Manistee Lake

Kalkaska County; T27N, 28N, R6W, Sections 3, 27, 33, 34, 35
Manistee River Watershed; last surveyed 2006.

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Environment

Manistee Lake is 860-acres in size (Figure 1), and is located eight miles northeast of Kalkaska, in Kalkaska County, Michigan, in the northwestern lower peninsula. Its maximum depth is 18 feet, with approximately 95% of the lake shallower than 15 feet. The North Branch of the Manistee River originates from Manistee Lake, flowing out of the southern end of the lake. There is no lake-level control structure on Manistee Lake. The shoreline of Manistee Lake is about 80% developed with homes and cottages. There are several man-made canals connected to the lake on the south side near the outlet. The northwestern shoreline of the lake is undeveloped cedar swamp, with one small stream flowing into the lake. There are also several other very small, intermittent streams that flow into Manistee Lake. The country surrounding Manistee Lake is hilly and mostly forested, with predominately sandy soils. According to Gomez (2007) Manistee Lake is a mesotrophic lake (based on Secchi disk readings); although in some years it has been characterized as slightly eutrophic. Public access is available on Manistee Lake through a county park with a boat launch on the southwestern corner of the lake. In addition, there are several road endings on the east side of the lake where it is possible to obtain access. A significant portion of the northwestern shoreline of Manistee Lake is owned by Camp Tanuga, a residential summer camp for children and families. There are also several small resorts located on Manistee Lake.

There are two citizen-based groups active on Manistee Lake; the Manistee Lake Association and the Manistee Lake Improvement Board. Both organizations are very involved in the management of Manistee Lake. They spearhead the aquatic macrophyte control program on Manistee Lake and also provide educational programs for landowners regarding proper riparian land management practices. They also assist with water quality monitoring and have provided funding to the Au Sable Institute for environmental studies conducted on Manistee Lake.

Eurasian milfoil (a non-native, invasive species) was first observed in Manistee Lake in 1996 (Richards 2003). Since then, Manistee Lake has had significant problems with Eurasian milfoil. However, instead of utilizing chemical herbicides or other methods of treatment, the Manistee Lake Association has successfully used milfoil weevils to control the Eurasian milfoil infestation on Manistee Lake. The first weevils were stocked over a three year preiod from 1999-2001, and more were added in 2007. The current management plan for Manistee Lake is to stock about 20,000 weevils annually, over the next three years.

History

Original reports from the 1930s (Fisheries Division files) on Manistee Lake describe a predominantly warmwater fish community, including largemouth bass, bluegill, pumpkinseed sunfish, yellow perch, bullhead, rock bass, and northern pike. Smallmouth bass and walleye were reportedly established through stockings done in the early 1900s (Laarman and Schneider 1986). Since that time, both species

have become important components of the fish community. Walleye reproduce naturally in certain years; this species was not stocked between 1946 and 1969, yet walleye populations in Manistee Lake were reportedly robust during that time (Taube 1956; Laarman 1980; Laarman and Schneider 1986). However, between 1969 and 1983, walleye reproduction was reportedly poor (Laarman 1980; Laarman and Schneider 1986), so stocking was required to provide a fishery. Walleye stocking has had variable success, especially when fry were used. The results of an intensive research project led the investigators to conclude that stocking with large fingerling walleyes would be most suitable (Laarman 1980; Laarman and Schneider 1986). However, since that time, we have learned that raising large fingerlings (usually called "fall fingerlings") is more expensive than raising smaller fingerlings, and production of fall fingerlings is inconsistent. While Manistee Lake has been regularly stocked with walleye (Table 1) by the Michigan Department of Natural Resources (MDNR) since 1969, those fish have usually been the smaller spring fingerlings. MDNR cannot consistently raise large numbers of fall fingerlings.

Other changes have taken place in the fish populations of Manistee Lake. Northern pike were originally reported to have been the dominant predator species (Laarman and Schneider 1986), until being replaced by walleye in the early part of the 20th century. White suckers, which were not reported in 1930, became a major component of the fish community, making up 35% of the total fish biomass in the 1970s (Laarman and Schneider 1986), and an even higher percentage in recent years (Fisheries Division files). Yellow perch were reportedly scarce in the 1970s, but in the 1980s large yellow perch, including many exceeding twelve inches, were present in the lake. Laarman (1980) established population estimates for most fish species in Manistee Lake from 1973-1978 and from 1981-1984.

There have been a number of fisheries surveys conducted on Manistee Lake in the last fifteen years. In 1993, a fall electrofishing survey aimed at evaluating survival of stocked walleye was conducted using the protocol outlined by Serns (1982, 1983). A total of 73 walleye were caught, ranging from 5 to 19 inches (Table 2). Walleye from seven different year classes were represented in the catch, including 34 young of the year (age-0) from the 1993 year class. This resulted in a catch rate of 8.5 age-0 walleye/mile. In Michigan, a catch rate of less than 45 age-0/mile shocked equals a "poor" year class (Ziegler and Schneider 2000). However, the fact that some age-0 were caught indicates that there was some survival of stocked fish. Also, the catch of walleyes from year classes when none were stocked indicates that natural reproduction continues to enhance the walleye population. The walleyes captured in the 1993 survey were growing about 0.6 inches slower than the State of Michigan average. Because this was a targeted walleye survey, other fish species were not captured or evaluated.

In 1996, a general fisheries survey of the fish community was completed using fyke and inland gill nets (Tonello 1999). Healthy populations of bluegill, black crappie, and walleye were found. A total of 24 walleyes ranging from 7 to 21 inches were caught. The growth index for walleyes was 0.3 inches under the State of Michigan average, but slightly better than in the 1993 survey. Bluegill growth exceeded the Michigan average by 1.3 inches. Smaller numbers of yellow perch, largemouth bass, smallmouth bass, northern pike, and hybrid sunfish were observed. There were also a large number of adult white suckers captured; representing 42.5% of the catch by weight.

Another fall walleye electrofishing survey was conducted on Manistee Lake on September 26, 2002 (Tonello 2004). This survey was aimed at evaluating the 2002 walleye year class and again, the protocols outlined by Serns (1982, 1983) were used. A total of 36 walleyes were caught, ranging from

6 to 19 inches (Table 3). Five different year classes were represented in the catch, including 15 age-0 walleye from the 2002 year class. This resulted in a catch rate of 3.75 age-0 walleye/mile. In Michigan, a catch rate of less than 45 age-0/mile electroshocked equals a "poor" year class (Ziegler and Schneider 2000). However, due to a shortage of walleye fingerlings, Manistee Lake only received 17,355 in 2002, when it was scheduled to have been stocked with 25,800 fish. Eleven walleyes captured were from the 1999 year class, indicating that the 1999 stocking effort contributed significantly to the population. Also, the catch of walleyes from non-stocking year classes indicated that natural reproduction was enhancing the walleye population. Growth for walleye captured in the 2002 survey was 0.3 inches below the State of Michigan average, exactly what it was in 1996. Because this was a targeted walleye survey, other fish species were not captured or evaluated. Other species observed included black crappie, bluegill, northern pike, and pumpkinseed sunfish.

Since 1996, a total of twelve exceptional fish caught from Manistee Lake have been entered into the MDNR, Fisheries Division Master Angler program. Nine entries were bluegill, one was a yellow perch, and two were black crappie.

Current Status

2004 Status and Trends Survey

The most recent comprehensive fisheries survey of Manistee Lake was conducted in 2004. Status and trends protocols (Kevin Wehrly, Institute for Fisheries Research, Ann Arbor; unpublished data) were used for the survey. The netting portion took place from May 17 through May 20, and the boom electroshocking portion on August 16. Gear used included large-mesh fyke nets (12 net-nights), trap nets (9 net-nights), experimental graded-mesh inland gill nets (2 net-nights), maxi-mini small-mesh fyke nets (3 net-nights), and a boom electroshocking boat (3 ten-minute transects). The purpose of this survey was to investigate the status of all fish populations in the lake. Of particular interest was the walleye population, since Manistee Lake is regularly stocked with walleye. In the previous general survey (Tonello 2004) large-mesh fyke, small-mesh fyke, and inland gill nets were used; trap nets were not used.

During the 2004 survey, a total of 754 fish were caught, representing 21 different species (Table 4). Black crappie, yellow perch, and white sucker were the most frequently collected species. A total of 129 yellow perch from 1 to nearly 13 inches were caught, representing 17.1% of the catch by number. Most yellow perch caught were juveniles under 5 inches. A total of 128 black crappie ranging from 5 to 12 inches were caught, representing 17.0% of the catch by number and 10.2% of the catch by weight. Fully 90% of the black crappie caught were over 7 inches. The other numerous species was white sucker, with 128 individuals caught. They represented 17.0% of the catch by number and 47.7% of the catch by weight.

Bluegill were also fairly abundant (Table 4), with 88 caught from 4 to over 11 inches. All but a few of the bluegill were over 6 inches. Pumpkinseed sunfish, rock bass, and hybrid sunfish were the other panfish species seen. Thirty-nine pumpkinseed sunfish from 6 to 9.3 inches and 19 rock bass from 7 to 11.3 inches were caught. All pumpkinseed sunfish and rock bass caught exceeded 6 inches. One lone bluegill-pumpkinseed sunfish hybrid in the 8-inch class was also caught.

Game fish species caught included largemouth bass, smallmouth bass, northern pike, and walleye (Table 4). A total of 33 largemouth bass were caught, from 2 to 16 inches. Nearly half of the largemouth bass were over 14 inches. Twenty-seven smallmouth bass from 1 to 17 inches were caught, with 44% of them exceeding 14 inches. Northern pike were represented in the catch by 12 individuals, which ranged from 15 to 36 inches; of those, 42% exceeded 24 inches. Walleye were the most numerous predator species, with 48 individuals from 14 to 22 inches. They represented 12.5% of the catch by weight.

Most species caught showed above-average growth (Tables 5 and 6), with the exceptions being walleye and yellow perch. From the netting portion age-3 and -4 smallmouth bass were growing 0.1 inches faster than the State of Michigan average length at age (Table 5). Age-3, -5, and -6 largemouth bass were growing 0.8 inches faster than the state average. Not enough (fewer than five) northern pike from any one age class were collected to make statistical inferences regarding age and growth. Black crappie (ages 2-6) were growing at 1.1 inches faster than the state of Michigan average length at age. Pumpkinseed sunfish (ages 5-7) were also growing well, at 1.6 inches faster than the state of Michigan average. Rock bass (ages 5, 7, and 8) and bluegill (ages 4 and 5) were also slightly exceeding their state average lengths at age. Age-3 yellow perch from netting were growing 0.5 inches slower than the state average, while age-1 yellow perch from the boom electroshocking survey were 1.0 inches behind the state average (Table 6). Walleye from six different age classes were caught, but only enough age-5 and age-8 individuals were collected to make statistical inferences. Those age-5 and age-8 walleye were 2.3 inches behind their state-average lengths at age. It should be noted that prior to the 2004 survey, walleye had been stocked in 1996, 1999, 2002, and 2003 (Table 1). No walleye younger than age-4 were caught.

Species that had been reported in previous surveys, but not in 2004 included black bullhead, blacknose shiner, blackchin shiner, grass pickerel, common shiner, golden shiner, and hornyhead chub. New species caught in the 2004 survey which had not been seen in previous surveys of Manistee Lake included northern redbelly dace, and northern pearl dace.

Limnological data was collected by MDNR in mid-July and early August 2004. Temperature and oxygen profiles were recorded for the entire water column (Tables 7 and 8). Due to the shallow nature of Manistee Lake, there was no established thermocline during either limnological survey, and water temperature readings were relatively consistent from the surface to the bottom. In July, dissolved oxygen (DO) readings ranged from 8.2 parts per million (ppm) at the surface to 8.0 ppm near the bottom. In the August sample, DO readings ranged from 10.2 ppm at the surface to 8.5 ppm at 15.2 feet. However, at the bottom of the lake (16.5 feet) the dissolved oxygen dropped to 0.5 ppm, which is well below the threshold where fish can survive. The Secchi disk reading (a measure of the water clarity) was 10.7 feet in July, and 9.1 feet in August. Alkalinity is a measurement of the lake-waters ability to buffer the effects of acids and ultimately determines the pH of the water. It is also a measure of lake productivity. This measurement was recorded as 80 ppm in the August sample, which is about average for a northern Michigan waterbody. Chlorophyll pigment is a measure of biological productivity and high levels can often lead to algal blooms. The results for Manistee Lake in August were 2.8 micrograms per liter. This value is relatively low for inland lakes, and indicates that Manistee Lake did not have an algae bloom occurring during the sampling. Also in the August sample, total phosphorus was measured at 0.017 ppm and total nitrogen was measured at 0.591 ppm. These readings are also fairly low for inland lakes and they confirm that Manistee Lake is a mesotrophic lake. No

alkalinity, chlorophyll, phosphorous, or nitrogen readings were taken in the July sample. In the July sample, the pH was 7.92 at the surface, 7.96 at mid-depth, and 7.96 at the bottom. No pH readings were taken in the August sample.

The results of the summer 2007 limnological sampling by Gomez (2007) are very similar to those reported by the MDNR in August, 2004. According to Gomez, the low amounts of nutrients found in the water of Manistee Lake may result from the majority of the nutrients being tied up in the abundant aquatic macrophytes in the system. Gomez also surmises that phosphorous is likely the limiting nutrient for macrophytes in Manistee Lake. The results of the 2007 and 2004 limnological sampling are also similar to earlier MDNR limnological sampling in 1955, 1974, and 1996.

2006 Fall Walleye Survey

The most recent fall walleye index survey took place on September 12, 2006. That survey was a one-night boom electroshocking effort aimed at assessing the 2006 walleye year class, also known as a Serns Index survey (Serns 1982, Serns 1983). In the survey, a boom electroshocking unit was used to survey 3.7 miles of the Manistee Lake shoreline (nearly one complete lap of the lake, Figure 2). In that effort, a total of 160 walleye were captured, ranging from 5.8 to 22.4 inches (Table 9). Age and growth analysis determined that 150 of the walleye were age-0 or from the 2006 year class (Table 10). The catch rate was 40.32 age-0 walleye/mile of shoreline sampled, which results in a year class strength estimate of 8,114.5 or 9.435 age-0 walleye/surface acre (Table 9). According to Ziegler and Schneider (2000) that ranks as another "poor" year class. Those age-0 walleye ranged from 5.8 to 8.2 inches and averaged 6.72 inches. They were growing 0.4 inches behind the State of Michigan average for age-0 walleye in September. Although the catch rate of 40.32 age-0 walleye/mile of shoreline ranks as a "poor year class" according to Ziegler and Schneider (2000), it was the highest recorded in a fall walleye survey on Manistee Lake. Three of the larger walleye captured were age-3 (2003 year class), two were age-2 (2002 year class), one was age-5 (2001 year class), and there were two each from ages 6 (2000 year class), 7 (1999 year class), and 8 (1998 year class). It should be noted that walleye were stocked into Manistee Lake in 2006, 2003, 2002, and 1999 (Table 1).

2007 Manual Sucker Removal

According to Hayes (1990), white suckers can have a dramatic effect on growth of other fish species. Although Hayes specifically studied yellow perch, the conclusion likely applies to other panfish species and juvenile walleye. In the last two netting surveys, white suckers have composed a substantial portion of the biomass of the catch. In the 1996 survey, white suckers composed 42.5% of the catch by weight (Fisheries Division files), and in 2004 they composed 47.7% of the catch by weight (Table 4). Therefore, from April 30 through May 3, 2007, we conducted a manual removal of white suckers. The goal of the effort was to reduce the biomass of adult white suckers in Manistee Lake to free up resources for other more desirable fish species. We used 15 large-mesh fyke nets (a total of 42 net lifts) set at various locations around the lake, setting the nets in locations where suckers might be concentrated for spawning. We removed 1,096 white suckers weighing 2,834.7 lbs and ranging in size from 12 to 23 inches. These fish were given away at the boat launch to all who wanted them. The Manistee Lake Association and the Manistee Lake Improvement Board provided assistance with the effort, as they helped "get the word out" about the effort, and information on good locations where spawning suckers were concentrated. They also assisted by distributing suckers to citizens.

The only other species recorded and counted was walleye. We caught 34 walleye ranging from 13 to 21 inches. Age and growth analysis showed that they were from age classes 2-7, and 9. As a whole, the walleye from the 2007 effort were growing 0.1 inches faster than the State of Michigan average lengths at ages (Table 11). Further scrutiny shows that while the older (ages 6 and 7) year classes still appear to be growing slowly, the younger ages (3 and 5 in particular) are growing faster. This represents a shift from what has been seen in previous surveys where walleye growth in Manistee Lake has been relatively slow.

Analysis and Discussion

The 2004, 2006, and 2007 MDNR fisheries surveys showed that Manistee Lake has generally healthy game fish populations. Walleye in particular are numerous and are a keystone predator. Largemouth and smallmouth bass populations are well balanced, with multiple year classes represented in the catch, and many individuals of both species exceeding the minimum legal-size limit of 14 inches. The northern pike population also appears to be healthy. Although only 12 individuals were caught in the 2004 survey, they represented seven different year classes and were growing well. The presence of a 36 inch pike in the 2004 survey shows that Manistee Lake is capable of producing large northern pike.

The panfish populations appear to be healthy, particularly black crappie, pumpkinseed sunfish, and bluegill. Individuals were present in the catch of the 2004 survey from a number of different year classes, indicating consistent natural reproduction. Bluegill and pumpkinseed sunfish of Master Angler size were present in the 2004 survey, and some Master Angler catches have been recorded in recent years. Perhaps the only downside to the 2004 fisheries survey was the lack of "catchable" yellow perch in the sample. Most caught in 2004 were smaller than 6 inches, although individuals up to almost 13 inches were observed.

The walleye population appears to be extremely healthy. Walleye were present from both stocking and non-stocking years, which confirms that some natural reproduction is taking place in most, if not all, years. However, the majority of the walleye aged from the 2004 survey were from stocking years. Therefore, the walleye fishery appears to be largely dependent on stocked fish. Although walleye were growing slower than the state average in the 2004 survey, growth appears to have improved recently, based on the results of the 2007 survey. The population is well-balanced with individuals present from numerous year classes. Nearly all walleye caught in the 2004 survey were of legal size (over 15 inches). Although the 1993, 2002, and 2006 Serns fall walleye sampling efforts all resulted in "poor" year classes according to Ziegler and Schneider (2000), it is possible that the index doesn't exactly fit Manistee Lake. A poor year class according to Ziegler and Schneider (2000) may actually be a very good year class on Manistee Lake.

According to Laarman (1980), from 1973 through 1978 the white sucker population of Manistee Lake was usually between 4,000 and 5,000 individuals except in 1973, when the estimate was nearly 7,000. It should be noted that confidence intervals were quite large with these estimates. However, if the white sucker population is usually between 4,000 and 5,000, then in spring of 2007 we possibly reduced the population by 20-25% by removing nearly 1,100 adult white suckers. It is hoped this action will free up resources for other species, including yellow perch, juvenile walleye, and panfish. This may result in increased growth rates for those species and possibly increased abundance as well.

Management Direction

The Manistee Lake walleye fishery is largely dependent upon stocking. Therefore, spring fingerling walleye (Muskegon River strain) should continue to be stocked into Manistee Lake, at a rate of 50/acre (or 43,000 fish) every third year, starting in 2009. Although some natural reproduction occurs in all or most years, it is not sufficient to support the fishery. Continued walleye stocking, along with supplemental natural reproduction, should continue to allow Manistee Lake to be one of the better walleye fishing lakes in the area. Fall walleye electrofishing surveys should be conducted in years when walleye are stocked, to assess the survival of the stocked fish. By looking at older walleye in addition to age-0 fish, natural reproduction from non-stocking years can also be ascertained from these surveys.

At this time, the Manistee Lake walleye stocking program is dependent on the ability of the Department to provide walleye fingerlings that are certified as disease-free. In recent years, Viral Hemorrhagic Septicemia (VHS) has been introduced into Michigan waters. VHS is a fish pathogen that has been responsible for a number of large, high-profile fish kills. In Michigan, VHS has mostly been limited to Great Lakes waters, but one inland lake (Budd Lake, Clare County) was also found to be infected. If disease-free walleye fingerlings are available, then walleye should be stocked into Manistee Lake. However, if there is any doubt as to whether or not the walleye fingerlings are truly VHS-free, then they should not be stocked. Stocking infected fish into Manistee Lake could potentially infect a large portion of the Manistee River watershed with VHS.

Native species like smallmouth bass, largemouth bass, bluegill, pumpkinseed sunfish, black crappie, rock bass, and northern pike should continue to thrive in Manistee Lake. The yellow perch population is currently an uncertainty. It is hoped that the yellow perch population structure will improve with the removal of nearly 1.5 tons of white sucker. Another general netting survey should be conducted within the next 5 years with the goal of examining the general fish populations of Manistee Lake. In particular, an attempt should be made to examine the effects of the white sucker manual removal on the fisheries ecosystem of the lake. In the next survey, white sucker abundance as well as the growth rates of walleye, yellow perch, and panfish should be closely examined. If white sucker abundance remains high and fish growth rates do not improve, further manual removal efforts may be warranted. Also, Serns fall walleye electrofishing efforts should be conducted in as many years as possible. In years when walleye are stocked, such surveys can help determine the effectiveness of the stocking effort. In non-stocking years, the Serns surveys can help determine the extent of walleye natural reproduction. Also, the growth rates of juvenile walleye can be another indicator as to whether or not manual white sucker removal efforts are having any effect.

Eurasian milfoil will likely continue to require treatment, at least in some years. We commend the Manistee Lake Association and the Manistee Lake Improvement Board for committing to treatment with weevils, instead of herbicides or other methods. Use of weevils will be more beneficial to the Manistee Lake ecosystem in the long run.

Any remaining riparian wetlands adjacent to Manistee Lake should be protected as they are critical to the continued health of the lake's aquatic community. Future unwise riparian development and wetland loss may result in deterioration of the water quality and aquatic habitat. Healthy biological communities in inland lakes require suitable natural habitat. Human development within the lake

watershed, along the shoreline, and in the lake proper has a tendency to change and diminish natural habitat. Appropriate watershed management is necessary to sustain healthy biological communities, including fish, invertebrates, amphibians, reptiles, birds and aquatic mammals. Generally for lakes this includes maintenance of good water quality, especially for nutrients; preservation of natural shorelines, especially shore contours and vegetation; and preservation of bottom contours, vegetation, and wood structure within a lake. Guidelines for protecting fisheries habitat in inland lakes can be found in Fisheries Division Special Report 38 (O'Neal and Soulliere 2006).

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Figure 1. Contour map of Manistee Lake, Kalkaska County, with net set locations from the May 2004 MDNR fisheries survey.

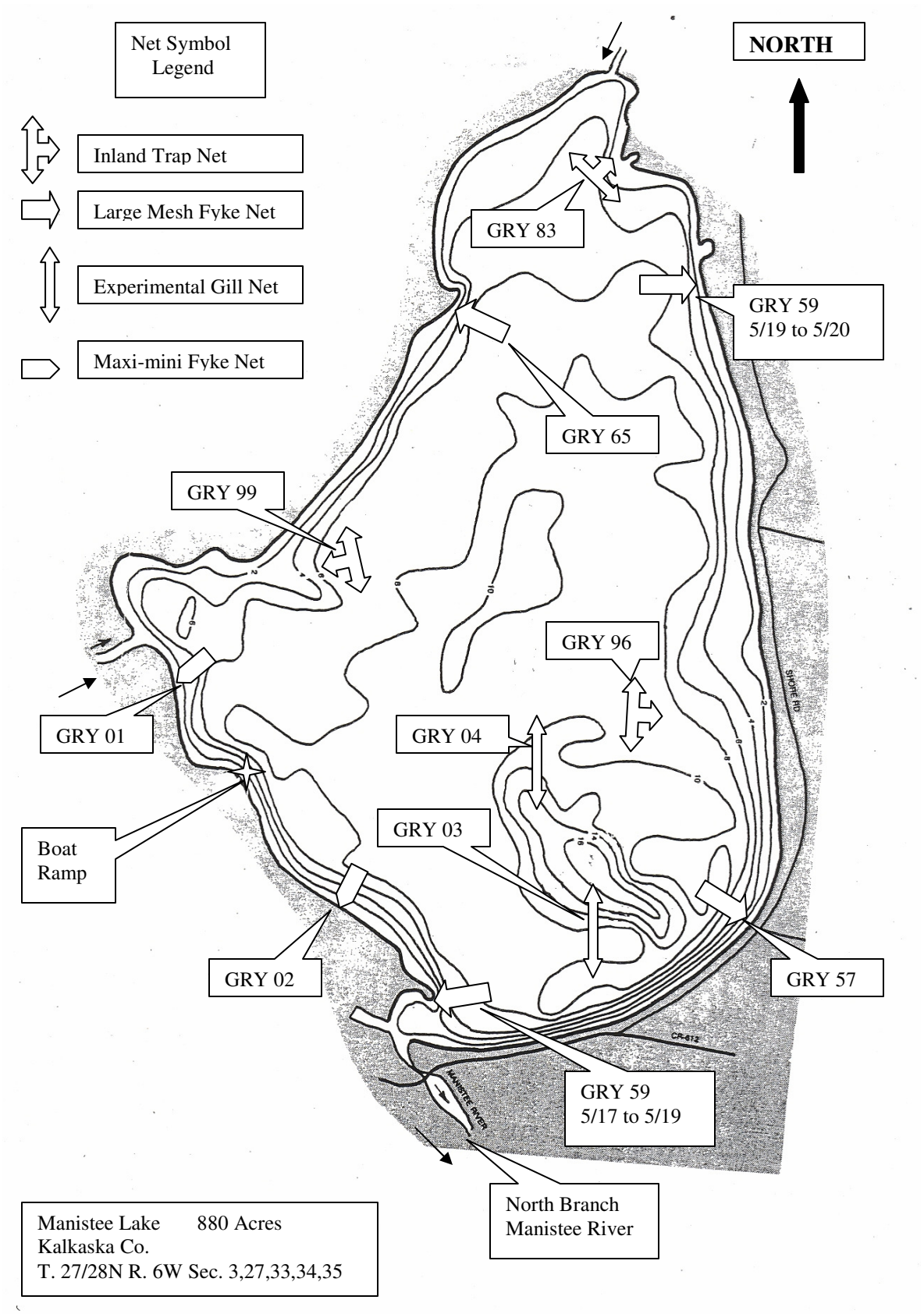

Figure 2. The route for the MDNR fall walleye electrofishing survey conducted on 9/12/2006.

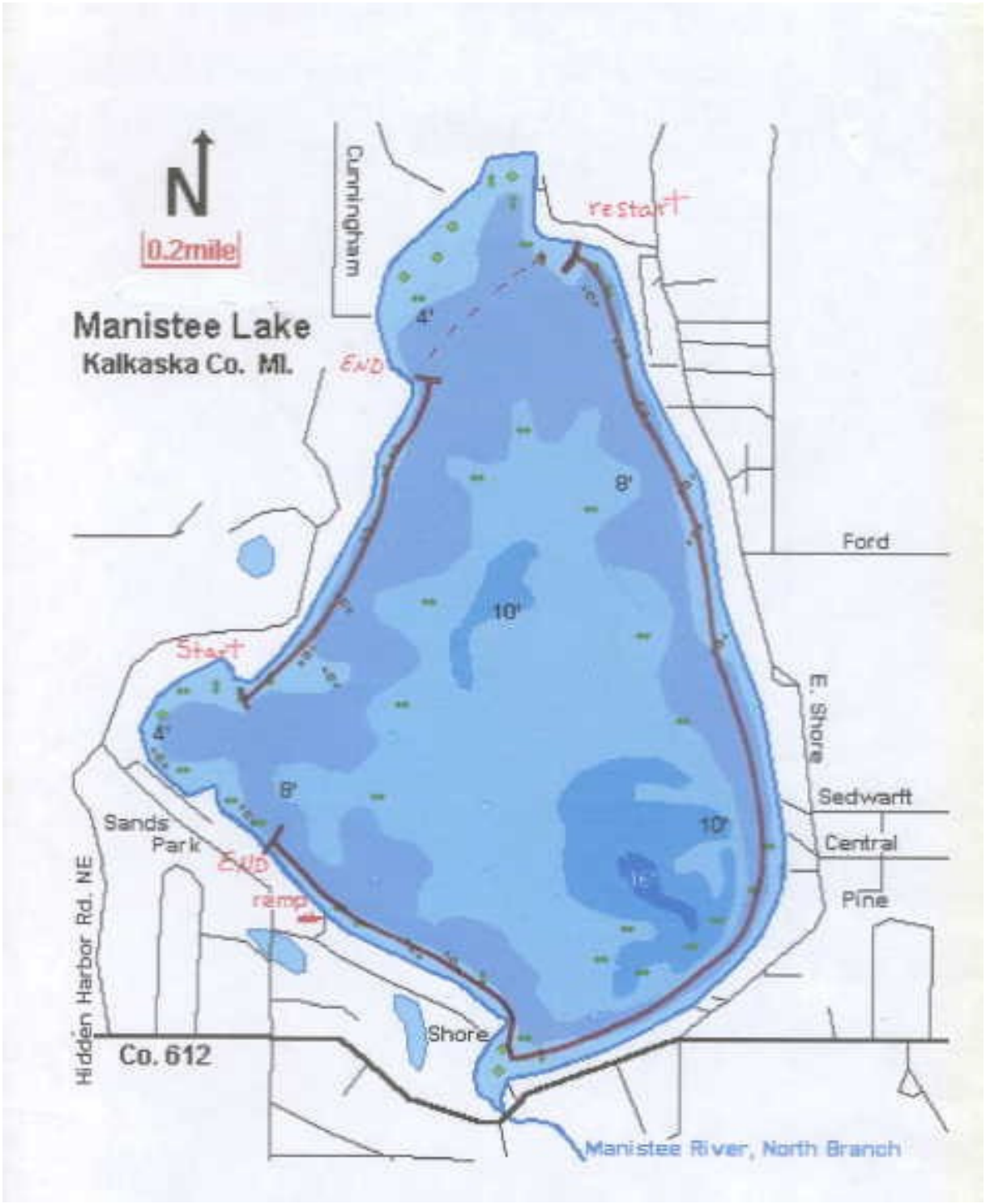

Table 1. Fish stocked in Manistee Lake, Kalkaska County, 1969-2007.

Year	Species	Number	Size	Strain
1969	walleye	1,000,000	fry	
1971	walleye	1,015,000	fry	
1972	walleye	1,100,000	fry	
1974	walleye	2,781	fingerlings	
1975	walleye	1,772	spring fingerlings	
	walleye	6,350	fall fingerlings	
1976	walleye	6,557	spring fingerlings	
1977	walleye	9,427	fall fingerlings	
1978	walleye	8,024	fall fingerlings	
1981	walleye	6,542	spring fingerlings	
	walleye	2,780	yearlings	
1982	walleye	16,377	spring fingerlings	
	walleye	1,933	yearlings	
1983	walleye	24,150	spring fingerlings	
1985	walleye	26,922	spring fingerlings	
1987	walleye	22,700	spring fingerlings	
1990	walleye	26,700	spring fingerlings	
1993	walleye	24,386	spring fingerlings	Muskegon
1996	walleye	39,633	spring fingerlings	Muskegon
1999	walleye	23,931	spring fingerlings	Muskegon
2002	walleye	17,355	spring fingerlings	Muskegon
2003	walleye	14,690	spring fingerlings	Muskegon
2006	walleye	34,425	spring fingerlings	Muskegon

Table 2. 1993 Manistee Lake Serns Index Survey Results

Miles of shoreline sampled: 4
Manistee Lake acreage: 860
Serns Age-0 constant: 0.234
Serns Age-1 constant: 0.194

Year Class	Age	# walleye captured	Catch Rate (# walleye/mile of shoreline sampled)	Year Class strength estimate	Serns Index (# walleye/surface acre)
1993	0	34	8.50	1710.5	1.989
1992	1	3	0.75	125.1	0.146
1991	2	9	2.25		*
1990	3	9	2.25		*
1989	4	12	3.00		*
1988	5	3	0.75		*
1987	6	3	0.75		

* No Serns constant exists for Ages 2-6.

Table 3. 2002 Manistee Lake Serns Index Survey Results

Miles of shoreline sampled: 4
Manistee Lake acreage: 860
Serns Age-0 constant: 0.234
Serns Age-1 constant: 0.194

Year Class	Age	# walleye captured	Catch Rate (# walleye/mile of shoreline sampled)	Year Class strength estimate	Serns Index (# walleye/surface acre)
2002	0	15	3.75	754.7	0.878
2001	1	4	1.00	166.8	0.194
2000	2	1	0.25		*
1999	3	11	2.75		*
1998	4	5	1.25		*

* No Serns constant exists for Ages 2-6.

Table 4. Number, weight, and length of fish collected from Manistee Lake with large mesh fyke nets, trap nets, maxi-mini fyke nets, inland gillnets, May 17-20, 2004, and electrofishing on August 16, 2004.

Species	Number	Percent by number	Weight (Pounds)	Percent by weight	Length range (inches)[1]	Average length	Percent legal size[2]
black crappie	128	16.7	69.2	10.3	5.2-12	9.6	90 (7")
bluegill	88	11.5	33.4	4.9	4-11.1	8.0	97 (6")
bluntnose minnow	15	2.0	0.1	0.0	1-3	2.6	
hybrid sunfish	1	0.1	0.0	0.0	8.5	8.5	100 (6")
Iowa darter	41	5.4	0.1	0.0	1-2	2.1	
johnny darter	21	2.7	0.1	0.0	1-2	1.9	
largemouth bass	33	4.3	41.4	6.1	2-16	12.8	45 (14")
mimic shiner	21	2.7	0.1	0.0	1-2	2.2	
northern pike	12	1.6	48.1	7.1	15-36	25.0	42 (24")
northern redbelly dace	2	0.3	0.0	0.0	2-2	2.5	
pearl dace	1	0.1	0.0	0.0	2-2	2.5	
pumpkinseed sunfish	39	5.1	18.9	2.8	6-9.3	8.2	100 (6")
rock bass	19	2.5	12.0	1.8	7-11.3	9.3	100 (6")
smallmouth bass	27	3.5	34.6	5.1	1.9-17	12.9	44 (14")
spottail shiner	11	1.4	0.2	0.0	2.6-4.1	3.9	
walleye	48	6.3	84.4	12.5	12-26	17.4	98 (15")
white sucker	128	16.8	322.1	47.7	4.3-22.6	18.3	
yellow perch	129	16.9	10.2	1.5	4-10	3.6	10 (7")
Total	764	100	674.8	100			

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

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

Table 5. Average total weighted length (inches) at age, and growth relative to the state average, for fish sampled from Manistee Lake with large mesh fyke nets, trap nets, maxi-mini fyke nets, and inland gill nets, May 17-20, 2004. Number of fish aged is given in parenthesis.

Species	Age I	II	III	IV	V	VI	VII	VIII	IX	Mean Growth Index
Black crappie		5.6 (9)	9.0 (13)	9.5 (12)	11.0 (12)	11.2 (7)				+1.1
Bluegill			4.3 (1)		7.5 (12)	8.1 (12)	8.1 (2)	9.5 (2)	11.1 (1)	+0.8
Hybrid sunfish				8.1 (1)						
Largemouth bass		7.9 (1)	11.2 (7)	11.6 (4)	14.0 (6)	15.0 (8)	15.6 (4)			+0.8
Northern pike	15.0 (1)	21.7 (3)	26.4 (3)	23.3 (2)	25.3 (1)	31.6 (1)		36.5 (1)		
Pumpkinseed				6.3 (2)	7.6 (5)	8.3 (5)	8.9 (6)	9.3 (1)	9.0 (3)	+1.6
Rock bass					7.7 (5)	8.9 (2)	9.2 (5)	10.2 (5)	10.0 (1)	+0.7
Smallmouth bass		9.3 (2)	11.8 (5)		14.0 (9)	14.8 (4)	14.8 (2)	17.2 (1)		+0.1
Walleye				14.9 (1)	16.7 (13)	17.1 (4)	17.7 (2)	18.4 (12)	19.2 (2)	-2.3
Yellow perch	3.4 (1)	6.3 (1)	6.0 (6)		10.0 (1)	11.1 (1)	11.5 (4)			-0.5

Table 6. Average total weighted length (inches) at age, and growth relative to the state average, for fish sampled from Manistee Lake by electrofishing, on August 16, 2004. Number of fish aged is given in parenthesis.

	Age								
Species	I	II	III	IV	V	VI	VII	VIII	IX	Mean Growth Index
Bluegill		4.1 (1)	6.4 (2)	6.4 (1)						
Largemouth bass	6.2 (1)									
Pumpkinseed		6.5 (2)								
Smallmouth bass	7.7 (2)					15.6 (1)	16.5 (1)			
Yellow perch	3.8 (12)	5.4 (6)	7.2 (1)							-1.0

Table 7. Water temperature and dissolved oxygen profile for Manistee Lake, Kalkaska County. Sampling was conducted on July 15, 2004.

Depth (ft)	Temperature (F)	Dissolved oxygen (ppm)
0	70.3	8.2
1	70.3	8.2
2	70.3	8.1
3	70.3	8.1
4	70.3	8.1
5	70.3	8.1
6	70.3	8.1
7	70.3	8.1
8	70.3	8.1
9	70.3	8.1
10	70.2	8.1
11	70.2	8.1
12	70.2	8.1
13	70.2	8.1
14	70.1	8.1
14.5	70.1	8.0
15	70.1	8.0
15.5	70.1	8.0

Table 8. Water temperature and dissolved oxygen profile for Manistee Lake, Kalkaska County. Sampling was conducted on August 9, 2004.

Depth (ft)	Temperature (F)	Dissolved oxygen (ppm)
0.0	72.0	10.2
1.0	72.0	10.2
2.1	72.0	10.1
3.2	72.0	10.0
4.2	72.0	10.0
5.2	71.9	9.9
6.2	71.9	9.8
7.1	72.0	9.7
8.1	71.9	9.7
9.3	71.9	9.7
10.0	71.9	9.6
11.4	71.9	9.6
12.2	71.9	9.6
13.2	71.9	9.5
14.1	71.9	9.4
15.2	71.1	8.5
16.5	70.1	0.5

Table 9. 2006 Manistee Lake Serns Index Survey Results

Miles of shoreline sampled:	3.72
Manistee Lake acreage:	860
Serns Age-0 constant:	0.234
Serns Age-1 constant:	0.194

Year Class	Age	# walleye captured	Catch Rate (# walleye/mile of shoreline sampled)	Year Class strength estimate	Serns Index (# walleye/surface acre)
2006	0	150	40.32	8114.5	9.435
2005	1		0.00	0.0	0.000
2004	2		0.00		*
2003	3		0.00		*
2002	4		0.00		*

* No Serns constant exists for Ages 2-6.

Table 10. Average total weighted length (inches) at age, and growth relative to the state average, for walleye sampled from Manistee Lake by electrofishing, on 9/12/2006. Number of fish aged is given in parenthesis.

	Age										Mean Growth
Species	0	I	II	III	IV	V	VI	VII	VIII	IX	Index
Walleye	6.72			17.0	16.5	17.7	17.8	20.6	18.2	18.2	-0.4
	(23)			(1)	(2)	(1)	(2)	(2)	(2)	(2)	

Table 11. Average total weighted length (inches) at age, and growth relative to the state average, for walleye sampled from Manistee Lake large-mesh fyke nets, from 4/30/03-5/3/07. Number of fish aged is given in parenthesis.

	Age										Mean Growth
Species	0	I	II	III	IV	V	VI	VII	VIII	IX	Index
Walleye			14.2	16.4	16.5	18.4	18.3	18.6		20.5	+0.1
			(3)	(6)	(2)	(7)	(7)	(7)		(1)	