4	4						
10	12	18	100	34	454		2		1					
11	25	18	433	10	274		16		2			1		
12	21	8	360	1	79	1	41		2	1	1	2		1
13	13	4	126		80		79		6					
14	3		270		118		118		6	1				3
15	25		319		206		43		3					
16	82		353		235		13		2	2				1
17	100		225		127		1		5					1
18	91		128		59				4	2				
19	38		51		18				6					
20	10		25		1				12	2				
21			15						15	15	1			1
22			11						17	7				
23			9						22	9				
24			4						34	12				
25			2						21	13	1			
26			2						15	9	1			
27									10	2				
28			1						5	2	3			
29									3		2			
30									3		1			
31											1			
32									1		1		1	
33														
34														
35									2					
36									2					
37														
38									1		1			
39														
40									2					
41											2			

Table 17.-Fish collected from Grand Lake from June 28 – July 1, 2004. Effort consisted of 9 large mesh fyke net nights, 10 large mesh trap net nights, 3 small mesh fyke net nights, 12 inland gill net nights, and 2 mini-fyke net nights.

Species	Total Catch	Percent by number	Length range (in)	Average length (in)
Yellow Perch	403	29.7	1 - 10	5.7
Rock Bass	353	26.0	1 - 11	5.7
Common Shiner	340	25.0	--	--
Smallmouth Bass	141	10.4	1 - 19	11.2
White Sucker	58	4.3	8 - 20	15.9
Longnose Gar	19	1.4	21 - 45	31.7
Walleye	13	1.0	6 - 26	16.5
Pumpkinseed	12	0.9	2 - 8	6.8
Bluegill	9	0.7	1 - 10	4.9
Logperch	4	0.3	3	3.5
Bluntnose Minnow	2	0.1	--	--
Brown Bullhead	2	0.1	12 - 14	13.5
Spotttail Shiner	2	0.1	2	2.5
Northern Pike	1	0.1	24	24.5
Total	1,359			