Department of Natural Resources, Fisheries Division

Muskegon River Fisheries Management Summaries

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The Muskegon River begins in north-central Lower Michigan, flowing from Higgins Lake and Houghton Lakes, southwesterly to the City of Muskegon and discharging into central Lake Michigan. The river is 212 miles long and drops 575 feet in elevation between its headwater and mouth (O'Neal 1997). The watershed incorporates over 2,350 square miles of land and approximately 94 tributaries flow directly into the mainstem.

The original fish community of the river system was composed of 97 species, and there have been a number of species that colonized or were introduced. The most recent fish community surveys were conducted on Higgins Lake (unpublished 2011), Houghton Lake (O'Neal 2011), the river and large impoundments (O'Neal 2002), and Muskegon Lake (unpublished 2008).

The Muskegon River Watershed Assessment provides substantial background on the physical characteristics of the river (O'Neal 1997), along with Wiley et al. (2009). The hydrology of the river is intermediate between coldwater and warmwater Michigan streams. Water temperature data and fisheries surveys verify the coolwater nature of this river (O'Neal 2001; O'Neal 2011). The predominant species of fish found in the river are suckers, but there are many sport fish also present in the river as well as the lakes. The lower river (from Croton Dam to Muskegon Lake), Muskegon Lake, Houghton Lake, and Higgins Lake provide some of the best fishing in Michigan.

These summaries are intended to highlight the existing fisheries in the river system, and provide brief summaries of recent studies conducted on important fish species along with needed research.

ANGLER-USE AND CATCH

Angler surveys of all sections of the mainstem of the Muskegon River were conducted between 1999 and 2008 (O'Neal 2015). Angler surveys were conducted on Higgins Lake, Houghton Lake and Muskegon Lake; four impounded river sections that include Reedsburg Impoundment, Rogers Impoundment, Hardy Impoundment and Croton Impoundment; the river segment from Reedsburg Dam to Rogers Impoundment; and the river segment from Croton Dam to Muskegon Lake (Figure 1). Although all of these surveys did not cover the winter period or after dusk, these angler surveys provide a conservative and reasonable assessment of the annual fisheries characteristics and angler effort in the various sections of the mainstem of the Muskegon River.

The estimated annual catch of fish in the 11 riverine and lake sections of the mainstem was 1,820,610. Twenty-eight species of fish were caught, with yellow perch, bluegill, rainbow smelt, pumpkinseed and rainbow trout comprising 85.4% of the total. Other species that had more than 10,000 fish in the annual catch estimates included rock bass, smallmouth bass, black crappie, northern pike, walleye, Chinook salmon, brown trout, and largemouth bass. The estimated number of fish released was 454,276, with yellow perch, bluegill, and rainbow trout accounting for 71.5%. Other species that had more than 10,000 fish in the annual release estimates included smallmouth bass, northern pike, brown trout, Chinook salmon, largemouth bass and walleye. The estimated number of fish harvested was 1,366,334, with yellow perch, rainbow smelt, bluegill, and pumpkinseed accounting for 87.7%. Other species that had more than 10,000 fish in the annual harvest estimates included rock bass, black crappie, rainbow trout, walleye, northern pike, and smallmouth bass. Higgins Lake, Houghton Lake, and Muskegon Lake accounted for 81.7% of total catch and 92.4% of total harvest. Higgins Lake, Muskegon Lake, and the river section from Croton Dam to Newaygo accounted for 68.1% of total released fish.

For every 100 hours of fishing, 124 fish were caught, 93 were harvested and 31 were released. The catch rate (per hour) of fish was high in the river section from Reedsburg Dam to Dolph Road and Higgins Lake, and relatively high in Muskegon Lake. The release rate of fish was high in the river section from Reedsburg Dam to Dolph Road and Reedsburg Impoundment, and relatively high in the river section from Dolph Road to Temple, Muskegon Lake, Hardy Impoundment and Croton Impoundment. The harvest rate of fish was high in Higgins Lake, the section of river from Reedsburg Dam to Dolph Road and Muskegon Lake.

Based on the fish harvest estimates, the annual value of harvested fish fillets by anglers in the mainstem of the Muskegon River was approximately $707,889. Houghton Lake, Higgins Lake, the river section between Croton Dam and Newaygo, and Muskegon Lake accounted for 91% of this value. Yellow perch, bluegill, northern pike, rainbow trout, walleye, pumpkinseed, Chinook salmon, and smallmouth bass accounted for 88.7% of the total fish fillet value.

An estimated 1,473,420 angler-hours were expended on the river during a one year period. The number of angler-hours per acre was very high for the river section from Croton Dam to Newaygo, and high for the river sections from Newaygo to Muskegon Lake and Reedsburg Dam to Dolph Road. The number of angler-hours per acre was very low in the river segment from Dolph Road to Temple.

Based on the value of $29 per angler-day (Department of the Interior 2013), the annual economic value of the fisheries in the mainstem of the Muskegon River was $12.4 million. Houghton Lake, the river section from Croton Dam to Newaygo, Higgins Lake, and Muskegon Lake had the highest total economic fishery values. The fishery value per acre in the river section from Croton Dam to Newaygo was very high, and high values were also found in the river sections from Newaygo to Muskegon Lake and from Reedsburg Dam to Dolph Road. The very high fishery values found in the river section from Croton Dam to Newaygo is the result of Lake Michigan migratory steelhead and salmon runs producing seasonal fisheries, and stocked rainbow and brown trout that produce summer fisheries. This section of river has moderate gradient with substantial areas of gravel substrate and cool water temperatures that are favorable for trout and salmon.

Croton Dam, Hardy Dam and Rogers Dam block migratory fish from movement into upper river segments. The impoundments cover 36.4 miles of river that have the highest gradients in the mainstem, and block another 33.1 miles of river from Rogers Impoundment upstream to Evart that has similar gradient to the area downstream of Croton Dam. There is the potential for significant increases in fisheries use (60%) and economic value of the fisheries with removal of the three hydroelectric dams, based on the fishery value per mile measured downstream of Croton Dam.

Public access site information throughout the river can be acquired in the Muskegon River Fishing Access Site Information document, from Fisheries Division at the Cadillac Service Center (231-775-9727), or at this link: http://www.michigan.gov/dnr/0,4570,7-153-10364_52259_65062---,00.html .

WALLEYE

Presently, fishing for walleye occurs in the Muskegon River during late spring through the winter, in Muskegon Lake from summer through the winter, and in Lake Michigan near the piers during fall and spring. The annual movements of Muskegon River walleye in Lake Michigan typically range from Leland to the Indiana border (Hanchin et al. 2007) and they also contribute to fisheries within this area. In addition to the average (1999 – 2005) harvest of 486 walleye in the Muskegon River, an estimated 2,082 walleyes were harvested in the summer and winter fisheries in Muskegon Lake, from April 2002 through March 2003 (Hanchin et al. 2007). The greatest harvest of walleyes probably occurs during the spring and fall fisheries in Lake Michigan near the piers, but harvest estimates are not available for this portion of the fishery, or in other areas along the Lake Michigan coast because most of the walleye fishing occurs at night and during the late fall to early spring when creel surveys are not conducted.

The Muskegon River historically supported one of the largest runs of adfluvial walleye in Michigan and supports the largest spawning stock of walleye in Lake Michigan south of Green Bay (Kapuscinski et al. 2010). Schneider and Leach (1979) noted that information on the original stock was lacking due to early development of the logging industry, around 1838. Commercial fisheries were not established until about 1880 due to lack of a channel between Muskegon Lake and Lake Michigan that could support commercial fishing boat traffic. By this time, logging was most likely affecting the walleye population. This is indicated by commercial catch records that show low catches of walleye until about 1907, followed by significantly higher catches. The increase in population abundance was attributed to construction of the Newaygo Dam (in 1900), that may have improved spawning habitat and recruitment by trapping excessive river bed sediment caused by deforestation and logging activities. Population levels remained relatively high until the 1950s. Spawning runs were estimated at 114,000 (±36,864) fish in 1953 and 139,000 (± 43,638) fish in 1954 (Crowe 1955). These levels were near the high end of the range for this period. A severe decline in the population occurred during the late 1950s and 1960s and the spawning run was estimated at about 2,000 fish in 1975 (MDNR Fisheries Division, unpublished data).

Schneider and Leach (1979) attributed the severe population decline beginning in the late 1950s to lack of recruitment. Recruitment problems were not attributed to spawning or water quality conditions in the river, but to dramatic changes that were occurring in fish communities of Muskegon Lake and Lake Michigan. Severe declines in native yellow perch and white bass, and large increases in gizzard shad and the introduced alewife in Muskegon Lake indicate these changes. Water quality problems with nutrients and chemical pollutants were significant in Muskegon Lake. Commercial fishing and sea lamprey predation also may have contributed to the decline in the walleye population, but these were not considered primary factors (Schneider and Leach 1979). Day (1991) provided some evidence that suggests predation and competition for food, by alewife and gizzard shad, may not have been severe enough to directly affect walleye recruitment in Muskegon Lake. Lack of information on biological communities in Muskegon Lake during this period makes absolute determination of the cause of the natural recruitment decline difficult. Natural recruitment of walleye continued to be low in the Muskegon River system through 2012 (O'Neal 2017).

Population abundance

A walleye stocking program was initiated in 1978 that increased the Muskegon River adult spawning run substantially. (Day 1991) estimated the spawning run to be 43,222 (± 25,372) fish in 1986. O'Neal (1998), estimated the number of walleye in the spawning run was 46,479 (±4,551)) and in 2002 the number of spawning adults was estimated at 37,890 (± 7,306) by Hanchin et al. (2007). O'Neal (1998) provided the highest amount of effort and the lowest uncertainty of recent abundance estimates. The number of age 5 – 15 females was estimated at 18,706, and the number of age 2 – 14 males was estimated at 27,774. Spawning run abundance dramatically increased from 1975, but it is not probable the population had attained the higher levels measured historically of over 100,000 fish. However, present day growth rates of walleye are very high compared to other Michigan populations and larger fish are more common in the population than during 1947 to 1963 (Hanchin et al. 2007).

Natural recruitment

Another change in the river that may now be affecting natural recruitment of walleye was the removal of Newaygo Dam in 1969. This opened an additional 14.4 miles of spawning habitat to walleye. However, the thermal character of the spawning grounds may have been changed. Schneider et al. (1991) reported water temperatures on spawning grounds below Croton Dam were less than laboratory optima for walleye egg incubation and fry feeding. The hydroelectric impoundments are delaying spring water temperature increases below Croton Dam (O'Neal 1997). Schneider et al. (1991) also found that strong year-classes of walleye were produced during years with exceptionally warm spring temperatures. However, strong year-classes also were related to low adult walleye population densities and occurred in about ten year cycles (Schneider and Leach 1979). In addition, higher water velocities near Croton Dam may not be optimal for walleye spawning (Ivan et al. 2010). Wiley et al. (2009) reported that water discharge in the Muskegon River has been slowly increasing since the early 1900s.

Day (1991) found walleye fry in the river during 1986 using drift nets, but was unable to find fingerlings in Muskegon Lake. Jude and Hensler (2006) found very few larvae in the river using drift nets and very low densities in Muskegon Lake.

More intensive walleye recruitment studies were completed in the river during 2003 – 2006 (Ivan et al. 2010) and 2009 - 2010 (Allison and Ruetz 2011; Rutherford et al. 2011, Rutherford et al. 2016). These studies were conducted to evaluate recruitment bottlenecks during the egg and larval stages downstream of Croton Dam.

Ivan et al. (2010) found that approximately 3 – 4 billion walleye eggs were produced annually in the Muskegon River based on different methods (fecundity and number of females spawning, and estimates from egg deposition in the river). They concluded that walleye egg survival was lower than in other studies and this resulted from low water temperatures and high water velocities based on a weighted useable area model. Based on egg survival, they estimated from 40 million to 1 billion fry could be produced annually.

Allison and Ruetz (2011) found that egg deposition was highest near Croton Dam and decreased downstream to Newaygo. Egg deposition occurred during a three week period during both years. Both field and laboratory studies found that egg predators (rusty crayfish and fish) did not significantly reduce walleye egg survival. There was no evidence that egg deposition or survival of eggs prior to hatch (on mats or incubators) was limiting reproductive success of walleye in the river. Egg survival on mats was 18% in 2009 and 35% in 2010 (higher than the 2% in 2005-2006 estimated by Ivan et al. 2010). Egg deposition was 42 times higher in 2009 than 2010. Egg survival was higher during 2010 when egg deposition was lower but this may have been related to higher river discharge and water velocities in 2009. Rutherford et al. (2011) estimated larval fish production from the nursery area (Croton Dam to the Thornapple Street PAS) in the Muskegon River at 17.9 (± 1.3) million in 2009 and 33.7 (± 4.0) million in 2010. Emigration of larvae from the nursery area to the lower section of the river at Maple Island Road (14.4 miles upstream of Muskegon Lake) was 1.8 (± 0.2) million in 2009 and 12.3 (± 1.3) million in 2010.

Despite the higher egg densities in 2009, larval walleye production was higher in 2010 due to greater egg survival. However, larval fish production was low when compared to the relatively high pre-hatch egg survival and the estimated 40 million to 1 billion potential larvae production in 2005-2006 that Ivan et al. (2010) estimated with a much lower egg survival. Larval production in the nursery area is also low when compared to the estimated average 3.6 billion eggs that are deposited. Survival from egg deposition to fry would approximate 0.5% in 2009 and 0.9% in 2010.

Rutherford et al. (2016) found that egg survival was positively related to water temperature and negatively related to flow at most sites in 2009 and 2010. In both years, walleye larvae that hatched in cooler temperatures were smaller than larvae that hatched later in warmer temperatures. Survival was highest for smaller larvae hatching early in April 2010 when temperatures were warm and discharges were low and stable, and much lower for larger larvae hatching later that year or small larvae in 2009 when water temperatures were colder and discharges were higher and more variable. The study results suggested that abiotic factors, primarily water temperature and river flow, likely control early survival of walleye in the Muskegon River.

O'Neal (2017) evaluated the catch rates of stocked and wild young-of-the-year walleye in Muskegon Lake for 15 years during 1997-2015. All fingerling walleye stocked into the Muskegon River and Muskegon Lake were marked with oxytetracycline. Fall samples were collected with electrofishing gear at one or two established index sites each year and juvenile walleye were examined for oxytetracycline. Stocked juveniles were found during all 12 years when stocking occurred and averaged 13.4 per mile. Wild juveniles were found in 12 of 15 years and averaged 4.7 per mile over the sample period; nearly three times lower than the catch rate of stocked fish. In 2009, fry production in the nursery area was estimated at 17.9 million (Rutherford et al. 2011) and the catch rate of wild young-of-the-year in Muskegon Lake was 1.9 per mile, below the 15 year average. In 2010, walleye fry production in the river was estimated at 33.7 million and the wild young-of-the-year catch rate was 5.1 per mile, above the 15 year average. Fingerling walleye stocking ranged from 5,000 to 594,000 during the sample period. There was no obvious relationship between the number of spring fingerling walleye stocked and fall fingerling hatchery walleye catch rates in Muskegon Lake (O'Neal 2014).

Based on the relatively stable spawning run abundance of adult walleye of 37,890 – 46,479 (1986 – 2002), the 15 year average catch rate of 15.4 per mile of fall fingerlings (1997-2015), and ratio of stocked to wild fall fingerlings, natural walleye fry production in the Muskegon River would need to increase by at least three times the current level to maintain the existing abundance of adult spawning fish.

Overall, natural walleye recruitment in the Muskegon River system is very low and has been since the late 1950s. Principal issues related to poor recruitment include alewife predation of larvae in Muskegon Lake and low production of larvae in the Muskegon River. Presently, the low production of larvae in the Muskegon River is appears to be related to low water temperatures during the spawning period, and high water velocities in the spawning area. Low water temperatures on the spawning grounds result from delayed water temperature warming in the hydroelectric impoundments. Water temperatures in the river upstream of the impoundments are warmer during the spring walleye spawning period. Water velocities in the spawning area below Croton Dam are moderate for the system based on moderate gradients. Historically (1930s-1950s), when natural recruitment was good, walleye spawned downstream of Newaygo Dam where gradient was lower. The three hydroelectric dams block free movement of walleye to about 75% of the river upstream of the dams. More suitable spawning areas may be located in upriver locations.

<u>Movements and food</u>

Muskegon River walleye are highly migratory and they annually range southward in Lake Michigan to about the Indiana border and northward to Leeland (Eschmeyer, P. H. 1950; Hanchin et al. 2007). Some fish have been found to migrate to northern Green Bay. Hanson (2006) evaluated the seasonal movements of walleye in the Muskegon River and Muskegon Lake. During March, April, and May of 2004 and 2005, adult walleye were located in the Muskegon River near Croton Dam. These months cover the pre-spawning through post-spawning period. In June, July, and August, most walleye inhabited Muskegon Lake or had traveled into Lake Michigan. One walleye repeatedly traveled between Muskegon Lake and Lake Michigan.

Prey consumption in the Muskegon River during April and May was composed largely of rainbow trout, brown trout and juvenile Chinook salmon (Diana 2006). During June and July, cyprinids, rainbow trout, juvenile Chinook salmon, and mottled sculpins were primary food items. Prey consumption by walleye in Muskegon Lake during April and May was composed primarily of cyprinids, alewife and invertebrates. From June through July, the alewife was the dominant prey along with brook stickleback, cyprinids and gizzard shad. Krueger et al. (2011) found that brown trout were the most important predator of juvenile Chinook salmon in the Muskegon River and walleye were second. However, predation by walleye on stocked rainbow and brown trout in the river may have reduced their predation on juvenile Chinook salmon.

<u>Genetics</u>

Scribner and Filchek (unpublished) evaluated the genetic structure of Great Lakes walleye populations in and around Michigan. They found that several of these populations were genetically distinct, including the Muskegon River population. They recommended that translocation and stocking of walleye should occur within the range of the source population. Muskegon River strain walleye are used to stock lakes and rivers in western Michigan, from the State of Indiana border to Grand Traverse Bay. This is the normal range of Muskegon River walleye in Lake Michigan that has been determined from multiple studies conducted since the 1950s (Eschmeyer 1950; Day 1991; Hanchin et al. 2007).

Summary

The adult walleye population in the Muskegon River presently appears to be supported primarily by stocking. The adult population generally is “healthy”, with acceptable mortality rates, very high growth rates, good numbers of large and old fish, and sufficient females to provide eggs for natural recruitment (Hanchin et al. 2007). Natural recruitment continues to be the primary impediment to achieving a self-sustaining population, and has been for more than 50 years. Relatively high natural recruitment was found only in 2007 during the fall surveys conducted between 1997 and 2015. Recent studies indicated very low survival of walleye eggs and fry in the Muskegon River (Allison et al. 2009; Allison and Ruetz 2011; Ivan et al. 2010; Rutherford et al. 2011).

Additional studies are needed to determine the reason for the low natural recruitment levels of walleye in the Muskegon River and Muskegon Lake. This includes fry production in the river and survival of fry and juveniles in Muskegon Lake. A 2016 fall evaluation of juvenile walleye in the upper portion of Hardy Impoundment found there was very high natural recruitment of juvenile walleye. This indicates that either water temperatures or water velocities, or both, are more favorable for walleye reproduction below Rogers Dam. A study has been designed to compare this location to the area downstream of Croton Dam to see if these factors are important. Another location that was included in this study was the river section downstream of the City of Newaygo, because this was the primary spawning are for walleye when peak spawning runs occurred historically.

The fingerling stocking and marking program should continue every other year. Evaluations of juveniles should be conducted every year in the fall, as described by O’Neal (2017). This will provide information needed to determine appropriate stocking levels and to track natural recruitment and movement of fish from other systems.

A walleye population estimate should be conducted in the Muskegon River during the spawning run, using methods similar to those used by O’Neal 2008. This will help determine the stability of the adult population and if fall juvenile surveys in Muskegon Lake are indicative of year-class strength.

LAKE STURGEON

The lake sturgeon is a Threatened species in Michigan. Historically, lake sturgeon were very abundant in the Muskegon River. The population declined substantially with other Lake Michigan populations as a result of logging and dam building in the river, water quality degradation, commercial fishing and invasive species in the Great Lakes. The lower portion of the river presently supports a remnant population.

Studies of the lake sturgeon population in Muskegon Lake and the lower Muskegon River began in the early 2000s (Altenritter et al. 2013; Harris 2014; Vecsei 2011; Wieten 2012). Another journal publication has recently been submitted summarizing the characteristics of this population (personal communication, Carl Ruetz, Grand Valley State University). Generally, these studies have found that there is an extant population of lake sturgeon in the Muskegon River, with the annual number of spawning adults in the river at 50 or less since 2002. Natural reproduction is occurring in the river and juveniles migrate to Muskegon Lake in the fall, where they may stay for up to five years. The distribution of lake sturgeon in Muskegon Lake is limited by low dissolved oxygen concentrations during summer, when they remain in shallow (mean = 24.6 ft) water. When fall turnover (mixing) occurs and dissolved oxygen concentrations increase in the hypolimnion, lake sturgeon then move to the deeper (mean = 51.8 ft) portions of the lake.

Age structure analyses found that 27 year classes were represented in the population, with fish ranging in age from 5 to 35 years old. The largest year-classes represented in the catch were 2007, 2008, 2009, and 2011. However, fewer than 50 individuals were captured for even the strongest juvenile year-class, and fewer than 20 individuals for most juvenile year-classes during the studies. There was a near absence of sub-adults in the study, indicating that there may be insufficient recruitment of juveniles to older ages to result in growth of the adult spawning population. The authors recommended that recruitment of young-of-the-year to the sub-adult stage should be a focus point of future studies.

The studies also indicated that a change in the hydropower operations at Croton Dam to a more natural run-of-the-river flow regime, in 1994, appears to have increased juvenile lake sturgeon production. This was indicated because 19 of the 27 year classes present in the catch occurred after 1994. Another issue related to the hydropower dams is water temperature changes in the spawning and nursery area of the river. The impoundments delay normal warming of water during the spring spawning period (O'Neal 1997), and this may be affecting hatching and survival of fry. Walleye spawn in the same area of the river as lake sturgeon. Walleye fry production and survival in the river is reduced due to poor hatching and small fry resulting from cold water temperatures and high flows (Rutherford 2016). Although lake sturgeon spawn after walleye, this issue should be evaluated.

Another concern with survival of juvenile lake sturgeon in the Muskegon River is mortalities caused by sea lamprey treatments that occur every two to three years. The Muskegon River produces large numbers of juvenile sea lamprey that migrate to the Great Lakes and eventually prey on various species of fish, including lake sturgeon. The Muskegon River is one of the primary streams where sea lamprey production must be controlled to manage the abundance of adult lamprey in the Great Lakes. Great care is taken to reduce juvenile lake sturgeon mortalities during treatments but some mortality will occur during most years. Presently, lamprey treatments in the river occur during late September, because most of the juvenile lake sturgeon usually have migrated to Muskegon Lake by that time.

Juvenile sturgeon mortalities were known to occur at the B. C. Cobb Power Plant. This facility is located at the mouth of the Muskegon River on Muskegon Lake. Juvenile sturgeon mortalities were occurring within the cooling water intakes by impingement on the trash racks. The B. C. Cobb plant was decommissioned in the summer of 2016, and this should result in a reduction of juvenile lake sturgeon mortality in the future.

The establishment of a streamside lake sturgeon rearing facility has been discussed in recent years. There is considerable public support for this type of facility. Fisheries Division has advised that further study of this population should occur to help determine if the population is increasing naturally before a supplemental stocking program is initiated.

MUSKELLUNGE

Great Lakes Muskellunge were a native species in the Muskegon River system (Seelbach 1988). Their numbers significantly declined along with many other species due to logging and other development in the watershed. There had been no muskellunge collected or reported captured in the river or lake for many years. Fisheries Division developed a Great Lakes Muskellunge broodstock from the native Lake St. Clair population. Fall fingerling Great Lakes Muskellunge stocking began in the Muskegon River and Muskegon Lake in 2012. The upper Muskegon River, at the M55 crossing east of Houghton Lake and at Leota, was stocked with 4,080 fingerlings from 2012 through 2014. Muskegon Lake and the lower river have been stocked with 19,296 fingerlings from 2013 through 2015. Muskellunge stocking was moved from Muskegon Lake to a location in the Muskegon River just upstream of Muskegon Lake in 2015 to reduce bird predation on the vulnerable fingerlings that tend to swim near the surface after stocking. Angler reports and photos from the river upstream of Big Rapids and Muskegon Lake indicate stocked fish are surviving and had reached lengths of 25 to 30 inches by the summer of 2016.

Fingerling Great Lakes Muskellunge stocking is also occurring in White Lake, Mona Lake and the lower Grand River. The long term goal of stocking these locations is to establish good fisheries supported by natural reproduction in the central portion of Lake Michigan.

WHITE BASS

The white bass is a native species in Michigan that provided very good sport fisheries along the Lake Michigan coast in the past. Their distribution apparently extended nearly the entire length of Michigan's Lake Michigan shoreline, in Lake Huron, Lake St. Clair, Lake Erie, and possibly Lake Superior (Scott and Crossman 1973; Bailey et al. 2004). White bass were very abundant and provided popular sport fisheries in the drowned river mouth lakes in east-central Lower Michigan prior to 1960.

A few adult white bass were transferred to Lake Macatawa (86 adults) and White Lake in 1976, from Lake Erie. White bass were not present in significant numbers in any of the drowned river mouth lakes until about 1990, when anglers began to catch them in Lake Macatawa. A 1996 survey of Lake Macatwa reported the collection of 34 white bass (8”-16”) and 207 white perch (5”-12”), a non-native competitor. A survey in 2000 reported the collection of 109 white bass (11”-26”) and 89 white perch (6”-11”). Confirmed reports of a few adult white bass and white perch have been made from White Lake and Muskegon Lake during the past 20 years, but numbers appeared to be low. White perch juveniles were frequently collected during fall 2005 electrofishing surveys in Muskegon Lake and White Lake. White bass were not collected in general fisheries surveys of Muskegon Lake in 2008 or White Lake in 2007. Adult white perch were collected in both lakes.

Restoring white bass to the drowned river mouth lakes was attempted in 1997 but failed due to a high water year when adults could not be collected from the Macatawa (Black) River spawning run. It was again proposed in 2000 but sufficient staffing was not available. Lake Macatawa is the proposed brood stock source. Based on genetic analyses comparisons from fish collected in 1996, Lake Macatawa white bass are different from the eastern Great Lakes (Lake Erie, Thomas Todd, USGS, personal communication). There likely was a remnant population in Lake Macatawa, and this population should be used as brood stock for the other Lake Michigan ports. Stocking should help restoration of white bass because the non-indigenous white perch are a competing species. Potential lakes to be stocked include Muskegon Lake, White Lake, Mona Lake, and Lake Macatawa, using fry or fingerlings with stocking rates based on the Fisheries Division Fish Stocking Guidelines.

TROUT AND SALMON

Many of the tributaries of the Muskegon River are coldwater streams that support trout. The mainstem is considered a coolwater stream and does not support natural trout populations. This is because juvenile trout have high mortality rates in warm water. Trout stocking was conducted in the Big Rapids area of the river for a number of years. Stocking at this location was discontinued after surveys found that survival was poor and few fish were being caught by anglers.

The section of river downstream of Croton Dam is stocked with Chinook salmon, steelhead (Great Lakes migratory rainbow trout), and resident rainbow and brown trout that do not all migrate out of the river. The stocked fish provide excellent all-year fisheries in this river section (O’Neal and Kolb 2015).

Chinook salmon were first successfully stocked in Michigan in 1967, and the Muskegon River was one of the two streams where they were introduced. Juvenile Chinook salmon are not subjected to mortalities from high water temperature in the river like trout, because they hatch during spring and migrate from the river in May and early June before water temperatures warm to lethal levels. By the late 1970s, approximately 300,000 natural Chinook salmon smolts were being produced in the Muskegon River (Carl 1980). Similar levels of Chinook salmon natural reproduction in the Muskegon River were estimated during 2003 − 2004, although annual production of smolts varies by a multiple of ten (Rutherford, E., unpublished data). Chinook salmon fingerling stocking in the river ranged from about 100,000 to 300,000 from 1980 through 2005. Chinook salmon populations in Lake Michigan began to decline in the late 1980s due to various factors, and lake-wide stocking level reductions began in 1999 to preserve the declining forage fish base in Lake Michigan. Stocking levels in the Muskegon River declined to 18,000 fingerlings in 2014 and will be discontinued in 2017. The river continues to produce natural smolts. Significant predation of Chinook salmon parr in the Muskegon River occurs by brown trout and to a lesser extent by walleye (Krueger et al. 2011; Krueger et al. 2013; Krueger et al. 2016).

Steelhead (Michigan strain rainbow trout that migrate to Lake Michigan) stocking levels in the lower Muskegon River were stable from 1980 through 2016. Steelhead provide a fishery in the Muskegon River from the fall through spring months, and also contribute to the Lake Michigan pier, shore and boat fisheries. The steelhead fishery in the Muskegon River is one of the best in Michigan (Jonas et al. 2009), and is also one of the most consistent fisheries over time. Although steelhead spawn and produce large numbers of juveniles in the river, survival of natural fish is low because summer water temperatures in the Muskegon River are too high (Godby et al. 2007; Luttenton et al. 2015). Rainbow trout were the species with the highest angler catch, and number of fish harvested and released in the lower Muskegon River during 1999 − 2005. The angler survey reported the combined catch of all rainbow trout, and this included steelhead and the Eagle Lake strain that is stocked to provide summer fisheries. However, most of the late fall through the spring peak in angler-use is primarily comprised of anglers fishing for steelhead. The spring steelhead fishery has been present for many years, and we continue (2016) to observe heavy angler-use for this species while DNR crews collect walleye eggs in the river each spring.

Rainbow trout (primarily Eagle Lake strain) and brown trout (primarily Wild Rose strain) are stocked into this river section, primarily to provide summer fisheries. Rainbow and brown trout stocking increased substantially in 1993 (from 74/acre to 134/acre). The objective of this stocking level increase was to improve the overall catch of trout in the summer fisheries. Stocking rates were increased to 211,500 (490/acre) in 1998, with the primary purpose of increasing the annual carryover of trout to provide larger fish for anglers. This stocking increase did not improve the annual carryover of trout (O’Neal 2001, 2003a). During this period, the angler survey data indicated few trout were captured downstream of the City of Newaygo, so most of the stocked trout were moved to upstream locations. Beginning in 2008, trout stocking was reduced to 125,000 (290/acre), with all but 5,000 brown trout stocked between Croton Dam and the City of Newaygo. This level of stocking is within the rates recommended in the Michigan fish stocking guidelines (maximum of 300/acre), for the section of river from Croton Dam to Muskegon Lake. At the same time, the level of brown trout stocking was reduced to a total of 40,000. Brown trout stocking was reduced because studies found that brown trout predation on juvenile Chinook salmon in the Muskegon River is significant (Krueger et al. 2011; Krueger et al. 2013; Krueger et al. 2016), and rainbow trout feed mostly on invertebrates.

The 2016 annual stocking cost for rainbow and brown trout was $182,800. The summer (June, July, and August) fishery accounted for 25.8% of the annual angler-hours during 1999 through 2005. Based on this percentage, the summer fishery was valued at approximately $664,611 (total year = $2.58 million), substantially exceeding the value of stocking. Rainbow and brown trout are caught throughout the year. The total number of brown trout stocked during 1999 – 2005 was 586,291, and the total number caught was 103,350, or 17.6% of the number stocked. The total number of rainbow trout stocked during 1999 – 2005 was 1,268,812, and the total number caught was 639,167 accounting for 50.4% of the number stocked. Rainbow trout are more readily caught by anglers in the Muskegon River because they primarily feed during daylight hours. Brown trout tend to feed from late evening through early morning and there is a night fishery. Brown trout catch may have been underestimated more than rainbow trout catch because of the difference in their feeding patterns. Our angler surveys were not conducted after dark or during the winter months, so overall catch was underestimated for both species.

The Eagle Lake strain of rainbow trout has been used for many years in the Muskegon River. These fish produced consistently good rates for both harvest and release of fish during 1999 through 2005. The highest harvest rate of rainbow trout occurred in 1999, when the minimum size limit for harvest was 8 inches. The highest release rate of rainbow trout occurred during 2005 followed by 1999. The Wild Rose strain of brown trout has been used for many years in the Muskegon River. This strain has produced consistently good harvest and release rates of fish, from 1999 through 2005. The highest harvest and release rates of brown trout occurred during 1999, when the minimum size limit for harvest was 8 inches. Paired comparisons of marked Wild Rose strain brown trout and Gilchrist Creek strain brown trout found that the Wild Rose strain performed better in the fishery (O'Neal 2001).

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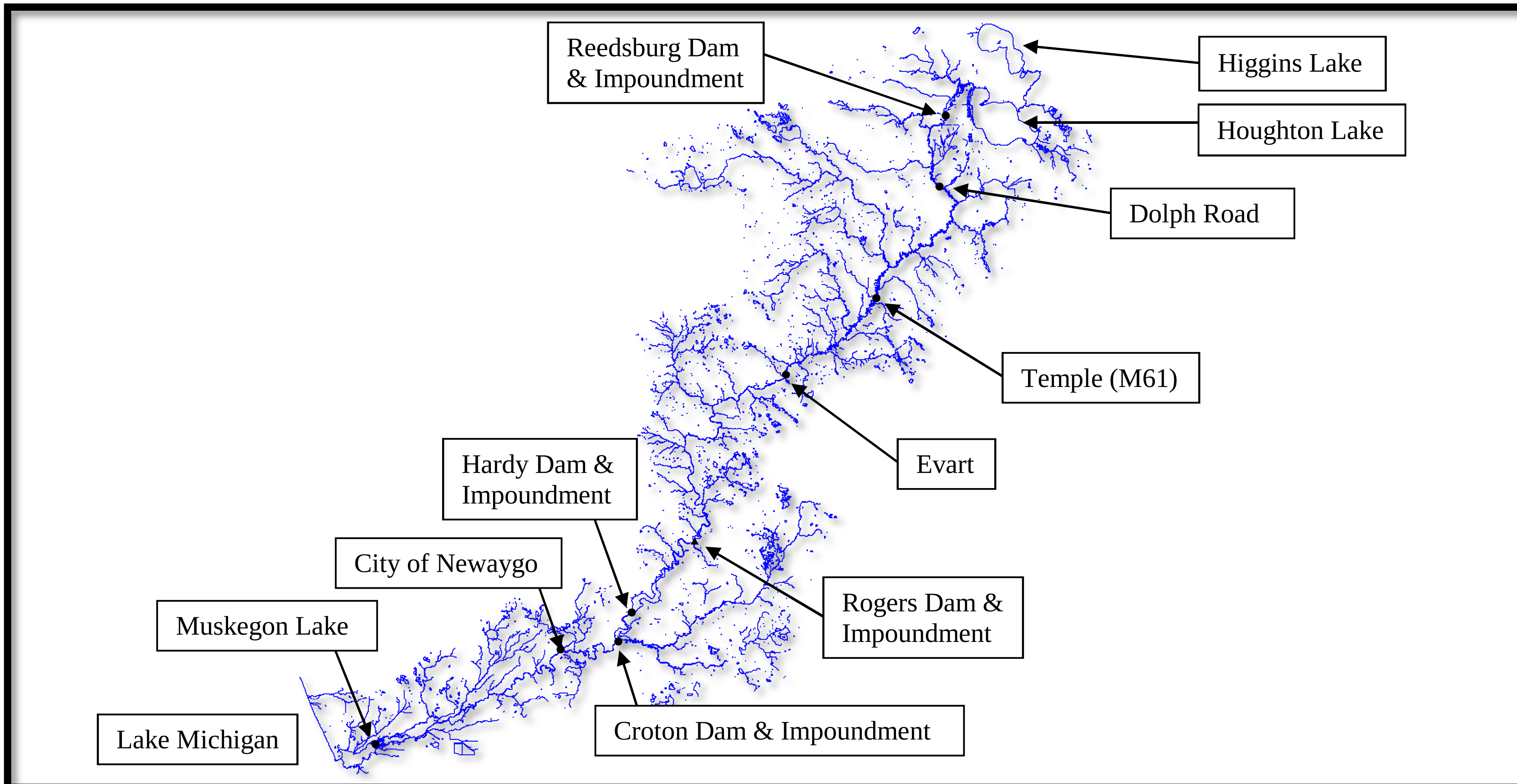

Figure 1. Locations of lakes, impoundments and specific river segments in the mainstem of the Muskegon River.