Glen Lake Chain
(Glen, Little Glen, Big Fisher, Little Fisher, and Tucker Lakes)
Leelanau County (T29N, R14W/15W, Multiple Sections)

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Environment

The Glen Lake watershed is located in Leelanau County, Michigan, in the northwest Lower Peninsula. This watershed drains approximately 46 square miles of land or 29,721 acres (U'Ren et al. 2009). Within this watershed there are five distinct basins; Little Glen Lake (1,450 acres),Glen Lake (4,865 acres), Big Fisher Lake (42 acres), Little Fisher Lake, and Tucker Lake (15 acres) (Figure 1). For the purpose of this report, Big Fisher and Little Fisher Lakes will be collectively referred to as Fisher Lake. Additionally there are two small ponds in the watershed, Day Mill Pond and Brooks Lake. Day Mill Pond (7 acres) is located on the northwestern shore of Little Glen Lake and drains into the lake through a small stream, while Brooks Lake (10 acres) flows in through a small creek on the eastern shore of Glen Lake. The primary inlet to the Glen Lake system is Hatlem Creek, which flows into the southern end of Glen Lake near the intersection of County Roads 616 and 675. The primary outlet to the Glen Lake system is the Crystal River, which discharges into Sleeping Bear Bay on Lake Michigan. Little Glen Lake and Hatlem Creek both drain into Glen Lake, which itself drains into Big Fisher Lake then Little Fisher Lake before finally flowing into the Crystal River.

Hatlem Creek is a Type 1 designated trout stream open to fishing from the last Saturday in April to September 30th. On Type 1 streams, any tackle type may be used and the creek has a possession limit of 5 fish per day, with no more than 3 fish 15"or larger. Brook trout and brown trout must be 8" or more, rainbow trout must be 10" or more, and lake trout must be 24" or more in order to harvest. Hatlem Creek receives large runs of emerald shiners during certain times of the year, and was a popular spot for anglers and bait dealers to easily collect large numbers of minnows. In order to protect this highly valuable forage fish, minnows may not be collected from Hatlem Creek (Michigan Fishing Guide 2010).

The Crystal River is a Type 3 designated trout stream open to fishing all year. Any tackle type may be used on Type 3 streams, and the river has a possession limit of 5 fish per day, with no more than 3 fish 15" or larger. Minimum size limits for brook trout, brown trout, and rainbow trout are all 15" or more, and lake trout need to be 24" or more. Despite there being only one mile of land between the start of the Crystal River and Lake Michigan, the river winds a 6.2 mile path through cedar swamps before emptying into the lake. The Crystal River has one dam just downstream from where the river flows out of Little Fisher Lake, which is a court mandated structure used to control lake levels. This dam was originally the site of the Fisher Mill operation, and in 1938 the location was deeded to the Glen Lake Improvement Association, the group now known as the Glen Lake Association (U'Ren et al. 2009). In 1944 the county court set the lake levels at 596.75 feet above sea level. The dam was rebuilt by the Glen Lake Association in 2002 in order to make it more efficient to adjust the water levels (Glen Lake Association 2010).

This watershed is unique in that the lakes within it represent multiple trophic states. Glen Lake (Figure 2) is an oligotrophic lake with a maximum depth of 130 feet, very sparse or minimal vegetation, and is

clear in color with low productivity. Little Glen Lake (Figure 3) is a mesotrophic lake with a maximum depth of 13 feet, moderate vegetation levels, and is moderately productive. Fisher, Tucker, and Brooks Lakes are all eutrophic lakes, relatively shallow in nature, abundant vegetation, and are highly productive systems. The fact that these diverse trophic states are all interconnected provides for a unique set of intertwined environments that allow for this watershed to play host to an exceptional variety of species and recreational opportunities.

Bottom substrate in both Little Glen Lake and Glen Lake is very sandy, with marl in the deeper regions of the lakes. Both lakes, Glen Lake in particular, also have large stretches of rocky shoal area near the shoreline that provide good spawning habitat for many fish species. Substrate in all of the other lakes is a mixture of marl and sand.

Perimeter distances have been calculated for the three larger lakes, Glen Lake, Little Glen Lake, and Fisher Lake. Glen Lake has the largest perimeter of 10.82 miles. Little Glen Lake has a perimeter distance of 6.46 miles, and the perimeter of Fisher Lake is 1.95 miles (personal communication, Matt Tonello, MDIT).

The land in the Glen Lake watershed is characterized by multiple soil series' including Kalkaska-Mancelona, Kalkaska- Rubicon, Kalkaska-East Lake, Kalkaska- Leelanau, Deer Park, and East Lake-Lupton-Eastport soils. These nutrient lacking soils, coupled with the large amount of remaining wetland and forested area, filter out nutrients and allow the lakes in this watershed to maintain high levels of water quality. This area is predominately forested and comprised of sandy lakeplains, high moraines, dunes, cedar swamps, and lowland bogs (U'Ren et al. 2009). There is very little agriculture or industry in this area and 31.2% (9,276 acres) of the watershed is under the ownership of the National Park Service as part of the Sleeping Bear Dunes National Lakeshore (U'Ren et al. 2009). All of Little Glen Lake's surface area and 18% of Big Glen Lake's surface area falls within the boundaries of the Sleeping Bear Dunes National Lakeshore (personal communication, Matt Tonello, MDIT).

Several species recognized as species of concern, threatened, or endangered can be found within the Glen Lake watershed. The wetlands surrounding Hatlem Creek provide habitat for the state and federally endangered Michigan monkey flower (Mimulus glabratus var. Michiganesis), the state threatened red shouldered hawk (Buteo lineatus), and state species of concern eastern box turtle (Terrapene Carolina carolina) (U'Ren et al. 2009). Additional plant species of concern such as ginseng (Panax quinquefolis), walking ferns (Camptosorus rhizophyllis), calypso orchids (Calypso bulbosa), and pine-drops (Pterospora andromedea) have also been identified within the Crystal River corridor.

There is one public access site with a boat launch on the Glen Lake chain. This site is a Michigan Department of Natural Resources (DNR) public access site located on Little Glen Lake, off of Day Forest Road. Additional access site include the Old Settlers County Park day-use area located along the southeastern shore of Glen Lake, and the Glen Lake Beach Park day-use area located on the western shore of Little Glen Lake.

Two citizens groups in the region have historically been active in the management of the Glen Lake chain. The Friends of the Crystal River was formed in the late 1980's with the focus of preserving land along the Crystal River. The Glen Lake Association (GLA) is a highly active non-profit group whose primary focus is to maintain the high quality of the Glen Lake watershed, and maintains such programs

as controlling the Crystal River Dam, operating a boat wash station at the DNR boat launch, and annual shoreline surveys of vegetation.

History

Stocking History

Stocking in the Glen Lake watershed has been primary in Glen Lake, though periodic stockings have occurred in some of the other lakes as well. Fisher Lake was stocked with warmwater fish species such as bluegill and black bass during the late 1930's and early 1940's (Table 1). Brook trout were stocked for one year in 1963, and no fish species have been stocked into the lake since.

The Crystal River also received some stocking around the turn of the twentieth century. Brook trout were stocked at a rate of 6,000 fish in the years 1896 and 1897, and 6,000 rainbow trout were stocked in 1909 (Table 2). Fisheries division records show no other stockings since.

Little Glen Lake has only been stocked twice in recent times, though many of the early stocking records do not have exact locations so it is unknown if any early stockings attributed to Glen Lake actually occurred in this basin. MDNR Fisheries Division stocked 3,000,000 walleye fry in 1991 and 2,000,000 walleye fry in 1993 before discontinuing the program (Table 3). A boomshocking survey was conducted in 1994 to assess the success of these walleye stockings; however no walleye were collected in this survey. Walleye stocked in the fry lifestage generally exhibit poor survival in Michigan, so the absence of fish the in the stocking evaluation survey could be attributed to the lifestage of walleye stocked, not necessarily the lake's ability to support walleye.

Glen Lake has a very long and diverse stocking history that goes back well over 100 years. From 1894 until 1944, a variety of cool water fish such as bluegill, smallmouth bass, largemouth bass, walleye, northern pike, and yellow perch were stocked (Table 3). A statewide policy was issued in 1946 the discouraged the stocking of cool water fish (specifically bluegill, smallmouth bass, largemouth bass, and yellow perch) because natural reproduction of these species is usually sufficient enough to sustain an adequate fishery. In addition to these species, lake trout stocking also began in 1894 (Table 4). Lake trout were stocked somewhat sporadically from 1894 to 1980, and the current stocking level of 20,000 yearlings annually began in 1996 and continues today. Lake trout have provided for a very popular and productive fishery on Glen Lake that cannot be sustained without stocking. Splake were stocked sporadically from 1966 to 1981, and then yearly from 1981 to 1995 with approximately 20,000 yearlings stocked annually (Table 5). Splake were stocked throughout the 1980's as a replacement for lake trout, which were in limited supply. The splake stocking program was discontinued in 1995 due to poor returns and catch rates. Rainbow trout were sporadically stocked from 1952 to 1983, with Michigan strain winter steelhead being stocked in addition to the rainbows in 1973 (Table 6). The current rainbow trout stocking program is designed as a research project (MDNR Fisheries Research Project F-80-R-7, study #743) that began in 2004. The purpose of this study is to evaluate potential differences in catchability, survival, recruitment, and growth between the Eagle Lake strain rainbow trout and the Michigan strain winter steelhead in various inland waters, including Glen Lake. From 2004 to 2009 Fisheries Division has stocked 10,000 Eagle Lake strain (LP clip) and 10,000 Michigan strain (RP clip) annually into Glen Lake. Due to a clerical error in 2010 only 5,000 Eagle Lake strain rainbow trout were stocked, but 20,000 Eagle Lake strain rainbow trout will be stocked in 2011.

Brown trout were stocked annually into Glen Lake from 1985 to 1997 (Table 7). Fisheries Division conducted a survey to assess the brown trout stocking program in 1997, however no brown trout were collected and the program was discontinued. Lake whitefish were stocked into Glen Lake in 1956 and 1959, while brook trout were stocked from 1960 to 1962 (Table 8).

Glen Lake and Little Glen Lake Fisheries Survey History

Fisheries Division has conducted a wide variety of surveys on Glen Lake. The first fisheries survey in August 1949 was written up in a very comprehensive report by Rodeheffer and Day (1950). This survey occurred in both Little Glen and Glen Lakes and included the use of gill nets, bag seines, "common sense" seines, and a hook and line survey. In Glen Lake, yellow perch were described as the most abundant species. In one 125-foot seine haul 4,531 perch were collected, and all but 17 of those fish were young of the year or age 0. Fish from Glen Lake collected in the survey whose relative abundance was listed as "abundant" included yellow perch, rock bass, and bluntnose minnow. Fish species with a relative abundance listed as "common" included smallmouth and largemouth bass, lake trout, cisco, white sucker, sand shiner, spottail shiner, logperch, and Johnny darter. Bluegill, northern pike, burbot, mimic shiner, and hornyhead chub were also collected in low numbers.

The portion of the survey conducted in Little Glen Lake showed a very similar fish community. Yellow perch were again the most abundant species with as many as 2,000 fish being collected in one 125-foot seine haul. Only yellow perch, Johnny darter, and bluntnose minnow were classified as "abundant" based upon their relative abundance. Species considered "common" included smallmouth and largemouth bass, white sucker, blacknose shiner, sand shiner, spottail shiner, central mudminnow, and Iowa darters. Very few bluegill, northern pike, bullhead, or common shiners were caught.

The next fisheries survey was in April 1955. This survey was comprised of four 125-foot experimental gill nets, set for one net night in Little Glen Lake near where the lakes flows into Glen Lake. These nets caught 66 yellow perch (4 to 13.9 inches in length), 33 white suckers (12.3 to 17.2 inches in length), 4 rock bass (9.6 to 12 inches in length), and 2 cisco (9 inches in length). Of the 66 yellow perch caught, 20 of those were between 10.4 and 13.9 inches in length. This survey was repeated again in June 1955, using three 125-foot experimental gill nets set in the same location. This survey collected one white sucker (approximately 16 inches in length) and over 200 yellow perch, whose size range was described as 'small". One 13.2 inch yellow perch was noted. Based on Fisheries Division records, both of these surveys were targeting lake herring.

Fisheries Division conducted a netting survey in November 1965 that consisted of setting two trap nets and three 125-foot experimental gill nets for one net night in Glen Lake. A total of 202 fish were caught in the survey, including 153 yellow perch (6 to 12 inches), 33 white suckers (6 to 18 inches), 15 cisco (8 to 14 inches), and one rainbow trout (18 inches). Growth analysis indicated that yellow perch were growing above state average. Age 5 yellow perch (11 fish aged) were growing a whole inch above the state average length at age.

The next fisheries survey occurred in 1973, when Great Lakes gill nets (10, 50ft panels) were set in Glen Lake to evaluate the splake stocking program. Fisheries Division collected 276 lake herring (8 to 12 inches in length, 9 inch average), 192 yellow perch (6 to 10 inches in length, 7 inch average), 43 splake (8 to 14 inches in length, 10 inch average), and 71 white suckers. Minimal numbers of

smallmouth bass, rock bass, and lake trout were also collected. This survey indicated good survival of recently stocked splake.

Fisheries Division conducted a survey in 1979 to assess the splake and lake trout populations in Glen Lake. Great Lakes gill nets (10, 50ft panels) were used to collect 200 lake herring (7 to 10 inches in length, 9 inch average) and 73 yellow perch (5 to 10 inches in length, 7 inch average). Minimal numbers of lake trout, splake, smallmouth bass, northern pike and rock bass were also collected.

Little Glen Lake was surveyed concurrently with Glen Lake in 1979. One Great Lakes gill net was set for one net night. This net caught 44 yellow perch (4 to 11 inches in length, 7 inch average), and minimal numbers of largemouth bass, northern pike, lake herring, rock bass, and common white suckers.

Fisheries Division surveyed Glen Lake using gill nets in 1987 to assess the splake population. This survey caught 58 walleye (9 to 24 inches in length, 21 inch average), 18 lake trout (10 to 23 inches in length, 19 inch average), 33 smallmouth bass (5 to 22 inches in length, 15 inch average), 16 northern pike (19 to 25 inch average, 21 inch average length), and 21 yellow perch (5 to 8 inches in length, 7 inch average). Low numbers of bluegill, lake herring, largemouth bass, rainbow smelt, longnose gar, white sucker, splake, brown trout, and rock bass were also caught. Growth analysis indicated exceptional growth rates for walleye and smallmouth bass, as well as acceptable growth rates for rainbow smelt, yellow perch and rock bass. Walleye were growing at 2.2 inches above the state average length at age, while smallmouth bass were growing at 1.9 inches above state average. Northern pike were growing significantly slower, 3 inches below the state average length at age. This survey reinforced what was noted in the 1973 survey, which documented a large and diverse forage base, and is indicated by the exceptional growth rates of walleye and smallmouth bass.

Splake and lake trout stocking was evaluated again in 1991. Great Lakes gill nets were used to collect 232 yellow perch (5 to 11 inches in length, 7 inch average) lake herring (8 to 12 inches in length, 9 inch average), lake trout (28 to 36 inches in length, 33 inch average), and minimal numbers of common white suckers, rock bass, splake, smallmouth bass, coho salmon, and brown trout. The yellow perch growth rates were below that of the state average length at age, but still within acceptable limits. Lake trout were growing above the state average length at age, and age class analysis indicated some natural reproduction. Very few brown trout or splake were caught in this survey, indicating that the stocking program for these species was not producing adequate numbers of fish to support a fishery. Based on the results of this survey, and no reports of splake being caught by anglers, the splake stocking program was discontinued by Fisheries Division in 1995.

Little Glen Lake was surveyed in September 1994 in order to evaluate the survival of stocked walleye fry. Three stations around the lake were sampled with a boomshocking boat for a total of 3.4 shocking hours. No walleye were collected in this survey and no anglers reported catching any walleye, so as a result this stocking experiment was discontinued. The survey crew did observe smallmouth bass, white sucker, yellow perch, rock bass, bluegill, common shiner, sand shiner, logperch, and pumpkinseed sunfish during the survey.

Fisheries Division conducted a survey in 1997 in order to assess the lake trout and brown trout stocking program in Glen Lake. Great Lakes gill nets were used to collect 726 yellow perch (5 to 13

inches in length, 7 inch average), 228 lake herring (8 to 19 inches in length, 9 inch average), 7 lake trout (33 to 37 inches in length, 36 inch average), and minimal numbers of white suckers, lake whitefish, rock bass, silver redhorse, smallmouth bass, and splake. Age and growth analysis showed that yellow perch (-1.4 inches) and lake herring (-1.0 inches) were both growing below the state average length at age. Based upon the results of this survey showing poor recruitment and survival, as well as the lack of angler utilization, Fisheries Division decided to discontinue the stocking of brown trout.

A series of stocking evaluation surveys have been conducted on Glen Lake in order to evaluate the Eagle Lake strain rainbow trout and Michigan strain steelhead that have been stocked into inland waters as part of MDNR Fisheries Research Project F-80-R-7, study #743. The first survey occurred in 2006 using a boomshocking boat. This effort covered 4.62 miles over 2.17 hours of shocking time, and collected 15 lake herring (7 to 10 inches in length, 8 inch average), 1 coho salmon (10 inches), and 1 Michigan strain steelhead (15 inches).

In 2007 Fisheries Division used 4 inland gill nets set for two net nights to survey Glen Lake. Michigan strain steelhead were the most abundant species in the catch with 58 (13 to 26 inches in length, 22 inch average), followed by 16 white suckers (16 to 22 inches in length), 11 Eagle Lake strain rainbow trout (14 to 24 inches in length), and 10 smallmouth bass (16 to 18 inches in length). Minimal numbers of lake trout, lake herring, largemouth bass, northern pike, and yellow perch were also caught. One unclipped rainbow trout was also collected, though the lack of a fin clip may be the result of fin regeneration from a poor clipping.

The final Fisheries Division survey under this study was conducted in 2008. This survey used a boomshocking boat to cover 3.5 miles, and collected 5 smallmouth bass, 4 Michigan strain steelhead, 2 unclipped rainbow trout, 2 yellow perch, 1 coho salmon, and 1 Eagle Lake strain rainbow trout. In all three years, a total of 77 rainbow trout were captured in all surveys. Only three unmarked fish have been captured to date (one in 2007 and two in 2008) and the remainder have been either Eagle Lake or Michigan strain fish. Steelhead comprised 84% of all marked rainbow trout captured. The preliminary results from this study indicate the Michigan strain steelhead are recruiting to the fishery better than the Eagle Lake strain rainbow trout (Andy Nuhfer, unpublished data).

Tucker Lake, Day Mill Pond, and Crystal River Fisheries Survey History

Fisheries Division surveyed the fisheries population of Tucker Lake using trap nets in 1969. At the time it was estimated that about 90% of Tucker Lake was covered with vegetation, and the maximum depth was 15 feet. This survey collected 17 bluegill (6 to 8 inches in length, 8 inch average) as well as minimal numbers of largemouth bass, bullheads, northern pike, and white suckers.

A 1979 survey written up by Kelly and Price (1979) for the National Park Service (NPS) indicated that the surveyors in Tucker Lake had collected six species of fish at that time. Those included bluegill, pumpkinseed sunfish, yellow perch, largemouth bass, northern pike and rock bass.

Tucker Lake was surveyed in 2003 by the Grand Traverse Band of Ottawa and Chippewa Indians (GTB). The lake was sampled with three fyke nets and one gill net for a total of 10 net nights, and 15 minnow traps were fished for one night (Fessell 2007). Fish species collected were bluegill, pumpkinseed, yellow perch, rock bass, northern pike, largemouth bass, central mudminnow, yellow

bullhead, brown bullhead, and Iowa darter. Growth for northern pike appeared to be below the state average length at age, while rock bass and bluegill appeared to be slightly above. Largemouth bass were significantly greater than the state average length at age (+2.5 inches). Nine painted turtles and one snapping turtle were also caught during the survey, and the survey crew noted a significant amount of the woody debris in the lake resulting from beaver activity, including at least one active beaver lodge.

Day Mill Pond was first surveyed by the NPS in 1979 (Kelly and Price 1979), but only one northern pike was collected. GTB surveyed Day Mill Pond again in 2003 using a backpack electrofishing unit deployed from a canoe (Fessell 2007). In 8.2 minutes of electrofishing time, only central mudminnows were collected. There is a culvert under Highway 109 that at times connects Day Mill Pond to Little Glen Lake, when water levels are high. The presence of a northern pike in the pond in 1979 is indicative of the potential for Day Mill Pond to be utilized as spawning habitat for northern pike.

Past surveys of the Crystal River have shown a predominately warm/cool water fish community. Migratory salmonids such as steelhead, coho salmon, and Chinook salmon have been known to inhabit the river at certain times of the year, but have not been documented in any survey. Fisheries Division surveyed the river in 1965 and collected 8 species of fish. GTB conducted an electrofishing survey on the river in 1998. The five most abundant species collected during their three-station survey were rock bass, Johnny darter, hornyhead chub, central mudminnow, and smallmouth bass.

Fisher Lake and Brooks Lake Survey History

Fisheries Division does not have any knowledge of historical fisheries surveys for either Fisher Lake or Brooks Lake.

Additional Historical Surveys

Many other additional surveys and monitoring programs that have been or are still being conducted in the Glen Lake watershed. Water quality monitoring has been conducted by the Leelanau Watershed Council (LWC), The Glen lake Association (GLA), the U.S. Geological Survey (USGS), and the Sleeping Bear Dunes National Lakeshore (SLBE), and over time has shown that the water quality is excellent (U'ren et al. 2009). Invertebrate sampling in Hatlem Creek and the Crystal River have been conducted by the GLA (Glen Lake Association 2010) and the USGS (Nichols et al. 2007), and in both surveys the sample sites were given a "Good" rating on a scale ranging from Excellent to Poor. The Michigan Department of Environmental Quality (MDEQ) routinely monitors bacteria levels at the public beach and day-use area on Little Glen Lake, and has also surveyed Glen Lake and Tucker Lake as part of their Fish Contaminant Monitoring Program.

Creel Census Surveys

According to Fish Division reports, a creel survey had been conducted prior to 1933, but an exact year is not known (Rodeheffer and Day 1950). This survey indicated that lake trout were being caught in Glen Lake prior to the first Michigan Department of Conservation lake trout stocking effort in 1933 (Rodeheffer and Day 1950). An airplane count was conducted in February 1960 and revealed 29 shanties on the ice at Little Glen Lake and 45 shanties on the ice at Big Glen Lake (Fisheries Division records). A second airplane count was conducted in February 1961 and revealed 35 shanties on the ice at Little Glen Lake and 33 shanties on the ice at Big Glen Lake (Fisheries Division records). The most recent creel survey was conducted during the summer of 2008 (May through September) and the

winter of 2009 (January through March) (Table 9). Summer creel was conducted on Glen Lake, Little Glen Lake, Little Fisher Lake, and Fisher Lake, while winter creel was conducted only on Glen Lake and Little Glen Lake. Winter creel survey results included 6,186 total fish harvested during 6,111 angling hours. The summer creel survey results included 14,668 total fish harvested during 13,700 angling hours. This creel survey data supports the fish community that has been described in many of the past lake surveys, and clearly shows that yellow perch are the most sought after fish species in the Glen Lake watershed. Lake trout angling efforts may have been underrepresented in this creel effort, as the reported catch was much lower than Fisheries Division had expected it to be based upon historical angler reports. The creel survey also revealed the popularity of the winter-time rainbow smelt fishery.

Master Angler Entries

The DNR Fisheries Division Master Angler program has had multiple entries from the Glen Lake watershed. The Crystal River had has one entry, a 30.25 pound Chinook salmon caught in 1996. Eight entries have been submitted for Little Glen Lake since 1990, which include 1 pumpkinseed sunfish, 3 smallmouth bass, and 4 rockbass. Big Glen Lake has had 26 entries since 1990, 1 pumpkinseed sunfish, 1 brown bullhead, 1 yellow perch, 1 brown trout, 2 bluegill, 6 smallmouth bass, 7 rock bass, and 6 lake trout. The largest entry was a 34.19 pound lake trout submitted in 2004.

Current Status

The most recent comprehensive fisheries assessment of the Glen Lake system was conducted in 2009. During the 2009 effort, fisheries surveys were conducted on Glen Lake, Little Glen Lake, and Fisher Lake. For all of the surveys, DNR Status and Trends protocols (Wehrly et al. 2009) were followed.

Glen Lake

The netting portion of the 2009 Glen Lake survey took place from May 27 through June 3, and the electrofishing portion occurred on July 15. This survey was conducted using trap nets (12 net-nights), experimental graded-mesh inland gill nets (10 net-nights), Great Lakes gill nets (7 net-nights), a minnow seine (6 seine hauls) and an electrofishing boat (3 ten-minute transects). The purpose of this survey was to investigate the status of all fish populations in Glen Lake. Of particular interest were the lake trout and rainbow trout populations, since the State regularly stocks Glen Lake with those species.

During the 2009 survey of Glen Lake 1,072 fish were caught, weighing 606 pounds and representing 18 different species (Table 10). Lake herring (cisco), yellow perch, and white sucker were the most frequently collected species. A total of 305 lake herring from 7 to 16 inches were caught, representing 28.5% of the catch by number and 9.8% by weight. The vast majority of the lake herring collected were juveniles that were 8 or 9 inches in length. A total of 303 yellow perch ranging from 3 to 14 inches were caught, representing 28.3% of the catch by number and 13.4% of the catch by weight. The yellow perch averaged 7.4 inches in length, with 54% exceeding the minimum acceptable size of seven inches. A total of 182 white suckers were caught, representing 17% of the catch numerically, and 51.6% of the catch by weight. Other species represented in the catch but in smaller numbers included bluegill, bluntnose minnow, coho salmon, emerald shiner, Iowa darter, Johnny darter, lake trout, logperch, northern pike, rainbow trout, rock bass, sand shiner, smallmouth bass, spottail shiner, and mudpuppy.

The larger game fish species were caught in relatively small numbers from Glen Lake (Table 10). Smallmouth bass were the most commonly caught gamefish, with 17 collected from 1 to 20 inches in length. Fifteen lake trout were caught, from 9 to 35 inches in length. Three rainbow trout were caught, ranging from 11 to 16 inches in length. Two of the rainbow trout bore fin clips identifying them as Little Manistee strain steelhead, which had been previously stocked by the Department. Two northern pike were caught, 26 and 33 inches in length, and one 16 inch coho salmon was also caught.

Most species caught in the 2009 Glen Lake survey showed above average growth (Tables 11 and 12). Rock bass were growing 0.7 inches faster than the State of Michigan average length at age, and yellow perch were growing 0.6 inches faster than the State average. Although not enough lake trout, rainbow trout, smallmouth bass, or northern pike from any one age class were collected to make statistical inferences regarding age and growth, all the individuals of those species were growing substantially faster than the State of Michigan length at age.

Species that had been reported in previous Glen Lake fisheries surveys, but were not observed in the 2009 survey included brown trout, burbot, hornyhead chub, largemouth bass, longear sunfish, longnose gar, mimic shiner, rainbow smelt, silver redhorse, splake, and walleye. Although lake whitefish have never been captured in DNR Fisheries surveys of Glen Lake, there is one file report of a lake whitefish having been caught by an angler in 1982. This is the only known report of lake whitefish in Glen Lake.

Limnological data on Glen Lake was collected by DNR in early September 2009 (Table 13) and by the U.S. Geological Survey (USGS) in August of 2008 (USGS 2010; Table 14). Temperature and oxygen profiles were recorded for the entire water column. Dissolved oxygen (DO) readings ranged from 8.8 parts per million (ppm) at the surface to 6.7 ppm near the bottom. However at depths between 45 and 60 feet, DO readings were over 11 ppm. These readings are consistent with those from other large, deep inland lakes in Michigan. A secchi depth (a measure of water clarity) reading was not taken during the September DNR Fisheries sampling effort, but was recorded in the August 2008 USGS survey effort at 28 feet (USGS 2010). Also in the USGS August 2008 sample, total phosphorus was measured at 7 and 12 micrograms/liter and total nitrogen was measured at 220 micrograms/liter. In the September 2009 Fisheries Division sampling effort, the Glen Lake pH was 8.46 at the surface. At a depth of 51 feet, the pH had only dropped slightly, down to 8.43. From there, the pH dropped to 7.66 at the bottom.

Shoreline data was collected on Glen Lake by DNR Fisheries personnel on September 1, 2009 (Table 15). Data collected included the number of docks, submerged trees, and houses found per kilometer of shoreline, as well as how much of the shoreline is armored or hardened with a structure in order to prevent erosion. Glen Lake averaged 19.1 docks per kilometer, 11% shoreline armoring, 21.7 submerged trees per kilometer, and 21.2 houses per kilometer.

Little Glen Lake

The netting portion of the 2009 Little Glen Lake survey took place from June 2 through June 4, and the electrofishing portion took place on June 15. Gear used included trap nets (3 net-nights), fyke nets (9 net-nights), inland gill nets (3 net-nights), a maxi-mini fyke net (1 net-night), 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 Little Glen Lake.

During the 2009 survey of Little Glen Lake 1,659 fish were caught weighing 456.2 pounds and representing 13 different species (Table 16). The emerald shiner was the most frequently collected species with 995 individuals caught, and represented 60% of the catch by number. Rock bass and yellow perch were also well-represented in the Little Glen Lake survey. A total of 282 rock bass ranging from 5 to 12 inches in length were caught, comprising 17% of the catch by number and 20.9% by weight. A total of 240 yellow perch ranging from 4 to 13 inches in length were caught, comprising 14.5% of the catch by number and 9.1 % by weight. Although only 59 white suckers were caught in the survey, they represented 33.2% of the catch by weight. Smallmouth bass (45 individuals collected) and northern pike (10 individuals collected) also comprised substantial proportions of the biomass of the catch at 17.8% and 15.3%, respectively. The smallmouth bass ranged between 4 and 21 inches in length, and the northern pike ranged between 25 and 38 inches. Other species represented in the catch in smaller numbers included bluegill, bluntnose minnow, brown bullhead, Johnny darter, longnose gar, sand shiner, and spottail shiner.

Most species caught in the Little Glen Lake 2009 survey showed above-average growth (Table 17). Rock bass (ages 3-7) were growing 1.4 inches faster than the State of Michigan average length at age, and smallmouth bass (ages 2-5) were growing 1.7 inches faster than the State average. Age 4 northern pike were growing 5.6 inches faster than the State average. Yellow perch (ages 1-7) were growing slightly slower than the State average at -0.1 inches, and age-3 bluegill were growing 0.6 inches faster than the State average.

Species that had been reported in previous fisheries surveys of Little Glen Lake but were not observed in the 2009 survey included black bullhead, blacknose shiner, central mudminnow, common shiner, Iowa darter, largemouth bass, and yellow bullhead.

Limnological data was collected on Little Glen Lake by USGS in August of 2008 (USGS 2010; Table 18). The secchi depth reading was recorded at 12 feet (USGS 2010). Also in the USGS August 2008 sample, total phosphorus was measured at 13 and 10 micrograms/liter and total nitrogen was measured at 390 and 370 micrograms/liter. In the September 2009 Fisheries Division limnology sampling effort, the Glen Lake pH was 8.46 at the surface. At a depth of 51 feet the pH had only dropped slightly to 8.43, and from there the pH dropped to 7.66 at the bottom. Chlorophyll pigment is a measure of biological productivity and high levels can often lead to algal blooms. The chlorophyll results for Little Glen Lake in August of 2008 were 2.7 micrograms per liter (USGS 2010).

Shoreline data was collected on Little Glen Lake by DNR Fisheries personnel on September 1, 2009 (Table 15). Little Glen Lake averaged 17.9 docks per kilometer, 4% shoreline armoring, 0.3 submerged trees per kilometer, and 23.0 houses per kilometer.

Fisher Lake

Fisher Lake had not been sampled by DNR Fisheries Division prior to the 2009 fisheries survey. The netting portion of the 2009 Fisher Lake survey took place on May 28-29. Gear used included trap nets (3 net-nights), fyke nets (8 net-nights), inland gill nets (4 net-nights), and one maxi-mini fyke net (1 net night). The purpose of this survey was to investigate the status of all fish populations in Fisher Lake.

During the 2009 survey of Fisher Lake, a total of 1,092 fish were caught, weighing 116.6 pounds and representing 20 different species (Table 19). Numerically, minnow species, including spottail shiner (373 individuals), mimic shiner (171 individuals), emerald shiner (98 individuals), sand shiner (69 individuals), and bluntnose minnow (61 individuals) were the most frequently collected species in Fisher Lake. Rock bass were also very abundant, with 252 individuals from 1 to 11 inches in length collected, comprising 55.4% of the catch by weight. Other species represented in the catch in smaller numbers included black bullhead, bluegill, brown bullhead, green sunfish, lake herring, largemouth bass, logperch, longear sunfish, northern pike, pumpkinseed sunfish, steelhead, smallmouth bass, white sucker, and yellow perch.

Only enough rock bass and yellow perch were collected to make statistical inferences regarding age and growth (Table 20). Rock bass (ages 2-8) were growing 0.2 inches faster than the State of Michigan average length at age, and yellow perch (ages 3, 5) were growing 1.7 inches slower than the State average.

The Secchi depth reading was 12 feet. No other limnological data was collected from Fisher Lake in the 2009 survey. Shoreline data was collected on Fisher Lake on September 1, 2009 (Table 15). Fisher Lake averaged 11.4 docks per kilometer, 2% shoreline armoring, 0 submerged trees per kilometer, and 12.1 houses per kilometer.

Analysis and Discussion

According to Rodeheffer and Day (1950), during the first half of the twentieth century Glen Lake was not as heavily fished as some other large inland lakes in Michigan because it was "somewhat removed from the beaten vacation roads". This likely still holds true today. For example, in the summer of 2008 and the winter of 2009, Glen, Little Glen, and Fisher Lakes received an estimated 19,811 angler hours (Tracy Kolb DNR, personal communication). In comparison, Higgins Lake, which has a similar fish community to Glen Lake, received an estimated 160,150 angler hours in the winter of 2002 alone (Su et al. 2007). Like the 1949 survey (Rodeheffer and Day 1950), the 2009 DNR fisheries surveys showed that the Glen Lake watershed has generally healthy fish populations. In comparing the two surveys, it appears that little has changed in Glen Lake and Little Glen Lake over the last 60 years.

As was the case in 1949, yellow perch are the mainstays of the Glen and Little Glen Lake fisheries. Rodeheffer and Day (1950) commented that Glen Lake had "a reputation of being outstanding for year-round perch fishing", and that Little Glen Lake was "known throughout the county for its good perch fishing". In the summer 2008 creel census of Glen and Little Glen Lakes, an estimated 14,000 yellow perch were harvested by anglers, with an additional 9,700 released. In the winter 2009 creel census, it was estimated that another 6,000 yellow perch were harvested (Tracy Kolb, DNR, personal communication). Clearly, fishing for yellow perch remains very popular on Glen and Little Glen Lakes.

Rodeheffer and Day (1950) indicated that Glen Lake was a "good lake for lake trout". This observation has been carried on to modern times, as Glen Lake should currently be considered one of the better inland lakes in Michigan for catching lake trout. The fishery is largely based on stocking, although there may be some natural reproduction as well. The lake trout in Glen Lake grow very well and

achieve large sizes, as evidenced by a 46.5 inch, 34 pound specimen that was caught by an angler in 2000.

Rodeheffer and Day (1950) stated that "Glen Lake is a good smallmouth lake". Based on the results of the 2009 survey, this statement is still accurate. Also, Master Angler records show that Glen Lake provides trophy potential for smallmouth bass. Several smallmouth bass over 23 inches in length have been caught from Glen Lake. Despite this potential, smallmouth bass are not heavily fished on Glen Lake. Little Glen Lake also had robust smallmouth bass populations in both the 1949 and 2009 fisheries surveys. In the 2009 survey, individuals were captured up to 20 inches. According to Master Angler records, anglers have caught several smallmouth bass over 23 inches in length in recent years. One difference in the two surveys was that largemouth bass were captured in the 1949 survey, but not in the 2009 survey. Largemouth bass were captured in the Fisher Lake survey, so they are still present in the watershed.

Rock bass were very abundant in Glen and Little Glen Lakes in the 1949 survey, as they were in the 2009 survey. Rodeheffer and Day (1950) commented that there was little fishing for them in 1949, and today there is very little fishing pressure on rock bass. The lake herring population in Glen Lake remains robust as well. Rainbow trout and coho salmon were not present in Glen Lake in 1949, but were present in 2009. The rainbow trout fishery is supported by stocking, while the coho salmon are naturally reproducing. Coho salmon likely became established in Glen Lake back in the 1970s when fish that had been stocked in other rivers strayed into the Crystal River and leapt the dam, gaining access to Glen Lake and its tributary streams. The offspring of these fish found the deep, cold waters of Glen Lake to their liking and never needed to migrate all the way back to Lake Michigan.

Rainbow smelt are likely a relatively recent addition to the Glen Lake fish community, having been first documented in Glen Lake in a 1987 fisheries survey. A non-native species, rainbow smelt are common in Lake Michigan and other large oligotrophic lakes in Michigan. Although rainbow smelt were not caught in the 2009 netting survey, they were observed in the 2009 winter creel survey. Rainbow smelt are likely permanently established in Glen Lake and do provide a fishery, particularly through the ice. The rainbow smelt will also likely serve as source of forage for rainbow trout and lake trout, although they may also compete with yellow perch and lake herring for available food resources.

While northern pike were considered rare in the 1949 survey of Little Glen Lake (Rodeheffer and Day 1950), ten were captured in the 2009 survey. Although this is not a large number, half of those captured were over 30 inches in length, with the largest going 37 inches. Nine of the ten northern pike captured were from the 2005 year class, and they were growing nearly 6 inches faster than the state average. It appears that northern pike may not successfully reproduce every year in Little Glen Lake, but those that are produced are capable of growing to large sizes. Northern pike will likely always be rare in Glen Lake, as it does not provide optimum spawning and rearing habitat. However, those that do survive in Glen Lake will have the potential to grow to large sizes by foraging on lake herring, rainbow smelt, and stocked trout.

Growth of most species in Glen and Little Glen Lakes was above average in the 1949 fisheries survey (Rodeheffer and Day 1950), and it remained so in the 2009 survey. In virtually all of the fisheries surveys done between 1949 and 2009, growth for most species in Glen and Little Glen Lakes has been

above average. Lake trout and smallmouth bass in particular have exhibited excellent growth over the last 60 years.

Water clarity on Glen Lake has been somewhat variable over the years, although Glen Lake has always tended to be very clear. In the 1949 survey, the secchi depth was 20.0 feet. In the 1979 DNR fisheries survey, secchi depth was 24.9 feet, and in the USGS 2008 effort, it was 28 feet (USGS 2010). According to the Glen Lake Association (2010), between 2001 and 2009, secchi depth averaged 18.4 feet during that period, with a low of 16.6 feet in 2003 and a high of 21.3 feet in 2009. All of these readings are higher than those of other large deep lakes in Michigan, which averaged 10.2 feet (Wehrly et al. 2010).

The phosphorous concentrations recorded on Glen Lake (7 and 12 micrograms/liter) were lower than those recorded on other large deep lakes throughout the state (21 micrograms/liter; Wehrly et al. 2010). The total nitrogen concentration on Glen Lake (220 micrograms/liter) was also lower than the state average for large deep lakes in Michigan (440 micrograms/liter; Wehrly et al. 2010). The landscape surrounding the Glen Lake watershed is filled with wetlands, forested areas, and nutrient lacking soils, which may account for the high water quality in these lakes.

Water clarity on Little Glen Lake has been more variable than Glen Lake, particularly in the last ten years. In the 1949 survey, the secchi depth was 11.0 feet. In the 1979 DNR survey, secchi depth was 9.5 feet, and in the USGS 2008 effort, it was 12 feet (USGS 2010). According to the Glen Lake Association (2010), between 2001 and 2009, secchi depth averaged 7.2 feet during that period, with a low of 5.4 feet in 2002 and a high of 9.4 feet in 2009. According to Wehrly (2010), medium, shallow lakes in Michigan typically had secchi depths that averaged around 7.9 feet.

The phosphorous concentrations recorded on Little Glen Lake (13 and 10 micrograms/liter) were slightly lower than those recorded on other large shallow lakes throughout the state (15 micrograms/liter; Wehrly et al. 2010). The total nitrogen concentrations recorded on Little Glen Lake (390 and 370 micrograms/liter) were slightly lower than the state average for medium, shallow, inland lakes in Michigan (500 micrograms/liter; Wehrly et al. 2010). The chlorophyll A concentrations recorded on Little Glen Lake (2.7 micrograms/liter) were similar to those recorded in other large shallow lakes in Michigan (2.8 micrograms/liter; Wehrly et al. 2010).

The pH readings from the 2009 September DNR Glen Lake sampling effort were very similar to readings taken by Rodeheffer and Day (1950). In September 2009, the pH was 8.46 at the surface and 7.66 at the bottom. In the August 1949 survey, the pH was 8.1 at the surface and 7.4 at the bottom. In the 1979 DNR survey pH was recorded as 8.5 at the surface, 9.0 at mid-depth, and 8.5 at the bottom. These readings are normal for northern Michigan inland lakes.

Alkalinity measurements were not taken in the 2009 DNR or 2008 DEQ sampling efforts. In 1949, Rodeheffer and Day (1950) measured alkalinity at 135 ppm at the surface and 155 ppm at the bottom. In the 1979 DNR sampling effort, alkalinity was 153.9 ppm at the surface, 171.1 ppm at mid-depth, and 153.9 ppm at the bottom. These readings are normal for northern Michigan lakes.

Both Glen and Little Glen Lakes were more heavily developed with docks and dwellings than other lakes in Michigan (Table 15). Glen Lake had 19.1 docks per kilometer of shoreline, while the average

large deep lake in Michigan had only 4.3 docks per kilometer (Wehrly et al. 2010). Glen Lake also had 21.2 dwellings per kilometer, compared to 9.2 dwellings per kilometer for other large deep lakes in Michigan. Little Glen Lake had 17.9 docks per kilometer, while the average large shallow lake in Michigan had only 8.9 docks per kilometer. Little Glen Lake had 23.0 dwellings per kilometer, compared to 11.5 dwellings per kilometer for other large shallow lakes in Michigan. Fisher Lake was less heavily developed, with 11.4 docks per kilometer of shoreline and 12.1 dwellings per kilometer. However, Glen Lake (11%), Little Glen Lake (4%), and Fisher Lake (2%) all had less shoreline armoring than other comparable inland lakes in Michigan. For other large deep lakes in Michigan, the average shoreline armoring is 24.2%, while for large shallow lakes, it is 28.4%. For small lakes, the average shoreline armoring is 7.5% (Wehrly et al. 2010).

Management Direction

Based on the results of the 1949 fisheries survey, Rodeheffer and Day (1950) recommended continued stocking of lake trout and rainbow trout. Those recommendations are still being practiced some 60 years later. The current Glen Lake lake trout and rainbow trout fisheries are largely dependent upon stocking. Therefore, yearling lake trout (Lake Superior strain) should continue to be stocked into Glen Lake, at a rate of 4.1/acre (or 20,000 fish) annually. Continued lake trout stocking should ensure that Glen Lake remains one of Michigan's better inland lake trout fisheries. Consistent above-average growth should ensure that the potential remains for anglers to catch trophy lake trout in excess of 20 pounds. Yearling rainbow trout (Eagle Lake strain) should continue to be stocked into Glen Lake, at a rate of 4.1/acre (20,000 fish) annually. While studies have showed that Little Manistee (Michigan) strain steelhead perform better than Eagle Lake-strain rainbow trout in Glen Lake and other inland lakes (Andy Nuhfer, DNR, personal communication), we currently do not have enough hatchery space to raise enough Little Manistee-strain steelhead to satisfy all Great Lakes stocking requests in addition to inland lake requests. At this time, Great Lakes stocking efforts are a higher priority than inland lakes for steelhead stocking. Until more steelhead become available for inland stocking, the Eagle Lake-strain rainbow trout will continue to maintain the fishery in Glen Lake.

Native species like smallmouth bass, rock bass, yellow perch, and lake herring should continue to thrive in Glen Lake. Although lake herring provide an excellent forage base for large predatory gamefish species like lake trout, rainbow trout, and coho salmon, they are a state-threatened species. The suggested lake trout stocking densities of 4.1/acre are well within the recommended Michigan guidelines of 2-8/acre (Dexter and O'Neal 2004), and are on the conservative side, given the outstanding growth shown by Glen Lake lake trout. The suggested rainbow trout stocking densities of 4.1/acre are even more conservative, as the recommended guidelines are up to 10/acre for large inland lakes in Michigan (Dexter and O'Neal 2004). These conservative stocking levels should continue to allow for good lake and rainbow trout fisheries, while also protecting the integrity of the lake herring population.

According to the late Dr. Carl Latta, the pre-eminent authority on nongame fishes in Michigan, the Glen Lake emerald shiner population is unique, as inland emerald shiner populations are typically very small in size. He characterized the emerald shiner population of Glen Lake as a "fragile resource and important to the overall fishery health of Glen Lake" (Cadillac DNR Office Files). For that reason, Hatlem Creek should remain closed to the harvest of minnows.

The native species of Glen, Little Glen, and Fisher Lakes should continue to thrive, even without direct management actions. Yellow perch should continue to be a primary attraction for anglers on Glen and Little Glen Lakes. Northern pike should also continue to provide a good fishery on Little Glen Lake. Although smallmouth bass are not heavily pursued by anglers on Glen Lake, they should continue to be available to those interested in pursuing them, and they should also continue to provide some trophy potential. Due its small size and shallow nature, Fisher Lake will likely never be a major sportfishing destination, but it should continue to provide decent fisheries for yellow perch and rock bass. Although the coho salmon population in Glen Lake is not native, it is unique. Crystal Lake in Benzie County is the only other inland lake in the Great Lakes region that is known to have a self-sustaining population of coho salmon.

DNR Fisheries Division should work collaboratively with the National Park Service, the Grand Traverse Band of Ottawa and Chippewa Indians, the Glen Lake Association, the MDEQ, and the various non-profit environmental agencies (Leelanau Conservancy, Leelanau Conservation District, CRA, etc.) to identify aquatic connectivity barriers and sustain or enhance aquatic connectivity among all the basins within the Glen Lake watershed (specifically Day Mill Pond, Brooks Lake, Fisher Lake, and Tucker Lake). Enhanced aquatic connectivity will help sustain healthy fish populations in perpetuity.

Any remaining riparian wetlands adjacent to Glen Lake, Little Glen Lake, or Fisher Lake should be protected as they are critical to the continued health of the watershed. Future unwise riparian development and wetland loss may result in deterioration of 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. Beneficial management actions for lakes involves: maintenance of good water quality; minimization of nutrient inputs; 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). Additionally, dredging of the littoral zone should be avoided on Glen and Little Glen Lakes, particularly where gravel and cobble substrates are present. This nearshore habitat is critical for a number of important Glen Lake fish species. Gravel and cobble substrates provide spawning habitat and also host many important aquatic invertebrates that help to sustain healthy fish populations.

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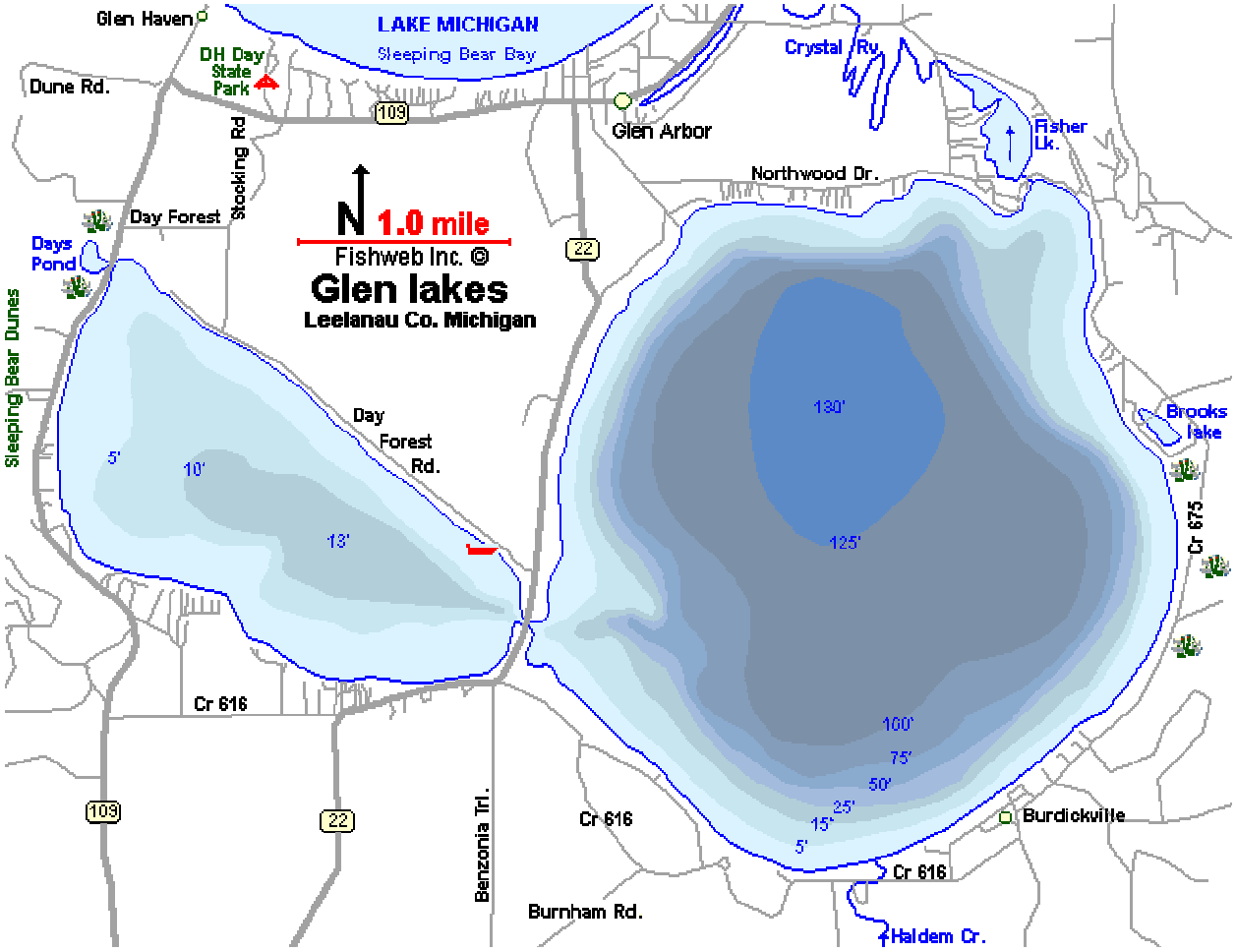
Figure 1. Map of Glen Lake chain of Lakes.



Map courtesy of www.fishweb.com

*Little Glen Lake is the western basin; Glen Lake is the eastern basin.

** Big Fisher Lake is the southern basin; Little Fisher Lake is the northern basin.

***Tucker Lake is not shown on this map, should be located to the north east of Little Fisher Lake.

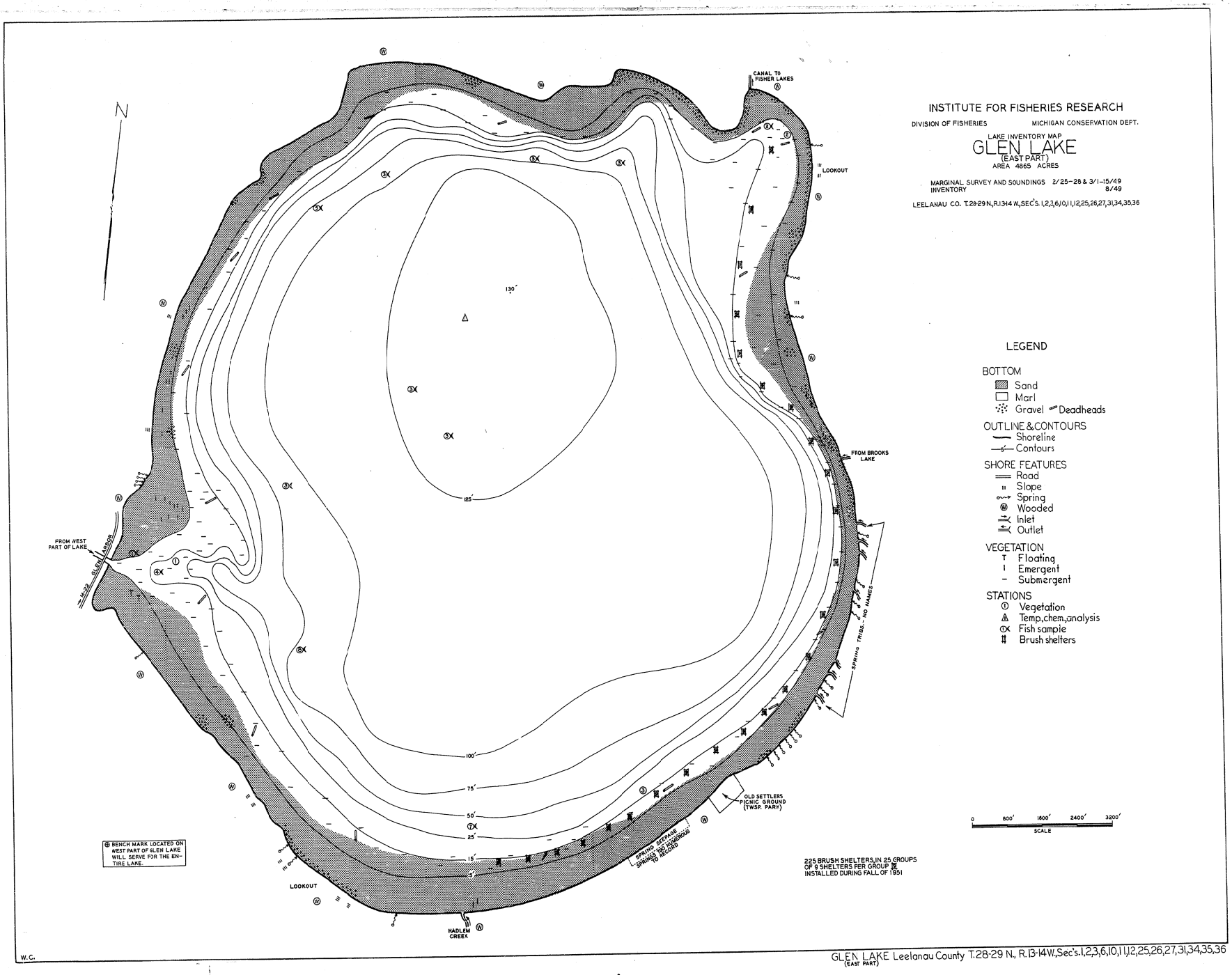


Figure 2. Map of Glen Lake.

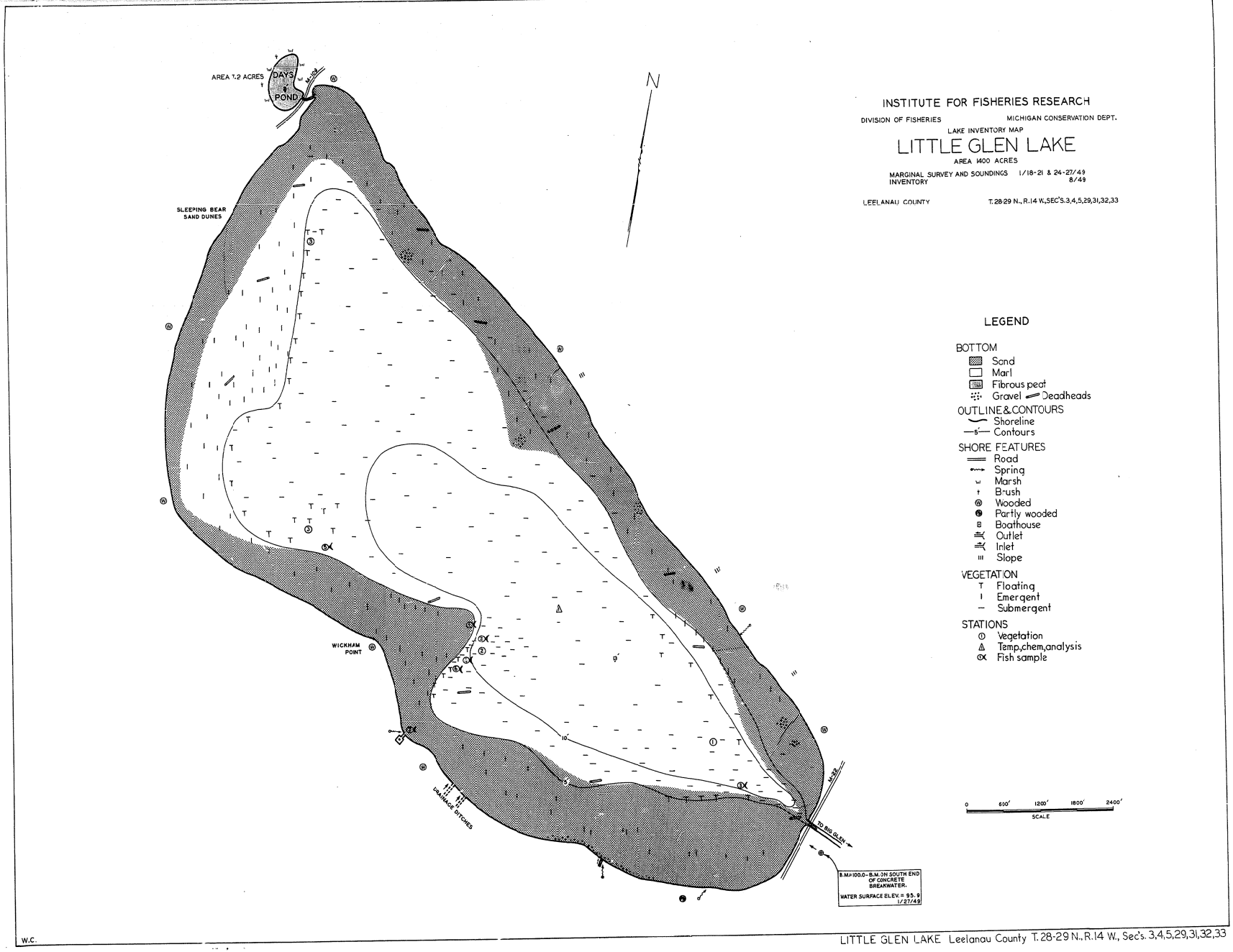


Figure 3. Map of Little Glen Lake.

Table 1. Historic fish stockings in Fisher Lake.

Year	Species	Number of Fish	Size
1938	Bluegill	10,000	Fingerlings
1941	Smallmouth bass	200	Fingerlings
1942	Smallmouth bass	200	Fingerlings
1943	Largemouth bass	7,000	Yearlings
1944	Largemouth bass	400	Fingerlings
1963	Brook trout	150	Legal size

Table 2. Historic Crystal River stockings.

Year	Species	Number of Fish	Size
1896	Brook trout	6,000	n/a
1897	Brook trout	6,000	n/a
1909	Rainbow trout	6,000	Fry

Table 3. Warmwater and coolwater fish species stocking, Glen Lake and Little Glen Lake.

Year	Species	Number of Fish	Size
1894	Walleye	200,000	Fry
1908	Largemouth bass	600	Fingerlings
1909	Smallmouth bass	400	Fingerlings
1910	Smallmouth bass	6,000	Fry
1933	Bluegill	14,000	Fingerlings
	Walleye	300,000	Fry
	Walleye	9,000	Fingerlings
1934	Yellow perch	10,000	Fingerlings
	Largemouth bass	1,500	Fingerlings
	Smallmouth bass	1,000	Fingerlings
	Bluegill	10,000	Fingerlings
1935	Pike	240,000	Fry
	Smallmouth bass	10,000	Fingerlings
	Bluegill	10,000	Fingerlings
1936	Pike	450,000	Fry
	Largemouth bass	1,000	Fingerlings
	Smallmouth bass	2,500	Fingerlings
1937	Pike	360,000	Fry
	Largemouth bass	2,000	Fingerlings
	Smallmouth bass	1,000	Fingerlings
	Bluegill	2,000	Fingerlings
1938	Pike	200,000	Fry
	Largemouth bass	2,000	Fingerlings
	Bluegill	45,000	Fingerlings
1939	Pike	300,000	Fry
	Smallmouth bass	868	Fingerlings
	Largemouth bass	1,000	Fingerlings
	Bluegill	50,000	Fry
1941	Smallmouth bass	500	Fry
	Largemouth bass	500	Fry
	Bluegill	25,000	Fry
1942	Pike	300,000	Fry
	Smallmouth bass	1,000	Fry
1943	Largemouth bass	500	Fingerlings
	Bluegill	1,000	Yearlings
1944	Largemouth bass	1,500	Fingerlings
	Smallmouth bass	700	Sub-legal
	Bluegill	500	Fingerlings
1991	Walleye	3,000,000	Fry
1993	Walleye	1,998,480	Fry

Table 4. Lake trout stocking in Glen Lake.

Year	Species	Number of Fish	Size/Strain
1894	Lake trout	15,000	
1895	Lake trout	20,000	
1896	Lake trout	25,000	
1897	Lake trout	25,000	
1905	Lake trout	50,000	Fry
1909	Lake trout	40,000	Fry
1910	Lake trout	30,000	Fry
1933	Lake trout	9,000	
1934	Lake trout	7,000	
1935	Lake trout	10,000	
1941	Lake trout	15,200	Adults
1942	Lake trout	25,000	Yearlings
1944	Lake trout	1,000	Legal-size
1945	Lake trout	2,400	Legal-size
1946	Lake trout	2,000	Legal-size
1947	Lake trout	3,500	Sub-legal size
1948	Lake trout	650	Legal-size
1949	Lake trout	2,550	Legal-size
1950	Lake trout	5,000	Legal-size
1952	Lake trout	5,000	Sub-legal size
1953	Lake trout	5,000	Legal-size
1954	Lake trout	5,000	Legal-size
1955	Lake trout	5,000	Legal-size
1956	Lake trout	5,000	Legal-size
1957	Lake trout	5,000	Legal-size
1958	Lake trout	5,000	Legal-size
1959	Lake trout	15,000	Legal-size
1960	Lake trout	5,000	Legal-size
1961	Lake trout	5,000	Legal-size
1962	Lake trout	5,000	Legal-size
1963	Lake trout	5,383	Legal-size
1964	Lake trout	5,000	Legal-size
1965	Lake trout	3,000	Sub-legal size
1970	Lake trout	20,000	Fall Fingerlings
1971	Lake trout	10,000	Yearlings
1972	Lake trout	8,575	Fingerlings
1978	Lake trout	35,000	Yearlings
1979	Lake trout	30,000	
1980	Lake trout	33,000	
1996	Lake trout	25,000	*Marquette*
1997	Lake trout	15,220	*Marquette*
1998	Lake trout	19,800	*Marquette*
1999	Lake trout	20,000	*Marquette*
2000	Lake trout	17,700	*Marquette*
2001	Lake trout	22,000	*Marquette*
2002	Lake trout	22,470	*Marquette*
2003	Lake trout	29,500	*Marquette*
2004	Lake trout	30,000	*Marquette*
2005	Lake trout	22,000	*Marquette*
2006	Lake trout	20,800	*Marquette*
2007	Lake trout	20,000	*Marquette*
2008	Lake trout	17,000	*Lewis Lake*
2009	Lake trout	10,000	*Lewis Lake*
2010	Lake trout	20,000	*Lake Superior*

Table 5. Splake stocking in Glen Lake.

Year	Species	Number of Fish	Size
1966	Splake	50,000	Spring fingerlings
1972	Splake	35,280	Yearlings
1973	Splake	50,000	Fingerlings
1974	Splake	50,000	Yearlings
1975	Splake	50,000	Fall Fingerlings
1977	Splake	30,000	Yearlings
1981	Splake	20,000	Yearlings
1982	Splake	35,000	Yearlings
1984	Splake	19,600	Yearlings
1985	Splake	40,240	Yearlings
1986	Splake	54,800	Yearlings
1987	Splake	49,915	Yearlings
1988	Splake	18,000	Yearlings
1990	Splake	20,000	Yearlings
1991	Splake	20,000	Yearlings
1992	Splake	20,000	Yearlings
1993	Splake	17,400	Yearlings
1994	Splake	30,793	Yearlings
1995	Splake	20,000	Yearlings

Table 6. Rainbow trout stocking in Glen Lake.

Year	Species	Number of Fish	Size/Strain
1952	Rainbow trout	5,000	Sub-legal size
1953	Rainbow trout	5,000	Sub-legal size
1954	Rainbow trout	5,000	Sub-legal size
1955	Rainbow trout	5,000	Legal-size
1956	Rainbow trout	5,000	Sub-legal size
1964	Rainbow trout	7,236	Legal-size
	Rainbow trout	10,581	Sub-legal size
1967	Rainbow trout	8,000	Yearling
1970	Rainbow trout	20,000	Yearling
1971	Rainbow trout	39,998	Yearling
1973	Rainbow trout	20,000	*Harrietta*
	Rainbow trout	20,196	*Michigan*
1983	Rainbow trout	40,000	*Harrietta*
2004	Rainbow trout	10,000	*Michigan*
	Rainbow trout	10,000	*Eagle Lake*
2005	Rainbow trout	13,279	*Michigan*
	Rainbow trout	13,116	*Eagle Lake*
2006	Rainbow trout	12,000	*Michigan*
	Rainbow trout	12,000	*Eagle Lake*
2007	Rainbow trout	10,000	*Michigan*
	Rainbow trout	10,000	*Eagle Lake*
2008	Rainbow trout	10,000	*Michigan*
	Rainbow trout	10,000	*Eagle Lake*
2009	Rainbow trout	10,000	*Michigan*
	Rainbow trout	10,000	*Eagle Lake*
2010	Rainbow trout	5,000	Eagle Lake

Table 7. Brown trout stocking in Glen Lake.

Year	Species	Number of Fish	Strain
1985	Brown trout	15,330	*Harrietta*
1986	Brown trout	16,450	*Plymouth Rock*
	Brown trout	9,900	*Wild Rose*
1987	Brown trout	16,900	*Soda Lake*
	Brown trout	3,100	*Plymouth Rock*
1988	Brown trout	20,000	*Soda Lake*
1989	Brown trout	20,000	*Plymouth Rock*
1990	Brown trout	20,000	*Plymouth Rock*
1991	Brown trout	19,800	*Plymouth Rock*
1992	Brown trout	19,600	*Plymouth Rock*
1993	Brown trout	19,450	*Wild Rose*
1994	Brown trout	20,000	*Wild Rose*
1995	Brown trout	8,600	*Seeforellen*
	Brown trout	10,000	*Soda Lake*
1996	Brown trout	18,720	*Wild Rose*
1997	Brown trout	21,298	*Seeforellen*

Table 8. Miscellaneous stockings in Glen Lake.

Year	Species	Number of Fish	Size
1956	Whitefish	1,000	Fry
1959	Whitefish	4,000	Fry
1960	Brook trout	5,000	Legal
1961	Brook trout	10,000	Legal
1962	Brook trout	5,000	Legal

Table 9. Glen Lake and Fisher Lake creel survey data, Summer 2008 and Winter 2009.

	Fisher Lake Summer 2008	Glen Lake Summer2008	Glen Lake Winter 2009
Angler Hours	1,066	13,700	6,111
Angler Trips		1,682	931
Smallmouth bass	31	78	
Yellow perch	124	14,066	6,062
Bluegill	230	237	
Rainbow trout		89	
Rock bass		135	
White Sucker		21	7
Lake trout		23	7
Channel catfish			1
Rainbow smelt			58
Cisco		19	51
Harvested	385	14,668	6,186
Northern pike		12	
Largemouth bass	79	70	
Smallmouth bass	79	609	
Yellow perch	243	9,729	721
Bluegill	311	335	
Rainbow trout		77	
Rock bass		1,158	10
White sucker		95	4
Lake trout		1	
Cisco		8	
Released	712	12,094	735
Total Catch	1,097	26,762	6,921

Table 10. Number, weight, and length of fish collected from Glen Lake with trap nets, inland gillnets, Great Lakes gillnets, and minnow seine on May 26-29, and electrofishing on July 15, 2009

Species	Number	Percent by number	Weight (Pounds)	Percent by weight	Length range (inches)[1]	Average length	Percent legal size[2]
Bluegill	5	0.5	0.5	0.1	4-5	5.3	0 (6")
Bluntnose minnow	29	2.7	0.1	0.0	1-2	1.5	
Coho salmon	1	0.1	1.5	0.2	16-16	16.0	100 (10")
Emerald shiner	41	3.8	0.3	0.0	2-3	3.3	
Iowa darter	1	0.1	0.0	0.0	1-1	1.5	
Johnny darter	9	0.8	0.0	0.0	1-2	1.6	
Lake herring	305	28.5	59.1	9.8	7-16	9.0	
Lake trout	15	1.4	105.5	17.4	9-35	26.0	93 (15")
Logperch	9	0.8	0.2	0.0	2-4	3.5	
Mudpuppy	1	0.1	0.0	0.0	9-9	9.5	
Northern pike	2	0.2	12.8	2.1	26-33	29.5	100 (24")
Rainbow trout	1	0.1	3.1	0.5	20-20	20.5	100 (15")
Steelhead	2	0.2	2.1	0.3	11-16	14.0	50 (15")
Rock bass	81	7.6	16.5	2.7	1-9	6.1	57 (6")
Sand shiner	59	5.5	0.2	0.0	1-3	2.3	
Smallmouth bass	17	1.6	9.9	1.6	1-20	5.0	12 (14")
Spottail shiner	9	0.8	0.1	0.0	3-3	3.5	
White sucker	182	17.0	312.8	51.6	1-20	15.4	
Yellow perch	303	28.3	81.3	13.4	3-14	8.0	54 (7")
Total	1,072	100	606.0	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 11. Average total weighted length (inches) at age, and growth relative to the state average, for fish sampled from Glen Lake with trap nets, Great Lakes gill nets, inland gill nets, and minnow seining, May 26- June 3, 2009. Number of fish aged is given in parenthesis. A minimum of five fish per age group is statistically necessary for calculating a Mean Growth Index, which is a comparison to the State of Michigan average.

Species	Age I	II	III	IV	V	VI	VII	VIII	IX	X	Mean Growth Index
Bluegill			5.3 (3)	5.9 (2)							
Lake trout	9.0 (1)		19.1 (1)	24.7 (1)	25.4 (2)	26.4 (4)	27.9 (4)	33.9 (2)			
Northern pike				26.9 (1)	33.5 (1)						
Rainbow trout			20.2 (1)								
Rock bass		3.9 (8)	5.7 (17)	6.7 (7)	7.7 (12)	8.6 (4)	9.1 (2)				+0.7
Smallmouth bass		8.4 (3)								20.4 (1)	
Steelhead		16.0 (1)									
Yellow perch		5.7 (1)	6.5 (5)	7.0 (24)	8.2 (16)	10.7 (16)	11.5 (9)	12.9 (4)	13.0 (5)	14.1 (2)	+0.6

Table 12. Average total weighted length (inches) at age, and growth relative to the state average, for fish sampled from Glen Lake with electrofishing, July 15, 2009. Number of fish aged is given in parenthesis. A minimum of five fish per age group is statistically necessary for calculating a Mean Growth Index, which is a comparison to the State of Michigan average.

	Age									
Species	I	II	III	IV	V	VI	VII	VIII	IX	Mean Growth Index
Rock bass		3.8 (2)			7.3 (1)					
Steelhead		11.5 (1)								
Smallmouth bass									20.0 (1)	
Yellow perch	3.9 (1)									

Table 13. Water temperature, dissolved oxygen, and pH profile for Glen Lake, Leelanau County. Sampling was conducted by DNR Fisheries personnel on September 1, 2009.

Depth (ft)	Temperature (F)	Dissolved oxygen (ppm)	pH
0	67.5	8.8	8.5
3	67.6	8.8	8.5
6	67.6	8.8	8.5
9	67.6	8.8	8.5
12	67.6	8.8	8.5
15	67.6	8.8	8.5
18	67.6	8.7	8.5
21	67.6	8.7	8.5
24	67.6	8.7	8.5
27	67.5	8.7	8.5
30	67.5	8.7	8.5
33	67.5	8.7	8.5
36	67.5	8.7	8.5
39	67.5	8.6	8.5
42	67.4	8.6	8.5
45	60.5	11.2	8.4
48	58.8	11.3	8.4
51	55.3	11.8	8.4
54	53.6	11.7	8.4
57	52.6	11.3	8.3
60	50.8	11.1	8.3
63	50.2	10.8	8.3
66	49.0	10.2	8.2
69	48.5	9.7	8.1
72	48.0	9.6	8.1
75	47.6	9.4	8.0
78	47.1	9.2	8.0
81	46.7	8.7	7.9
84	46.4	8.4	7.9
87	46.2	8.3	7.8
90	45.6	8.0	7.8
93	45.5	7.8	7.7
96	45.2	7.3	7.7
99	44.7	6.7	7.7

Table 14. Total phosphorous, total nitrogen, secchi depth, and chlorophyll for Glen Lake, Leelanau County. Sampling was conducted by USGS personnel on August 5, 2008.

Depth (ft)	Total phosphorous µg/l	Total nitrogen µg/l
3	7	
60	12	220

Secchi depth = 28 feet

Table 15. Shoreline data for Glen Lake, Little Glen Lake, and Fisher Lake Leelanau County. Sampling was conducted by DNR Fisheries personnel on September 1, 2009.

	Small docks per km	Large docks per km	Total docks per km	Percent shoreline armoring	Submerged trees per km	Dwellings per km
Glen Lake	18.7	0.3	19.1	11.0	21.7	21.2
Little Glen Lake	12.9	5.0	17.9	4.0	0.3	23.0
Fisher Lake	9.2	2.2	11.4	2.0	0.0	12.1

** Large docks are described as having more than 2 boat slips, while small docks have only 1 or 2 boat slips.

Table 16. Number, weight, and length of fish collected from Little Glen Lake with fyke nets, trap nets, inland gillnets, and maxi-mini fyke nets, on June 1-4, 2009 and electrofishing on June 15, 2009.

Species	Number	Percent by number	Weight (Pounds)	Percent by weight	Length range (inches)[1]	Average length	Percent legal size[2]
Bluegill	6	0.4	0.7	0.2	1.8-6.3	5.2	33 (6")
Bluntnose minnow	2	0.1	0	0.0	2-3.9	3.0	
Brown bullhead	7	0.4	6.7	1.5	11-15.9	12.7	100 (7")
Emerald shiner	995	60.0	6.2	1.4	2-3.9	3.0	
Johnny darter	1	0.1	0.0	0.0	1-1	1.5	
Longnose gar	1	0.1	2.9	0.6	31-31	31.5	
Northern pike	10	0.6	69.8	15.3	25.8-37.2	30.6	100 (24")
Rock bass	282	17.0	95.4	20.9	5-12.9	7.3	84 (6")
Sand shiner	3	0.2	0.0	0.0	2-2	2.5	
Smallmouth bass	45	2.7	81.4	17.8	4.7-20.7	14.2	58 (14")
Spottail shiner	8	0.5	0.1	0.0	2-3.9	3.4	
White sucker	59	3.6	151.5	33.2	15-21.9	18.6	
Yellow perch	240	14.5	41.6	9.1	4.2-13	7.2	40 (7")
Total	1,659	100	456.2	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 17. Average total weighted length (inches) at age, and growth relative to the state average, for fish sampled from Little Glen Lake with fyke nets, maxi-mini fyke nets, and inland gill nets, May 17-20, 2004. Number of fish aged is given in parenthesis. A minimum of five fish per age group is statistically necessary for calculating a Mean Growth Index, which is a comparison to the State of Michigan average.

	Age										
Species	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	Mean Growth Index
Bluegill			5.9 (5)									+0.6
Northern pike				29.8 (9)				37.2 (1)				+5.6
Rock bass			6.3 (24)	7.5 (15)	8.6 (14)	10.1 (7)	10.7 (9)		12.2 (3)		12.5 (1)	+1.4
Smallmouth bass	4.7 (2)	8.8 (5)	11.1 (13)	15.3 (8)	16.5 (8)	17.9 (3)	17.7 (2)	19.6 (3)	20.1 (2)			+1.7
Yellow perch	4.4 (7)	6.1 (9)	6.6 (9)	7.4 (5)	8.0 (13)	9.1 (12)	10.8 (6)	12.6 (1)		13.0 (1)		-0.1

Table 18. Total phosphorous, total nitrogen, secchi depth, and chlorophyll for Little Glen Lake, Leelanau County. Sampling was conducted on August 5, 2008.

Depth (ft)	Total phosphorous µg/l	Total nitrogen µg/l	Chlorophyll A µg/l
3	13	390	
6	10	370	
12			2.7

Secchi depth = 12 feet (bottom)

Table 19. Number, weight, and length of fish collected from Fisher Lake with fyke nets, inland gillnets, and maxi-mini fyke nets, on May 27-29, 2009.

Species	Number	Percent by number	Weight (Pounds)	Percent by weight	Length range (inches)[1]	Average length	Percent legal size[2]
Black bullhead	3	0.3	1.8	1.5	7.4-13.9	5.2	100 (7")
Bluegill	3	0.3	0.2	0.2	1.5-5.6	4.2	0 (6")
Bluntnose minnow	61	5.6	0.2	0.2	1-3.9	2.0	
Brown bullhead	3	0.3	1.6	1.4	6.7-12.2	9.8	67 (7")
Emerald shiner	98	9.0	0.8	0.7	2-3.9	3.3	
Green sunfish	1	0.1	0.0	0.0	2.9-2.9	2.9	0 (6")
Lake herring	2	0.2	0.7	0.6	10.7-11.3	11.0	
Largemouth bass	5	0.5	5.4	4.6	11.5-14.8	12.7	20 (14")
Logperch	1	0.1	0.0	0.0	2.5-2.5	2.5	
Longear sunfish	3	0.3	0.1	0.1	2.8-3.2	3.0	
Mimic shiner	171	15.7	0.9	0.8	1-2.9	2.5	
Northern pike	1	0.1	12.4	10.6	37.7-37.7	37.7	100 (24")
Pumpkinseed sunfish	2	0.2	0.2	0.2	3.2-5.5	4.4	100 (6")
Rock bass	252	23.1	64.6	55.4	1.2-11.2	6.5	57 (6")
Sand shiner	69	6.3	0.3	0.3	2-2.9	2.5	
Steelhead	1	0.1	2.2	1.9	18.8-18.8	18.8	100 (8")
Smallmouth bass	2	0.2	3.8	3.3	12.5-17.7	15.0	50 (14")
Spottail shiner	373	34.2	1.9	1.6	2-2.9	2.5	
White sucker	7	0.6	13.1	11.2	13.7-20.3	16.5	
Yellow perch	34	3.1	6.7	5.7	3.1-12.7	7.2	29 (7")
Total	1,092	100	116.6	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 20. Average total weighted length (inches) at age, and growth relative to the state average, for fish sampled from Fisher Lake with fyke nets, maxi-mini fyke nets, and inland gill nets, May 27-29, 2009. Number of fish aged is given in parenthesis. A minimum of five fish per age group is statistically necessary for calculating a Mean Growth Index, which is a comparison to the State of Michigan average.

Species	Age I	II	III	IV	V	VI	VII	VIII	IX	X	XI	Mean Growth Index
Bluegill			5.4 (2)									
Lake herring						11.0 (2)						
Largemouth bass			12.4 (2)	12.2 (2)	14.8 (1)							
Longear sunfish			3.0 (4)									
Northern pike											37.7 (1)	
Pumpkinseed				4.4 (2)								
Rock bass		3.2 (5)	4.4 (16)	6.1 (22)	7.3 (17)	8.6 (10)	8.8 (7)	10.4 (6)	10.7 (3)	11.2 (1)		+0.2
Smallmouth bass			12.5 (1)		17.6 (1)	17.7 (1)						
Yellow perch		5.9 (3)	6.5 (9)	8.5 (1)	6.9 (7)	9.3 (4)	12.7 (2)					-1.7