Nichols Lake

Newaygo County, (T15N, R13W, Sections 15 & 16; T16N, R13W, Sections 5 & 6)
Pere Marquette River Watershed - Big South Branch

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Environment

Geography
Nichols Lake is located in Newaygo County, in the western portion of the lower peninsula of Michigan (Figure 1). This lake is part of the Lake Michigan, Pere Marquette River and Big South Branch of the Pere Marquette River watersheds. Nichols Lake has no inlet or outlet streams. Public access is provided by two U.S. Forest Service (USFS) boat ramps, a fishing pier, and campground.

Land Use
The area around Nichols Lake was heavily logged during the mid-to-late 1800s. Historical photographs of this general area showed few, if any, trees were left standing after the logging operations. A survey of the lake in 1937 indicated the shoreline areas were wooded so some degree of shoreline cover in second growth forest was restored by that time.

The U.S. Forest Service owns approximately 85 % of the shoreline of Nichols Lake. The remaining shoreline is in private ownership that is all located on the eastern shore of the lake. A shoreline survey of human dwellings, artificial shore armor (rocks and seawall), and submerged trees was conducted in 2007. The human dwelling density for Nichols Lake was relatively low, artificial shore armor was moderate to low, and submerged tree densities were moderate to low when compared to other Michigan lakes (Figures 2).

Lake Morphology
Nichols Lake was mapped and general physical features inventoried in 1937 (Figure 3). The west basin had a maximum depth of 57 ft, the east basin was about 25 ft deep and the south basin was about 15 ft deep. The lake had a surface area of approximately 160 acres and the shoreline was 2.9 miles long.

Water Temperature and Chemical Features
Alkalinity, chlorophyll-a, water transparency, water temperature, and dissolved oxygen information was acquired during surveys conducted in 1937, 1939, 1957, 2002 and 2003. Alkalinity was measured in 1937, 1939, 1957, 2002 and 2003 in Nichols Lake. Alkalinity values were moderate during this period when compared to other Northern Lower Peninsula Michigan lakes, indicating average biological productivity in Nichols Lake (Figure 4, Tables 1 & 2). Ph values were typical for Michigan lakes at depths from the surface to 60 ft in 2002 (typical range = 6.0-9.0).

Total phosphorous concentrations in 2002 and 2003 were moderate to low when compared to other Northern Lower Peninsula Michigan lakes. These values indicated mesotrophic to oligotrophic productivity conditions in Nichols Lake (Figure 4, Table 1). The nitrogen-phosphorous ratio indicated phosphorous was the limiting nutrient for plant growth (N/P>15:1).

Chlorophyll-a concentrations were measured in Nichols Lake in 2002 and 2003. Chlorophyll-a concentrations were within the normal range when compared to other Northern Lower Peninsula Michigan lakes. Chlorophyll-a concentrations indicated mesotrophic to oligotrophic productivity conditions in Nichols Lake (Figure 4, Table 1).

Water transparency (Secchi disc) was measured in Nichols Lake during 1937, 1939, 1957, 2002 and 2004. Water transparency was moderate in 1939 and relatively high in all other years when compared to other Northern Lower Peninsula Michigan lakes (Figure 5, Tables 1 & 2). Water transparency indicated borderline mesotrophic to oligotrophic conditions with the exception of 1939, which indicated mesotrophic conditions. The reason for lower water transparency in 1939 is uncertain because weather conditions were similar to other years and similar Secchi disk values were found in both the main and east basins. However, the measurements were collected in June when water temperatures were cooler (see below).

Water temperature profiles related to depth were collected in Nichols Lake during 1937, 1939, 1957, 2002, and 2003 (Figure 6). A thermocline was established between depths of 15 ft and 50 ft during 2003 and 2004 in both the east and west basins. The south bay is shallow and a thermocline did not develop. A thermocline was established at similar depths in the main basin in 1939 and 1957. In June of 1937, a thermocline was present but water temperatures were cooler than other years. Cooler water temperatures measured in 1937 likely were the result of measurements collected earlier in summer

Dissolved oxygen levels in the main basin generally were greater than 5 mg/l to depths of 25-35 ft in all years (Figures 7). However, during 1937 oxygen levels tended to be lower than other years. This could be related to an overturn event, which would be consistent with the cooler water temperatures measured on that date (Figure 6). Anoxic conditions existed in the hypolimnion during all years. Dissolved oxygen levels in the east basin were lower than main basin levels in both 2002 and 2003. This may indicate more enriched conditions in the east basin, which also was indicated by somewhat higher chlorophyll-a and nitrogen concentrations, and lower water transparency (Table 1).

The main basin of Nichols Lake has a cool (69ºF or lower) layer of water with dissolved oxygen levels greater than 5 mg/l. This segment of water exists within the thermocline at depths of about 20- 35 ft. The oxygenated thermocline layer was present in all years evaluated.

Biological Features

Zooplankton samples were collected from Nichols Lake in 2002 and 2003. Mean zooplankton size was average when compared to other Northern Lower Peninsula Michigan lakes (Figure 8 Table 1).

Fifteen species of aquatic plants were collected during the original survey and mapping of Nichols Lake in 1937 (Table 3). Comments from this survey indicated aquatic plants were considered sparse throughout the lake and this was likely limiting biological production in the lake. Comments from a lake resident indicated aquatic plants had been found in much greater abundance in past years, but had declined as marl deposits increased in the lake. This initial investigation of aquatic plants was limited and intended to give only a general description of the common species present in the lake.

An intensive survey of aquatic plants in Nichols Lake was conducted in 2001 and 2002. Surveys were conducted by the Michigan Department of Natural Resources (MDNR) Fisheries Division using hook and quadrat methods and the Michigan Department of Environmental Quality (MDEQ) using hook sampling and visual observations. Thirty five species of aquatic plants were found in this survey (Table 3). All but two species collected in 1937 were collected in 2001-2002. Curly-leaf pondweed and Eurasian water-milfoil were non-native species found in the recent surveys.

The MDNR aquatic plant surveys in 2001-2002 using hook and quadrat sampling were designed primarily to evaluate species composition and biomass (wet weight) of submerged and emergent plants within the water. Wetland species shoreward of the waters edge were not evaluated. Samples were collected at 23 transects located at 656.2 ft intervals around the lake. At each transect, samples were collected at 10 depths (0.8 ft, 1.6 ft, 3.3 ft, 6.6 ft, 9.8 ft, 13.1 ft, 16.4 ft, 19.7 ft, 23 ft, and 26.2 ft). At each depth, hook samples were collected in each of 4 quadrants in 2001 (n=648) and in 2 quadrants in 2002 (n=340). Quadrat samples using scuba gear were collected at 95 of these same sites to make biomass and species composition comparisons between the two methods.

Eight native plant species or groups were found at levels greater than 1.5 % of total weight and accounted for 96.2 % of total weight (Figure 9). The macro-algae muskgrass (Chara spp.) accounted for 43.9% of total biomass, followed by common waterweed at 20.0% and native water-milfoil at 12.7%. Eurasian water-milfoil and curly-leaf pondweed (too low to weigh) accounted for a very low portion of total weight. Curly-leaf pondweed likely was more abundant than indicated because this plant generally reaches peak abundance during early summer rather than late summer when these samples were collected. Also, a comparison of hook and quadrat samples indicated the relative biomass of some plants were somewhat underestimated (muskgrass, bulrushes and sedges) and others were somewhat overestimated (common waterweed, native water-milfoil, and native pondweeds) by hook sampling. These differences did not change the overall dominance pattern of submerged plants but emergent rushes and sedges were nearly equal in relative biomass to common waterweed.

Some aquatic plants occurred more frequently but contributed less to overall biomass of the plant community. These plants included Naiads., Illinois pondweed, large-leaf pondweed, sweet-scented waterlily, and bulrushes (Figure 9). Naiads generally are small plants with low biomass and the pondweeds were likely not very abundant. Hook sampling did not effectively collect the bulrushes.

Aquatic plants were found growing to depths of 23 ft in Nichols Lake (Figure 10). The greatest biomass and frequency of plants were found at depths of 3.3-16.4 ft. As noted earlier, hook samples were not effective at sampling bulrushes and quadrat sampling indicated that bulrush frequency and biomass were very high in nearshore waters and above the waterline. The full extent of bulrush distribution above and below the waterline was mapped using a global positioning instrument in 2001. Bulrushes were found around the entire shoreline of Nichols Lake (Figure 11). The bed width and density of bulrushes varied in different areas of the lake and were lower in areas used as beaches or with hardened shoreline and where sand fill and cutting occurred near dwellings.

The two non-native plants, Eurasian water-milfoil and curly-leaf pondweed were found widely distributed in Nichols Lake (Figure 12). Both of these plants were found in relatively low abundance in 2001 and 2002. Historical sampling information indicated Eurasian water-milfoil, and most likely curly-leaf pondweed, were originally found only in the eastern portion of the lake where aquatic plant removal occurred adjacent to the private properties (see discussion below). These plants have now spread to other areas of the lake.

Known chemical treatment applications for aquatic vegetation removal in Nichols Lake from 1996 through 2007 were summarized in Table 4. Chemical treatments or other types of plant removal likely occurred prior to 1996 but information was not available for earlier years. In 1997 a survey of aquatic vegetation in Nichols Lake was conducted by the MDEQ, MDNR, and USFS. Eurasian water-milfoil and curly-leaf pondweed were found in the east end of the lake where plant removal had occurred in the past. Curly-leaf pondweed was also found in two locations on the west shore of the lake. Curly-leaf pondweed was most abundant in the east end of the lake and likely was first established in that area of the lake. Chemical treatments for aquatic plants in the east end of the lake occurred every year through 2007, with the exception of 2002 and 2003. The two years when treatments did not occur followed a letter from the MDNR to the Lake Association recommending against removing native vegetation in the lake. The MDNR has consistently recommended to MDEQ that they not allow chemicals that remove native plants be used in Nichols Lake. Removing native plants allows reintroduction and potential further expansion of non-native plants in the lake.

Chemicals that have consistently been used in Nichols Lake include copper products, Reward (diquate dibromide), Hydrothol 191 algaecide and herbicide (endothall), Aquathol-K (endothall), and in recent years Renovate 3 (triclopyr; Table 4). Renovate 3 is a systemic that is used for controlling Eurasian water-milfoil but also kills native water-milfoil, yellow pond-lily, pickerelweed, sweet-scented waterlily, and watershield. All of the other chemicals used were contact herbicides. Copper products are generally used to control algae (filamentous and planktonic) as well as macroalgae (muskgrass and stonewort). Hydrothol 191 can also be used to kill algae, as well as coontail, pondweeds, common waterweed, milfoils, and naiads. Aquathol-K is similar to hydrothol 191 except it is generally not used to target algae or common waterweed. Reward is similar to hydrothol 191 except it is not generally used to target planktonic algae and macroalgae. Overall, chemical treatments continue to target removal of native plants in Nichols Lake.

A survey of frogs and toads was conducted along the shoreline of Nichols Lake on August 28, 2001 by Fisheries Division. The purpose of this survey was to evaluate the distribution of frogs and toads along the shoreline of the lake. The survey was conducted by walking the edge of the water around the lake and marking the sighting of each frog or toad with a global positioning unit. No attempt was made to identify species although most specimens were frogs. A total of 699 (241/mi) frogs and toads were counted along the shoreline of the lake (Figure 13). Frogs and toads were strongly associated with bulrushes and were less abundant in areas where bulrushes were in low density, beach areas, armored shorelines, and areas where bulrushes had been cut.

History

The first survey of Nichols Lake was conducted in 1926 (Table 5). This was a brief examination of the lake and lake herring (cisco) were first captured in this survey. In 1937, the lake was mapped, fish were surveyed, and observations were made on aquatic vegetation, amphibians and invertebrates. Lake herring (cisco) were last captured in this survey. General surveys for fish and limnological parameters were conducted in 1939, 1942, and 1957. Between 1968 and 1975 surveys focused on evaluating the size structure of bluegill and yellow perch populations, which were considered poor for fishing at that time. In 1974, an antimycin treatment was conducted in the south bay and east end of the lake to reduce panfish numbers and increase growth rates. This treatment was limited and not successful. During 1975 and 1976, surveys focused on walleye stocking evaluations. In 1978, the USFS proposed to conduct a full rotenone treatment to remove all fish from the lake and restock, install brush shelters, and install rock to serve as a walleye spawning reef. The Lake Association opposed the rotenone treatment. The USFS acquired a permit to install rock for a spawning reef in 1979. In 1981, the USFS removed numerous small panfish from Nichols Lake using nets. From 1990 through 1993, the management program changed to stocking larger spring fingerling walleye to increase survival and some adult walleye to help evaluate the effectiveness of the walleye spawning reef. This program was not successful and, beginning in 1994, the management program switched to stocking large numbers of spring fingerling walleye. Walleye survival improved and in 1999 alternate year stocking was implemented to further improve survival and growth of walleye. Alternate year stocking of walleye was also used to evaluate the level of natural reproduction occurring in the lake.

The DNR conducted an intensive survey of aquatic vegetation in 2001 and 2002, and a limnological survey in 2002. A status and trends survey was conducted in 2003 and results indicated fish growth was about average except for northern pike, the size structure of the bluegill population was satisfactory, and adult walleye catch rates were about average for inland lakes in Michigan. In 2004, walleye stocking numbers were decreased to improve growth rates. The Nichols Lake Association requested a no size limit regulation be established for northern pike in 2005. A habitat survey was conducted by the MDNR in 2007.

Stocking various fish species including bluegill, largemouth bass, smallmouth bass, yellow perch, walleye (fry), rainbow trout, and brook trout occurred intermittently between 1929 and 1975 (Table 6). Trout and walleye stocking during this period was considered unsuccessful. A consistent program of stocking walleye fingerlings began in 1990 and continues today. Stocking in 2007 and 2009 did not occur due to the moratorium of stocking inland waters as a result of the disease Viral Hemorrhagic Septicemia in Lake Michigan walleye (brood stock). Stocking walleye fingerlings should resume after the threat of transferring the viral disease to this lake has been resolved.

Current Status

Fishery surveys were conducted by the MDNR on Nichols Lake in 1995 and 2003. Information from these surveys will be used to summarize the current fish community conditions in this lake and make comparisons to the historical fish community.

Twelve species of fish and two species of turtles were collected during the 2003 survey and a similar species composition of fish was present in the 1995 collection (Table 7). The prevalent fish species collected, in biomass and numbers, were bluegill, largemouth bass, northern pike, black crappie, pumpkinseed, rock bass, walleye, bullhead, and yellow perch. These same species were the dominant species of fish collected in the 1937 and 1957 surveys. Spottail shiner and western banded killifish were the only forage species collected in 2003, and bluntnose minnow were present in the 1995 survey. Bluntnose minnow and western banded killifish were present in the 1937 survey. Spottail shiners and black crappie were not collected in any surveys until 1995 and 2003, indicating these species may have been introduced. Northern pike were not collected in the 1937 survey but were reported present by anglers. It is uncertain, although possible, that spottail shiner and black crappie were introduced into Nichols Lake because abundant species like these are captured effectively with standard sampling equipment used in early collections. Lake herring were first collected in 1926 and last collected in the

1937 survey (Latta 1995). Smallmouth bass were collected in low numbers in the 1937 survey but not collected since that time. These two species may have been extirpated from Nichols Lake.

The size distributions of the prevalent fish species collected in the 1995 and 2003 surveys were similar (Table 8). Relatively good numbers of large black crappie, bluegill, pumpkinseed, rock bass, walleye, and bullheads were collected. A smaller percentage of legal size largemouth bass and only one legal size northern pike were present in the catch.

Trap net and gill net catch rates were much higher in 1995 than in 2003 (Table 9). This likely resulted from a difference in the timing of the surveys and associated water temperatures. In 1995, the survey was conducted at the beginning of June when water temperatures ranged from 67-69 ºF. In 2003, the survey was conducted in late June and early July when water temperatures ranged from 75-77 ºF. Many fish species, especially bass and panfish, are most active during spring spawning season when water temperatures are increasing and this likely resulted in higher catch rates in 1995. Catch rates for walleye were typical for Michigan inland lakes both in 1995 and 2003.

The growth rates of largemouth bass, northern pike and walleye collected in the 2003 survey were similar to the 1995 survey (Table 10). The statewide average growth rate will be used to compare the growth rates of fish species in Nichols Lake to the average (mean) growth rate of a fish from many lakes throughout Michigan. Bluegill, largemouth bass, and pumpkinseed in Nichols Lake had slightly below average growth rates compared to state averages. Adult walleye had growth rates slightly above state average and northern pike were growing well below state average. Information from 1981 indicates largemouth bass growth rates may have increased and northern pike growth rates may have decreased during the past 14-22 years (1995-2003).

Bluegill growth and size structure was used to classify the population in Nichols Lake using methods provided by Schneider (1990). The bluegill population was ranked very poor based on electrofishing collections and satisfactory based on net collections (Table 11). Even though there were a fair number of bluegills in the 6-8 in size range, smaller bluegill were proportionally very abundant and growth was somewhat low. Bluegills larger than 8 inches were present in the catch which is a good indicator for satisfactory bluegill fishing.

Six surveys, from 1991 through 1999, were specifically conducted to evaluate the survival and growth characteristics of age-0 and age-1 walleye (Table 12). These surveys were conducted during September or October using an electrofishing boat to capture juvenile walleye in shallow water near the shoreline. Sufficient numbers of age-0 walleye to estimate growth were available for 4 years and sufficient numbers of age-1 walleye for growth estimation were available for 2 years. The growth rate of age-0 walleye was slightly below or above state average growth. Age-1 growth rates were average one year and well above average the other year. It is common for stocked lakes in Michigan to have slow walleye growth in the first year of life and faster growth in the second year. The catch rate of age-0 fish ranged from 0.7-25.9/mi of shoreline sampled which is considered low for Michigan lakes (Ziegler and Schneider 2000). The catch rate of yearling walleye ranged from 0.3-4.6/ mi of shoreline sampled which is also considered low. Population estimates using Peterson-Chapman mark-recapture procedures were conducted in 1997 and 1999. Estimates for age-0 fish were 0.2/acre in 1999 and 4.0/acre in 1997. The abundance of age-1 walleye was estimated at 0.4/acre in 1997. These estimates were consistent with the low values represented by catch rates. Walleye survival from stocked fish in

Nichols Lake is sufficient to support a moderate population of adult walleye, which is typical of many stocked inland lakes in Michigan.

Schneider (2005) provided methods for assessing the habitat quality of lakes based on fish, limnological parameters, aquatic plants, and alteration of the shoreline. Nichols Lake scored 43 of a possible 50-53 (Table 13). This is a relatively high score but indicates some degradation of habitat. Habitat scores were diminished somewhat due to introduction of walleye, black crappie and spottail shiner (possible); presence of acid tolerant species; low dissolved oxygen in the hypolimnion; productivity enrichment; and some shoreline alteration.

Analysis and Discussion

Bluegill, pumpkinseed, black crappie, rock bass, largemouth bass, northern pike, and bullheads dominate the fish community of Nichols Lake. This species complex is typical of warmwater-coolwater lakes in Michigan. The size structure of the catch indicated favorable fishing conditions for all of these species except northern pike. Growth rates of theses species were about average when compared to statewide growth rates, with the exception of northern pike. Northern pike were growing well below state average. Comparison of 1995 and 2003 data to 1981 data indicated growth rates of largemouth bass may have increased and northern pike may have decreased during the past 22 years. No legal northern pike were captured in 1995 and only one in 2003. Yellow perch catches were too low to determine size structure of the population but there was evidence of slow growth.

Walleye were stocked into Nichols Lake as early as 1930. They occurred intermittently in surveys until 1991 when a consistent stocking program began. Survival of stocked walleye has been low but sufficient to sustain a moderate adult population with good growth rates. The presence of walleye appears to benefit the growth rate and size structure of the bluegill population. Juvenile bluegill are abundant and slow growing but growth of older fish is higher and the overall size structure of the population is satisfactory. Stocking walleye into lakes with abundant, slow growing bluegills has been shown to improve the growth rate and size structure of bluegill populations (Schneider 1997). Abundant small bluegills were not reported in the 1937, 1957, or 1968 surveys and bluegill from 7-9 in were reported in the 1957 and 1968 surveys. Poor bluegill population size structure was reported in the 1973, 1975, and 1977 surveys where no fish larger than 6.9 in were collected. However, these surveys used electrofishing gear only and also targeted juvenile walleye, indicating shallow water sampling where small bluegills are abundant. The netting survey in 1976 reported some bluegill larger than 8 in. The 1995 survey indicated a satisfactory bluegill population. A factor possibly affecting bluegill size structure was a manual removal of small bluegill and yellow perch in 1981. Variable fishing harvest may also have affected the size structure throughout this period. Overall, the available information does not provide clear evidence that the size structure of the bluegill population has changed significantly from 1937 to present.

Some changes in fish community composition appear to have changed since the first surveys in 1926 and 1937. Lake herring were collected in the 1926 and 1937 surveys but not in later surveys. The 1937 survey noted they were speared in large numbers in earlier years but had decreased in abundance. Anglers have not reported catching any lake herring during the past 20 years. Although lake herring have not been present in any recent surveys, they are difficult to catch and targeted surveys during spawning season are often needed to detect their presence. A cool oxygenated thermocline is needed for survival of lake herring and this habitat component has not changed in Nichols Lake since 1939. The 1937 survey reported lower dissolved oxygen levels throughout the water column along with lower water temperatures. It is uncertain if this was the result of sampling error, or an earlier collection date which may have been associated with an overturn event. This leaves some uncertainty in the water quality characteristics and potential effects on the fish populations during 1937. Another factor that could have affected lake herring is the introduction of walleye into Nichols Lake. Although population levels were suspected to be low, some walleye were in the lake as early as 1937. Low numbers of smallmouth bass were collected in 1937 but not in any following surveys, indicating this species may have been extirpated. Walleye were introduced into Nichols Lake, and black crappie and spottail shiner may have been introduced.

The mean size of zooplankton in Nichols Lake was about average when compared to other Michigan lakes. This was consistent with the average growth rates exhibited by most fish species in the lake.

Frog and toad numbers were relatively high in the lake during August and these amphibians appeared to be strongly associated with the extensive bulrushes encircling most of the lake. Some areas had lower densities of frogs and toads which appeared to be related to naturally low levels of emergent plants, cutting of emergent plants, and beach sanding.

Nichols Lake has a diverse community of aquatic plants dominated by native species. Aquatic plants grow to depths of 23 ft, and highest densities occur at depths of 3 to 16 ft. The south basin has moderate plant growth throughout the basin. The main basin has relatively steep slopes with moderate plant growth around the outer edges. The east basin has moderate to dense growth of plants along the edges and extending to the middle of the bay. Bulrushes and other emergent plants are present around nearly the entire lake. The east basin may have somewhat more dense plant growth due to nutrient enrichment from the private dwellings in that part of the lake. This was indicated by high chlorophyll-a concentration and lower water transparency. There is significant groundwater movement into this end of the lake as indicated by high groundwater velocities and the evident spring seeps coming out of the hillsides along the east basin.

Two non-native aquatic plants, Eurasian water-milfoil and curly-leaf pondweed, are present in relatively low abundance in the lake. These species are most abundant in the east basin and appear to be slowly spreading to other areas of the lake. These plants appear to have invaded initially in the east basin following the chemical removal of native plants. The native plants in the other two basins appear to be limiting extensive invasion to the rest of the lake. A management program should be designed to protect Nichols Lake from expansion of these plants in the lake. Protecting all native plants and manual removal of non-native plants should be part of this program.

Alkalinity levels in Nichols Lake indicate there should be moderate biological productivity, but the presence of marl may be affecting productivity by limiting the availability of carbon and nutrients. Total phosphorous, chlorophyll-a levels and water transparency presently indicate mesotrophic to oligotrophic conditions. Water transparency has indicated mesotrophic to oligotrophic conditions consistently since 1937. Phosphorous is the limiting nutrient for algal growth. Nichols Lake has a cool, well oxygenated thermocline layer at depths of about 20 ft to 35 ft. An oxygenated thermocline was present in all surveys conducted in the 1930s, 1950s, and in 2002 and 2003. Anoxic conditions occurred in the hypolimnion during all years. Dissolved oxygen levels in the east bay were lower than main basin levels in both 2002 and 2003. This may indicate more enriched conditions in the east basin, which also was indicated by somewhat higher chlorophyll-a and nitrogen concentrations, and lower water transparency. Overall, Nichols Lake appears to be a moderately deep, mesotrophic-oligotrophic lake that has a cool, oxygen rich thermocline present during summer.

The lake habitat quality index was relatively high but indicated some degradation. Habitat scores were diminished somewhat due to introduction of walleye, and possibly black crappie and spottail shiner; presence of acid tolerant species; low dissolved oxygen in the hypolimnion; productivity enrichment; and some shoreline alteration.

The USFS ownership of about 85% of the land surrounding Nichols Lake has provided significant protection of fisheries and wildlife habitat in the Nichols Lake catchment. The USFS has managed for naturally wooded uplands, natural shorelines, and no manipulation of in-lake aquatic vegetation. The campground setting is in the uplands with a significant buffer from the lake and is almost not visible from the lake. United States Forest Service development of the shoreline is minimal for the two boat ramps, two beaches and a fishing pier. A rock reef was added to provide spawning for walleye but it was not successful and consideration should be given to restoring this area to natural shoreline.

The private property is all located along the east shoreline of the lake. There is more habitat degradation in this area resulting from beach sanding, cutting of shoreline vegetation, some shoreline armoring, and chemical treatments of aquatic vegetation

Christiansen (1966) found that deadwood was significantly greater in undeveloped than in developed lakes in northern Wisconsin and Michigan. He found that deadwood within the lake was positively correlated with levels of riparian tree density and negatively correlated with dwelling density. Nichols Lake has low dwelling densities and only moderate to low in-lake deadwood. This may be partly the result of historical deforestation of the uplands and also the morphometry of the lake. Some areas of the north, south and west shores have wide wetland areas with little tree growth near the water. Deadwood provides an important substrate for plants and animals in the littoral zone of lakes (France 1997), provides spawning habitat for fish, and serves as cover and a predation refuge for fish (Hanson and Margenau 1992; Rust et al. 2002) Saas et al. (2006) found that yellow perch were reduced to extremely low densities and largemouth bass growth rates decreased after wood habitat was removed from a lake. Most species of fish in Nichols Lake have growth rates about average or slightly lower. Providing additional wood habitat (whole trees) to Nichols Lake should be considered to improve growth rates and population size structure of fish.

Radomski and Geoman (2001) found that developed shorelines had substantially less emergent and floating-leaf vegetation than undeveloped shorelines in Minnesota lakes. Significant aquatic vegetation losses were visible at dwelling densities of 9.6/mi. Bryan and Scarnecchia (1992) found that species richness and total fish abundance were consistently greater in naturally vegetated sites compared to developed sites in both nearshore (0-3.3 ft) and intermediate (3.3-6.6 ft) depth zones. Both emergent and submerged vegetation protect and reduce erosion on the shorelines of lakes (Cotel et al. 2009). Dwelling densities in Nichols Lake are only high in the east basin, and chemical removal of vegetation is occurring in this area of the lake. Full protection of native vegetation should be provided in all areas of the lake to protect important fish and wildlife habitat and to control shoreline erosion.

Amphibians can also be affected by habitat alterations. Woodford and Meyer (2003) found that adult green frog populations were significantly lower in lakes with developed shorelines (average dwelling densities = 21.0/mi) than lakes with little or no development (average dwelling density = 2.9/mi). The natural shoreline of Nichols Lake should be protected to preserve amphibian habitat. Amphibian abundance in Nichols Lake can be improved in areas where shorelines have been altered.

Water transparency, chlorophyll-a, and dissolved oxygen concentrations indicate increased nutrient enrichment may be occurring in the east basin. Nutrient enrichment can occur from fertilizer applications near shorelines as well as septic tank drainage. Use of fertilizers should be restricted along the shoreline of the lake and septic tank enrichment should be evaluated. Chemical treatments designed to remove aquatic vegetation also increases nutrient cycling in lakes. This often results in planktonic and filamentous algal blooms following herbicide treatments of aquatic plants. Permits have been granted to apply copper products for control of algal blooms after chemical treatments in Nichols Lake. Copper also is toxic to invertebrates that support the food chain for fish.

Management Direction

These management objectives are based on a full historical review of the information available on fisheries and habitat evaluations of Nichols Lake. The habitat objectives are consistent with the Conservation Guidelines for Michigan Lakes (O'Neal and Soulliere 2006) and established Fisheries Division Policies. Generally, to provide for ecologically sustainable fish and wildlife resources, individual habitat components of lakes should not be altered by more than 25% on a lake-wide scale.

Objective 1. Protect water quality and maintain a cool, oxygen rich thermocline in Nichols Lake. This is necessary to sustain the warmwater-coolwater fish community of Nichols Lake. Goals that can help achieve this objective include discontinuing fertilizer use, using non-phosphate fertilizers, maintaining a 35 ft buffer strip along the shoreline, installing a sewer system, and minimizing the destruction of aquatic plants by controlling only non-native species when needed.

Objective 2. Restore and protect nearshore aquatic vegetation for fish, amphibians and reptiles. Goals that can help accomplish this objective include restoring hardened shorelines to naturally sloped shorelines, maintain 75% of individual properties with natural shorelines, and discontinue cutting and removal of native plants from nearshore areas.

Objective 3. Protect the abundance, diversity, and architectural structure of the native aquatic plant community in Nichols Lake. This can be accomplished by providing full protection of native plants in the lake, and controlling non-native plants where necessary and with methods that provide adequate protection for native plants.

Objective 4. Control non-native Eurasian water-milfoil and curly-leaf pondweed. These plants are present but not abundant and appropriate methods to protect native plants should be used. This objective should be achieved by continued monitoring and using manual removal methods when possible.

Objective 5. Restore or improve wood habitat in the lake for fish, amphibians, and reptiles. This can be accomplished by establishing and maintaining a natural buffer strip along the shoreline with a minimum width of 35 feet. Short term improvement can be accomplished by installation of trees around the lake within the nearshore and offshore littoral zone. Discontinue any removal of submerged wood from the lake.

Objective 5. Reduce the use of copper applications to protect plant and zooplankton populations. Minimizing aquatic plant treatments only for necessary control of non-native species will reduce the need for planktonic and filamentous algae treatments. The native macro-algae Chara spp. should not be chemically removed.

Objective 6. Improve the growth and size structure of largemouth bass and panfish populations to help maintain fish community balance and improve fishing. Actions that can help to improve growth and size structure of fish include maintaining good native aquatic plant communities throughout the lake, and reducing the overall effects of human development on these lakes. Continue to maintain an adult walleye population through stocking. This will help to maintain good predator-prey balance within the fish community. Manual removal of small panfish with nets may also be an option to increase panfish growth. This method has shown benefits in other lakes. Any manual removal project should be planned for a 3-5 year period and include appropriate evaluations.

Objective 7. Improve the growth and size structure of the northern pike population to help maintain fish community balance and improve fishing. This objective will be achieved following establishment of new northern pike regulations for Michigan, which are presently under review. Appropriate regulations will be applied based on biological characteristics of the population.

Objective 8. Conduct targeted evaluations to determine if lake herring (cisco) are present in Nichols Lake. Lake herring are a threatened species in Michigan. These evaluations should be conducted using Fisheries Division protocols. Consideration should be given to reintroduction if none are found.

Objective 9. Conduct evaluations of amphibian populations on this lake every 10 years to monitor abundance and species composition. These evaluations should be conducted using Fisheries Division protocols.

Objective 10. Conduct a thorough forage fish assessment in Nichols Lake. This evaluation should be conducted using Fisheries Division protocols.

References

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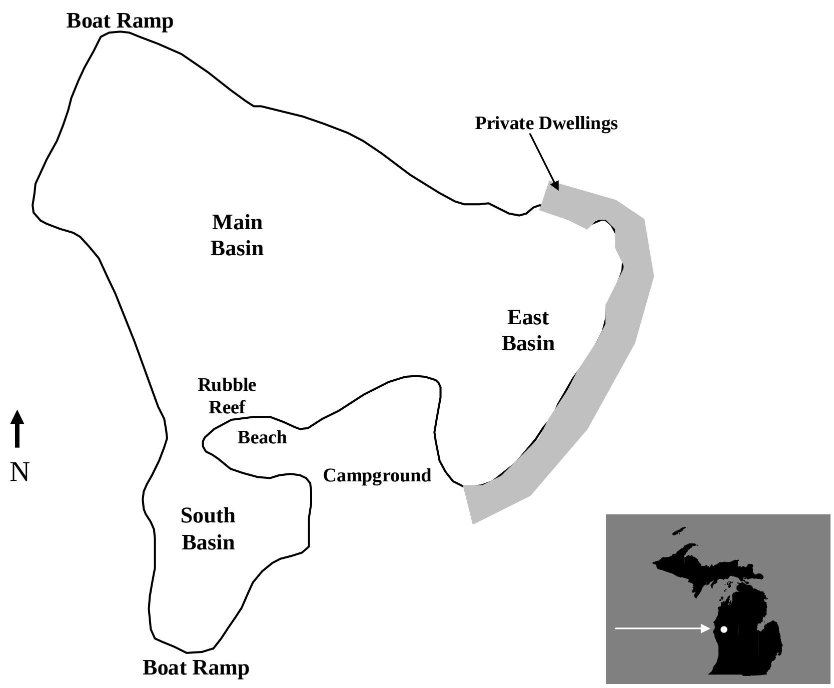

Figure 1. Map of Nichols Lake, Newaygo County, public boat launches, beach, and campground.

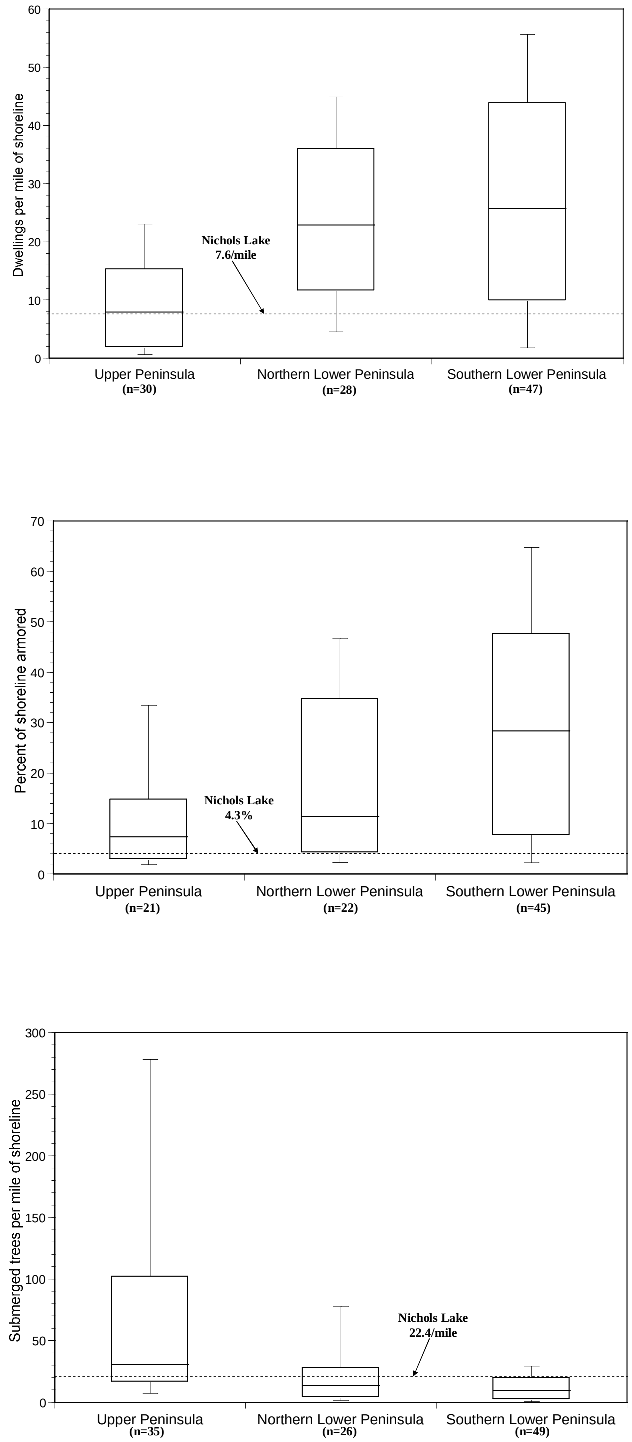

Figure 2. Density of shoreline dwellings (upper graph), percentage of shoreline with artificial armor (middle graph), and submerged tree densities for Nichols Lake in 2007. The box plots represent minimum, maximum, 25th and 75th percentile, and median values for lakes in the northern, middle, and southern regions of Michigan.

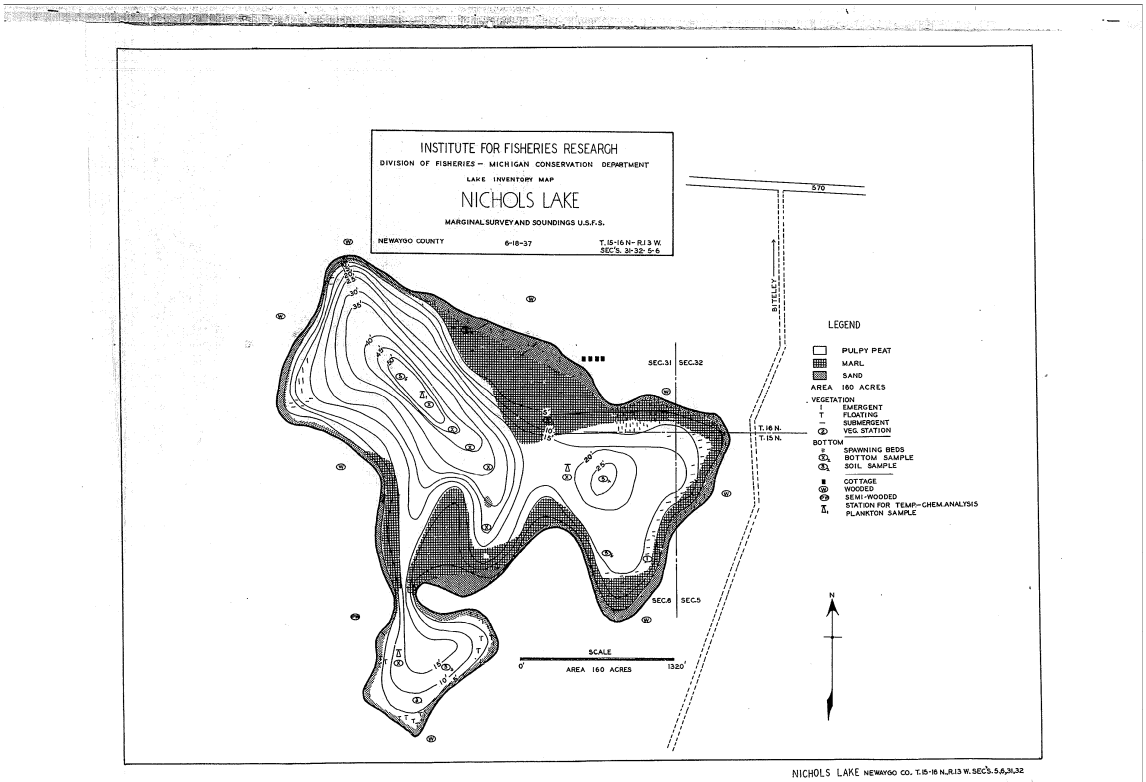

Figure 3. Inventory map of Nichols Lake, Newaygo County, 1937. Nichols Lake has a surface area of approximately 160 acres and shoreline length of 2.9 miles.

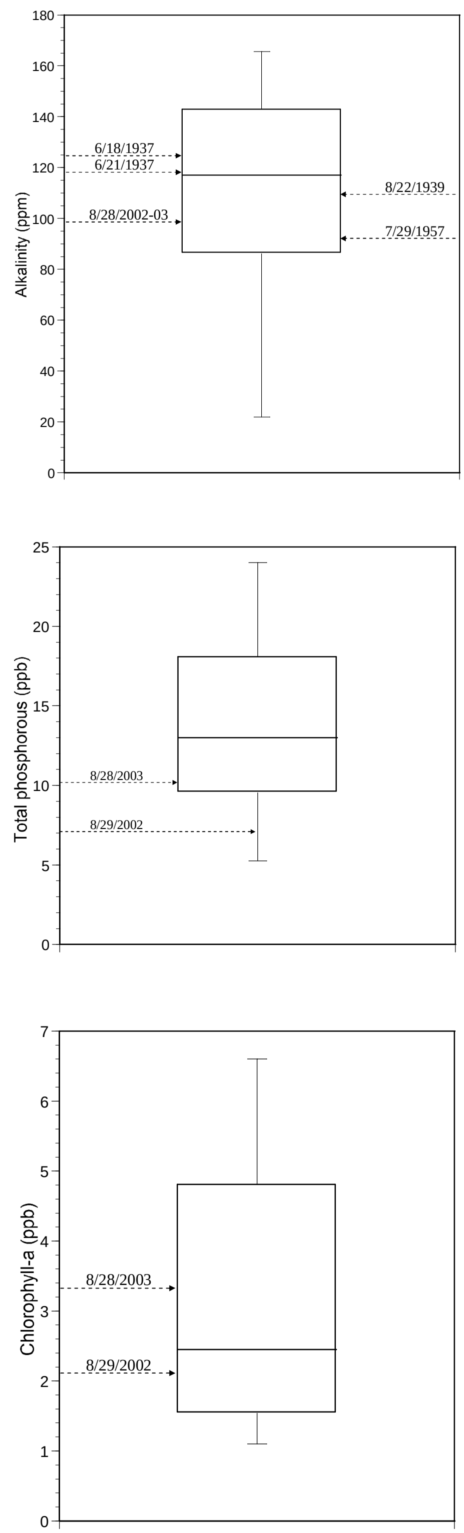

Figure 4. Comparison of Nichols Lake chemical parameters to other Northern Lower Peninsula Michigan lakes. The box plots represent minimum, maximum, 25th and 75th percentile, and median values for alkalinity (n=27, upper graph), total phosphorous (n=25, middle graph), and chlorophyll-a (n=22, lower graph).

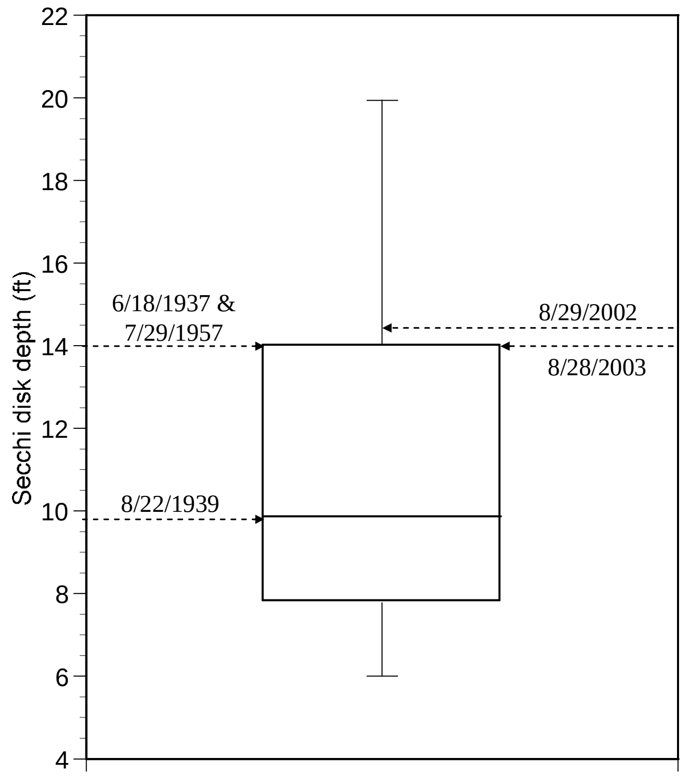

Figure 5. Comparison of Nichols Lake water transparency to other Northern Lower Peninsula Michigan lakes. The box plot represents minimum, maximum, 25th and 75th percentile, and median values for water transparency (n=43).

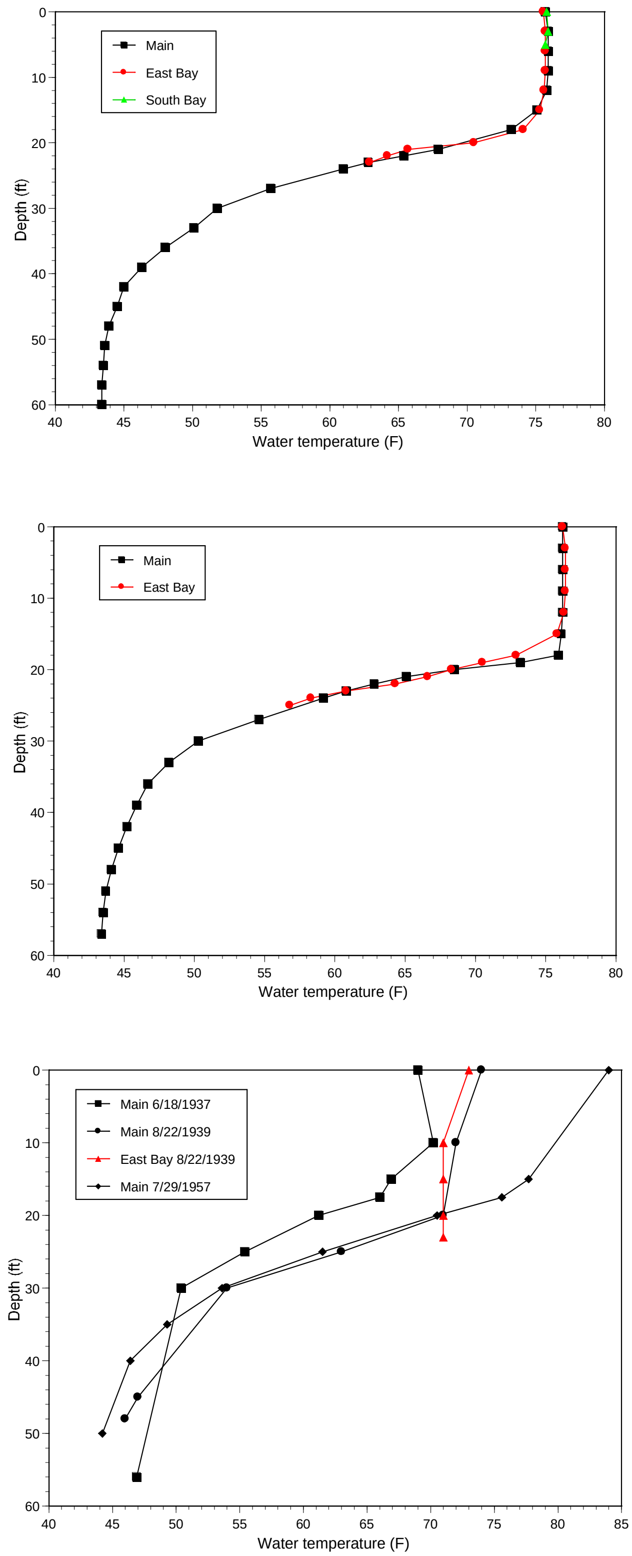

Figure 6. Water temperature profiles in Nichols Lake on August 29, 2003 (upper graph); August 28, 2003 (middle graph); and on June 18, 1937, August 22, 1939, and July 29, 1957 (lower graph).

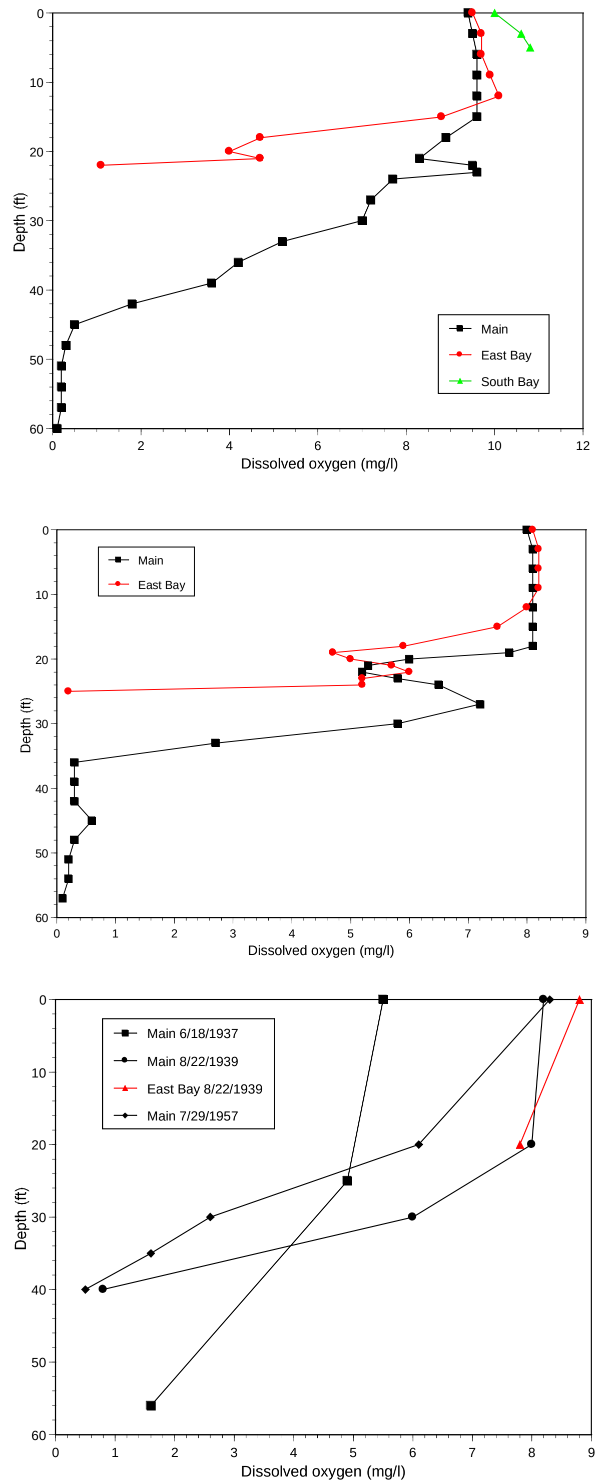

Figure 7. Dissolved oxygen profiles in Nichols Lake on August 29, 2002; August 28, 2003; and on June 18, 1937, August 22, 1939 and July 29, 1957.

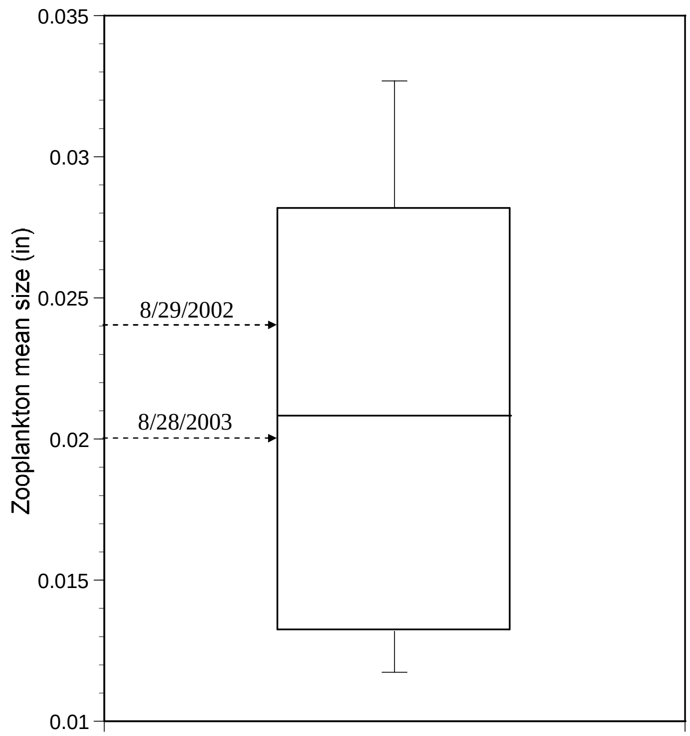

Figure 8. Comparison of zooplankton mean size in Nichols Lake to other lakes in the Northern Lower Peninsula of Michigan sampled from 2003 through 2008. The box plot represents minimum, maximum, 25th and 75th percentiles, and median values for Northern Lower Peninsula lakes (n=36).

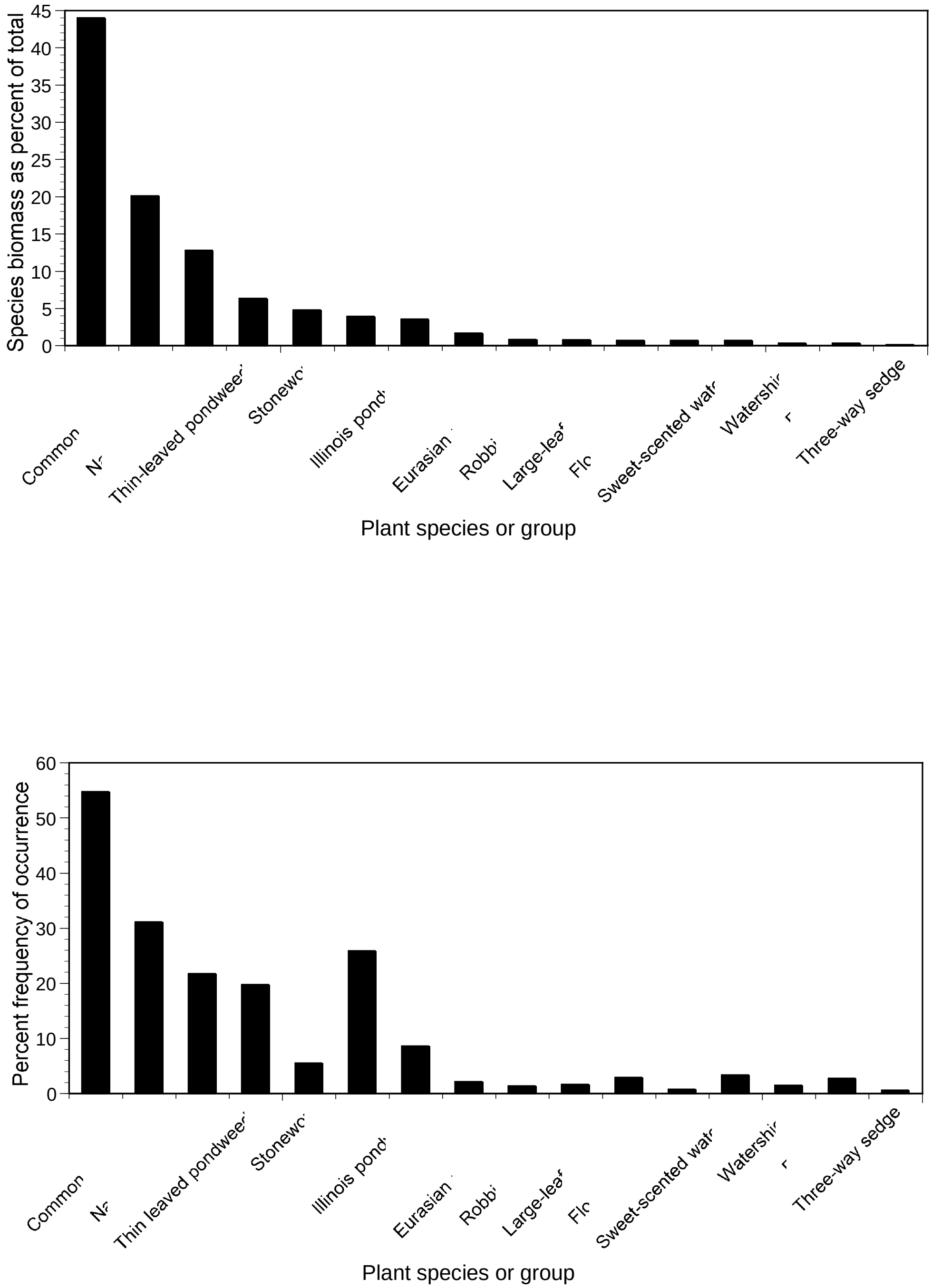

Figure 9. Species biomass as a percentage of total biomass (upper graph) and percent frequency of occurrence (bottom graph) for various aquatic plant species and groups collected with hook samples (n=648, 23 transects) in Nichols Lake in 2001.

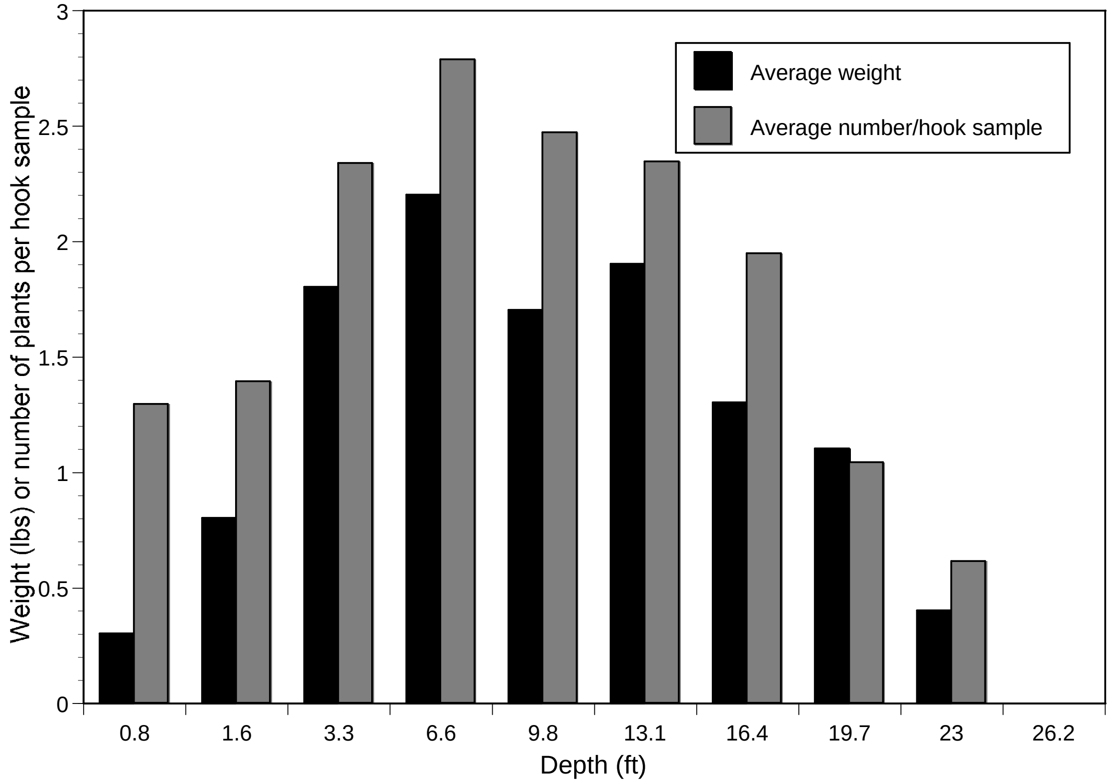

Figure 10. Aquatic plant distribution by depth in Nichols Lake during summer 2001. Averages determined from 648 hook samples collected at 23 transects spaced at 656.2 ft intervals around the lake.

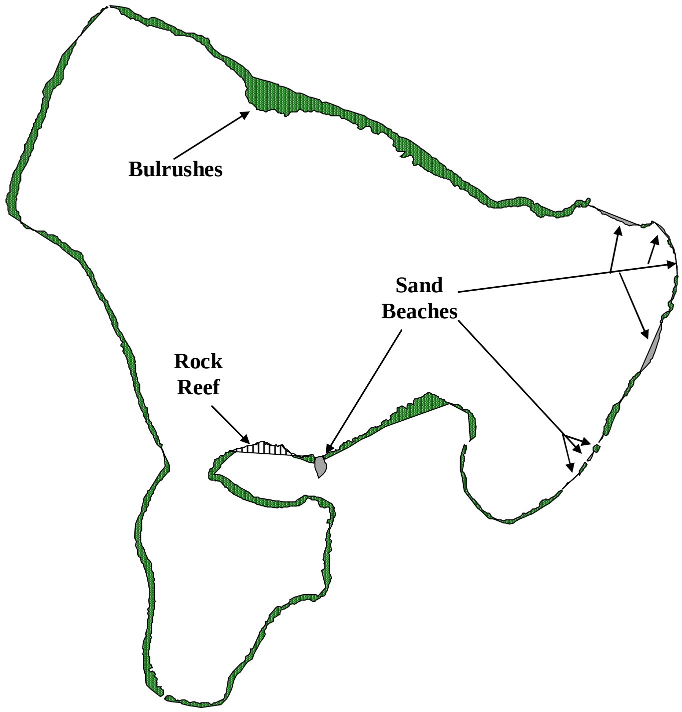

Figure 11. The distribution of bulrushes, and locations of artificial sand beaches and a rock reef in Nichols Lake during August 2001.

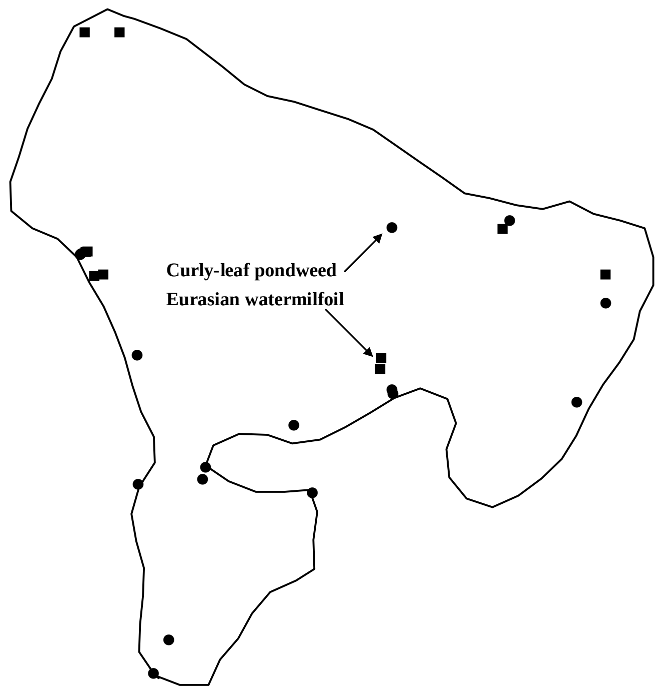

Figure 12. Distribution of Eurasian water-milfoil and curly-leaf pondweed in Nichols Lake during August 2001 & 2002.

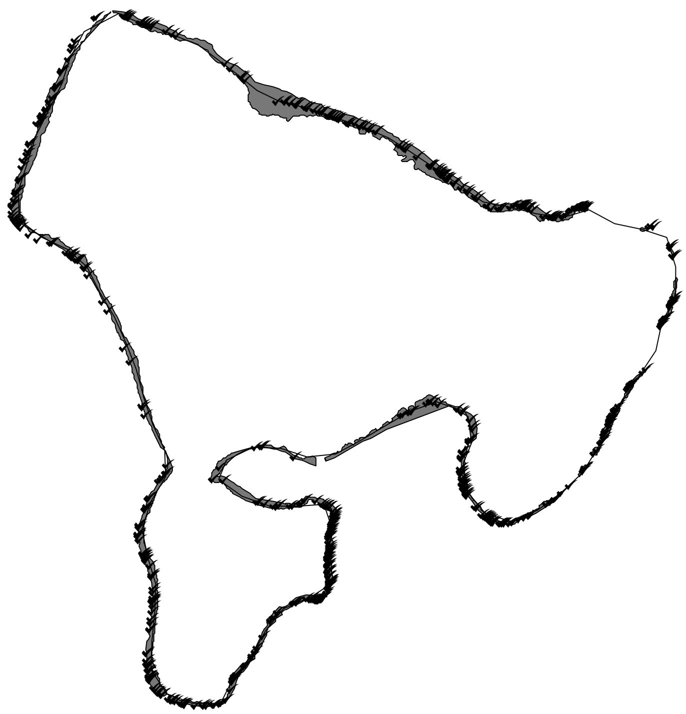

Figure 13. Distribution of frogs and toads (individuals indicated by check mark) along the shoreline of Nichols Lake on August 28, 2001.

Table 1. Limnological parameters evaluated in Nichols Lake, Newaygo County, in 2002 and 2003. All values are in ppm unless indicated otherwise.

Date	**08/29/2002**	**08/28/2003**	**08/29/2002**	**08/28/2003**	**08/29/2002**
Basin	**East Bay**	**East Bay**	**Main**	**Main**	**South Bay**
Secchi Disk (ft)	14.0	13.0	16.0	15.0	5.0 bottom
Alkalinity	101.0	99.0	99.3	100.0	94.9
Chlorophyll-a	0.0025	0.0035	0.0022	0.0032	0.0015
Total phosphorous	0.008	0.007	0.010	0.006	0.012
Ammonium	0.041	<0.01	0.045	0.014	<0.01
Nitrite & nitrate	<0.01	<0.01	<0.01	<0.01	<0.01
Kjeldahl nitrogen	0.434	0.855	0.307	0.503	0.634
Total nitrogen	0.434	0.855	0.307	0.503	0.634
N/P ratio	54.2	122.1	30.7	83.8	52.8
Trophic status					
Secchi disk	Mesotrophic	Mesotrophic	Oligotrophic	Mesotrophic	-
Chlorophyll-a	Mesotrophic	Mesotrophic	Mesotrophic	Mesotrophic	Oligotrophic
Phosphorous	Oligotrophic	Oligotrophic	Mesotrophic	Oligotrophic	Mesotrophic
Nitrogen/Phosphorous limited	P	P	P	P	P
Zooplankton					
Mean body length (in)			0.024	0.020	
90th percentile body length			0.063		
Daphnia/net > 0.53 in			388.0		

Table 2. Limnological parameters evaluated in Nichols Lake in 1937, 1939, and 1957.

Date	**6/18/1937**	**6/21/1937**	**8/22/1939**	**7/29/1957**
Secchi disk (ft)	14		9-10	14
Alkalinity (ppm)	126	118	108	93

Table 3. Aquatic plants found in Nichols Lake during 2001 and 2002 using hook and quadrat sampling gear, and visual observation. Note: V indicates found by MDEQ visual observation.

Common name	Scientific name	2001-2002	1937
Muskgrass	*Chara spp.*	X	X
Stonewort	*Nitella spp.*	X	
Common waterweed	*Elodea canadensis*	X	
Coontail	*Ceratophyllum demersum*	X	
Bladderwort	*Utricularia spp.*	X	
Native water-milfoil	*Myriophyllum spp.*	X	X
Eurasian water-milfoil	*Myriophyllum spicatum*	X	
Curly-leaf pondweed	*Potamogeton crispus*	X	
Flat-stemmed pondweed	*Potamogeton zosteriformis*	X	
Floating pondweed	*Potamogeton natans*	X	X
Illinois pondweed	*Potamogeton illinoensis*	X	X
Large-leaf pondweed	*Potamogeton amplifolius*	X	
Leafy pondweed	*Potamogeton foliosus*	X	
Naiad	*Najas spp.*	X	X
Pondweed	*Potamogeton strictifolius*	X	
Robbins pondweed	*Potamogeton robbinsii*	X	
Small pondweed	*Potamogeton pusilus*	X	
Thin-leaved pondweed	*Potamogeton spp.*	X	
Variable pondweed	*Potamogeton gramineus*	X	X
White-stemmed pondweed	*Potamogeton praelongus*	X	X
Sweet-scented waterlily	*Nymphea spp.*	X	
Watershield	*Brasenia schreberi*	X	
Sedge	*Carex spp.*	X	X
Three-way sedge	*Dulichium arundinacium*	X	
Hardstem bulrush	*Schoenoplectus acutus*	X	X
Softstem bulrush	*Schoenoplectus tabernaemontani*	X	
Three-square bulrush	*Schoenoplectus pugens*	X	X
Bulrush	*Schoenoplectus subterminalis*		X
Twig-rush	*Cladium mariscoides*	X	
Horsetail	*Equisetum spp.*	X	
Swamp loosestrife	*Decodon verticillatus*	X	
Creeping spike rush	*Eleocharis palustris*		X
Yellow pond-lily	*Nuphar advena*	V	X
Pickerelweed	*Pontedaria cordata*	V	X
Broad-leaved cat-tail	*Typha latifolia*	V	X
Iris	*Iris spp.*	V	
Cardinal flower	*Lobelia cardinalis*	V	

Table 4. Summary of known chemical treatment applications for aquatic vegetation removal in Nichols Lake, 1996-2007. All treatments were in east basin in the area bordered by dwellings (Figure 1).

Year	Comment
1996	Approximately 4 surface acres treated with unknown amounts of chemicals.
1997	Permit application requested the use of Reward, Hydrothol-191, and copper products, amounts used were unknown
July 31, 1997	General plant survey found Eurasian water-milfoil and curly-leaf pondweed only in the area of the lake previously treated with chemicals
1998	Permit application requested the use of Reward, Hydrothol-191, Aquathol-K, and copper products, amounts used were unknown
1999	Chemicals used were Reward, Hydrothol-191, and copper products
2000	Chemicals used were Reward and copper products
2001	Chemicals used were Reward and copper products
2002	Chemicals used were Reward and copper products
2005	Chemicals used were Reward, Hydrothol-191, Aquathol-K, and copper products
2006	Chemicals used were Reward, Aquathol-K, Renovate 3, and copper products
2007	Chemicals used were Reward, Aquathol-K, Renovate 3, Hydrothall-191, and copper products

Table 5. List of MDNR files for Nichols Lake.

Date	Comments
1926	Brief examination of lake, recommend stocking largemouth bass and bluegill, lake herring (cisco) first captured
6/18/1937	Lake mapped and limnological survey, lake herring last captured, sandy shore with wooded uplands, shoals largely marl with pulpy peat sediments in deep water, very little cover with limited aquatic plants, numerous tadpoles with few adult frogs, few crayfish, mayflies and Odonata present, observation from resident that aquatic vegetation was much more abundant in past with much lower deposits of marl
8/22/1939	Limnological survey
1942	Limnological survey
7/29/1957	Gill net survey, adult walleye present
7/8/1968	Electrofishing survey for bluegill and juvenile walleye
6/29 & 7/11/1973	Electrofishing, trap and gill net survey, bluegill and yellow perch appear to be stunted, adult walleye present, recommend partial chemical thinning of panfish and to stock walleye
5/1/1974	Treat the south basin and east basin of the lake with antimycin to reduce panfish numbers, relatively low mortalities reported
1974	Fisheries Division proposal to improve pond for walleye rearing, not completed.
6/10&7/1/1975	Electrofishing and gill net survey, no walleye juveniles collected, overabundant panfish reported, adult walleye present
1976	Lake Association proposes to find a northern pike rearing marsh
9/13/1976	Gill & trap net survey, no walleye collected
9/13/1977	Electrofishing survey, no walleye collected
2/15/1978	USFS proposes to conduct full rotenone treatment, install a walleye spawning reef, restock the lake, then install fish structures
9/11/1978	Nichols Lake Taxpayers Association states opposition to removal of the fish population with rotenone, favored reef installation and walleye stocking
9/11/1978	DNR questions the uncertain benefits of a reef, if walleye will survive well in this small lake, and the need for fish shelters given appropriate vegetation present
9/20/1978	Lilley Township opposes the rotenone treatment
12/19/1978 & 1/16/1979	DNR and Corps of Engineers issue USFS permits to install rock for spawning reef
2/14/1980	USFS requests permit from DNR to install fish shelters
3/20/1980	USFS requests DNR opinion on manual removal of panfish to improve growth and size structure
6/8-18/1981	USFS fyke net removal of 17,825 small fish, mainly bluegill and pumpkinseed, with some bullhead, rock bass and yellow perch
11/27/1989	Prescription, recommend stocking 3,200 fall fingerling or 6,400 spring fingerling walleye for three years

Table 5. Continued

Date	Comments
1990	DNR stocks 3,581 small fall fingerling walleye and 48 adult walleye to evaluate benefits of spawning reef, reef spawning evaluated by USFS
10/7/1991	Electrofishing survey, 1990 and 1991 walleye survival was present but low, 92 adult walleye stocked, reef spawning evaluated by USFS
10/13/1992	Electrofishing survey, 1992 walleye survival low, reef spawning evaluated by USFS
12/11/1992	Prescription, recommend stocking 3,200 fall fingerling walleye for one year then 16,000 (100/acre) spring fingerlings for four years.
1993	USFS proposes and installs fishing pier
9/14 & 20/1994	Survival of stocking large numbers of spring fingerlings was better than previous years stocking of low number of small fall fingerlings
6/1 & 9/13/1995	Electrofishing, trap and gill net general survey; reasonable adult walleye present; bluegill, bass and crappie satisfactory, northern pike small and growing slowly
1996	First known chemical treatment to remove aquatic vegetation, about 4 acres in the east bay in front of private homes
9/9/1997	Electrofishing survey, reasonable survival of juvenile walleye with growth rates just below state average, alternate year stocking recommended
1/6/1999	Prescription, recommend stocking 16,000 spring fingerling walleye every other year to improve survival and growth
3/11/1999	DEQ denies USFS permit to install fish shelters per DNR recommendation
9/15/1999	Electrofishing survey, low survival of juvenile walleye, growth rates just above state average
Summer 2001 & 2002	DNR survey of aquatic vegetation community throughout the lake
8/29/2002	Limnological survey, collect water quality and zooplankton information
6/30 & 8/28/2003	Standard status and trends biological survey and limnological survey; fish growth about average except for slow growing northern pike; size structure of bluegill population satisfactory; adult walleye catch average for inland lake
12/13/2004	Prescription, recommend stocking 8,000 (50/acre) spring fingerling walleye every other year to improve growth rates
1/3/2005	Nichols Lake Association requests DNR for no size limit for northern pike and information on weed control
8/27/2007	Limnological survey, collect status and trends habitat information

Table 6. Numbers of fish stocked into Nichols Lake from 1929 through 2008. Stocked fish were fingerlings unless indicated as fry (F), yearling (Y) or adult (A). Brook trout were stocked in 1965 and rainbow trout from 1942 through 1944.

Year	Species					
	Bluegill	Trout	Largemouth bass	Smallmouth bass	Walleye	Yellow perch
1929	1,250					96,000 F
1930	2,400				50,000 F	
1939	7,000					
1940	1,247 A		400 Y	1,000		
1941			200	1,088		
1942		3,216 Y			100,000 F	
1943		5000 Y				
1944		5,000 Y				
1965		9,000				
1974					800,000 F	
1975					900,000 F	
1990					3,582	
					48 A	
1991					4,251	
					92 A	
1992					5,858	
1993					1,400	
1994					20,875	
1995					85,885	
1996					16,000	
1997					13,004	
1998						
1999					16,663	
2000						
2001					11,000	
2002						
2003					16,303	
2004						
2005					16,163	

Table 7. Fish and turtle species collected in Nichols Lake in 1957, 1973, 1995, and 2003. Collection methods are indicated by GN = gill net, TN = trap net, SE = seine, and EL = electrofishing. 1- Northern pike reported by anglers in 1937.

Common name Method	Scientific name	1937 Unknown	1957 GN	1968 E	1973-77 TN, GN, E	1995 TN,GN	2003 TN, GN, SE, E
Fish							
Black bullhead	*Ameiurus melas*					X	
Black crappie	*Pomoxis nigromaculatus*					X	X
Bluegill	*Lepomis macrochirus*	X	X	X	X	X	X
Bluntnose minnow	*Pimephales notatus*	X				X	
Brown bullhead	*Ameiurus nebulosus*				X	X	X
Bullhead	*Ameiurus spp.*	X					
Central mudminnow	*Umbra limi*			X			
Lake herring (cisco)	*Coregonus artedi*	X					
Green sunfish	*Lepomis cyanellus*	X	X				
Golden shiner	*Notemigonus crysoleucas*	X		X	X		
Largemouth bass	*Micropterus salmoides*	X	X	X	X	X	X
Northern pike	*Esox lucius*	X[1]	X		X	X	X
Pumpkinseed	*Lepomis gibbosus*	X	X	X	X	X	X
Redhorse	*Moxostoma spp.*				X		
Rock bass	*Ambloplites rupestris*	X	X	X	X	X	X
Walleye	*Sander vitreus*	X	X		X	X	X
Smallmouth bass	*Micropterus dolomieu*	X					
Spottail shiner	*Notropis hudsonius*						X
Warmouth	*Lepomis gulosis*				X		
Western banded killifish	*Fundulus diaphanous menona*	X					X
White sucker	*Catostomus commersonii*	X			X		
Yellow bullhead	*Ameiurus natalis*		X	X	X	X	X
Yellow perch	*Perca flavescens*	X	X	X	X	X	X
Turtles							
Common musk turtle	*Sternotherus odoratus*	X	NA	NA	NA	NA	X
Common map turtle	*Graptemys geographica*	X	NA	NA	NA	NA	X
Painted turtle	*Chrysemys picta*	X	NA	NA	NA	NA	
Snapping turtle	*Chelydra serpentine*	X	NA	NA	NA	NA	

Table 8. Length distributions of fish collected with trap and gill nets in Nichols Lake during 1995 and 2003.

Length	Black crappie		Bluegill		Largemouth bass		Northern pike		Pumpkinseed		Rock bass		Walleye		Yellow perch		Bullheads	
(in)	1995	2003	1995	2003	1995	2003	1995	2003	1995	2003	1995	2003	1995	2003	1995	2003	1995	2003
3		1	3	1							1							
4	1		48	17					5	1	1							
5			121	21					24		6	1						
6			120	22	1				22	1	30							
7	1		68	7	1	2			9	2	13	1						
8	2		7	1		6			1	1	4		1					
9	20			1	5	1					6	2					3	
10	28	1	1		6	3					1				1	1	6	1
11	35	4			3	1	1				2	2			2		24	
12	4	3			2	5											28	1
13		1			4												8	1
14	1				4	1												1
15								1						1				2
16					1		3	1										
17						1	5	2					2					
18							6	2					7	2				
19							14	1					2	4				
20							17	3					2	1				
21							14						1	1				
22							7							6				
23							5							2				
24																		
25								1					1					
Total	92	10	368	70	27	20	72	11	61	5	64	6	16	17	3	1	69	6

Table 9. Catch per unit effort of fish collected in trap nets and gill nets during 1995 and 2003 from Nichols Lake.

Species	06/01/1995		06/30/2003	
	Number collected	Catch per unit effort	Number collected	Catch per unit effort
Trap nets	**6 lifts**		**6 lifts**	
Walleye	3	0.5	17	2.8
Black crappie	88	14.7	10	1.8
Bluegill	361	60.2	66	11
Largemouth bass	26	4.3	18	3.0
Pumpkinseed	61	10.2	4	0.7
Yellow perch	1	0.2	2	0.3
Rock bass	58	9.7	6	1.0
Northern pike	5	0.8	3	0.5
Bullhead	143	23.8	6	1.0
Gill nets	**4 lifts**		**4 lifts**	
Walleye	13	3.3	0	0.0
Black crappie	4	1.0	0	0.0
Bluegill	7	1.8	4	1.0
Largemouth bass	1	0.3	2	0.5
Pumpkinseed	0	0.0	1	0.2
Yellow perch	2	0.5	0	0.0
Rock bass	6	1.5	0	0.0
Northern pike	67	16.8	8	2.0
Bullhead	11	2.8	0	0.0

Table 10. Growth rates of fish, relative to state averages, for fish collected in Nichols Lake during 1981, 1995, and 2003. Sample sizes are designated in parentheses.

Species	1981	1995	2003
Bluegill			-0.3 (61)
Largemouth bass	-1.6 (87)	0.2 (21)	-0.3 (25)
Northern pike	1.8 (13)	-5.6 (54)	-4.6 (7)
Pumpkinseed			-0.4 (7)
Yellow perch			-0.9 (22)
Walleye		0.7 (9)	0.4 (12)

Table 11. Bluegill growth and size structure classification for Nichols Lake in 2003. Refer to Schneider (1990) for methods[1].

Sample method	Average length (in)	%>6”	%>7”	%>8”	Average score	Rank
Electrofishing data	3.5	1.2	0.6	0.0		
Electrofishing score	1	1	1	1	1	Very poor
Net data	5.9	47.0	13.6	3.0		
Net score	3	3	4	5	4	Satisfactory

1. Scores and ranks are as follows: 1=very poor, 2=poor, 3=acceptable, 4=satisfactory, 5=good, 6=excellent, and 7=superior.

Table 12. Summary of recent walleye stocking, fall juvenile surveys, growth indices, and population estimates for Nichols Lake.

Year	Number stocked	Stocking stage	Mark	Age-0 collected	Age-0 per mile	Age-0 catch/hr	Age-0 growth index	Age-1 collected	Age-1 per mile	Age-1 catch/hr	Age-1 growth index	Population estimate age-0	Population estimate age-1
1990	3,582	FF	LV										
1991	4,251	FF	RV	6	2.1			10	3.4				
1992	5,858	FF	RP	2	0.7			1	0.3				
1993	1,400	FF											
1994	20,875	SF		123	21.2		-0.2	0					
1995	85,885	SF		10	1.7		-0.5	27	4.6		2.0		
1996	16,000	SF											
1997	13,004	SF		150	25.9	33	-0.8	16	2.7	3.5	0.2	638 (+-412)	71 (+-41)
1999	16,663	SF		25	4.3	6.9	0.6	0				33 (+-22)	
2001	11,000	SF											
2003	16,303	SF											
2005	16,163	SF											

Table 13. Habitat quality scores for Nichols Lake based on fish community composition[1]. Several other variables were used to determine scores including limnological parameters, aquatic plant abundance, and alteration of the shoreline (Schneider 2002).

Metric		Possible score	Score	Comments
1	Native fish fauna	1-5	4	Denote a point for introduction of black crappie & spottail shiner
2	Winterkill	1-5	5	Winterkill intolerant species = 86% by number and 89% of biomass of sample
3	Acidity	1,2,3,5	3	pH>5, acid tolerant and other species present
4	Thermocline/hypolimnion DO	1-5	3	No indicator species present
5	Productivity/enrichment	1-5	3	Bullhead = 7.2% of sample biomass
6	Turbidity	1-4	4	Turbidity intolerant banded killifish present
7	Silt	1-4	4	Silt intolerant walleye present
8	Macrophytes	1,2,3,5	3	Bluegill = 18% of sample biomass, 4 macrophyte dependent species present (northern pike, bluegill, largemouth bass, yellow bullhead)
9	Edge modification	1-5	4	Shoreline modification = 15%, 2 edge modification intolerant species present (northern pike and banded killifish)
10	Level stabilization	1-5	5	No lake-level control
11	Predation/competition	2,3,5	5	Natural dominant species present
	Total		43	

1. The range of possible scores is 12-53. A maximum score would be achieved in a deep, oligotrophic, non-acidic lake with moderate densities of aquatic macrophytes, which was unaffected by species introductions, low DO (dissolved oxygen), eutrophication, or modifications of edge or water levels. Typical shallow, mesotrophic, Michigan lakes with no DO below the thermocline would score a maximum of 50. Natural Michigan lakes that are shallow, productive and have fish kills due to low DO in winter would score a maximum of 31. Most lakes in Michigan presently will not have maximum scores due to human alterations.