Big Shag Lake
Marquette County, T45N/R26W/S25 & 26
Escanaba River, Last Surveyed 2023

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Environment

Location
Big Shag Lake is a 188-acre natural lake located in Forsythe Township in south central Marquette County (T45N/R26W/Sec. 25, and 26) in Michigan's Upper Peninsula (Figure 1). The city of Marquette is located approximately 28 miles north and is the largest city in the Upper Peninsula. Gwinn is an unincorporated community located just 3.8 miles northeast of Big Shag Lake, and it is a popular destination for individuals interested in fishing, hunting, and a variety of other outdoor activities.

Geology and geography
The bedrock surrounding the main basin of Big Shag Lake is composed of igneous and sedimentary rocks that were formed during the Precambrian and Paleozoic periods, respectively. The northwest region of Big Shag Lake is dominated by Archean Granite, Gneissic, Michigamme, and Bijiki Iron formations, which are typical of Precambrian igneous bedrock types (MDNR 2001). In contrast, the southeast region is dominated by Munising and Trempealeau formations, which are more typical of Paleozoic sedimentary bedrock types (MDNR 2001). The rich geological formations in this region have attracted the mining industry, providing mining opportunities that have supported communities in Gwinn and nearby New Swanzy for over a century.

The landscape of adjacent areas is dominated by forest (77.4%), wetlands (8.9%), and urban development (6.9%) (Figure 2). The substrate composition of Big Shag Lake and surrounding areas are mostly of medium texture (77.3%) with Karlin Sandy Loam, Carbondale & Tawas, and Greenwood & Dawson soils (USDA 2019). The immediate shoreline of Big Shag Lake is rocky with steep drop-offs comprised of pebble, cobble, and boulder sized substrates. A series of rocky points exist around the lake projecting lakeward below the ordinary high-water mark. Given the steep slope and narrow southwest to northeast axis of the lake, substrate materials that support the points are vulnerable to wake-induced shoreline erosion.

Big Shag Lake is positioned on a southwest to northeast axis and contains a series of rocky points. The longest fetch length from the southwest to the northeast shore is approximately 1.0 mile, and the average depth of the lake is 19 feet. Big Shag Lake is approximately 985 feet wide on average, but width measures can range from 748 to 2,646 feet. Based upon fetch and depth measures, the northeast shore of Big Shag Lake has the potential to receive 12-inch waves (moderate energy) during a 35-mile-per-hour windstorm (WDNR 2021). In contrast, the northern and southern shorelines are more protected and are predicted to experience 5-inch waves (low energy) in a 35-mile-per-hour windstorm (WDNR 2021).

Shoreline erosion caused by natural wind events is unlikely, and hard armoring in this waterbody is not justifiable in most instances. However, the use of recreational vessels that enhance nearshore wave energy may have the potential to unnaturally damage nearshore aquatic resources in Big Shag Lake (Francis et al. 2023). Based upon the moderate to low energy potential for the shoreline of Big Shag

Lake, hard armoring materials (e.g., steel, limestone, vinyl, rip rap) should not be used to modify the shoreline.

Watershed description
Big Shag Lake, Mitchell Bay, Little Shag Lake, Miller Lake, and Hay Wire Lake are all adjacent to one another and represent a complex of waterbodies located within the upper reaches of the Escanaba River watershed. Big Shag Lake is mostly disconnected without major inlets or outlets. However, surrounding wetland areas drain to Miller Creek, which flows southwesterly to Chandlers Brook. The Big Shag Lake lakeshed (Figure 3) encompasses 1,590 acres, of which nearly 12% is water (MGLP 2025). Approximately 88% of the Big Shag Lake lakeshed is unprotected and vulnerable to residential and commercial development. The immediate shoreland area of Big Shag Lake encompasses 174 acres which is largely unprotected and vulnerable to development in the future (MGLP 2025).

Development, public ownership, and access
A large majority of the Big Shag Lake shoreline is privately owned; however, the Michigan Department of Natural Resources (MDNR) provides a public boat launch on the northeast end of the lake (GPS 46.270418 -87.499507) (Figure 1). The public launch at Big Shag Lake includes a hard-surfaced ramp with sufficient depth to accommodate most watercraft. There are eight vehicle-only parking spaces, and the site includes one vault toilet. The Big Shag Lake public access site is managed by MDNR Parks and Recreation Division out of the Escanaba Customer Service Center.

Fishery Resource

History
During the early 20th Century, fisheries biologist John Nicholas Lowe was an instructor at Northern State Teachers College (now Northern Michigan University). J. N. Lowe collected fish from several waterbodies in Michigan's Upper Peninsula, establishing some of the earliest contemporary documentation of fish communities. Big Shag Lake was surveyed by J. N. Lowe on 14 September 1924 and on 5 June 1926 and seven species were captured (Yellow Perch, Common White Sucker, Blacknose Shiner, Northern Redbelly Dace, Mimic Shiner, Iowa Darter, and Golden Shiner). J. N. Lowe noted that Big Shag Lake was a "shallow lake, good for bass".

Fisheries management began in earnest on Big Shag Lake during the 1930s and 1940s. The lake bottom was first mapped by the Michigan Department of Conservation (hereinafter referred to as "MDNR") in 1936 and 1937. Bluegill, Largemouth Bass, Walleye, Smallmouth Bass, and Yellow Perch were all stocked in Big Shag Lake during the time between 1933 and 1943 (Table 1). During this period, it was common practice to stock Bluegill, bass, Yellow Perch, and other warmwater species in Michigan. By the early 1940s, efforts to stock warmwater species were less common, and efforts were made to rely on natural reproduction, which was more cost-effective and tended to exceed hatchery capabilities (Cooper 1948). By 1946, the Michigan Fish Commission had a policy to curtail stocking of warmwater species given the "incontestable evidence that the average planting of these-warmwater species has involved an insignificant number of fish as compared to the number already present" (Cooper 1948, pp 8).

By 1937, there were approximately 18 camps that existed on Big Shag Lake. In the next two decades, additional residential developments were established along the shore of Big Shag Lake, and angling pressure subsequently increased, as did the need for fisheries management efforts.

During the 1950s and 1960s, agency staff sought to learn more about the Big Shag Lake fish community by conducting fisheries surveys. At the same time, petitions were signed by anglers and requests were issued to the MDNR to stock cold-water trout in Big Shag Lake. Due to the lack of deep habitat in the lake, no immediate action was taken. Pressure continued and during the late 1950s, the MDNR responded to request for trout stocking by outlining criteria used to justify trout management. At this time, MDNR used the following criteria to justify the stocking of trout in inland lakes: 1) a lake intended to be stocked with trout needed to have an area or layer of water suitable for trout that was being used little or not at all by other desirable species, and 2) the lake had to have suitable conditions for trout that currently was not providing a satisfactory fishery because no suitable species were present, or the populations were stunted. In the former case, where there were unused lake strata, trout were stocked to provide additional angling opportunities. In the latter instance, undesirable species were removed using fish toxicants to remove competitors, prior to the introduction of trout via stocking. Big Shag Lake did not meet these criteria and therefore was not stocked with trout. Requests for stocking likely increased as the number of residents increased. By 1957, the number of cottages on the lake had increased nearly 6-fold, with a total of 106 cottages along the shoreline (compared to 18 just two decades prior).

In July of 1957, a fish community survey was conducted by the MDNR Institute for Fisheries Research, which included measurements of water transparency, temperature, and dissolved oxygen. Secchi disk depth, used to measure water transparency, was reported to be 9.0 feet. Water temperature in Big Shag Lake ranged from 71.7°F at the surface to 66.0°F at 23 feet deep. Temperature profiles collected suggested that Big Shag Lake did not thermally stratify and therefore would produce, at best, a ‘marginal’ fishery for trout. Dissolved oxygen was measured at the water surface (9.7 mg/L) and at 22 feet deep (5.4 mg/L). The dissolved oxygen profile suggested that sufficient oxygen existed to support aquatic organisms from the surface to 22 feet deep. The netting survey captured Bluegill, Pumpkinseed, Yellow Perch, Walleye, and Common White Sucker. Yellow Perch and Common White Sucker dominated the catch by number.

The general sentiment around fishing during the late 1950s was that Big Shag Lake was good for Yellow Perch and fair for Smallmouth Bass. Agency staff noted that spawning habitat available at that time was good for Yellow Perch, Smallmouth Bass, and other sunfishes, and fair for Walleye. In response to previous observations and findings, no fish stocking occurred in Big Shag Lake during the 1950s or 1960s. Favorable fishing reports and increased angling interest led to additional requests for stocking during the late 1950s and early 1960s. In 1960, an area resort owner sent a letter to the MDNR requesting that Big Shag Lake be stocked due to concerns that the 1957 survey may have reduced the fish population. The letter indicated that fishing conditions had changed compared to previous years.

In April of 1963, a winter/spring fish kill was reported in Mitchell Bay of Big Shag Lake. Agency staff observed Largemouth Bass, Walleye, Bluegill, Yellow Perch, minnows, and adult frogs dead on the lake bottom with many gulls feeding. The fish kill occurred as the channel between Mitchell Bay and Big Shag Lake became blocked by ice. The decomposition of aquatic vegetation, which is abundant in Mitchell Bay, further depleted oxygen and resulted in the fish kill. Additionally, agency staff noted that the winter from 1962 to 1963 had been ‘unusually severe’ (cold). Severe winters are often associated with prolonged ice cover on inland lakes which increases decomposition and limits oxygen availability resulting in natural fish kills.

In the summer of 1968, a petition was submitted to the MDNR requesting Walleye stocking. Managers documented an abundant population of stunted Yellow Perch, and managers were hesitant to stock younger Walleye due to limited resources in the lake, as evidenced by the stunted growth of Yellow Perch. Due to the limited availability of larger Walleye for stocking and the previously mentioned concerns, no fish were stocked until the early 1970s.

In the 1970s, fisheries management efforts on Big Shag Lake increased as was evident by increased survey effort, habitat improvement projects, species introductions, maintenance stocking, and manual removals of undesirable fish. During the early 1970s, managers were concerned that the increased developments around Big Shag Lake were negatively impacting shoreline habitat for aquatic species. Common practices of residents along lake riparian areas included "beach cleanup" (removal of logs, sticks, rocks, etc.), to provide easier access and improve aesthetics. In 1973 the MDNR conducted a physical habitat assessment of the Big Shag Lake shoreline and agency staff noted that fish habitat was better in areas adjacent to undeveloped areas of the lake when compared to developed areas. It was recommended that brush shelters be placed along the 2- to 5-foot depth contour to improve habitat for bass and panfish in the lake. These structures were installed in Big Shag Lake soon after the habitat evaluation. Rocky habitat was found in the south arm of the lake and was noted to be sufficient to support natural reproduction of Walleye. Marginal spawning habitat for Northern Pike occurred in areas where high water had flooded vegetation (Northern Pike had yet to be observed or captured in Big Shag Lake at this time). Additional notes from this 1973 habitat survey stated that Tiger Muskellunge would be an 'attractive addition' to the Big Shag Lake fishery for anglers seeking trophy fishing opportunities. Tiger Muskellunge were expected to prey upon an overabundant, undersized Yellow Perch to improve the size structure.

To accompany the recent habitat assessment, MDNR staff also conducted a fish community survey of Big Shag Lake in August of 1973. A total of six species were captured (Bluegill, Common White Sucker, Pumpkinseed, Smallmouth Bass, Yellow Perch, and Walleye). Yellow Perch were noted to be abundant and undersized, and only a few advanced age Walleye were present in the catch, indicating that natural reproduction had not occurred recently (all fish > 20 inches). Walleye gonads, liver, and kidneys were observed to be abnormal, which may explain the lack of natural reproduction. Fishing reports at the time of this survey indicated that Smallmouth Bass fishing was 'fair to good'.

In June of 1973, managers of Big Shag Lake responded to a request from a State House representative to stock Walleye. Walleye stocking had previously occurred in 1942 (420,000 spring fry). Managers noted that natural reproduction had taken place, and this had sustained the Walleye population in Big Shag Lake for some time. Previously noted declines in the Walleye fishery are believed to have occurred due to competition and predation, and the gradual loss of shoreline habitat from 'beach cleanup' and development of riparian areas by cottage owners. In 1974 and 1975, 800,000 spring fry and 3,160 fall fingerling Walleye were stocked in Big Shag Lake.

Following stocking in 1974 and 1975, MDNR staff conducted a netting survey in May of 1978 to evaluate the survival and growth of stocked Walleye and to provide additional information on the Big Shag Lake fish community. Fishing reports for Big Shag Lake collected just before the 1978 survey indicated that fishing for sunfish was 'good', fishing was 'fair for Smallmouth Bass', Walleye fishing was noted as 'poor', and Yellow Perch were all 'too small'.

The spring 1978 netting survey captured a total of nine species (Bluegill, Hybrid Sunfish, Common White Sucker, Northern Pike, Pumpkinseed, Smallmouth Bass, Longnose Sucker, Yellow Perch and Walleye). Only three Walleye were captured, and all were greater than 25 inches, suggesting limited to no survival of Walleye stocked in 1974 and 1975. Suckers were observed to be large and abundant. Panfish were common in the south end of the lake and were of attractive size. Yellow Perch were 'extremely abundant' and undersized. A single Northern Pike was captured, representing the first record of the species in Big Shag Lake. In August of 1978, managers surveyed Big Shag Lake to gather limnological information including water transparency, temperature, and dissolved oxygen. Secchi disk depth was reported to be 10.5 feet. Water temperature in Big Shag Lake ranged from 72.0°F at the surface to 68.0°F at 22 feet deep. Similar to the oxygen profile gathered in 1957, Big Shag Lake did not show signs of thermal stratification. Dissolved oxygen ranged from 8.6 mg/L at the surface and 7.9 mg/L at 22 feet deep. The dissolved oxygen profile suggested that sufficient oxygen existed to support aquatic organisms from the surface to 22 feet deep.

In late May of 1978, a public meeting was held with MDNR biologists and interested lake residents. The purpose of the meeting was to share results from the Walleye evaluation survey. Managers sought public opinions regarding future fisheries management actions on Big Shag Lake. The meeting was held on 31 May, and approximately 33 people attended, which included residents from both Little Shag Lake and Big Shag Lake. Managers at this public meeting discussed the results of stocking 800,000 spring-fry Walleye in 1974 and 3,160 fall fingerlings in 1975. The survey results from the spring of 1978 indicated that stocking was unsuccessful, as only 3 Walleye were captured. The failure of stocking efforts with spring fry and fall fingerling Walleye prompted managers to develop a plan to utilize Mitchell Bay for rearing. A 5-step plan was established: 1) place a barrier between Big Shag Lake and Mitchell Bay in the fall, 2) remove all desirable fish from Mitchell Bay and release them in Big Shag Lake, 3) chemically treat Mitchell Bay to remove all suckers and any remaining predators, 4) stock and routinely feed Walleye until the following spring, and 5) remove the barrier the following June to allow Walleye to swim freely into Big Shag Lake.

There are no records to indicate Mitchell Bay was ever used for rearing Walleye. However, another 25,000 spring fingerling Walleye were stocked in Big Shag Lake in 1979. MDNR stocked 550 fall fingerling Tiger Muskellunge in 1978. During the 1970s and early 1980s, Yellow Perch were caught by anglers in large numbers in Big Shag Lake, as well as a few large, older Walleye. Surveys conducted during this timeframe showed an aging Walleye population with limited to no return on investment from stocking 800,000 spring fry, 25,000 spring fingerlings, and 16,160 fall fingerlings in previous years.

In early 1979, MDNR wrote the "Big Shag Lake Management Plan," which was shared with residents and anglers. The primary management recommendation was to reduce the biomass of Common White Sucker and Yellow Perch with manual removal surveys. It was hypothesized that overabundant populations of Yellow Perch and Common White Sucker were negatively impacting natural reproduction and reducing the survival of stocked gamefish (namely, Walleye). Manual removals occurred in 1979, when a total of 38 pounds per acre of Common White Sucker and 11 pounds per acre of Yellow Perch were removed from Big Shag Lake. Managers further recommended that the shoreline of Big Shag Lake be treated with Antimycin (a fish toxicant) to reduce the nearshore abundance of undersized Yellow Perch. However, there is no record that a treatment ever occurred.

Fall fingerling Tiger Muskellunge were stocked every other year throughout much of the 1980s. Despite the failed stocking attempts in the 1970s, Walleye stocking continued every other year with the hope that manual removal of Common White Sucker and Yellow Perch in 1979 would improve survival. In 1980, anglers reported that Yellow Perch fishing was 'superb' during the winter of 1979 to 1980. Male Yellow Perch averaged approximately 8.0 inches and females ranged from 9.0 to 10.5 inches. That winter, ice shanties populated the southern end of the lake, near Mitchell Bay, and on the northern end of the lake near the public access site.

In June of 1981, MDNR conducted surveys to evaluate the stocking of Walleye, the recent introduction of Tiger Muskellunge, and the impacts of the manual removals of fish. Both small mesh fyke nets and experimental gill nets were set, and a total of nine species were captured, including Bluegill, Pumpkinseed, Bluntnose Minnow, Smallmouth Bass, Largemouth Bass, Common White Sucker, Yellow Perch, Tiger Muskellunge, and Walleye. All species captured were growing below the state average, except for Walleye, which were growing an inch above the state average. A total of nine Walleye were captured, 3 were age-two and 6 were age-three. Common White Sucker were noted to be lower in abundance, and a 'tremendous number' of juvenile Yellow Perch were captured. A Common Loon was also observed on Big Shag Lake during this survey.

In September of 1982, Big Shag Lake was again surveyed by the MDNR to evaluate the Yellow Perch populations' continued response to manual fish removal efforts in 1979. Gears deployed included trap nets, gill nets, and a large seine. A total of 8 species were captured, including Tiger Muskellunge, Walleye, Smallmouth Bass, Pumpkinseed, Bluegill, Bluntnose Minnow, Yellow Perch, and Common White Sucker. Changing gear types and the timing of surveys made the evaluation of the manual removal difficult. However, managers did note that a reduced number of Yellow Perch were captured with a larger average size. In 1983, a letter was sent by an angler who sought to compliment MDNR on the good work being done with Muskellunge in Marquette County. The angler noted that they fished Big Shag Lake in June of 1983 and 'really enjoyed the Muskie action".

To evaluate the success of Walleye stocking efforts, which had occurred biennially since the late 1970s, Big Shag Lake was surveyed by the MDNR in June of 1984. The survey utilized experimental monofilament gill nets with a range of mesh sizes. Despite the substantial sampling effort, very few Walleye were captured. The survey captured several stocked-year-classes of Tiger Muskellunge, and growth was satisfactory. Managers noted that Tiger Muskellunge were being sought by anglers and appeared to be of high value.

In June of 1989, another survey was conducted to gather information on Walleye and Tiger Muskellunge stocking efforts and information about the fish community. Fyke nets and gill nets were used, and a total of 7 species were captured (Yellow Perch, Pumpkinseed, Bluegill, Largemouth Bass, Walleye, Common White Sucker, and Tiger Muskellunge). A total of 8 Walleye and 1 Tiger Muskellunge were captured during that survey, and managers noted that fishing pressure was high, making it difficult to sustain fisheries for predator species in Big Shag Lake.

During the early 1990s, the Big Shag Lake Association sought a collaborative relationship with MDNR to share insights on fisheries management. A meeting was held, and survey information was shared by MDNR staff. The association provided positive feedback about the meeting and volunteered to provide MDNR staff with scale samples from Walleye, bass, and Tiger Muskellunge to provide additional information on harvest and the age structure of those populations. In the mid-1990s, MDNR

staff attended annual meetings held by the Big Shag Lake Association to encourage communication and share information gathered during fisheries surveys. Survey results were reported in the Association's newsletters.

In 1992, the Big Shag Lake Association contacted MDNR to express interest in whether Mitchell Bay could be blocked off for Walleye rearing as had been proposed during the 1970s. The MDNR response was that Mitchell Bay was not blocked off for Walleye rearing because recent advances in fish rearing capacity made more fish available. For example, spring fingerling Walleye were then being efficiently produced in rearing ponds. Additionally, if Mitchell Bay were blocked for fish rearing, it would create problems for boaters. In response to the 1992 letter, managers sought collaborations with anglers and suggested that additional sucker removals might help improve the size structure of panfish populations. MDNR requested that the Big Shag Lake Association provide volunteers to assist with the removal effort. The Big Shag Lake Association, through additional correspondence with MDNR, approved of the intent to conduct a 'sucker removal' survey.

In May of 1993, a survey was conducted, and all suckers captured were removed. Fyke nets were deployed, which captured eight species (Bluegill, Pumpkinseed, Yellow Perch, Smallmouth Bass, Walleye, Largemouth Bass, Common White Sucker, and Tiger Muskellunge). A total of 6.9 pounds per acre of Common White Sucker were removed (compared to 38 pounds per acre removed in 1979). Panfish were common in nets and noted to be of sufficient size to attract anglers. Several year-classes of Smallmouth Bass were captured, and many fish were within the 2 to 4 pound range. Fisheries managers noted that Big Shag Lake attracted a diverse group of anglers who targeted Tiger Muskellunge, Walleye, panfish, and bass. Managers recommended a continued stocking of Walleye and Tiger Muskellunge. However, Tiger Muskellunge were last stocked in Big Shag Lake in 1990. Reasons for the cessation in stocking are unclear but likely related to availability.

In the mid-1990s, the Big Shag Lake Association reported that Green Sunfish were being captured by anglers, and that observations had been confirmed by MDNR. The association also reported that Northern Pike were established in Big Shag Lake, though only one had been documented in an MDNR survey conducted in 1978. By the late 1990s, area residents and anglers were concerned about the number of Northern Pike in the lake. While Northern Pike had been in Big Shag Lake for several decades, numbers appeared to increase during the late 1990s and early 2000s. At this time, few, if any, stocked Walleye were surviving to a harvestable size.

In 1998, a fyke net survey was conducted to evaluate the relatively recent statewide 14-inch minimum size limit for bass. Six species were captured: Bluegill, Largemouth Bass, Northern Pike, Pumpkinseed, Yellow Perch, and Smallmouth Bass. Consistent with local association reports, several Northern Pike were captured in Big Shag Lake, suggesting that the species had become well established. At that time, agency staff mentioned that this was the first capture of Northern Pike in Big Shag Lake; however, the 1978 capture was previously documented in the 1979 management plan drafted by MDNR staff. Agency staff and area residents are unaware of how Northern Pike were introduced in Big Shag Lake. The 1998 fyke net survey did not catch many bass, and an additional electrofishing survey was conducted in May of 1998 to target bass. A total of 212 Largemouth Bass were captured in the electrofishing survey with an average size of 10.0 inches (4.0-8.0 inches), and 3% of fish captured were equal to or greater than 14.0 inches. Managers noted that the growth of Largemouth Bass was well below the state average.

In April of 2000, a survey was conducted by MDNR staff to evaluate Walleye stocked during the late 1990s, as well as provide general fish community information. Seven species were captured, including Walleye, Bluegill, Largemouth Bass, Northern Pike, Pumpkinseed, Common White Sucker, and Yellow Perch. A total of 14 Walleye were captured, again suggesting that the survival of stocked fish was limited. Continued indications of low survival led to the discontinuation of Walleye stocking in 1999. A total of 61 Northern Pike were captured, and sizes ranged from 9.0 to 35.0 inches (average 17.4 inches). Growth rates were classified as very poor (4.8 inches below the state average). Based on survey findings, fisheries managers shifted focus toward providing a mixed bag fishery for Northern Pike, Largemouth Bass, Bluegill, Pumpkinseed, and Yellow Perch.

In 2002, MDNR staff presented at the annual meeting of the Big Shag Lake Association. Topics discussed at this meeting included the discontinuation of Walleye stocking, riparian land use, zebra mussel monitoring, minnow habitat improvement, small fish sampling, and the future management of Big Shag Lake. The presentation was noted as being well received. Anglers mentioned that Northern Pike were being captured, but larger fish were not common. Largemouth Bass were reported as being caught regularly, and Bluegill were reported as being larger than they were in recent times. One person expressed concern about the lack of suckers and Yellow Perch.

In late April and early May 2007, a survey was conducted to assess the growth of Northern Pike and to gather general information about the fish community. Anglers at the time reported that bass and panfish fishing was ‘good’. A total of 10 species were captured in the survey, Northern Pike, Walleye, Smallmouth Bass, Largemouth Bass, Bluegill, Pumpkinseed, Yellow Perch, Common White Sucker, Bluntnose Minnow, and Golden Shiner. Age analysis indicated that Bluegill and Pumpkinseed were growing at or slightly below the state average. Northern Pike were growing at approximately 5.2 inches below the state average, and the age at which the species reached a harvestable length (24 inches) was 9 years. After the survey, fisheries management for Big Shag Lake was focused on three actions: 1) improve the size of Northern Pike with a no minimum size limit regulation, 2) improve shoreline habitat within the littoral zone, and 3) conduct a Status and Trends assessment within the next 7 to 10 years to gather updated fish community and shoreline habitat information.

In April of 2009, a winter/spring fish kill was reported in Big Shag Lake. An area landowner noted that approximately 3,000 Bluegill had died and were decaying on the bottom of the lake within Mitchell Bay. The 2008 to 2009 winter was noted as severe, and anglers had reported that augers had ‘bottomed out’ in the channel between Mitchell Bay and Big Shag Lake. Similar to the winter/spring kill that occurred several decades prior (in 1963), fish were likely trapped in Mitchell Bay by ice as decomposing plant material depleted oxygen levels within the bay.

In October 2009, a fish community survey was conducted. Largemouth Bass were underrepresented in the 2007 survey, so additional effort was scheduled to characterize the bass population. Northern Pike, Bluegill, and Yellow Perch were also collected during the survey. Largemouth Bass were shown to be growing well below the state average, and that it took approximately 8 years to reach the legal size of 14 inches.

During the 2010s, a “no minimum size limit” regulation was adopted for Northern Pike to increase harvest, reduce the stock density, and improve the size structure. The no minimum size limit regulation allowed for five fish of any size to be harvested, with only one greater than 24 inches in the daily

possession limit. MDNR Fisheries Division and Parks and Recreation Division replaced the boat ramp at Big Shag Lake to increase fishing access and improve habitat at the site.

In June of 2018, a winter/spring fish kill was reported in Big Shag Lake. Several lake-shore property owners reported dead fish in the northeast region of the lake. Pictures shared with MDNR staff showed deceased Yellow Perch and Bluegill. Similar to the 1963 and 2009 fish kills, oxygen depletion during the winter months was likely responsible. The MDNR conducted a qualitative visual assessment, counting approximately 60 dead panfish nearshore. At the time of the visual assessment, Bluegill were noted to be on spawning beds, and Largemouth Bass were seen swimming in deeper water adjacent to spawning beds. Mitchell Bay was also surveyed, and no mortality was observed at this location.

In August of 2018, an MDNR biologist met with interested citizens about the Big Shag Lake fishery. A brief overview of Big Shag Lake's past fisheries management strategies was shared with those in attendance, and MDNR staff expressed interest in conducting surveys to reevaluate the status of fish populations and inform updated management planning. Shoreline habitat and fish community surveys were scheduled for 2019 following Status and Trends protocols (Wehrly et al. 2015). The shoreline habitat survey revealed a heavily developed shoreline with limited nearshore woody habitat. Residents collaborated with MDNR Fisheries Division and identified shoreline locations where woody habitat could be added. During the winter of 2023, a total of 6 submerged trees and 4 brush bundles were placed at identified locations in the lake (Table 2). Results from the fish community survey suggest that anglers could expect high catch rates for Bluegill and Pumpkinseed. Yellow Perch were less abundant but larger in size relative to past surveys. Catches of Largemouth Bass, Smallmouth Bass, and Northern Pike were low prompting additional surveys that were completed in 2023. Results are included in this report.

Current status of the fish community

Four recent surveys were conducted to assess the status of the Big Shag Lake fishery and to determine the presence and prevalence of invasive species. Surveys evaluated populations of Largemouth Bass, Northern Pike, and panfish (Bluegill and Pumpkinseed). The first was a fall survey, conducted to estimate the population size of Largemouth Bass and to provide insights into the effectiveness of fishing regulations. Two surveys (winter and fall) evaluated the effectiveness of Northern Pike regulations for Big Shag Lake meant to reduce abundance and improve size structure. The fourth was a discretionary survey conducted in 2019 and followed the Status and Trends inland lake survey protocols (Wehrly et al. 2015). The 2019 Status and Trends survey method effectively assessed panfish populations and the status of nearshore habitat.

Methods

Largemouth Bass – The first survey was a nighttime capture-mark-recapture boat electrofishing survey that occurred over three nights from 21 June to 24 June 2022. The survey involved an initial marking period (21 June), followed by two consecutive nights of marking and monitoring recaptures. The entire perimeter of the Big Shag Lake shoreline was sampled each night of the survey. All Largemouth Bass captured had the anal fin partially clipped to serve as the initial ‘mark’ and for the evaluation of recaptures during subsequent survey nights. Electrofishing effort totaled 26,880 seconds (or 448 minutes). Electrofishing units were set to a 60 per second pulse rate, and amperage settings ranged from 4.0 to 5.5. Water temperature ranged from 72.0 to 74.3°F during the survey period.

Northern Pike – The second and third netting surveys were conducted in accordance with the MDNR experimental survey protocol (Bauman and Mylchreest 2005). The first survey was conducted under

the ice during the winter from 6 March to 9 March 2023. The second survey was conducted during the fall from 23 October to 26 October 2023. In each season, a total of 5 gill nets were set overnight and checked daily for three nights, for a total effort of 15 net nights.

Bluegill and Pumpkinseed – To assess the Big Shag Lake panfish community, a fourth survey was conducted, that began on 10 June 2019. A variety of gear types were used, including two small- and four large-mesh fyke nets, two experimental gill nets, one seine, and a boat electrofishing unit. The small- and large-mesh fyke nets were set for two and three net nights for a total effort of four and twelve net nights, respectively. Two experimental gill nets were set for two nights for a total effort of four net nights. Four seine hauls were towed in nearshore areas. Boat electrofishing occurred on 29 July 2019 and consisted of three transects approximately a quarter mile in length, totaling 30.5 minutes of effort.

Fish collected in surveys were measured to the nearest tenth of an inch. Total lengths were used to calculate the average size, size ranges, length-abundance distribution, and percent legal or preferred size for each species. The abundance and density of Largemouth Bass were assessed using a Chapman-Peterson population estimator. The relative abundance for Northern Pike, Bluegill, and Pumpkinseed was assessed using catch per unit effort (CPUE) calculated as the number of fish captured per unit of effort (e.g., net night, seine haul, electrofishing minutes). Northern Pike CPUE data from winter and fall surveys were compared to those listed in the Management Plan for Northern Pike in Michigan (Smith et al. 2016, Table 3) and to the regional CPUE data from inland lakes sampled in accordance with the experimental protocol (Bauman and Mylchreest 2005). Bluegill and Pumpkinseed CPUE data from the 2019 survey were compared to the summary of regional and statewide CPUE data from inland lakes as part of the Status and Trends survey program (Wehrly et al. 2015, Tables 135 and 123, respectively).

Age structures (10 per inch group) were collected from Largemouth Bass, Northern Pike, Bluegill, and Pumpkinseed for age analysis. Scale samples were collected from panfish species less than 6.0 inches and Largemouth Bass less than 10.0 inches. Anal fin spines were collected from panfish greater than 6.0 inches, Largemouth Bass greater than 10.0 inches, and all Northern Pike. Weighted age compositions using length and age references for each gamefish species were calculated as described by Schneider (2000a). A mean growth index for each age class was calculated by subtracting the state average mean length-at-age from the mean length-at-age represented from the four surveys conducted on Big Shag Lake. Growth indices for age classes represented by a minimum of five fish were averaged to provide a mean growth index (Schneider et al. 2000b).

Largemouth Bass and Northern Pike growing slower than 1.00 inch below the state average are considered “below average”, while fish growing faster than 1.00 inch above the state average are considered “above average”. Growth of Northern Pike captured during the winter was evaluated by comparing growth index values to those listed in the Management Plan for Northern Pike in Michigan (Smith et al. 2016, Table 2). Bluegill and Pumpkinseed growing slower than 0.50 inches and faster than 0.50 inches compared to the state average are considered below or above the state average, respectively. The size structure of the Bluegill population was rated using the mean growth index and the proportion of fish greater than 6, 7, and 8 inches captured using large-mesh fyke nets and electrofishing gear (Schneider 2000b; Schneider 1990).

Physical and Oxythermal Habitat – On 14 August 2019, the Big Shag Lake littoral zone and lakeshore were visually surveyed to quantify physical habitat, including residential development (dwellings per mile), boat dock density (docks per mile), large woody debris (submerged logs and large diameter (>3-inch tree limbs per mile), and the average percent shoreline armored. Habitat surveys were conducted by traveling in a boat parallel to shore, approximately 100 to 200 ft from the water's edge. Data were recorded for each 1,000 ft segment until the entire shoreline (including islands) was surveyed. Only dwellings located immediately along the shoreline were counted. Percent shoreline armoring is a qualitative estimate of the linear amount of each shoreline segment that was comprised of materials (e.g., sheet piling, concrete, riprap, gabions, boulders, and wood) intentionally placed to prevent erosion. Percent shoreline armoring was estimated to the nearest 10%. Any submerged trees visible between the boat and shore were enumerated.

To assess the available oxythermal habitat in Big Shag Lake, temperature and dissolved oxygen were measured at three-foot intervals within the deepest basin of the lake. Measurements occurred during winter and summer months to reflect thermal extremes when hypoxic or anoxic conditions may limit aquatic life. Winter oxythermal profiles were gathered in March of 2023, while two summer profiles were collected in July of 2019 and 2021.

Invasive species – Since 2018, several surveys have been conducted on Big Shag Lake including those listed above. During these surveys, MDNR Fisheries Division staff made note of any aquatic invasive species observed. MDNR staff investigated information in the Midwest Invasive Species Network (MISIN 2024) to evaluate the presence or absence of aquatic invasive species in Big Shag Lake.

Results

Largemouth Bass – A total of 727 individual Largemouth Bass, averaging 11.7 inches, were captured during three nights of electrofishing. Largemouth Bass size ranged from 4.0 to 19.0 inches (Figure 4), and 20% of the catch met or exceeded the minimum size for harvest (14.0 inches). According to the Chapman-Peterson population density formula, Big Shag Lake has an estimated total density of 10.0 Largemouth Bass per acre, or 1,905 individuals (Table 3). The density of legal-size Largemouth Bass was estimated as 2.0 fish per acre, or 385 individuals (Table 3). The catch rate of Largemouth Bass after three nights of electrofishing was 1.8 fish per minute. The catch rate for Largemouth Bass 14 inches or greater was 0.24 fish per minute.

Ten age classes of Largemouth Bass (range, age 2 to 11) were captured (Table 4). Largemouth Bass aged 2 to 8 had a mean growth index of -1.10 inches when compared to the state average length at age. Evaluation of length at age information indicates that Largemouth Bass in Big Shag Lake reach legal size (14 inches) between the ages of 6 and 7. After reaching 14 inches, growth rates declined to a mean growth index of -2.50 inches relative to the state average. The total annual mortality rate estimated for Largemouth Bass, aged 4 to 8 was 41% and was 59% for fish aged 6 to 8.

Northern Pike (winter) – A total of 105 Northern Pike, averaging 18.8 inches, were captured during three days of netting (Table 5). Northern Pike size ranged from 12.0 to 26.0 inches, and 7.6% of the catch met or exceeded 24 inches. The catch rate of Northern Pike in Big Shag Lake during the winter survey was 7.0 fish per net night. Six age classes (range, 1- to 6 years old,) were represented in the catch. Length at age information indicates that Northern Pike in Big Shag Lake reach 24 inches between the ages of 5 and 6. The mean growth index for Northern Pike between the ages of 3 and 6 is -2.19 (Table 6). Of the Northern Pike captured during winter 36% were female, 61% were male, and

3% were of unknown sex. The average total length of female Northern Pike was 20.8 inches, males were 18.7 inches, and unknown sex fish were 14.3 inches.

Northern Pike (fall) – A total of 96 Northern Pike, averaging 22.5 inches were captured during three days of netting (Table 5). Northern Pike size ranged from 15.0 to 40.0 inches, 32.3% of the catch met or exceeded 24 inches. The catch rate of Northern Pike in Big Shag Lake during the fall survey was 6.4 fish per net night. A total of nine age classes (range age 1 to 9) were captured. Length at age information indicated that Northern Pike in Big Shag Lake reach 24 inches between the ages of 3 and 4. The mean growth index for Northern Pike ages 2 to 7 is -3.64 (Table 6). Females comprised 44% of the catch, and males comprised 56% in the fall survey. The average total length of females was 25.6 inches and males were 20.4 inches.

Bluegill – During the 2019 Status and Trends survey, a total of 1,244 Bluegill were caught across all gear types. Bluegill averaged 3.0 inches and comprised 67.5% of the catch by number and 19.7% of the catch by biomass. Bluegill size ranged from less than an inch up to 8.0 inches, with 7% of the catch meeting or exceeding the preferred size of 6.0 inches (Table 7). A total of seven age classes (range, age 4 to 10) were represented in the catch (Table 8). Bluegill aged 6 to 8 had a mean growth index of -2.00 compared to the state average (Table 8). Length at age indicates that Bluegill reach the preferred size of 6 inches between the ages of 6 and 7. Bluegill CPUE values for each gear type are summarized in Table 9. Large mesh fyke net CPUE of preferred size Bluegill was 6.4 fish per net night during the 2019 survey. The average size of Bluegill captured in large mesh fyke nets was 5.3 inches, and 41% of the catch exceeded the preferred size of 6.0 inches. According to the Bluegill size score index (Schneider 1990), fish captured in large mesh fyke nets in 2019 were rated “acceptable”. The boomshocking CPUE of preferred size Bluegill was 0.4 fish per minute. The average size of Bluegill captured when boomshocking was 3.5 inches, and 9% of the catch exceeded the preferred size of 6.0 inches. The Bluegill size score index for fish captured Boomshocking in 2019 was considered “very poor”.

Pumpkinseed – During the 2019 Status and Trends survey, a total of 196 Pumpkinseed were caught across all gear types. Pumpkinseed averaged 7.7 inches and comprised 10.7 % of the catch by biomass. Pumpkinseed size ranged from 2.0 to 8.0 inches, with 31 % of the catch meeting or exceeding the preferred size of 6.0 inches (Table 7). Seven age classes were observed (range, 3 to 10) (Table 8). Pumpkinseed aged 4 to 7 had a mean growth index of -0.30 inches when compared to the state average (Table 8). Pumpkinseed in Big Shag Lake reach the preferred size of 6 inches between the ages of 4 and 5. Pumpkinseed CPUE values for each gear type are summarized in Table 9.

Physical and Oxythermal Habitat – The entire shoreline of Big Shag Lake, including an island, was surveyed, equaling a total of 4.5 miles of effort. Physical indicators such as the density of dwellings, boat docks, and shoreline armoring were reported as “high”, while the density of submerged trees was reported to be ‘low’ or ‘moderate’ (Table 10).

Oxythermal habitat (e.g., temperature and dissolved oxygen) during the winter months was hypoxic, where conditions could limit growth and survival of aquatic organisms particularly at depths of 20 ft or greater (Table 11). During the summer months, hypoxic conditions occurred which could be limiting at depths ranging from 15 to 18 ft (Table 12).

Invasive Species – No aquatic invasive species were documented in Big Shag Lake. Similarly, a review of the Midwest Invasive Species Network found no occurrences of aquatic invasive species. However, invasive Purple Loosestrife was recently observed in a neighboring system in July of 2023, elevating concerns for the future.

Analysis and Discussion

Big Shag Lake is a medium-sized shallow lake with a heavily developed shoreline that contains fish species typical of inland lakes in northern Michigan. Results of the physical habitat survey suggest that residential development along the lake shoreline is high, and the density of fish habitat nearshore is low. Despite high development and limited physical habitat, Big Shag Lake provides anglers with an acceptable mixed-bag fishery comprised of panfish, Largemouth Bass, and Northern Pike, with occasional catches of good-sized Yellow Perch and Smallmouth Bass.

Largemouth Bass – Mark-recapture population estimates for Largemouth Bass are rare in the Upper Peninsula of Michigan. In 1985, mark-recapture estimates of population size were conducted on Big Shag Lake and 5 other Upper Peninsula lakes. During this time, the density of Largemouth Bass ranged from 0.2 to 6.6 fish per acre in Big Shag Lake (Wagner 1988). Other systems evaluated included systems with varying degrees of angling pressure, designated as unexploited and exploited lakes. The average density of Largemouth Bass in unexploited lakes was 8.2 fish per acre, and in exploited lakes was 3.0 fish per acre. The current density estimate for Big Shag Lake is comparatively high (10.0 fish per acre) and could be impacting the size structure of the population. There are some caveats: previous years' estimates were obtained with different sampling gear and occurred under different size regulations (past limit 12 inches vs. current limit 14 inches).

Non-legal-sized Largemouth Bass comprised 80% of the stock numerically, and legal-sized Largemouth Bass represented 20%. The truncation in the frequency of size groups above 13 inches is indicative of stockpiling below the legal-size limit. However, growth of Largemouth Bass less than 14 inches, and the age of maturity (6 to 7 years of age) are consistent with the statewide average (Wehrly et al. 2015), negating the presumption that the population is under stress. As Largemouth Bass exceed 14 inches, growth slows considerably, suggesting that forage is limited for larger individuals in the population.

Northern Pike – Catches of Northern Pike in Big Shag Lake were similar during winter and fall, surpassing the regional 75th percentiles in both seasons. Growth of 3, 4, and 5-year-old Northern Pike was slow. The comparatively high density and slower growth observed in this population would support continuation of current regulations (no minimum size limit and one fish > 24 inches). Anglers are encouraged to target and harvest Northern Pike in Big Shag Lake to help improve the size structure and growth of this population.

It is not known when Northern Pike were first introduced into Big Shag Lake or where they originated from. Northern Pike were first captured in surveys during the spring of 1978, and a management plan drafted in 1979 included mention of Northern Pike. Anglers reported catching Northern Pike throughout the early to mid-1990s, when surveys conducted by MDNR also captured increasing numbers of Northern Pike. Northern Pike are an established gamefish in the Big Shag Lake fish community and are managed accordingly. The comparatively high density in Big Shag Lake provides an opportunity for young anglers to have success in pike fishing during both the open water and ice fishing seasons.

Panfish - Catch rates of Bluegill and Pumpkinseed in Big Shag Lake are comparable to the region. It is rare for Bluegill or Pumpkinseed in Big Shag Lake to exceed 6 inches (Table 7), which may be indicative of truncated size structure due to selective harvest of larger individuals. The average size of Bluegill is relatively small, yet opportunities to catch larger individuals exist. The average size of Pumpkinseed in Big Shag Lake is higher compared to Bluegill, which may be indicative of different angling pressures between the two species. Anglers are encouraged to selectively harvest smaller Bluegill and Pumpkinseed, and are encouraged to release larger individuals.

Physical and Oxythermal Habitat – The shoreline of Big Shag Lake has been substantially altered from its natural state. Shoreline modifications, including the installation of seawalls or rip rap, can affect habitat and nutrient flow, leading to potential adverse impacts on fish, reptiles, amphibians, and the overall ecology of the lake. Lake shore property owners are encouraged to adopt natural shoreline principles supported by the Michigan Natural Shoreline Partnership (MNSP 2025). The average density of beneficial woody habitat in Big Shag Lake (102 logs per mile) is less than half the observed density in the region (203 logs per mile). Natural, undeveloped lakes throughout northern Michigan and Wisconsin have large woody debris densities ranging from 470 to 1,545 logs per mile of shoreline (O'Neal and Soulliere 2006). Established methods to improve the abundance of woody debris in nearshore areas should be adopted in Big Shag Lake (WDNR 2014).

Big Shag Lake experiences periods of hypoxia and anoxia (i.e., low dissolved oxygen levels) in the hypolimnion. These hypoxic and anoxic conditions have resulted in sporadic natural fish kills during stressful periods of the year. The two stressful periods of the year include the summer and winter when water temperatures are relatively high (summer), and dissolved oxygen concentrations are low (summer and winter). Oxythermal conditions limit the extent to which cold- and cool-water species (e.g., trout, Walleye) can inhabit the lake and favor warm-water species such as panfish, Northern Pike, and Largemouth Bass.

Invasive Species – Waterbodies in the Gwinn, Michigan area are largely devoid of aquatic invasive species; however, concerns remain for expansion into the Upper Peninsula. No aquatic invasive species have been documented in Big Shag Lake. However, the threat of invasive species (namely, Zebra Mussels) is a concern. The introduction of Zebra Mussels could further limit lake productivity. Invasive Water Milfoil exists in the region but has not been documented in Big Shag Lake. Invasive Water Milfoil would be expected to become a nuisance for residents on the lake and anglers, and also has the potential to influence nutrient flow and the food web. Invasive species outreach, education, and prevention measures are vital to stopping the expansion of species like Zebra Mussels and Invasive Water Milfoil.

Management Direction

Current

Fish Community - The Big Shag Lake fish community provides a 'mixed bag' warmwater fishery for Northern Pike, Largemouth Bass, Bluegill, and Pumpkinseed. Current regulations for Northern Pike are sufficient and should support continued improvements in the size structure. Managers will continue to promote Northern Pike angling opportunities in Big Shag Lake and will promote this lake as an ideal location for young anglers to become more engaged in fishing.

Largemouth Bass and panfish regulations may be adjusted to improve the size structure. However, there is no management plan to guide regulatory decisions for Big Shag Lake at this time. The MDNR Fisheries Division has recently formed a bass and panfish committee that is tasked with drafting such guidelines. Once guidelines are established, additional survey effort may be required to gather biodata used to evaluate regulations and propose alternatives when prudent.

Physical Habitat Improvement – Shoreland and shoreline development can cause poor water quality, erosion, and additional losses to fish habitat. The density of dwellings and the rate of armoring are high in Big Shag Lake. Based on a national lake assessment (USEPA 2024), the loss of natural shorelines is the biggest threat to the overall health of inland lakes in Michigan. Big Shag Lake landowners are encouraged to consider establishing natural shorelines to reduce wave energy and stabilize fine sediment loads. Rehabilitation projects designed to restore areas of shoreline impacted by alteration could be focused on areas highlighted in red in Figure 5. For more information about how to identify contractors and incorporate natural shoreline principles, landowners can visit the Michigan Natural Shoreline Partnership website (MNSP 2025).

A preliminary habitat improvement project was completed on Big Shag Lake during the winter of 2023. A total of four brush bundles and 6 submerged logs were placed at locations listed in Table 2. The density of nearshore woody habitat is still limited in Big Shag Lake. The fish community would benefit from additional habitat improvement projects, such as tree drops to aggregate and protect fish and their prey. Lake landowners and local conservation districts are encouraged to work collaboratively with the MDNR Fisheries Division and the Michigan Department of Environment, Great Lakes, and Energy to improve the density of nearshore woody habitat in Big Shag Lake. An example of a project that serves to improve the density of nearshore woody habitat includes the “Fish Sticks” program (WDNR 2014). Rehabilitation projects designed to improve the density of nearshore woody habitat should target regions of the lake shoreline where the number of logs per mile is less than 200 (Figure 6). Funding for additional monitoring and nearshore habitat improvement projects may be available through the MDNR Fisheries Aquatic Habitat Grant Program (MDNR 2025).

Invasive Species – Fisheries Division recommends that representatives from Big Shag Lake, as well as staff from the local conservation district and Cooperative Invasive Species Management Area (or CISMA), work collaboratively to apply for funding to prevent future introductions of invasive species in Big Shag Lake and the Gwinn, Michigan region via outreach initiatives. Funding for prevention, detection, eradication, and control of aquatic invasive species may be possible through the Michigan Invasive Species Grant Program (MISGP 2025).

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Tables and Figures

Table 1. Historical stocking records for Big Shag Lake (Marquette County) by decade, species, and number stocked.

Decade	Species	Number Stocked
1930s	Bluegill	35,300
1930s	Largemouth Bass	800
1930s	Smallmouth Bass	1,050
1930s	Walleye	1,428,000
1930s	Yellow Perch	2,900
1940s	Bluegill	10,200
1940s	Largemouth Bass	500
1940s	Smallmouth Bass	500
1940s	Walleye	840,000
1970s	Northern Pike	550
1970s	Walleye	841,160
1980s	Tiger Muskellunge	2,310
1980s	Walleye	79,446
1990s	Tiger Muskellunge	400
1990s	Walleye	104,410

Table 2. The type, GPS location, and approximate water depth for habitat structures placed in Big Shag Lake during winter 2023.

Habitat Type	GPS Location	Water Depth (ft.)
Brush Bundle	46.265317 -87.513658	10 to 15
Brush Bundle	46.2653 -87.513644	10 to 15
Brush Bundle	46.272786 -87.506356	12 to 20
Brush Bundle	46.272683 -87.505956	12 to 20
Submerged Log	46.264992 -87.511897	12 to 20
Submerged Log	46.272239 -87.505206	12 to 20
Submerged Log	46.272158 -87.504181	12 to 20
Submerged Log	46.272444 -87.503428	18 to 20
Submerged Log	46.272597 -87.502819	12 to 20
Submerged Log	46.272742 -87.502289	12 to 20

Table 3. Inch group, number (N) captured, the proportion of Largemouth Bass captured per inch group relative to the total number of Largemouth captured (N = 727), and the estimated total number of Largemouth Bass per inch group in Big Shag Lake, Marquette County Michigan (N = 1,905 individuals). The estimated total number of Largemouth Bass is based upon a Chapman-Peterson population estimate formula.

Inch Group	N Captured	Proportional Observation	Estimated Number
4	1	0.001	3
5	3	0.004	8
6	7	0.010	18
7	27	0.037	71
8	48	0.066	126
9	41	0.056	107
10	54	0.074	141
11	96	0.132	252
12	146	0.201	383
13	157	0.216	411
14	98	0.135	257
15	33	0.045	86
16	9	0.012	24
17	4	0.006	10
18	1	0.001	3
19	2	0.003	5

Table 4. Largemouth Bass (LMB) age class, number of fish aged, range in total length (inches), state average length (inches), weighted average total length, and the mean growth index for Largemouth Bass captured in Big Shag Lake, Marquette County Michigan during the fall 2022.

LMB Age Class	Number Aged	Total Length Range	State Average Length	Weighted Average Total Length	Mean Growth Index
2	35	4.9 to 10.3	8.7	8.2	-0.5
3	18	8.3 to 14.8	10.6	10.4	-0.2
4	21	10.4 to 14.1	12.0	12.0	0.0
5	13	12.3 to 16.0	13.7	13.2	-0.5
6	13	12.4 to 16.9	15.0	13.7	-1.3
7	13	13.7 to 17.2	16.7	14.6	-2.1
8	7	13.9 to 18.3	17.6	14.8	-2.8
9	3	16.9 to 18.5	18.6	17.2	-1.4
10	1	16.1 to 16.1	19.3	16.1	-3.2
11	3	17.1 to 19.4		18.5	

Table 5. Number of Northern Pike captured in Big Shag Lake, Marquette County Michigan by inch group during the winter and fall surveys conducted in accordance with an experimental protocol (Bauman and Mylchreest, 2025).

Inch Group	Winter	Fall
12	**1**	0
13	**2**	0
14	**3**	0
15	**5**	**1**
16	**10**	**1**
17	**14**	**2**
18	**20**	**8**
19	**10**	**18**
20	**11**	**9**
21	**9**	**11**
22	**7**	**5**
23	**5**	**7**
24	**6**	**6**
25	**1**	**4**
26	**1**	**2**
27	0	**2**
28	0	**3**
29	0	0
30	0	0
31	0	0
32	0	**3**
33	0	0
34	0	**2**
35	0	0
36	0	0
37	0	**1**
38	0	0
39	0	0
40	0	**1**

Table 6. Northern Pike age class, number aged, range in total length (inches), state average total length, weighted average total length, and the calculated mean growth index of individuals captured during the winter (top) and fall (bottom) surveys conducted in Big Shag Lake, Marquette County Michigan 2022. Shaded areas denote weighted average total length for ages 3-, 4-, and 5-year-old Northern Pike.

Winter NOP Age Class	Number Aged	Total Length Range	State Average Length	Weighted Average Total Length	Mean Growth Index
1	9	13.1 to 18.5	11.7	15.87	+4.17
2	32	14.9 to 22.0	17.7	17.57	-0.13
3	36	15.7 to 23.9	20.8	19.22	-1.58
4	19	18.2 to 25.1	23.4	21.45	-1.95
5	6	21.3 to 24.8	25.5	23.14	-2.36
6	5	22.0 to 26.4	27.3	24.44	-2.86

Fall NOP Age Class	Number Aged	Total Length Range	State Average Length	Weighted Average Total Length	Mean Growth Index
1	2	15.3 to 16.3	17.7	15.80	
2	12	18.0 to 21.4	20.8	19.45	-1.35
3	18	17.1 to 25.8	23.4	20.53	-2.87
4	31	18.2 to 32.6	25.5	22.48	-3.02
5	10	19.2 to 29.7	27.3	24.10	-3.20
6	5	19.0 to 26.7	29.3	22.14	-7.16
7	9	22.9 to 32.5	31.2	26.96	-4.24
8	3	26.7 to 40.8		35.10	
9	3	20.4 to 34.1		29.28	

Table 7. Inch group, and total abundance of Bluegill and Pumpkinseed captured (all gear types) in Big Shag Lake, Marquette County 2019.

Inch Group	Bluegill Abundance	Pumpkinseed Abundance
0	2	0
1	320	18
2	567	55
3	104	25
4	59	22
5	101	16
6	59	26
7	31	29
8	1	5

Table 8. Age (years), number (N) aged, range in total length, State of Michigan average (Avg.) size at age, average total length in Big Shag Lake and growth index of Bluegill (top) and Pumpkinseed (bottom) collected in Big Shag Lake, Marquette County 2019.

Bluegill Age	N Aged	TL Range (in.)	State Avg. TL (in.)	Avg. TL (in.)	Growth Index*
4	1	4.50 to 4.50	6.20	4.50	
5	4	4.40 to 6.50	6.90	5.40	
6	14	4.50 to 7.60	7.40	5.49	-1.91
7	14	5.30 to 7.60	8.00	6.12	-1.88
8	5	5.40 to 7.60	8.40	6.06	-2.34
9	1	7.30 to 7.30	8.70	7.30	
10	1	8.00 to 8.00		8.00	

Pumpkinseed Age	N Aged	TL Range (in.)	State Avg. TL (in.)	Avg. TL (in.)	Growth Index*
3	2	4.00 to 4.10	5.20	4.05	
4	11	4.10 to 6.50	5.80	4.70	-1.10
5	11	5.30 to 7.30	6.30	6.49	+0.19
6	11	5.50 to 8.00	6.80	6.47	-0.33
7	9	5.80 to 8.00	7.20	7.40	+0.20
8	2	8.00 to 8.50		8.25	
10	1	8.70 to 8.70		8.70	

Table 9. Summary of catch CPUE of Bluegill (top) and Pumpkinseed (bottom) by gear, including only sites and gears with catches greater than zero. Catch per unit effort for electrofishing is number of fish per minute. Catch per unit effort for large-mesh fyke net, gill net, small-mesh fyke net, is the number of fish per net night. Catch per unit effort for seining is the number of fish per haul (Wehrly et al. 2015, Tables 123 and 135). Shaded areas indicate Big Shag Lake values relative to statewide catch rates.

Bluegill	Low	25th	Median	75th	High	Big Shag Lake
Electrofishing	<1.10	1.10	3.50	6.57	>6.57	0.08
Large-mesh fyke	<2.50	2.50	8.51	25.86	>25.86	15.58
Gill net	<0.33	0.33	1.00	2.50	>2.50	0.25
Small-mesh fyke	<1.50	1.50	6.25	19.50	>19.50	172.00
Seine	<7.75	7.75	25.96	64.33	>64.33	56.00

Pumpkinseed	Low	25th	Median	75th	High	Big Shag Lake
Electrofishing	<0.17	0.17	0.39	0.97	>0.97	0.01
Large-mesh fyke	<0.44	0.44	1.67	4.67	>4.67	7.08
Gill net	<0.25	0.25	0.50	1.00	>1.00	0.25
Small-mesh fyke	<1.00	1.00	1.90	5.60	>5.60	21.75
Seine	<0.50	0.50	1.00	2.00	>2.00	1.00

Table 10. Physical indicators include dwelling density (dwellings per mile), boat docks (docks per mile), shoreline armoring (average percent armored), and large woody debris (trees per mile) measured in Big Shag Lake, the regional average (Northern Lake Michigan Management Unit, N = 48 surveys), 25th percentile, 75th percentile, and 2019 status for Big Shag Lake.

Regional Statistics	Dwelling Density	Boat Docks	Shoreline Armoring	Submerged Trees
Average	13.9	10.2	10.3	202.9
25th Percentile	1.3	1.3	0.0	21.9
Median	12.2	8.1	5.0	83.0
75th Percentile	22.7	16.9	17.5	219.6
Big Shag Lake	29.5	29.8	17.5	101.5
Rating	High	High	High	Low-Moderate

Table 11. Depth, water temperature (°F), and dissolved oxygen concentration (mg/L) measured during winter of 2023 in Big Shag Lake, Marquette County. During the winter months, hypoxic conditions begin to limit aquatic organisms at a depth of approximately 20-ft (shaded below).

Depth (ft)	Temp (°F)	Oxygen (mg/L)
0	32.00	11.92
2	32.00	11.65
4	32.10	11.57
6	32.30	11.07
8	33.60	10.65
10	35.10	10.40
12	36.00	9.49
14	36.70	7.32
16	37.00	6.58
18	37.40	5.28
20	38.20	3.15
21	38.40	2.02
22	38.50	0.00
23	38.50	0.00
24	38.70	0.00
26	39.00	0.00
28	39.70	0.00
29	40.50	0.00

Table 12. Depth (in feet, ft.), water temperature (°F), and dissolved oxygen concentration (mg/L) measured during summer of 2019 (left) and 2021 (right). During the summer months of 2019 and 2021, hypoxic conditions begin to limit aquatic organisms at a depth of 15- and 18-ft, respectively (shaded below).

Depth (ft)	2019 Temp (°F)	2019 Oxygen (mg/L)
3	72.6	8.52
6	72.2	8.38
9	72.1	8.22
12	72.0	8.14
15	69.7	2.05
16	65.0	1.00
17	63.1	0.00
18	60.8	0.00
19	58.7	0.00
20	56.6	0.00
21	54.1	0.00
24	50.6	0.00
27	49.2	0.00
29	49.0	0.00

Depth (ft)	2021 Temp (°F)	2021 Oxygen (mg/L)
1	74.6	8.58
2	74.6	8.57
3	74.5	8.54
4	74.5	8.55
5	74.5	8.55
6	74.5	8.56
7	74.4	8.52
8	74.4	8.55
9	74.4	8.54
10	74.4	8.49
11	74.4	8.51
12	74.3	8.44
13	74.2	8.37
14	74.0	8.22
15	73.4	7.77
16	72.0	6.96
17	70.9	5.72
18	68.0	2.84
19	66.1	0.11
20	63.2	0.00
21	60.8	0.00
22	58.5	0.00
23	56.3	0.00
24	55.0	0.00
25	54.2	0.00

Figure 1. Map of the location and bathymetry of Big Shag Lake in Marquette County, Michigan.

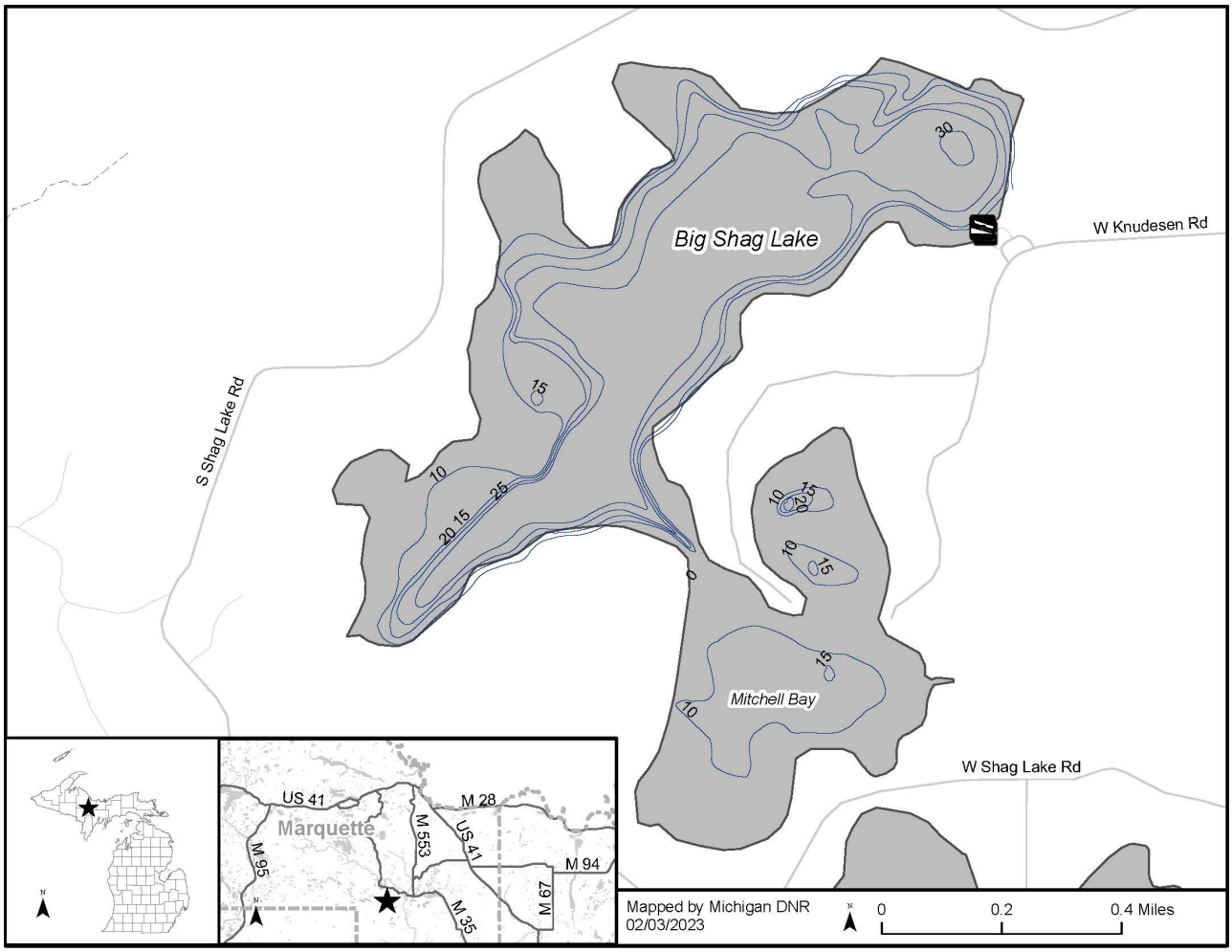


Figure 2. Landuse map and watershed delineation for the Big Shag Lake located in Marquette County, Michigan.

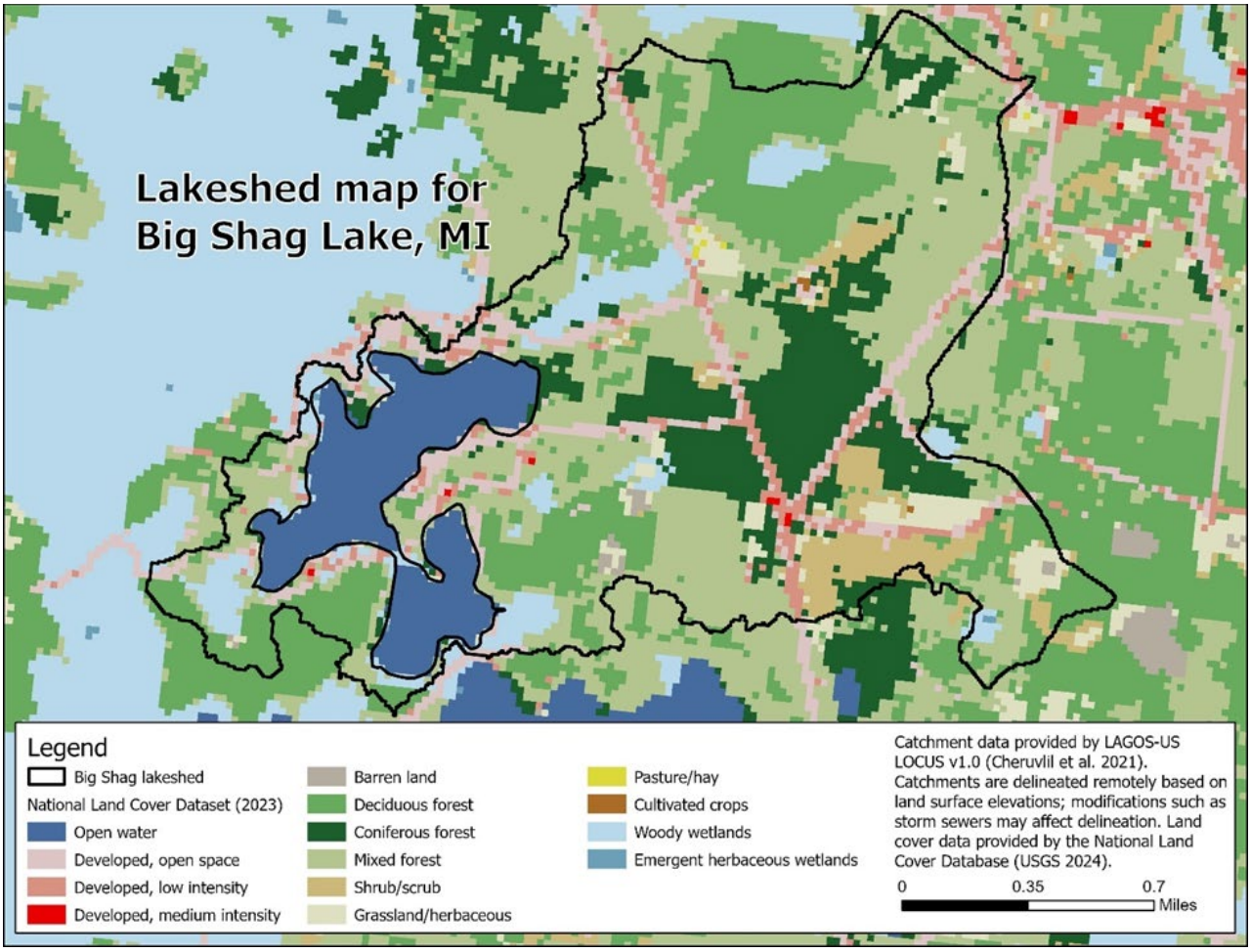


Figure 3. Lakeshed map for Big Shag Lake located in Marquette County, Michigan.

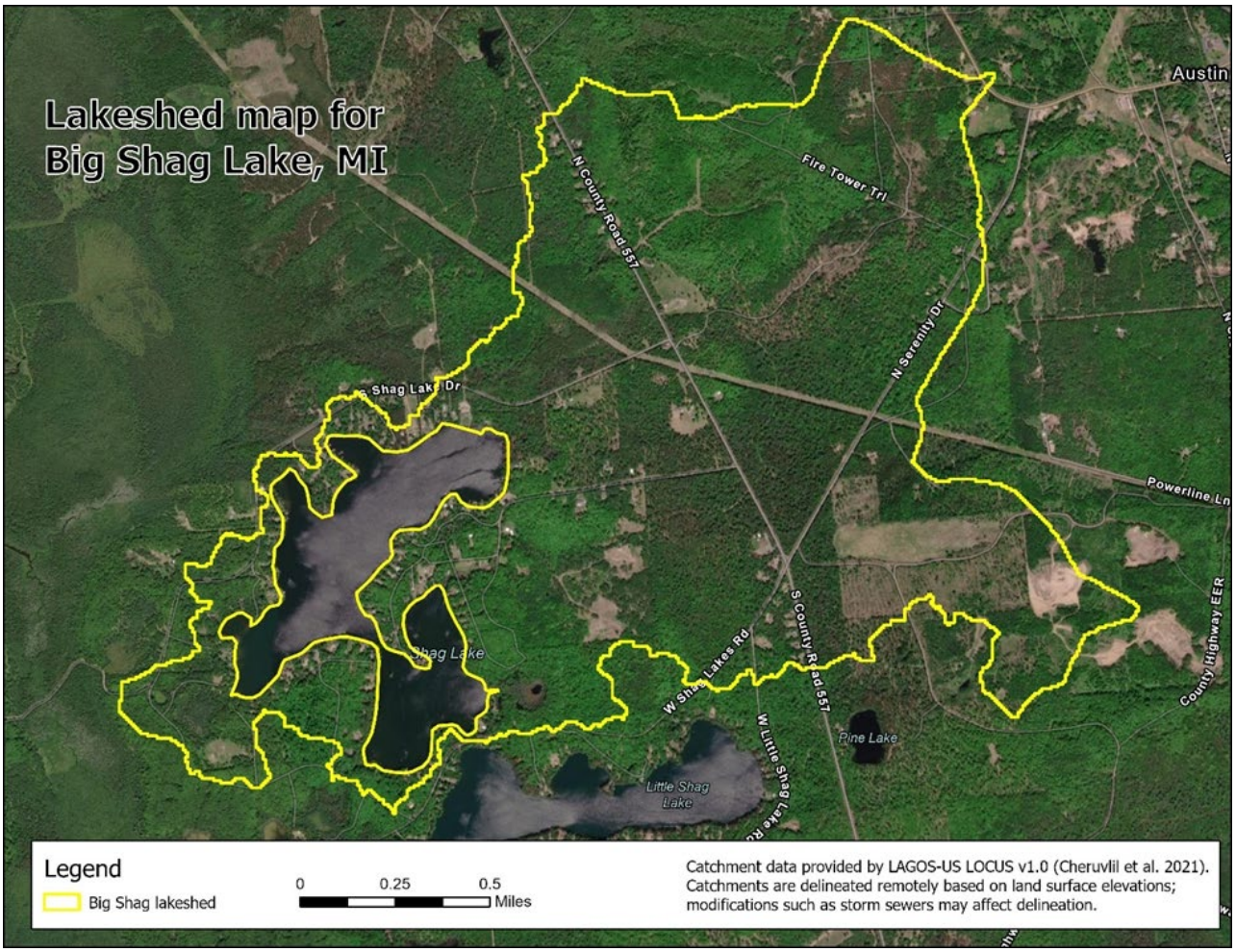


Figure 4. Length-distribution of Largemouth Bass captured in Big Shag Lake, Marquette County, during the fall of 2022 in the electrofishing survey (N = 727 unique individuals).

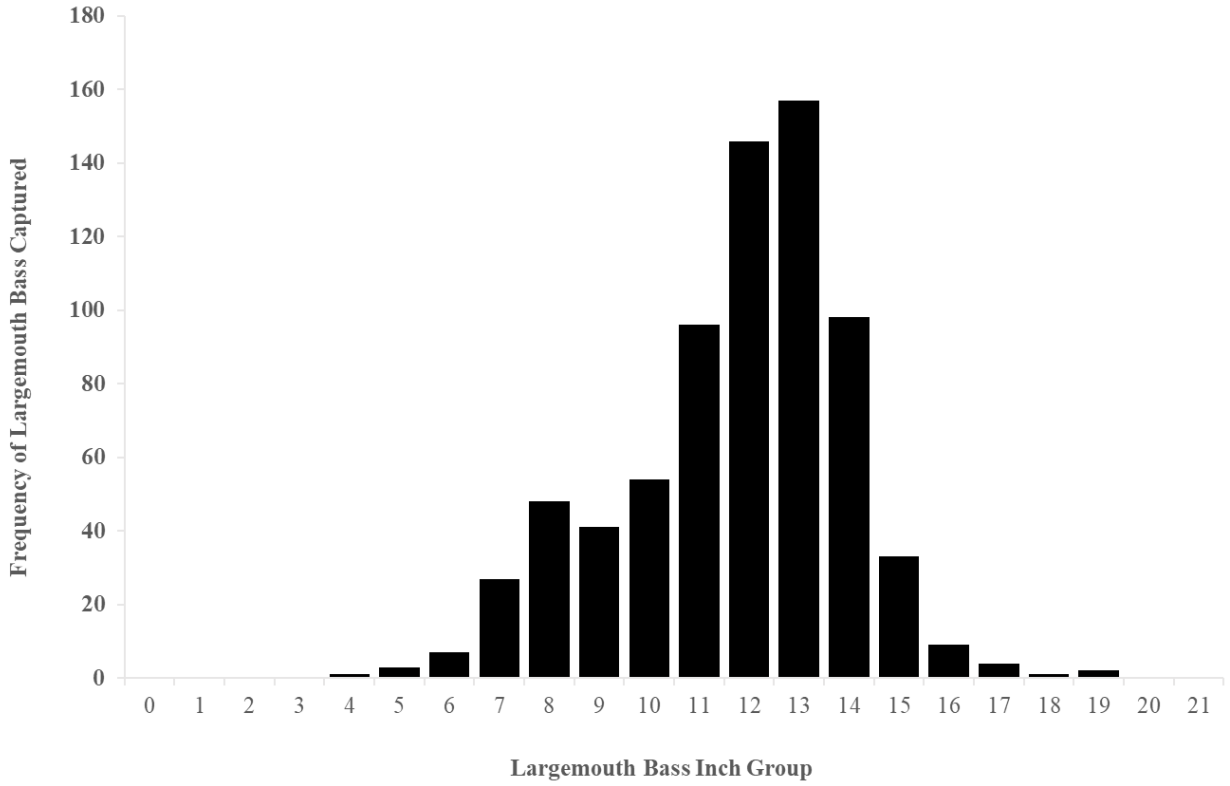


Figure 5. Percent of shoreline that has been altered from its natural state per 1,000 ft transect in Big Shag Lake, Marquette County.

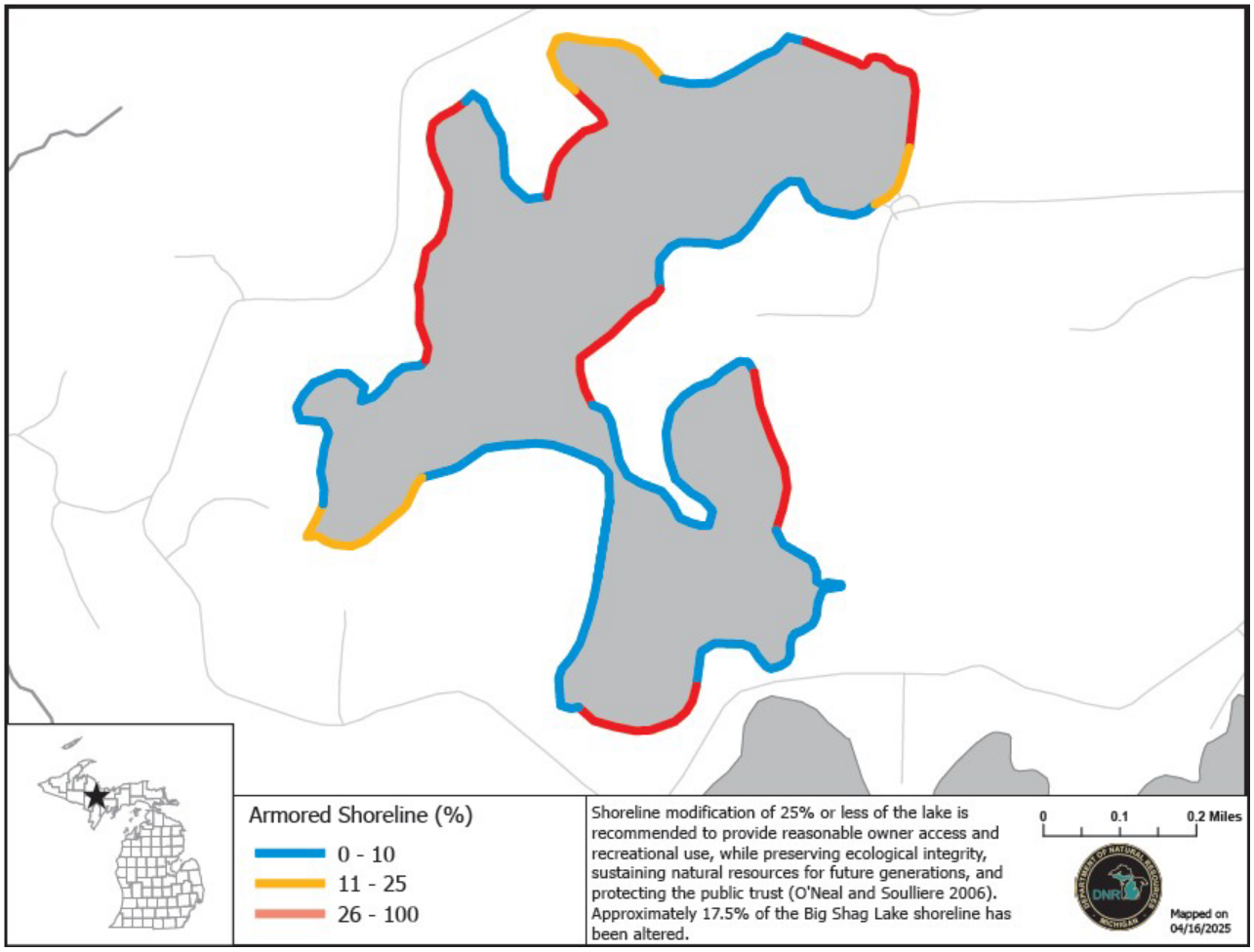
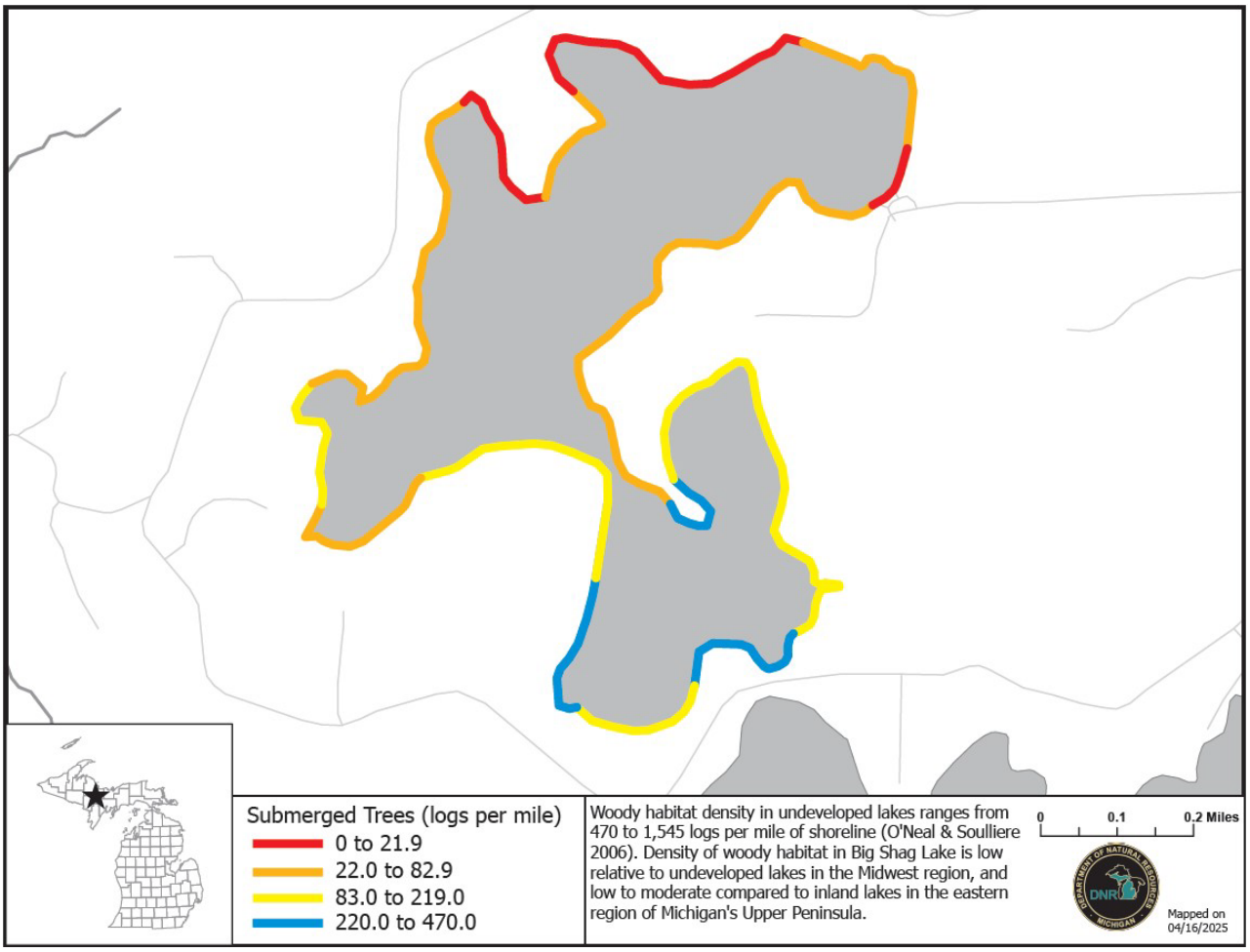


Figure 6. Density of submerged trees (logs per mile) per 1,000 ft transect in Big Shag Lake, Marquette County.



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