Avalon Lake
Montmorency County
Thunder Bay River watershed, last surveyed 2010

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Environment

Avalon Lake, formerly known as Brush Lake, is located in the northeast part of Montmorency County about five miles, by road, northwest of the town of Hillman. The natural lake of glacial origin is 372 acres in size and has no inlets. Its water supply is derived from limited surface runoff from the surrounding terrain and underground seepage. It is drained by a small, permanent outlet approximately two feet in width located at the southwest end of the lake. This control structure is maintained by the county drain commissioner who establishes a legal lake level as directed by the local circuit court (Cwalinski et al. 2006). The outlet from Avalon Lake is the source of Little Brush Creek which eventually feeds Brush Creek. The Civilian Conservation Corps prepared the bottom map of the lake in the winter of 1935 (Allison and Kilpela 1943). Sand, marl, and some gravel are the dominant substrate with some pulpy peat in the deeper sections of the lake. The deepest part of the lake is over 75 feet deep with a large percentage of the lake deeper than 40 feet. Water clarity is typically very good. Aquatic vegetation in this rather sterile lake is very limiting. Zebra mussels are present in Avalon Lake and compete for food with the native fish and plankton community. Most of the shoreline is developed with private houses and cottages, while a fair sized public boat launch exists on the east end. This ramp is hard-surfaced and provides parking for 25 boat trailers.

History

Fish management practices date back to the 1920s at Avalon Lake when the first basic fish assessments were completed throughout the lakes of northern Michigan. Summer evaluations of the lake by Michigan Department of Conservation (MDOC) personnel found a lake with a sand and gravel bottom with very little aquatic vegetation. Maximum depth was approximately 70 feet. Plankton species were considered fairly abundant, yet benthic invertebrates, though diverse, were not abundant. Notes from this period indicate that rock bass and yellow perch were quite common in Avalon Lake, much like they are today. Bluntnose minnows were also abundant, and species such as blacknose dace, white suckers, darters, largemouth bass, and bluegill were considered less common. Basic creel data collected by MDOC Law Enforcement Division a decade later (1934-1939) found that the Avalon Lake fishery was mainly driven by yellow perch and smallmouth bass, and to a lesser extent rock bass and largemouth bass.

During the 1930s, Avalon Lake started receiving fish stocking efforts from MDOC to supplement the existing fish community. Much of these stocking efforts were experimental, and many would have no effect on the future fish community or fishery. For example, walleye fry were stocked in varying numbers in Avalon Lake between 1937 and 1939. Despite this, no walleye were ever recorded in future surveys or angler catches. Largemouth bass fingerlings were stocked on three occasions from 1937-1940. Smallmouth bass (fingerlings and adults) and fingerling bluegill were also stocked during this period (1937-1941). Yellow perch fingerlings were stocked from 1938-1939 and 1941. It was common for the MDOC to stock many northern Michigan water bodies with warm and cool water species since

aquaculture was new to the Department at that time. Years later, stocking efforts became more focused on species not present in the lake, such as trout. These later stocking efforts were usually targeting specific management objectives based on the conditions of the lake. For example, aquatic surveys at Avalon Lake showed it had morphological and limnological attributes that were highly conducive to the survival of trout (e.g. cold water below thermocline and good dissolved oxygen). Based on these observations, brook trout were stocked in 1949 and 1986. In addition, lake trout yearlings were stocked at low rates from 1951-1953, 1955-1957, and 1961-1963. Lake trout were also stocked as adults in 2009 (Table 1) with fish coming as broodstock from the Federal hatchery system. Much effort was put into the creation of a rainbow trout fishery in Avalon Lake, which dates back to the initial stocking efforts of rainbow trout in the mid 1940s. Both fingerling or yearling rainbow trout were stocked from the 1940s almost annually through 1961. The rainbow trout stocking program was discontinued and resurrected multiple times after 1961 with stocking again occurring 1970-1971, 1973-1975, and many years after 1981 (Table 1). The popular cold water species stocking for Avalon Lake eventually became the splake. Splake were, and still are, a popular species in Michigan, derived as a hybrid cross between a male brook trout and a female lake trout. Splake stocking began in Avalon Lake in 1965 and continued through 1969. Stocking of splake was temporarily postponed during the 1970s but was resumed in the 1980s (Table 1) and is to be explained in more detail later in this report.

As previously mentioned, many warm and cool water species were stocked for a period of years in the 1930s in Avalon Lake. Following the variable stocking efforts, MDOC conducted a comprehensive aquatic community survey of the lake in August of 1942 (Allison and Kilpela 1943). A limited amount of aquatic vegetation was found in the lake, and only four species were observed. A limnological profile found the lake thermally stratified with good dissolved oxygen (6ppm or greater) observed throughout the water column and was present almost to the bottom of the lake. Many northern Michigan lakes thermally stratify but have rapidly declining dissolved oxygen below the thermocline. Avalon Lake, however, had suitable oxygen for fish throughout the deep, cold waters. The presence of deep, oxygenated, cold water is most likely a result of having a limited watershed with relatively minor influences on water quality. Secchi disk readings were 12 feet during the 1942 survey, indicating high water clarity. Notes from that survey indicate that 83 cottages existed on the lake along with 2 resorts and 2 boat liveries. Primary use of the lake was for boating and swimming. The lake was considered rich in zooplankton, and poor in phytoplankton, although there is little data to support that statement. Predator fish were considered to be generally low in abundance during the early surveys, yet rock bass and smallmouth bass numbers were considered adequate to good. Northern pike were thought to be in low abundance in Avalon Lake according to angler reports. Yellow perch at this time were considered inadequate and other species found in low numbers were bluegill, largemouth bass, pumpkinseed sunfish, and white suckers. However, the cisco (lake herring), were found in good numbers in Avalon Lake presumably because of the availability of cold and well oxygenated water.

Following the 1942 survey, MDOC enacted a management plan for Avalon Lake which called for discontinuation of stocking of certain warm and cool water species. The focus would then become utilizing the cold water niche of Avalon Lake and trying to produce a trout fishery through stocking. Trout stocking efforts would begin later that decade and fisheries managers also recommended the placement of more brush shelters throughout the lake to attract fish and increase harvest. The main species in the lake at this time were yellow perch, rock bass, smallmouth bass, cisco, and bluntnose minnows. In the fall of 1943, MDOC used a 50 foot seine and netted the east shore of Avalon Lake multiple times on December 1 and 2 (Allison and Shetter 1944). The nighttime netting was done when

the water temperature was 38F and was done to gain baseline data on the vulnerability of cisco near the shoreline during spawning. Cisco were considered an important prey fish in the lake, however there were also reports of illegal sport-fish catches for this species. A total of 250 cisco were netted during December 1 and 2, 1943, with all fish ranging from 7-9 inches long. These results indicated that a healthy cisco (cold water species) population was present and suitable spawning conditions were available. All of the cisco collected were later determined to be age 3 (Allison and Shetter 1944).

Rainbow trout stocking efforts began in Avalon Lake by the end of World War II. In early November 1946, MDOC used two experimental gill nets to assess the recent stocking of trout, but only four rainbow trout were collected. A similar effort was made in late November of 1947 when one gill net and two trap nets captured 5 rainbow trout ranging from 4-24 inches. Also collected were cisco, white suckers, small yellow perch (5-6 inches), and rock bass. MDOC and local residents installed 49 brush shelters in the lake in 1949, and 350 brush shelters the following year.

Rainbow trout and lake trout stocking efforts continued at Avalon Lake in the 1950s, however, MDOC survey efforts were minimal during this period. An early June 1951 trout stocking evaluation was done with experimental gill nets and only captured yellow perch, rock bass, and white suckers. However, notes indicate that the rainbow trout stocking efforts were producing good returns to the creel during this period.

Fisheries efforts were more extensive in the 1960s at Avalon Lake and management changed its focus to lake trout, which had been stocked at that time, and to a more consistent rainbow trout stocking effort. MDOC conducted a trout stocking evaluation in the fall of 1960 using experimental gill nets over a four day period. The gill netting resulted in no rainbow trout being collected, but a few lake trout and brown trout were captured. The presence of brown trout in the gill net catch was surprising and it is not known how they were introduced into the lake. Yellow perch and cisco were again common in the gill net catches. Cisco growth was considered good, with growth rates better than statewide average for this species. Cisco ranged from 9-11 inches and were all age 1 and age 2 fish.

Fisheries managers with MDOC then realized that trout stocking efforts were being hampered, to some extent, by the native fish population in Avalon Lake through competition for food resources, particularly from the white sucker and yellow perch populations. It is well documented that trout survival is enhanced when other competing species are less abundant. MDOC conducted a fish survey in early to mid May of 1961 with the purpose of checking on the logistics of capturing white suckers. They used two trap nets over three nights to survey the spawning run of this species. Being able to efficiently capture white suckers could lead to future fish removals. The surveyors found the peak of the sucker spawning to be around May 10, with most of this activity along the south shoreline. Also observed in the trap net survey was one large rainbow trout.

Later that year, MDOC conducted a trout evaluation at Avalon Lake following continued annual trout stocking efforts. Similar to previous efforts, the survey was done with experimental gill nets between November 20-22. A total of 31 rainbow trout ranging from 8-13 inches were collected, as well as cisco and yellow perch. It was at this time (1961) that fisheries managers decided to discontinue the rainbow trout stocking efforts, citing poor growth and survival of these fish, as well as poor angler returns.

Evaluation of the fish community in Avalon Lake continued in the 1960s. Shoreline seining was done in mid October of 1963, which found large numbers of small perch and smallmouth bass. Angler reports continued to filter to managers by 1964 and suggested that the dominant fish in the catches were yellow perch less than 8 inches long. MDOC conducted a limnological profile in June of 1964, possibly to determine if the cold water niche of the lake had changed which could help to explain the poor survival of stocked trout. However, the profile demonstrated that the cold water habitat was very good, with good dissolved oxygen throughout the water column and plenty of cold water through the summer. Such conditions should enhance trout survival throughout the year. It was at this time that MDOC fisheries managers recommended a complete chemical reclamation of the lake. Such treatment would have applied a chemical specific for killing off the fish community, at least a good portion of it. Thereafter, the stocking of desirable species, such as trout, would follow the reclamation. However, this management action was never implemented because of opposition from the local lake association.

Managers knew that Avalon Lake was fairly low in base productivity, and that the fish population was dominated by small yellow perch and white suckers. Chemical reclamation of the fish community was no longer an option, but there was another opportunity to fill the deep, coldwater niche. Previously, rainbow trout had been stocked but returns from the stocking were low because of overlap and competition with the native fish species of Avalon Lake. These trout are known planktivores and insectivores, which are limited vital resources in this lake. Thus, managers needed to stock a fish that could prey on the available young perch and at the same time utilize the cold water habitat of the lake. The splake was selected to fill this niche and were introduced to Avalon Lake in 1965. This hybrid species was being produced by the MDOC hatchery section and was a cross between a lake trout and brook trout. They tend to feed closer to the bottom (where perch live), which is not a typical feeding behavior for rainbow trout.

Following the first splake stocking of 1966, MDOC used 11 experimental gill net lifts to assess splake survival and growth. Splake were caught in good numbers (69) and ranged from 8-12 inches, and condition was considered good. Also caught were 66 cisco and good numbers of yellow perch from 4-12 inches. A good proportion of the captured perch were 7 inches and larger. Seventeen lake trout 22-23 inches were also collected along with white suckers, pike, rock bass, and smallmouth bass.

Fish management was adjusted once more in Avalon Lake during the 1970s. Splake were the focus in the 1960s with rainbow trout being a lower priority. The flip-flop management began with rainbow trout, followed by the aforementioned change to splake, and then back to rainbow trout in 1970 through 1975, with splake stocking discontinued for many decades to come. Two days of gill netting by MDOC in mid April of 1970 found that splake were sparse in the lake, although four large specimens were collected. Cisco in the 8-10 inch range were common along with 6-7 inch yellow perch. Ironically, fishing reports in 1970 were poor for splake and fair for rainbow trout. Based on stocking events of the last decade, it should have been opposite. Reasons for such a change in management are not well understood for this period, but it is believed that splake (as a genetic hybrid) were not well accepted by the angling public.

The next trout stocking evaluation was made in 1975 by MDOC. Experimental gill netting was used in late September to survey the lake, however no splake were collected, which is not surprising since they had not been stocked since 1969. Rainbow trout, which were currently stocked on an annual basis, were common in the survey, but sizes were generally small (8-12 inches) and all were age 2 fish. Three

large lake trout were also collected during the survey, but it is possible these were large, misidentified splake. Again, cisco were common in the 8-10 inch range. Warm water species were also collected in the nets such as white suckers, rock bass, smallmouth bass, and yellow perch. Most of the yellow perch were in the 6 inch size range, yet fair numbers of 8-10 inch fish were also caught. Growth of this species was considered normal when compared to the statewide average. Five year classes of perch were collected. Five year classes of smallmouth bass were also collected, ranging in age from 2-6. Growth was average for this species as well, and most fish were in the 8-14 inch range. Only one northern pike was collected in the gill nets. General notes from anglers at that time indicated Avalon Lake had fair bass fishing, many small yellow perch could be found in its waters, and an occasional rainbow trout was caught.

MDOC still figured that the game fish community, both for trout and perch, could only be enhanced by reducing the numbers of perch and white suckers. Reducing these species would put less of a burden on the forage base and possibly enhance growth of remaining perch and trout. Attempts to do this through chemical reclamation had failed, but partial thinning of the fish community through netting had not been attempted yet. A survey was done in 1975 by MDOC from April 17-27 on Avalon Lake with the purpose of monitoring the movement of perch and suckers in the shallows. Baseline information on netting efficiency for these species would lead to future species removals. Gill nets and trap nets were used immediately following ice out. A handful of big northern pike were caught along with smallmouth bass, cisco, a few largemouth bass and bluegill, and rock bass. Yellow perch were common in the catch, ranging in length from 4-10 inches, but most were again in the 6 inch size range. No splake were collected and only 2 rainbow trout were caught. The white sucker spawning peak was in mid April, immediately after ice out, and all size ranges were observed. The yellow perch spawning peak was in early May. It is not known if any of these perch and suckers were removed from the lake during this survey.

Fish netting was conducted again by Michigan Department of Natural Resources (MDNR) in the 1980s at Avalon Lake. White sucker and yellow perch partial removals were done annually from 1981 through 1983. MDNR used 76 trap nets lifts and 64 fyke net lifts in April of 1981 to remove 3.4 pounds of yellow perch/acre (1,265 pounds of perch) and 10.5 pounds/acre of white suckers (3,906 pounds of suckers). These removals were considered a start on thinning out these populations, but recommendations were to do more. Most yellow perch captured and removed were in the 4-5 inch range and growth was considered slightly below statewide average. In the fall of that same year (1981), MDNR used experimental gill nets (8 lifts) in early November to evaluate the current rainbow trout stocking efforts (Table 1). Eighteen rainbow trout were collected in the nets. Most of the trout collected were yearlings (8-11 inches) from that year's stocking event. However, one large rainbow trout (29 inches) was collected. Growth was still considered poor, which should not have been a surprise since the perch and sucker removal efforts had just begun that year. One cisco and one rainbow smelt were also collected along with a few warm and cool water species.

The 1982 perch and sucker removal was done from April 28 through May 18. Trap and fyke nets were again used in the nearshore environment to remove 12 pounds per acre of both species (4,464 pounds of each species). White suckers removed were all sizes but most were 15-19 inches, while many of the yellow perch removed were in the 5 inch range. Other species caught and released that were common were smallmouth bass, rock bass, rainbow smelt, and a handful of northern pike.

The third in the series of fish removals was done by MDNR in mid May of 1983. Again, the perch and sucker removals were done in order to hopefully improve the rainbow trout community through enhanced growth and survival. Removal of the abundant, but small, yellow perch could enable better growth for the remaining perch community. Small mesh fyke nets (57 lifts, 116 net nights) were used that year. The final removal amounts were 16.5 pounds/ acre of yellow perch (6,138 pounds of perch), and 22.5 pounds/acre of white sucker (8,370 pounds of sucker).

Rainbow trout stocking continued in most years at Avalon Lake through the 1980s. Interestingly, splake stocking was also continued for much of this period (Table 1). The fish thinning practices of the early 1980s were costly, time consuming, and later questioned by fisheries managers as whether or not such efforts could actually remove enough perch and suckers to make a significant difference in the fish community. It was still believed that splake could reduce the small yellow perch of Avalon Lake much more efficiently through predation than could fish thinning (removal). Splake are piscivorous (fish eaters), particularly when they are larger than 11 inches and could help reduce juvenile perch numbers through predation. Thus, the tide had turned once again and splake became the prominent species of management at Avalon Lake, while rainbow trout stocking efforts had ceased by MDNR after 1989.

In 1989, a water quality analysis was done at Avalon Lake by Alpena Community College (Moreau 1989) at the request of the local lake association. The purpose was to gain baseline water quality data and compare it to any past data that was available. The study indicated that Avalon Lake had maintained good water quality over time. Secchi disk readings were 16-20 feet, indicating high clarity. A thick thermocline was still present with ample dissolved oxygen for fish throughout the water column. However, the lake was naturally low in phosphorus and had low phytoplankton productivity (both are essential for juvenile fish survival and growth). The trophic value of the lake was considered 37.5, placing it as a fairly unproductive, oligotrophic lake. None of this was a surprise since deep, clear lakes with limited watersheds are less productive. Other chemical results from the analysis can be found in Moreau (1989). The authors worked with MDNR at the time to make a few recommendations for the future of the fishery, and these were to: 1) build brush shelters and place in the lake to increase base productivity and attract fish, 2) continue fish removals/thinning if feasible, 3) find utilization of the cisco population through angling or by another species, 4) investigate northern pike stocking, and 5) attempt to stock lake trout or brown trout to feed on the abundant juvenile perch.

Yearling splake continued to be stocked into Avalon Lake through the 1990s (Table 1). Rainbow trout stocking efforts had ceased and some angler reports showed discontent for this management change. It appeared that some anglers enjoyed the rainbow trout fishery, and did not care for splake. MDNR used 12 gill net lifts in late October 1990 to assess recent splake stocking events. Survival of splake appeared good and growth was acceptable, while many 7-12 inch yearlings were collected. Age 2 splake (13-15 inches) were common, and a handful of age 3 fish (16-17 inches) were also collected. Small rock bass and yellow perch were still common, while other species caught in varying numbers were rainbow smelt, northern pike, bluegill, pumpkinseed, smallmouth bass, largemouth bass, white sucker, and even a small number of rainbow trout. Growth of many of the non-trout species had not changed compared to past growth indices.

By 1993, angler focus had switched primarily to a splake and yellow perch fishery. The management prescription for that time continued to call for splake stocking at a rate of 54/acre annually, or 20,000

yearling fish. Splake catches were considered good while perch were abundant with average growth rates. Small perch, those 4-6 inches, still dominated the perch fishery. Despite these observations, managers were content with the status of the lake at that time. Fisheries survey data is lacking for Avalon Lake from 1993 through 2009. Catch reports for this period indicate quality splake fishing with some large fish able to holdover each summer. The yellow perch fishery had not changed from the past, while more anglers were beginning to tune in to the quality smallmouth bass population that this fishery afforded. Some anglers had requested supplemental rainbow trout stocking efforts during this period as well.

Current Status

A recent fish community survey was conducted at Avalon Lake by MDNRE (Michigan Department of Natural Resources and Environment) Fisheries Division in 2010. Sampling design was based on the MDNRE Status and Trends lake survey protocol where effort is a product of lake size (Wehrly et al. 2009 in Draft). Effort consisted of 9 experimental gill-net lifts, 6 large mesh trap-net lifts, 6 large mesh fyke-net lifts, and 4 small mesh mini fyke-net lifts. The survey effort was done from May 10-13. Water temperature during the survey ranged from 53-55F. Lead lengths for the larger mesh trap and fyke-nets were 75-100 feet. A limnological lake profile (Table 2) was collected by the United States Geological Survey (USGS) on August 1 of the same year. This survey demonstrated that Avalon Lake still has thermal stratification and a coldwater niche. Dissolved oxygen levels suitable for game fish survival and growth (6ppm or more) were found nearly throughout the entire water column when measured in 65 feet of water. Temperature ranged from 75F at the surface to 51F at the bottom on August 1. A supersaturation of dissolved oxygen was found between 31 and 47 feet. The pH was normal with slightly basic values throughout the water column (Table 2). A secchi-disk reading of 24 feet was taken by MDNRE on August 25 of the same year indicating extremely high water clarity.

A total of 372 fish were caught during the 2010 survey (Table 3) and represented by 10 fish species. The relatively low catches, both in number and diversity, are not typical of more productive Michigan lakes. However, this is normal for an oligotrophic lake which is low in natural productivity. Fish such as splake and smallmouth bass dominated the predator catch, while largemouth bass and northern pike were relatively rare. Panfish consisted mainly of yellow perch and rock bass, with an occasional black crappie observed.

A total of 175 splake were netted, ranging in length from 7-17 inches in length. Growth of splake was slightly below statewide average (about an inch) for this species throughout a lifespan. Most of the splake collected ranged in length from 7-10 inches and were yearling fish that were stocked just a month earlier. Three age 2 splake were collected (12-13 inches) along with one age 4 fish (Table 5). Good information on historical splake growth is generally lacking for Avalon Lake, so no growth comparisons can be made. Another cold water species, the cisco (lake herring) was collected. One 9-inch cisco was found in the gill nets. It is probable that this species is more abundant than is shown in this survey and would be found in higher numbers if effort was directed at this species (e.g. deep water gill nets or fall sampling near shore).

The warm and cool water predators of Avalon Lake include smallmouth bass, largemouth bass, and northern pike. Caught during this survey was also a recently reintroduced species, the lake trout, which were stocked as adults from a Federal hatchery in 2009. Smallmouth bass are prolific as indicated by the catch of 48 individuals ranging from 2-18 inches. Growth for this species is also slightly below (-

0.8 inches) the statewide average, but well within an acceptable range. Fourteen-inch smallmouth bass were very abundant (Table 4) and legal size bass (14 inches and larger) are common. Nine year classes of bass were represented in the catch (age 1-9) which is good, and most were age 6 fish.

A total of 190 adult lake trout were stocked in Avalon Lake in the fall of 2009. These fish were large broodstock from the federal hatchery system in the Upper Peninsula. They averaged 28 inches at stocking. This effort was done to add species and catch diversity to Avalon Lake, but mostly, to simply give these "retired" broodstock lake trout a new habitat outside of the Federal hatchery system. We caught a high number (i.e., 30 fish) of these large lake trout during the May survey indicating that overwinter survival was considered excellent. Our catch ranged in length from 24-31 inches, averaging 27-28 inches, with an estimated total weight of 240 pounds (Tables 3, 4). Fish were caught in most gear types and catches were spread throughout the lake.

Two largemouth bass were caught during the survey (Table 4), which is to be expected because they have not been found to be prolific in Avalon Lake. Northern pike were also found to be in very low numbers during nearly every survey of Avalon Lake and the latest survey found a similar pattern. Three legal size (24 inches and larger) pike were caught including a large 40 inch specimen. Food is abundant for this species here, yet spawning habitat is naturally limiting.

Three species of panfish were collected during the recent survey. Yellow perch are the most abundant and popular fish. Perch collected during this survey ranged in length from 3-6 inches (Table 4). No quality size (8 inches and larger) perch were collected, but they are believed to be in the lake (just in smaller proportion). Perch growth index was -1.1 inches, meaning that perch in Avalon Lake grow about an inch slower than perch statewide for all ages combined. Perch appear to grow slightly slower today than when compared to past survey years (Table 5). No perch older than 5 were collected during this survey.

Rock bass and black crappie are the other panfish found in Avalon Lake, although in lower numbers. Two year classes of rock bass were collected (Table 5). Only one black crappie was caught. White sucker were collected in good numbers and sizes (Table 3 and 4). It is apparent that suckers grow well in this lake and compete for food resources.

Analysis and Discussion

The current fish community and environment of Avalon Lake can be generally characterized as having the following characteristics: 1) an unproductive, oligotrophic community with good water clarity, a strong summer thermocline, and good dissolved oxygen levels throughout the entire water column including in the colder, deeper water, 2) a panfish community with very limited diversity and dominated by small yellow perch, 3) a limited predator population not dependent on stocking and dominated by smallmouth bass, 4) a cold water species community dominated by stocked splake which appear to survive fairly well, 5) an additional cold water species community with cisco and possible rainbow smelt, both in unknown abundances, and 6) a non-game fish community dominated by white suckers.

The Avalon Lake panfish community is low in diversity and in quality. Species available to anglers include yellow perch, rock bass, and an occasional black crappie. Bluegill may be present, but in not enough numbers to produce a fishery. Perch thrive in the lake and have done so for years, although

perch growth rates are average to slightly below the statewide average, and have not changed over time. Yellow perch in Avalon Lake are limited more by primary productivity and forage then by predation.

The main predators of Avalon Lake are wild smallmouth bass and stocked splake. Smallmouth bass are probably not efficient predators on yellow perch and may survive on other species such as crayfish and macro-invertebrates. Splake were stocked with the intentions that they would provide a fishery while reducing the abundant small perch population. Both of these intentions are being accomplished, except perch sizes and growth rates have not changed. It is highly probable that some perch are being preyed on by larger splake (legal size and larger, or 12 inches and larger). Other predators such as largemouth bass and northern pike do not provide a fishery, but are caught incidentally and can grow to large sizes at Avalon Lake.

Historical and current catches of white suckers are high in Avalon Lake. They will always remain a common species here, despite whether sucker removal practices are used or not used. Species such as cisco and smelt are probably found in this lake still, especially cisco.

Management Direction

1) The Avalon Lake aquatic community should be monitored on a consistent basis. Many of the game fish play a vital role not only in the fishery, but also for overall ecosystem balance. A complete fish community survey documenting changes should be accomplished no later than 2025 at Avalon Lake. Periodic evaluations of the splake population should be made more frequently to determine growth rates and year class survival following stocking. Considerations should be given to determine if cisco are still a major component in this lake or if splake have preyed signficantly on this species (state threatened). Effort could be minimal and could mimic what was done by managers to catch cisco in this lake in the 1940s, or could be done with modern hydroacoustic gear. A future general survey of the aquatic community will also enable managers to determine perch growth, but it is believed that this will change very little over time.

2) Smallmouth bass are an important predator in Avalon Lake, provide an excellent fishing opportunity, and are vital in maintaining ecosystem balance. Plenty of legal size fish are available to anglers. Smallmouth bass are efficient predators on rusty crayfish which are non-native to northern Michigan and can hurt ecosystems by shredding and removing native vegetation. The limited aquatic vegetation community of Avalon Lake is important and needs to be protected. It is not known if rusty crayfish has infested Avalon Lake yet, like it has in many nearby lakes, but having a healthy smallmouth bass population should help keep the threat of rusty crayfish in check.

3) Anglers are urged to report catches of all species to the local MDNRE biologist. Sampling gear is not always efficient at capturing some fish, sometimes leaving information gaps for individual species. Such reports are useful for management of the fishery not only currently, but for future managers as well. The current State of Michigan fishing regulations are appropriate for Avalon Lake. Splake are managed by Type B trout regulations where the minimum size is 12 inches, fishing is year around, and all tackle types are allowed. The daily possession limit for splake is 5 fish, of which no more than 3 can be 15 inches or larger. Most splake attain this minimum size at or just before age 2. Thus, when stocked as yearlings, many can reach this size by their first winter or spring in Avalon Lake, allowing for some harvest.

4) Type B regulations are also appropriate for other trout (e.g. rainbow or brown trout) if and when stocked in Avalon Lake. Minimum size for these species would be 12 inches as well. Stocking efforts of rainbow trout in the past have been met with mixed results. The occasional stocking of such a species, particularly rainbow trout, would add diversity to the fishery and provide for a better open water angling experience. Currently, it is believed that the splake fishery is almost entirely relegated to the winter fishery. A planned stocking event of rainbow trout every three years would help with this trout fishing diversity without damaging the rest of the fish community. Rainbow trout are predominantly planktivores and insectivores and the fishery could be monitored easily by periodic evaluations and angler reports.

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Table 1. Recent trout stocking history for Avalon Lake from 1981-2010.

Year	Species	Number	Number/Acre	Approx. Avg. Length (in)
1981	Rainbow trout	18,600	50	6.2
1982	Rainbow trout	15,000	40	6.5
1983	Rainbow trout	9,300	25	6.7
1983	Splake	7,500	20	6.5
1984	Splake	7,500	20	5.2
1984	Rainbow trout	7,300	20	5.6
1985	Splake	7,500	20	8.0
1985	Rainbow trout	10,000	27	5.7
1986	Splake	7,500	20	7.9
1986	Rainbow trout	8,450	23	7.5
1986	Brook trout	860	2	5.9
1987	Splake	10,000	27	8.5
1987	Rainbow trout	10,000	27	7.4
1988	Splake	18,000	48	7.0
1989	Rainbow trout	9,500	26	7.2
1990	Splake	21,120	57	6.2
1991	Splake	20,000	54	6.1
1992	Splake	20,000	54	6.9
1993	Splake	13,600	37	7.0
1994	Splake	23,994	65	6.2
1995	Splake	21,200	57	6.4
1996	Splake	23,605	64	7.1
1997	Splake	20,256	54	6.8
1998	Splake	21,400	58	6.0
1999	Splake	22,200	60	6.8
2000	Splake	19,200	52	7.0
2001	Splake	20,440	55	7.2
2002	Splake	21,200	57	7.6
2003	Splake	21,000	57	7.1
2004	Splake	19,350	52	6.1
2005	Splake	23,998	65	7.0
2006	Splake	24,000	65	7.5
2007	Splake	19,095	51	7.4
2008	Splake	20,000	54	7.2
2009	Splake	24,003	65	6.8
2009	Lake trout	190	1	27.3
2010	Splake	21,200	57	7.3

Table 2. Water temperature and dissolved oxygen profile for Avalon Lake, August 1, 2010. Data collected by the USGS.

Depth (ft)	Temperature (F)	Dissolved Oxygen (ppm)	pH
3	75	6.7	8.5
10	74	6.7	8.3
17	74	6.9	8.2
24	73	6.8	8.2
31	67	9.3	8.3
33	66	9.4	8.3
35	63	9.6	8.4
37	62	9.8	8.3
39	59	9.9	8.3
41	58	9.8	8.3
43	57	9.7	8.3
45	56	8.9	8.3
47	55	8.5	8.2
54	53	6.7	7.9
61	51	3.7	7.7
65	51	2.0	7.5

Table 3. Species and relative abundance of fishes collected with survey gear at Avalon Lake, May 10-13, 2010.

Common Name	Number	Length Range *(inches)*	Weight (lbs)	Growth*
Splake	175	7 - 17	38.8	-0.8
White sucker	51	7 - 24	160.4	
Smallmouth bass	48	2 - 18	61.2	-0.8
Yellow perch	43	3 - 6	3.7	-1.1
Lake trout	30	24 - 31	240.0	
Rock bass	18	4 - 7	2.9	+0.5
Northern pike	3	24 - 40	25.4	
Largemouth bass	2	14 - 19	5.6	
Black crappie	1	8	0.3	
Cisco (herring)	1	9	0.4	
Mudpuppy	1	10	0.5	
TOTAL	**373**		**539**	

*represents the deviation from statewide average length in inches

Table 4. Length-frequency distribution of certain game fishes collected during the 2010 netting survey at Avalon Lake.

Length (in)	N. pike	S. Bass	Splake	L. bass	Cisco	Y. Perch	White sucker	Lake trout
1								
2		1						
3		6				2		
4						2		
5		2				17		
6		3				22		
7			37				1	
8		1	55				1	
9		2	53		1		2	
10			26				1	
11							2	
12			1					
13		5	2					
14		17		1				
15		5						
16		2						
17		2	1				1	
18		2					12	
19				1			7	
20							2	
21							6	
22							11	
23							4	
24	1						1	1
25								
26								3
27								9
28								11
29								3
30	1							2
31								1
32								
33								
34								
35								
36								
37								
38								
39								
40	1							
41								
42								
43								

Table 5. Comparison of mean length (inches) at age for various game fishes of Avalon Lake from 1970 to 2010. Number in parentheses represents number aged.

Species	Age group	1970 May	1977 April	1983 April	1990 Oct	2010 May
Yellow perch	I					3.6 (2)
	II			5.1 (17)	6.6 (9)	4.3 (2)
	III	5.2 (6)	5.9 (44)	5.7 (25)	7.5 (19)	5.8 (3)
	IV	7.0 (6)	7.7 (12)	7.2 (20)		6.2 (8)
	V	9.5 (1)	9.2 (1)	7.9 (6)		6.3 (3)
	VI			9.6 (3)		
	VII	10.5 (7)		12.7 (1)		
	VIII	11.2 (1)				
	IX					
	X					
Splake	I				9.6 (44)	8.9 (51)
	II	8.8 (2)			14.0 (8)	13.4 (3)
	III				16.9 (2)	
	IV	23.3 (4)				17.4 (1)
	V					
	VI					
	VII					
	VIII					
	IX					
	X					
	XI					
	XII					
Cisco	I					
	II		9.0 (2)		10.2 (4)	
	III					
	IV					9.6 (1)

Table 5.-continued

Species	Age group	1970 May	1977 April	1983 April	1990 Oct	2010 May
Rock bass	I					
	II			3.2 (12)		
	III	3.7 (1)		4.5 (22)	5.7 (14)	5.6 (16)
	IV	6.0 (9)		5.2 (4)	7.0 (9)	7.1 (4)
	V	6.5 (1)		6.8 (16)	7.5 (7)	
	VI			7.8 (5)	8.5 (4)	
	VII	8.7 (2)		8.8 (4)		
	VIII					
	IX					
	X					
	XI					
S. bass	I			3.6 (2)	7.8 (3)	3.2 (7)
	II			6.8 (14)	10.2 (7)	6.1 (5)
	III			9.0 (7)	12.2 (4)	9.2 (3)
	IV		11.6 (7)	11.4 (4)	14.8 (1)	14.3 (1)
	V		15.6 (2)	12.9 (13)		14.7 (3)
	VI			16.7 (3)		14.3 (16)
	VII			17.7 (1)		15.7 (4)
	VIII				18.4 (2)	17.1 (5)
	IX					18.5 (1)
	X					
	XI					
N. pike	I				13.2 (1)	
	II					
	III		21.8 (1)	22.9 (1)		24.7 (1)
	IV		26.2 (1)			
	V		29.0 (2)			
	VI					30.7 (1)
	VII	42.0 (1)	42.0 (1)			
	VIII					
	IX					40.1 (1)
	X					