

Grassy Lake

Schoolcraft County, Township 44 N / Range 18 W / Section 08
Watershed: Indian River, Last Surveyed 2016

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Environment

Grassy Lake is a 176-acre natural lake located in western Schoolcraft County (Township 44 N Range 18W Section 08) in Michigan's Upper Peninsula. In Alger County, Wetmore (Munising Township) and Shingleton reside to the north and northeast of Grassy Lake, respectively. Located between the Trenton and Black River Group bedrock formations, Grassy Lake's land cover is dominated by northern hardwood and conifer forest (68%) and wetlands (23%). Surrounding surficial geology consists of coarse textured materials mixed with Kalkaska, Paquin, and Tawas sands with mucky peat. Grassy Lake is located near the headwater region of the Indian River watershed which flows into Indian Lake. Grassy Creek (also referred to as "Deer Creek"), which originates from Herman Lake, serves as the only tributary to Grassy Lake which enters in the southeast corner of the lake and exits from the western shore. Deer Creek serves as a tributary to McKeever Lake, connecting the two waterbodies.

Grassy Lake is positioned on a northwest to southeast axis and contains an island located in the northern region of the lake. The total fetch length from northwest to southeast is approximately one mile. Shoal areas within the lake consist of sand, marl, and pulpy peat. The maximum depth of Grassy Lake is 30 feet deep with an average depth of approximately 10 feet. Aquatic vegetation in Grassy Lake consists of Bulrush, Potomageton, and Yellow Pond Lily.

On 17 August 1955, a temperature profile was recorded in Grassy Lake. Thermal stratification (which is evaluated using a temperature profile) in lakes typically occurs in deep lakes during the summer months of the year where three water column 'layers' form, which are called the epilimnion, metalimnion, and hypolimnion. The epilimnion consists of the upper layer of the water column which is characteristically warmer and has adequate levels of sunlight penetration to support photosynthesis and primary production. The hypolimnion is the bottom most layer of the water column typically characterized by colder water and light levels which are too dark to support photosynthesis. The metalimnion is the layer between the epilimnion and hypolimnion characterized by a quick transition in temperature change. The point at which temperature change is greatest within the metalimnion is referred to as the 'thermocline'. Although Grassy Lake is a relatively shallow lake, results from the 1955 temperature profile suggest the lake does thermally stratify in the deepest portion with a thermocline located at approximately 24 feet depth.

Dissolved Oxygen (DO) is a critical component to available habitat in aquatic ecosystems. Dissolved oxygen in lakes derives from the atmosphere as well as from aquatic plants during photosynthesis. Concentration of DO in lakes can limit the distribution and growth of fish in lakes as well as the size composition and biomass of zooplankton. Concentrations of DO begin to limit cool- and warmwater fish populations at approximately 3.0 mg/L and are often lethal below 0.5 mg/L (Schneider 2002). As DO becomes limited, two regions which characterize low levels of DO exist. The hypoxic region, which is characterized by having low levels (e.g., less than 2 to 4 mg/L) of DO and the anoxic region

which contains no DO. On 17 August 1955, DO measurements from the surface to the lake bottom ranged from 8.5 mg/L to 0.0 mg/L. Results from the DO profile suggest that Grassy Lake is hypoxic below 21 feet and is anoxic from 22 feet to the lake bottom. These anoxic and hypoxic condition are likely due to the amount of decomposing organic materials that have settled in Grassy Lake's deepest basin over time. Approximately 87 percent of the lake provides sufficient oxygen to support the aquatic community in Grassy Lake.

Total Alkalinity is a measure of buffering capacity and plays an important role in determining a waterbody's pH (Wetzel 2001, Wehrly et al, unpublished report). Alkalinity values in Michigan inland lakes can be classified into low (< 49.5 mg/L as CaCO₃), medium (49.5 to 141.5) and high (> 141.5) categories. On 17 August 1955, Alkalinity in Grassy Lake ranged from 71 to 74 mg/L (medium). Therefore, Grassy Lake has sufficient capacity to buffer against significant changes in pH which may occur during spring run-off or snow melt periods.

Grassy Lake and the surrounding landscape provide remote recreational opportunities including fishing, hunting, and camping. The entire 3.1 miles of undeveloped shoreline are owned by United State citizens and are administered collaboratively between the United States Forest Service and the Michigan Department of Natural Resources. A small island (also in public ownership) is located in the northern region and has been known to be inhabited by bald eagles. An unimproved "carry-in" boat launch is located in the southeast corner of the lake off USFS 2173 Rd which provides public access to Grassy Lake. This unimproved launch has a gradual slope which may be challenging for those interested in launching boats larger than 14 feet in length.

History

Management of Grassy Lake began in the 1930s when Bluegill and Walleye were first stocked. In 1934 Bluegill were stocked at a rate of 14 fingerlings per acre. Walleye spring-fry were stocked in 1936 and 1939 a rate of 681 and 1704 per acre, respectively. In 1943 Bluegill were stocked again at a rate of 1.7 yearlings per acre. Additional stocking occurred in 1943 when Largemouth and Smallmouth Bass were stocked at a rate of 1.7 and 1.1 fingerlings per acre, respectively. The presence or absence of fish species during this time was unknown given that there were no surveys conducted prior to stocking.

During the 1950s Grassy Lake was surveyed by the Institute of Fisheries Research to gather information pertaining to the aquatic community present in the lake. Results from fisheries surveys conducted in 1955 found that there were populations of gamefish present in Grassy Lake. Creel surveys were conducted in 1951 (60 hours effort) and 1959 (7 hours effort) which reported captures of Bluegill, Northern Pike, and Yellow Perch.

Grassy Lake was not surveyed again until the 1970s when general netting surveys were conducted to evaluate the status of gamefish populations. Surveys conducted in 1975 and 1979 found populations of Bluegill, Largemouth Bass, Pumpkinseed, and Yellow Perch growing either at or below state average length. Findings from these surveys prompted drafting the "Grassy Lake Management Plan" which was published in 1981 by the United States Forest Service (USFS). There were several proposed actions in the management plan: 1) provide special regulations to protect tertiary predators from overharvest, 2) conduct manual removals of non-target species (Black Bullhead and Common White

Sucker), 3) evaluate feasibility of installing a rock reef to improve spawning habitat for Smallmouth Bass and 4) re-evaluate management and conduct an evaluation in 1986.

In the 1980s stocking of Northern Pike and Muskellunge occurred in effort to establish additional predators, as well as provide a brood-source for Muskellunge stocking in area waters. In 1980, 330 wild Northern Pike (17 inches) were transferred to Grassy Lake. Additionally, in 1981 and 1984 Muskellunge were stocked at a rate of 2.3 and 0.6 fall fingerlings per acre, respectively. Following stocking (1984) a general survey was conducted in Grassy Lake to evaluate the recent stocking as well as provide information about the fish community. Results from this survey suggest that the standing crop or biomass in Grassy Lake in 1984 was approximately 32 pounds per acre. Additionally, results from this survey determined that most game species captured were growing below or equal to the state average similar to results from surveys conducted in the 1970s. Despite recent stocking efforts no Muskellunge were captured during the assessment which resulted in a cease in stocking of Muskellunge in Grassy Lake. Retrospectively, the survey conducted in 1984 would not likely have captured Muskellunge given that the time of year and gear types used were not very effective at capturing young Muskellunge. No fish have been stocked into Grassy Lake proper since 1984.

By the 1980s and early 1990s anglers had reported captures of large Muskellunge in the 20-pound class category. These captures prompted managers to conduct additional netting surveys in 1990 and 1994. In August of 1990 and August of 1994, a total of 8 species were captured during each of those two surveys. However, no Muskellunge were captured. Standing crop estimates from surveys conducted in 1990 and 1994 were 44 and 41 pounds per acre, respectively. Each survey conducted in the 1990s found equal biomass proportions of piscivores (Northern Pike, Largemouth Bass, and Rock Bass), benthivores (Common White Sucker, Black Bullhead), and pelagic planktivore-insectivores (Bluegill, shiners, minnows). Although in 1990, there were slightly lower proportions of pelagic species compared to piscivores and benthivores. Results from the 1994 survey showed that Grassy was an excellent fishery for Bluegill, while Pumpkinseed and Largemouth Bass were considered "good".

No Muskellunge were captured during the 1990s assessments however, when an additional assessment was conducted in June of 2003, three Muskellunge were captured with an average size of 31.8 inches ranging in size from 29.0 to 35.0 inches suggesting that these fish were approximately 3 to 5 years of age. Recent captures of Muskellunge in Grassy Lake confirmed several anecdotal reports that either; 1) Muskellunge had survived from 1980s stocking events and were residing in Grassy Lake and naturally reproducing or 2) Muskellunge were migrating upstream in Grassy ("Deer") creek into Grassy Lake from McKeever Lake.

Results from the 2003 survey showed that Northern Pike and Largemouth Bass were growing above state average length, while Bluegill were growing equal to or slightly below state average length. The standing crop or biomass of Grassy Lake was estimated to be 39 pounds per acre following the 2003 survey. After the 2003 survey an updated "Grassy Lake Management Plan" was published in April of 2005 by the USFS. The goal of this management plan was to maintain a quality fishery and predator-prey balance in Grassy Lake, managing for Muskellunge, Largemouth Bass, Northern Pike, and Bluegill. There were three proposed actions in the management plan: 1) fell 25 large trees along the shoreline to provide cover for adult and juvenile Largemouth Bass, 2) monitor Bluegill population for possible thinning, and 3) maintain 30-inch minimum size limit for Northern Pike. It is unknown if

trees were added to the shoreline to improve habitat availability for Largemouth Bass. In 2002, Northern Pike regulations were adjusted to provide additional angling opportunities for catching larger fish. This regulation allowed anglers to two fish with a 30-inch minimum size limit (Smith et al. 2016). The 30-inch minimum size limit for Northern Pike in Grassy Lake was changed back to 24 inches beginning in 2013. To date, it is unknown if thinning of Bluegill occurred in Grassy Lake.

In June 2012, Grassy Lake was surveyed again to evaluate the fish community. Results from this survey showed that standing crop biomass in Grassy Lake was 46 pounds per acre. Reports from the 2012 survey stated that Grassy Lake offered a nice fishery for Muskellunge, Northern Pike and Largemouth Bass. Additionally, panfish numbers were high in Grassy Lake although average size was below state average. A recommendation was made to improve shoreline habitat by adding large woody debris (i.e., tree drops), however it is unknown if additional habitat has been added to Grassy Lake.

By the mid-2010s Grassy Lake had been managed consistently to provide a quality fishery for Muskellunge, Northern Pike, Largemouth Bass, and Bluegill for several decades. Up to this point in time, management for Muskellunge in Grassy Lake consisted of stocking (in the 1980s). A focused survey effort aimed specifically at capturing Muskellunge during the time which they were most vulnerable to survey gear had not occurred. Furthermore, Muskellunge present in Grassy Lake were assumed to be those that had migrated from McKeever Lake which was also being targeted by managers to survey. As a result, given the investment in stocking and pointed interest in evaluating inland lakes managed for Muskellunge, managers were interested in conducting an assessment which quantified Muskellunge in Grassy Lake as well as McKeever Lake.

Current Status

Two surveys, conducted in June 2012 and May 2016, were used to determine the status of the Grassy Lake fishery. The intent of the general survey conducted in 2012 by the USFS was to gather fish community information for predators, panfish, as well as the forage base. During this 2012 survey large mesh fyke nets (n = 12) and trap nets (n = 12) were set for a total of 24 net nights. The 2016 survey effort consisted of large mesh fyke nets set for a total of 33 net nights to quantify the abundance of top-predators (e.g., Muskellunge and Northern Pike). A complete stocking history of Grassy Lake and McKeever Lake can be found in Table 1.

During the 2012 survey, a total of 1,163 fish were captured which included 9 species. Piscivore or gamefish species such as Muskellunge, Northern Pike, Largemouth Bass and Yellow Perch comprised 46 percent of the total biomass. Benthivores species such as Common White Sucker, and Black Bullhead comprised 24 percent of the total biomass while pelagic species (planktivore-insectivores) such as Bluegill, Hybrid Sunfish, and Pumpkinseed comprised 30 percent of the total biomass. Results showed that the total stand crop biomass for Grassy Lake in 2012 was 46 pounds per acre. A complete list of species captured prior to and during the 2012 assessment can be found in Table 2.

A total of 7 Muskellunge averaging 24.8 inches comprised 0.6 percent of the catch by number and 12.5 percent of the catch by biomass. Muskellunge size ranged from 19.0 to 40.0 inches however, no fish captured had reached the minimum legal size limit of 42 inches. Catch per Unit Effort (CPUE) for Muskellunge was 0.29 fish per net night in 2012.

A total of 7 Northern Pike averaging 28.5 inches comprised 0.6 percent of the catch by number and 11.8 percent of the catch by biomass. Northern Pike size ranged from 24.0 to 36.0 inches with 100 percent of the meeting or exceeding the legal size of 24 inches. The CPUE for Northern Pike was 0.29 fish per net night in 2012.

A total of 170 Largemouth Bass averaging 8.9 inches comprised 14.6 percent of the catch by number and 24.6 percent of the catch by biomass. Largemouth Bass size ranged from 4.0 to 17.0 inches with 8 percent of the catch meeting or exceeding the legal size of 14 inches. The CPUE for Largemouth Bass was 7.1 fish per net night in 2012.

A total of 24 Yellow Perch averaging 5.4 inches comprised 2.1 percent of the catch by number and 0.3 percent of the catch by biomass. Yellow Perch size ranged from 2.0 to 7.0 inches with 4 percent of the catch meeting or exceeding the acceptable size of 6 inches. The CPUE for Yellow Perch was 1.0 fish per net night in 2012.

A total of 665 Bluegill averaging 5.3 inches comprised 57.2 percent of the catch by number and 23.3 percent of the catch by biomass. Bluegill size ranged from 2.0 to 7.0 inches with 38 percent of the catch meeting or exceeding the acceptable size of 6 inches. The CPUE for Bluegill in Grassy Lake was 27.7 fish per net night in 2012.

During the 2016 survey, a total of 2,307 fish were captured which included 15 species. Piscivores, benthivores, and pelagic species comprised 70, 16, and 14 percent of the total biomass, respectively. Results from this survey showed that the standing crop biomass for Grassy Lake in 2016 was approximately 36 pounds per acre. Additionally, the 2016 survey captured a diversity of forage species (e.g., Bluntnose Minnow, Golden Shiner, Common Shiner) not previously represented in agency surveys.

A total of 32 Muskellunge averaging 35.0 inches comprised 1.4 percent of the catch by number and 55.1 percent of the catch by biomass. Muskellunge size ranged from 27.0 to 46.0 inches with 9 percent of the catch meeting or exceeding the minimum size limit of 42 inches (Figure 2). Eight year-classes were represented with signs of natural reproduction from non-stocking years (Figure 3). Although sample size is small, age analysis indicates that Muskellunge in Grassy Lake are growing approximately 3.1 inches below state average (Table 3). Comparatively, growth of Muskellunge in Grassy Lake is either equal to or greater compared to waterbodies in the Upper Peninsula (Table 3). Age analysis also indicated that the five- and six-year old age classes (from 2011 and 2010, respectively) showed the strongest representation. The CPUE of Muskellunge in Grassy Lake was 0.97 fish per net night in 2016. The capture of 32 Muskellunge included a total of 6 recaptures which suggests a density of approximately 0.15 individuals per acre (Table 4).

A total of 12 Northern Pike averaging 27.8 inches comprised 0.5 percent of the catch by number and 9.3 percent of the catch by biomass. Northern Pike size ranged from 19.0 to 36.0 inches with 83 percent of the catch meeting or exceeding the minimum size limit of 24 inches. Although sample size is small, age analysis indicates that Northern Pike in Grassy Lake are growing approximately 4.9 inches above state average. Age analysis also indicates that the four year-old age class (2012) showed the strongest representation. The CPUE of Northern Pike was 0.36 fish per net night in 2016.

A total of 41 Largemouth Bass averaging 13.1 inches comprised 1.8 percent of the catch by number and 7.9 percent of the catch by biomass. Largemouth Bass ranged in size from 3.0 to 19.0 inches with 37 percent meeting or exceeding the minimum size limit of 14 inches. Age analysis indicates that Largemouth Bass in Grassy Lake are growing equal to or slightly below state average. Age analysis also indicates that the six-year old age class (2010) showed the strongest representation. The CPUE of Largemouth Bass was 1.24 fish per net night in 2016.

A total of 358 Yellow Perch averaging 6.5 inches comprised 15.5 percent of the catch by number and 4.5 percent of the catch by biomass. Yellow Perch ranged in size from 3.0 to 9.0 inches with 7 percent meeting or exceeding the minimum preferred size of 6.0 inches. Age analysis indicates that Yellow Perch in Grassy Lake are growing slightly below state average. Age analysis also indicates that the one- and six-year old age class (2015 and 2010, respectively) showed the strongest representation. The CPUE of Yellow Perch was 10.9 fish per net night in 2016.

A total of 763 Bluegill averaging 6.0 inches comprised 33.1 percent of the catch by number and 15.8 percent of the catch by biomass. Bluegill ranged in size from 2.0 to 8.0 inches with 45 percent meeting or exceeding the minimum preferred size of 6.0 inches. Age analysis indicates that Bluegill in Grassy Lake are growing equal to the state average. Age analysis also indicates that the three-, four- and five-year old age classes (2013, 2012, and 2011) showed the strongest representation. The CPUE of Bluegill was 23.1 fish per net night in 2016.

Analysis and Discussion

Grassy Lake is characteristic of a medium sized, shallow-bodied productive (Meso-eutrophic) lake located in a relatively remote location with no shoreline development. These physical attributes provide ideal conditions to continue fishery management for providing remote angling opportunities for Muskellunge, Northern Pike, Largemouth Bass, Yellow Perch, and Bluegill. The fish community in Grassy Lake includes species typical of inland lakes in Michigan, Minnesota, and Wisconsin. A complete list of species captured during previous assessments can be found in Table 2. Overall, the fish community in Grassy Lake has changed very little over time with a few exceptions. For example, Muskellunge become a part of the Grassy Lake fish community in the late 1980s and are migrating during the early spring to and from McKeever Lake which continues to be stocked. These spring migrations could be a source of natural reproduction which occurs intermittently in either Grassy or McKeever lakes.

Over several decades, standing crop biomass (a measure of lake productivity and capacity) was quantified after each of six surveys (1984, 1990, 1994, 2003, 2012, and 2016). Standing crop biomass averaged 46 pounds per acre (range 36 to 53) from 1984 to 2016. Standing crop has declined since 1990, likely due to the decline in Black Bullhead and Common White Sucker since the introduction of Muskellunge which occurred in the early 1980s. Interestingly, the CPUE of panfish species (e.g., Bluegill, and Yellow Perch) has either increased or remained the same from the onset of Muskellunge introduction to 2016. These data suggest Muskellunge may have preyed upon benthic species, such as Black Bullhead and Common White Sucker, rather than the various panfish species inhabiting Grassy Lake. These observations of predation on benthic species by Muskellunge was also acknowledged by Smith et al. (2016). Most recently the standing crop biomass for Grassy Lake was approximately 36 pounds per acre.

Although too few Muskellunge were captured to provide a robust population estimate some inference can be made about the relative abundance in Grassy Lake. Density of Muskellunge in Grassy Lake was estimated to be 0.15 individuals per acre or approximately 1 Muskellunge per 6.7 acres of lake. Given the depth (5 to 20 feet) and temperature (<77°F) typically preferred by Muskellunge (Smith et al 2016), approximately 59 percent of Grassy Lake is within a habitable range. Therefore, an adjusted density of 0.27 fish per acre or 1 Muskellunge per 3.7 acres may be more appropriate for Grassy Lake. This estimate is within the range of density estimates for Muskellunge provided by Smith et al. (2016) (Table 4), albeit difference in methods for calculating fish density in other water bodies may be different and thus not as comparable.

Northern Pike were found to be growing nearly five inches above the state average total length. This is an anomaly for waters in the Upper Peninsula of Michigan where Northern Pike populations are typically growing at or below state average. This high rate of growth could be due to a 'bottom up' benefit whereby the abundance of Yellow Perch ensures that Northern Pike have forage available. Additionally, the Northern Pike population in Grassy Lake may be benefiting from 'top down' effects due to the presence of larger Muskellunge. Large Muskellunge could be preying upon a portion of the mid-sized Northern Pike population, now that Black Bullhead and Common Suckers are less abundant. This finding could support the idea that, under similar conditions, Muskellunge may be utilized to improve the size distribution of Northern Pike. A more in-depth survey would be needed to validate this claim given that Northern Pike were not the intended target of this survey. Northern Pike spawn prior to Muskellunge, therefore a large component of the Northern Pike population may not have been vulnerable to our gear at the time of this survey. After spawning, Northern Pike seek deeper water and enter into a period of recuperation followed by several weeks of lethargy as muscles and fat stores recover from a stressful spawning period.

Although growth of Muskellunge was below state average, growth appeared to be greater than or at least comparable to growth in other Upper Peninsula waterbodies. Also, capture numbers suggest a respectable number of fish are available providing catch and release opportunities to anglers interested in capturing their first Muskellunge or for those interested trying a new angling technique. An additional attractive characteristic of Grassy Lake is the close proximity to McKeever Lake as well as Dana Lake, both of which are managed to provide Muskellunge angling opportunities. Given the small size of these waterbodies, enthusiastic anglers can fish at least two of these lakes in one day (four hours each). This makes these three Muskellunge fisheries attractive angling destinations for casting anglers compared to anglers geared for trolling in larger lakes.

In the State of Michigan, there are approximately 116 Muskellunge populations (Smith et al 2016). Muskellunge management in Michigan is meant to provide anglers with the opportunity to catch large fish while promoting ecologically sustainable and balanced fish populations supported by either natural reproduction or judicious supplemental stocking (Smith et al. 2016). Furthermore, Muskellunge are a top predator and can help maintain a healthy predator-prey balance, while providing additional diversity in the fishing opportunities available to Michigan anglers (Smith et al. 2016). These opportunities are sparse in this area with respect to other areas within the Great Lakes region. Therefore, presence of Muskellunge in Grassy Lake should be an important consideration informing future management decisions for both Grassy and McKeever lakes.

Management Direction

Current management goals for Grassy Lake are two-fold: 1) continue collaboratively managing fisheries efforts with the USFS and 2), provide remote angling opportunities for Muskellunge, Northern Pike, Largemouth Bass, Yellow Perch, and Bluegill. Based on the results of this survey, these goals are on track and there are no recommended changes to regulations or stocking at this time.

East of the Ford River watershed, MI DNR Northern Lake Michigan Management Unit manages approximately eight inland lakes for the purpose of providing Muskellunge angling opportunities (Table 5). We recommend the following strategies to continue meeting fisheries management goals for Muskellunge in Grassy Lake:

- 1). Locate, document, and protect existing functional littoral and riparian habitat through joint local, federal, and state efforts.
- 2). Reach out to identify anglers which routinely visit Grassy Lake (and other Muskellunge waterbodies) to keep a diary of success and efforts.
- 3). Continue to evaluate stocking efforts in McKeever Lake to determine to what extent the Grassy Lake Muskellunge population may be affected by changes.
- 4). Future evaluations for Muskellunge conducted in the Northern Lake Michigan Management Unit should occur in accordance with the Muskellunge Long-term monitoring protocol (Smith et al (2016) Appendix B).

References

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Table 1. Historical stocking record for Grassy Lake (top) and McKeever Lake (bottom) by species, year, number (N) stocked, stocking rate (number (N) / acre), and total length (TL) - (inches (in)).

Waterbody	Species	Year	N Stocked	(N/acre)	TL (in)
Grassy Lake	Bluegill	1934	2500	14	-
Grassy Lake	Walleye	1936	120000	682	-
Grassy Lake	Walleye	1939	300000	1705	-
Grassy Lake	Bluegill	1943	300	2	-
Grassy Lake	Largemouth Bass	1943	300	2	-
Grassy Lake	Smallmouth Bass	1943	200	1	-
Grassy Lake	Northern pike	1980	330	2	16.4
Grassy Lake	Muskellunge	1981	400	2	7.6
Grassy Lake	Muskellunge	1984	111	1	9.9

Waterbody	Species	Year	N Stocked	(N/acre)	TL (in)
McKeever Lake	Bluegill	1934	2500	19	-
McKeever Lake	Largemouth Bass	1934	200	2	-
McKeever Lake	Bluegill	1935	6000	46	-
McKeever Lake	Largemouth Bass	1935	300	2	-
McKeever Lake	Walleye	1936	90000	687	-
McKeever Lake	Bluegill	1937	7200	55	-
McKeever Lake	Walleye	1939	300000	2290	-
McKeever Lake	Bluegill	1943	300	2.29	-
McKeever Lake	Largemouth Bass	1943	300	2.29	-
McKeever Lake	Largemouth Bass	1943	200	2.0	-
McKeever Lake	Northern pike	1980	276	2	15.5
McKeever Lake	Muskellunge	1981	300	2	7.6
McKeever Lake	Muskellunge	1984	260	2	9.9
McKeever Lake	Muskellunge	1990	260	2	8.0
McKeever Lake	Muskellunge	1998	251	2	11.1
McKeever Lake	Muskellunge	2001	200	2	12.0
McKeever Lake	Muskellunge	2003	260	2	11.5
McKeever Lake	Muskellunge	2010	200	2	9.8
McKeever Lake	Muskellunge	2013	210	2	8.1
McKeever Lake	Muskellunge	2015	210	2	9.2

Table 2. List of fish species captured, total number captured, and the catch per unit effort (CPUE) during the 1984, 1990, 1994, 2003, 2012, and 2016 assessments conducted in Grassy Lake, Schoolcraft County. CPUE is calculated by dividing the total number captured by the number of net set nights.

Species Caught	<u>Total Caught</u>						<u>CPUE</u>					
	2016	2012	2003	1994	1990	1984	2016	2012	2003	1994	1990	1984
Black Bullhead	5	3	2	2	64	56	0.15	0.13	0.08	0.08	2.78	2.55
Bluegill	763	665	1472	360	380	44	23.12	27.71	61.33	15.00	16.52	2.00
Bluntnose Minnow	7	0	0	0	0	0	0.21	0.00	0.00	0.00	0.00	0.00
Creek Chub	15	0	0	0	0	0	0.45	0.00	0.00	0.00	0.00	0.00
Common Shiner	680	0	0	0	0	0	20.61	0.00	0.00	0.00	0.00	0.00
White Sucker	14	13	7	7	6	20	0.42	0.54	0.29	0.29	0.26	0.91
Golden Shiner	305	0	0	0	0	0	9.24	0.00	0.00	0.00	0.00	0.00
Hybrid Sunfish	10	0	0	0	0	0	0.30	0.00	0.00	0.00	0.00	0.00
Largemouth Bass	41	170	75	56	41	18	1.24	7.08	3.13	2.33	1.78	0.82
Muskellunge	32	7	3	0	0	0	0.97	0.29	0.13	0.00	0.00	0.00
Northern Pike	12	7	37	11	18	34	0.36	0.29	1.54	0.46	0.78	1.55
Pumpkinseed	25	141	115	51	45	22	0.76	5.88	4.79	2.13	1.96	1.00
Rock Bass	40	133	255	153	38	27	1.21	5.54	10.63	6.38	1.65	1.23
Smallmouth Bass	0	0	0	0	0	4	0.00	0.00	0.00	0.00	0.00	0.18
Yellow Perch	358	24	0	15	22	2	10.85	1.00	0.00	0.63	0.96	0.09

Table 3. Relative size (in inches) at age for Muskellunge in Grassy Lake, McKeever Lake, Dana Lake, and the Cisco Chain of Lakes. Sample size for aging data are include in parenthesis “()”. Data from the Cisco Chain of Lakes was derived from Smith et al. (2016) while the remaining data were gathered from the Northern Lake Michigan Management Unit.

Age	Statewide Average	Grassy Lake	McKeever Lake	Dana Lake	Cisco Chain of Lakes
0	6.8	-	-	-	-
1	15.7	-	-	-	-
2	19.9	-	17.7 (2)	-	18.6
3	25.4	27.1 (1)	26.6 (1)	-	-
4	31.9	31.2 (1)	26.7 (4)	-	29.4
5	34.7	31.6 (7)	-	-	33.5
6	36.8	33.7 (7)	30.0 (1)	36.0 (1)	-
7	39.2	35.9 (3)	32.3 (1)	34.5 (1)	-
8	41.7	35.2 (3)	34.2 (1)	-	35.4
9	45.3	40.1 (3)	32.9 (4)	-	39.7
10	48.7	46.5 (2)	32.6 (1)	-	-
11	NA	-	-	-	39.6
12	NA	-	-	-	45.6
13	NA	-	45.2 (1)	39.0 (1)	-

Table 4. Estimated density (number of Muskellunge per acre) in other inland waterbodies (Smith et al. 2016). Surveys geared to quantify the abundance or densities per acre of Muskellunge are difficult to conduct. Subsequently, density estimates which may be used for comparing populations are sparse in the literature (Smith et al. 2016).

Density Estimate (fish per acre)	Waterbody	Source
0.18 to 0.99 (Range)	Bone Lake, Wisconsin	Cornelius and Margenau (1999)
0.84 (lake estimate)	Iron Lake, Michigan	Siler and Beyerle (1986)
0.20 to 1.00 (Range)	Wisconsin	Hansen 1986
0.50 (Average)	Wisconsin	Hansen 1986
0.15 (lake estimate)	Grassy Lake, Michigan	-

Table 5. A list by county, waterbody, lake size (Acres), population status (stocked or naturalized), and regulation type for Muskellunge in the Northern Lake Michigan Management Unit. Data derived from Smith et al. (2016).

County	Waterbody	Acres	Stocked or Naturalized	Special Regulations
Delta	Dana Lake	98	Naturalized	Yes
Luce	North Manistique Lake	1700	Stocked	No
Mackinac	Brevoort Lake	4001	Native	No
Mackinac	South Manistique Lake	4360	Stocked	No
Schoolcraft	Big Island Lake	130	Stocked	Yes
Schoolcraft	Cusino Lake	140	Stocked	No
Schoolcraft	Grassy Lake	176	Naturalized	Yes
Schoolcraft	McKeever Lake	140	Stocked	Yes

Figure 1. Map of Grassy Lake (46.215578 -86.577771) located in Schoolcraft County.

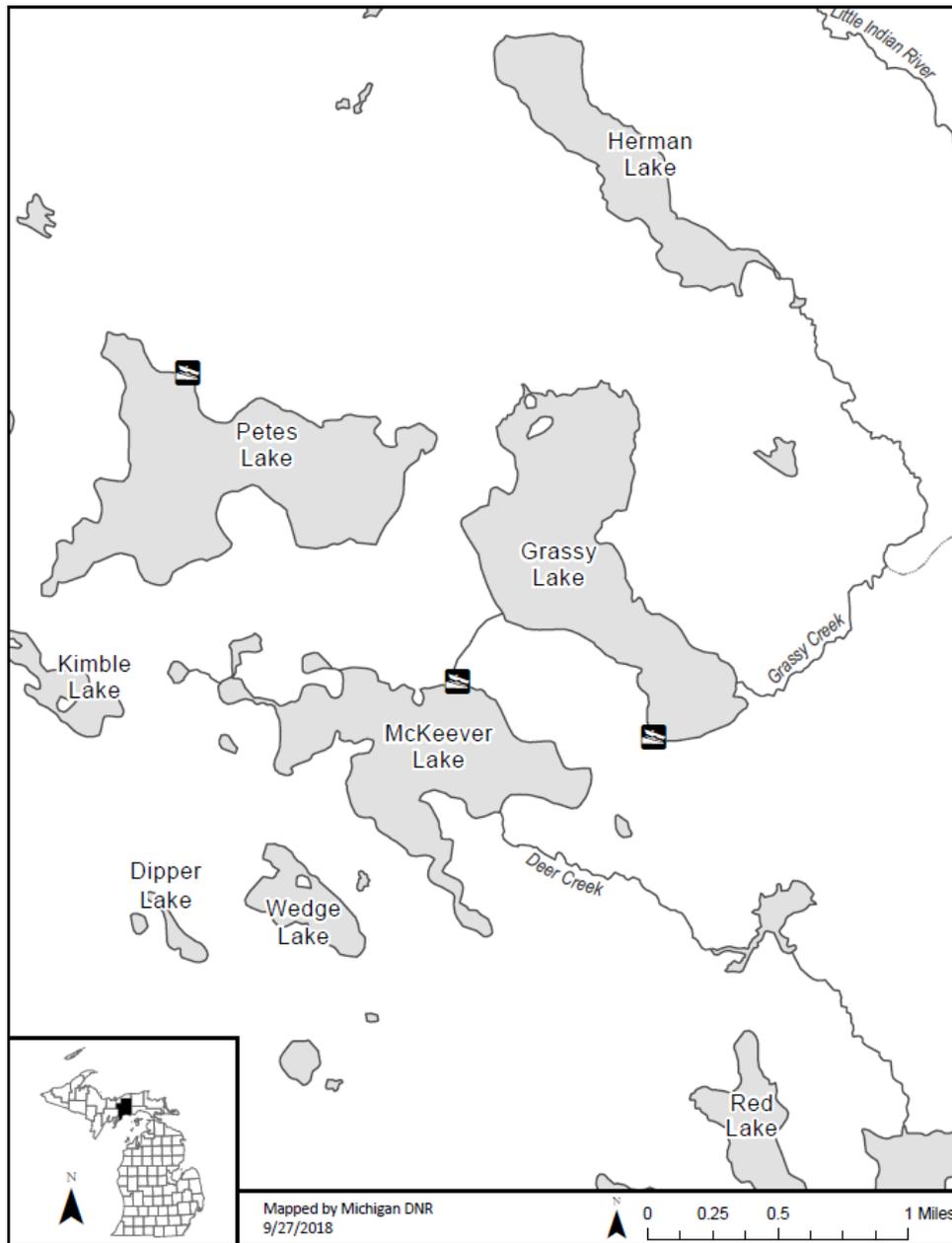


Figure 2. Size distribution of Muskellunge captured during 2016 netting survey in Grassy Lake, Schoolcraft County. Muskellunge size ranged from 27.0 to 46.0 inches with an average of 35.0 inches total length.

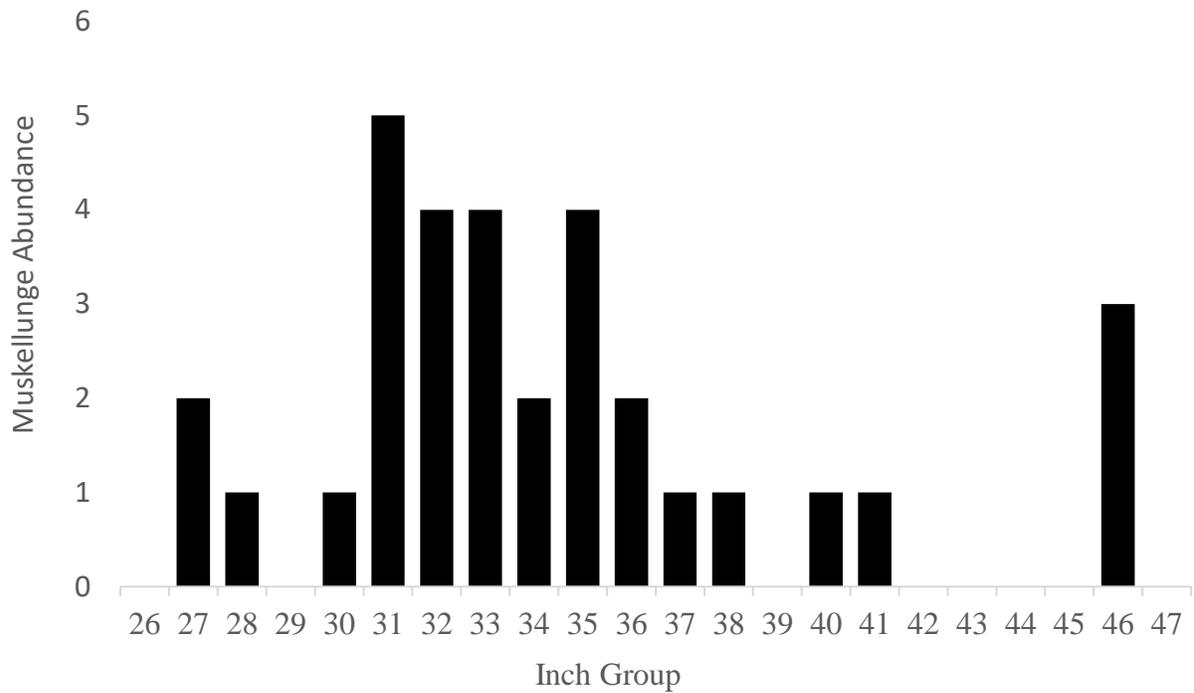


Figure 3. Age distribution of Muskellunge captured during 2016 netting survey in Grassy Lake, Schoolcraft County. Eight year-classes were represented with sign of recruitment to the population during non-stocked years. Strongest year-classes present were from 2010 and 2011, corresponding to ages 5 and 6.

