Holloway Reservoir
Genesee and Lapeer Counties, T 8N, R 8,9E, Sections: many
Flint River Watershed

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Environment

Holloway Reservoir is a 1,973 acre impoundment of the Flint River located 7 miles northeast of Flint in Genesee and Lapeer counties (Figure 1). The reservoir is approximately 8 miles in length with the upper boundary generally accepted at the Klam Road ending just northeast of the Village of Columbiaville. The reservoir was created by the construction of Holloway Dam in 1955. Original use of the reservoir was for a potable water supply and flow augmentation for the City of Flint. However, since 1967, secondary water supply, flow augmentation, and recreational use have been emphasized since the City of Flint began purchasing potable water from Detroit via their Lake Huron pipeline.

General soil types along this section of the Flint River are categorized as Boyer-Spinks-Cresco-Cohoctah association (Holcomb 1972). Boyer-Spinks-Cresco-Cohoctah association is described as level to gently sloping well-drained loamy sands that have a dominantly sand to sandy loam subsoil on outwash plains and level, somewhat poorly drained, fine sandy loams underlain by fine sandy loams to sand on bottom lands. This association includes the most coarse-textured soils in Genesee County and is conducive to groundwater inflow. The Darcy Groundwater Model indicates groundwater inflow to Holloway Reservoir is moderate and above the Lower Michigan mean (P. Seelbach, MDNR, Fisheries Division, personal communication).

The City of Flint maintains control of Holloway Dam, reservoir bottomlands, and reservoir water levels. Holloway Dam is a gravity fed earthen and concrete structure which spans 3,350 feet and has a designed discharge of 40,600 cubic feet per second. The dam has a hydraulic head potential of 35 feet but normal head is maintained at 30 feet. Water levels are manipulated via two 90 foot drum gates, 20 foot tainter gates, and two rectangular sluice gates. Operational procedures are a condition of compliance for the City of Flint's National Pollutant Discharge Elimination System (NPDES) permit issued to the Flint Wastewater Treatment Plant by the Michigan Department of Environmental Quality (MDEQ). Special conditions of the NPDES permit allows for reservoir water level manipulation to augment flow upstream of the Flint River Wastewater Treatment Plant. General operating procedures strive to achieve a spring elevation of 755 feet (above mean sea level) by May 1 of each year, maintain elevation throughout summer, then drawdown to a winter elevation of 751 feet during the first two weeks of November to prevent structural damage to the dam from freezing.

Much of the original land inundated by Holloway Dam was farmland and mixed forest. Numerous trees were cleared and the landscape re-shaped to fit the topography and form the existing reservoir boundaries. The catchment basin is estimated to be 523 square miles and includes drainages from the North and South branches of the Flint River, Hasler Creek, Henry Drain, and Hemmingway-Whipple Drain. Present day land use in the catchment basin is dominated by agriculture.

Development of Holloway Reservoir shoreline is considered light to moderate. In 2008, 164 dwellings were counted in 17.2 miles of shoreline. A number of these dwellings utilize steel and vinyl seawalls

to protect against erosion which is exacerbated by heavy recreational boat use. The Village of Columbiaville (population 800) is located on the southeast shore of the reservoir in the upper basin. Two road crossing bridges, Columbiaville Road and Mt. Morris Road, span the reservoir at different locations (Figure 1). An abandoned railroad bridge also spans the reservoir just upstream of Columbiaville. Navigation for most recreational vessels is possible under Columbiaville and Mt. Morris road bridges but overhead clearance is restricted at the railroad bridge when the reservoir is at full pool. Upstream of Columbiaville, shoreline is undeveloped and marshy in character. Most remaining shoreline is either undeveloped or lightly developed for recreational purposes by the Genesee County Parks and Recreation Commission (GCPRC).

The City of Flint has granted control and administration of their surrounding lands to the GCPRC for park, recreation, and conservation purposes. The GCPRC is the majority landowner on Holloway Reservoir and provides multiple recreational uses including Holloway Reservoir Regional Park, Wolverine Campground, and Buttercup Beach. In addition, GCPRC also administers park land surrounding Mott Lake downstream of Holloway Reservoir. As part of Holloway Reservoir Regional Park, the GCPRC operates the Walleye Pike Boat Launch off Henderson Road (Figure 1). The Walleye Pike Boat Launch is a modern paved and barrier-free facility capable of launching moderate sized boats. Shore fishing access is available at multiple locations including Klam Road, Zemmer Park, Stanley Road, Mt. Morris Road, Wolverine Campground, and at Holloway Dam.

The Holloway Reservoir shoreline, although fairly regular and elongated in shape, divides the reservoir into upper and lower basins at Mt. Morris Road. The shoreline varies greatly from marshy edge to gently sloping open shoreline to steep sand bank shoreline (Bryant 1992). Marshy edged shoreline is prevalent in the upper basin while gentle and steep banks are most associated with the lower basin. Both basins are similar in characteristic with gradual bottom contour changes. Maximum depths of 20-25 feet follow the historic river channel. Approximately 95% of the total surface acreage is considered littoral (< 15 feet). Average depth of the reservoir is estimated to be 8.5 feet. Bottom substrate is dominated by sand partially covered with a fine layer of silt.

In general, Holloway Reservoir is a warmwater, large size, shallow impoundment that is classified as eutrophic in nature. As with many impoundments in southern Michigan, eutrophication is accelerated from nutrient and sediment loading. Generally, most nutrients and sediments are transported into Holloway Reservoir via inlets draining the upper Flint River watershed. As a result, Holloway Reservoir is often turbid from algae growth or from sediments. Sediment turbidity is particularly high in spring and fall and following heavy precipitation. Limnological parameters measured in September, 2008 included temperature, oxygen, and pH (Table 1). Thermal stratification did not occur in the water column with temperatures gradually cooling from 76°F at the surface to 73°F at the bottom. Critical oxygen concentrations for fish (< 3 ppm) were observed at depths greater than 14 feet. Historic oxygen profiles of Holloway Reservoir indicate similar critical oxygen concentrations occur in the lower water column during the summer period. Bryant (1992) suggests this anoxic hypolimnion is the result of decaying phytoplankton and other organic decomposition occurring at the substrate water interface. Spring and fall oxygen concentrations are typically sufficient for most fish species. pH values ranged from 8.3 at the surface to 7.3 at the reservoir bottom. These values are typical of other waters in the region and are sufficient to support most aquatic life forms.

Detailed chemical analysis of Holloway Reservoir was conducted by MDEQ in April and September of 2003 (Table 2). Measurements of secchi disk, chlorophyll a, and total phosphorus allow for calculating trophic status using the Carlson Trophic State Index (TSI) (Carlson 1977). The TSI scale ranges from 0 to 100 with lowest values reflecting oligotrophic conditions and highest values reflecting hypereutrophic conditions. Using data provided from MDEQ in 2003, the TSI value for Holloway Reservoir was 59 indicating a mildly eutrophic state. TSI values have shown improvements in Holloway Reservoir water quality as evidenced by lower total phosphorus and chlorophyll a concentrations and greater secchi depth measurements (MDEQ 2000). In 1988, spring and fall TSI values indicated hypereutrophic conditions compared to eutrophic conditions in summer of 1998, and mildly eutrophic conditions in spring and fall of 2003. Other parameters measured in 2003 fall within expected values for impounded waters in this region of the State.

Overall, general water quality of Holloway Reservoir is fair and meets MDEQ standards for human body contact. Occasionally, bacterial counts of Escherichia coli spike following heavy precipitation and result in temporary closures of the Buttercup swimming beach for health concerns. Concerns over groundwater contamination from the Richfield Landfill, located off the north shore of the lower basin, have recently developed. Contaminated groundwater flows south from the landfill and enters Holloway Reservoir. The Richfield Landfill Corrective Action Plan, approved by MDEQ in 2008, calls for the installation of interceptor pumps to capture contaminated groundwater prior to entering Holloway Reservoir.

In 1989, MDNR (now MDEQ), Fish Contaminant Monitoring Program analyzed the edible portion of channel catfish from Holloway Reservoir. Results recommended restricted consumption of channel catfish for women and children to one meal per month due to elevated PCB concentrations. A Statewide mercury fish consumption advisory for all inland lakes, reservoirs, and impoundments also applies to Holloway Reservoir. The mercury advisory recommends no one eat more than one meal a week of rock bass, yellow perch, or crappie over 9 inches and no one eat more than one meal a week of any size largemouth bass, smallmouth bass, walleye, northern pike, or muskellunge. In addition, child bearing women and children under the age of 15 should restrict meals of the above mentioned species to once a month. A sample of channel catfish was collected for the MDEQ Fish Contaminant Monitoring Program in 2008 but results were not available for this report.

Aquatic vegetation serves primary ecosystem production by providing important habitat for zooplankton, macroinvertebrates, fish, and other aquatic species such as frogs and turtles. Algae blooms are a common occurrence throughout the summer in Holloway Reservoir. Rooted aquatic vegetation is not abundant due to low sunlight penetration but can be found in isolated areas. Cursory observations made by MDNR Fisheries personnel in September 2008 indicated isolated pockets of curly-leaf pondweed (Potamogeton crispus), Eursasian watermilfoil (Myriophyllum spicatum), American waterweed (Elodea canadensis), floating pondweed (Potamogeton natans), and yellow water lily (Nuphar lutea). Emergent vegetation including cattail (Typha latifolia), arrowhead (Sagittaria sp.), and bulrush (Scirpus americanus) were common in the upper basin of the reservoir. In addition to aquatic vegetation, a limited amount of submerged wood structure in the form of downed trees and root wads from the original clearing of the reservoir provide additional fish habitat.

History

Holloway Reservoir has an extensive history of fisheries management. Historic management objectives sought to provide and maintain a diverse warmwater fish community with particular emphasis on walleye, muskellunge, northern pike, smallmouth bass, channel catfish, bluegill, and black crappie. The first fish species stocked were northern muskellunge in 1961 and 1962 but their survival was poor and stocking was discontinued. The earliest MDNR Fisheries Division assessment occurred in 1968 and bluegill, pumpkinseed, black crappie, largemouth bass, and northern pike were identified as common species. In 1971, a chemical reclamation project was initiated to control the carp population within the upper Flint River watershed including Holloway Reservoir. An estimated 420 tons of carp were eradicated. Post-reclamation fish stocking included the introduction of rainbow trout for an interim fishery as well as northern pike, walleye, bluegill, and channel catfish. Carp quickly re-populated themselves to nuisance levels and another chemical reclamation was performed in 1976. An estimated 382 tons of carp were removed during this effort. Post-reclamation stocking included bluegill, black crappie, channel catfish, fathead minnows, largemouth bass, northern pike, pumpkinseed sunfish, tiger muskellunge, and walleye (Table 3). Management through fish stocking continued for channel catfish until 1978; for largemouth bass until 1979; for tiger muskellunge until 1990; and for walleye until 1992. Tiger muskellunge stocking was discontinued due to poor survival. Channel catfish, largemouth bass, and walleye stocking were discontinued when self sustaining populations developed. No fish have been stocked into Holloway Reservoir since 1992.

Fish community assessments have been conducted on Holloway Reservoir in 1968, 1969, 1972, 1974, 1976, 1978, 1979, 1981, 1983, 1989, 1999, and 2008. Those assessments document the presence of 25 fish species (Table 4). Two species, rainbow trout and tiger muskellunge are now extirpated. Rainbow trout were introduced to Holloway Reservoir to provide an interim fishery after reclamations in the 1970's and were not expected to survive long term. As mentioned previously, tiger muskellunge experienced poor survival leading to the cessation of stocking. Native species which have been aggressively stocked by MDNR include channel catfish, largemouth bass, northern pike, and walleye (Table 3).

Relative abundance from trap net catches indicates significant changes in the Holloway Reservoir fish community (Table 5). An increase in channel catfish abundance and decrease in black crappie abundance occurred between 1989 and 1999. Gizzard shad, first observed in Holloway Reservoir in 1986, showed an increase in abundance up until 1999 but appeared in lower abundance in 2008. Other population changes not depicted in trap net catches but verified with seine and electro-fishing sampling in 2008 included an increased abundance of round gobies and emerald shiners. The exotic round goby was first documented in Holloway Reservoir in 1996 and is now considered a colonized species. The exotic zebra mussel, detected in 1995, has also colonized in the reservoir. The presence of emerald shiners is most likely associated with anglers since they are a preferred species for the bait industry.

Walleye management in Holloway Reservoir has been Fisheries Division's primary focus since the mid-1970's. During the 1980's, anglers were reporting good catches of adult fish. Assessments investigating stocking survival, abundance, and natural reproduction have been conducted in 1984, 1993, 1995, 1999, and 2007. Natural reproduction was observed in 1984 (non-stocking year) when 34 young of the year (yoy) were collected in one hour of nighttime electro-fishing. In 1992, MDNR Fisheries Division developed methods for estimating yoy walleye density based on the research of Wisconsin Fisheries Biologist S.L. Serns (Serns 1982). A yoy density of 10/acre was considered sufficient for a significant walleye fishery to develop. In 1993, yoy walleye density in Holloway

Reservoir was estimated to be 14/acre. Since 1993 was a non-stocking year, all yoy walleye were assumed to come from natural reproduction and further stocking was deemed unnecessary. In 1995, an adult walleye population estimate was conducted using a combination of marked and recaptured walleye from trap nets and from tournament angler return. The population of adult walleye in 1995 was estimated to be in the realm of 11,000 to 18,000 fish or 6-9 fish/acre. By 1997, Holloway Reservoir had established itself as one of Michigan's premier inland walleye fisheries (Romanack 1997). Young of the year walleye densities were again monitored in 1999 and 2007. A weaker year class was found in 1999 when yoy densities were estimated at 4/acre. In 2007, a strong year class was found with yoy densities estimated at 12/acre.

Bluegill, largemouth and smallmouth bass, and northern pike have also been integral components of the Holloway Reservoir recreational fisheries. Past assessments show these species have sustained themselves in consistent abundance and they are targeted by selective anglers. In 1988, Holloway Reservoir was one of six large water bodies selected for special catch-release regulations for bass for the period April 1 to the Saturday of Memorial Day weekend. Evaluations of this special catch-release bass season were inconclusive and in 2005 Fisheries Division adopted pre-spawn catch-release angling for bass on a Statewide basis (refer to MDNR, Fishing Guide for actual dates).

Current Status

In May, 2008, Fisheries Division conducted a fisheries assessment using trap nets, seine, and electro-fishing gear. Gill nets were not used due to the known presence of channel catfish which have a tendency to damage gear. Four inland trap nets were fished for 3 nights at 4 locations. Six 25 foot seine tows were made at 6 locations and three 10-minute electro-fishing stations were sampled after dark. All fish were measured to the nearest inch group and scale or spine samples were collected on common sport fish for age and growth analysis.

A total of 820 fish representing 18 species were collected with combined efforts (Table 6). Channel catfish, walleye, and black crappie were the most abundant species collected comprising 57% of the total catch by number. Channel catfish and common carp accounted for 74% of the total biomass. Trap nets comprised 59% of the total catch by number while electro-fishing and seine efforts comprised 27% and 14%, respectively.

A total of 230 channel catfish averaging 15.5 inches comprised 28% of the total catch (Table 6). Trap nets accounted for 98% of the channel catfish catch with a catch per lift equaling 19 fish. Channel catfish ranged from 7 to 26 inches with 87% of the fish meeting or exceeding the legal harvest size of 12 inches. Age and growth data indicated channel catfish were growing significantly below State average having a mean growth index -7.1 (Table 7). Recruitment into the harvestable fishery appears to occur at age 5. Age distribution indicates the harvestable fishery is comprised of multiple age groups with strongest representation of fish between the ages of 7 and 11 (Table 8).

A total of 143 walleye averaging 6.9 inches comprised 17% of the total catch (Table 6). Electro-fishing comprised 92% of the total walleye catch with catch per hour of 259 fish. The electro-fishing catch was entirely comprised of yearling walleye and accounts for a small overall average size of the total catch. Eleven walleye averaging 22.3 inches were collected with trap net gear. Growth of yearling walleye averaged 5.5 inches and was 1.6 inches below State average. Insufficient numbers of

adult walleye were collected for valid comparison to State averages. However, the eleven adults aged showed above State average growth. Age distribution indicates a very strong 2007 year class (Table 8).

A total of 99 black crappie averaging 8.7 inches comprised 12% of the total catch (Table 6). Trap nets account for 92% of the total black crappie catch with a catch per lift equaling 6 fish. Black crappie ranged from 3 to 14 inches with 77% meeting or exceeding the acceptable harvest size of 8 inches. Age and growth analysis indicated black crappie recruit to the harvestable fishery at age 3 and are growing above State average having a mean growth index of +0.7 (Table 7). Age distribution indicates the harvestable fishery is composed of multiple year classes with highest representation of fish between the ages of 3 and 5 years (Table 8). Black crappie longevity appears to peak at age 5 and older fish are either harvested or die of natural causes.

A total of 76 bluegill averaging 7.2 inches comprised 9% of the total catch (Table 6). Trap nets accounted for 67% of the total catch with a catch per lift of 4 fish. Bluegill ranged from 2-9 inches with 78% meeting or exceeding the acceptable harvest size of 6 inches. Age and growth analysis indicates bluegill are growing above State average having a mean growth index of +1.9 (Table 7). Recruitment to the harvestable fishery appears to occur at age 3. Age distribution indicates the harvestable fishery is dominated by fish of ages 3-4 years (Table 8). Bluegill longevity appears to peak at age 6 and older fish are either harvested or die of natural causes.

Other important sport fish collected in low abundance included smallmouth and largemouth bass, northern pike, pumpkinseed sunfish, and yellow perch. Fourteen smallmouth bass ranging from 3 to 15 inches and averaging 11.9 inches were collected. Only one 14.5 inch largemouth bass was collected. Seven northern pike averaging 21.8 inches were collected. Two pumpkinseed sunfish averaging 6.0 inches were collected. Although there were insufficient numbers of these species for meaningful growth interpretation, the few specimens collected were all growing above State average.

Although only 66 common carp averaging 19.3 inches were collected, their abundance is still considered high. Common carp are notoriously wary of trap net gear and abundance is difficult to estimate. Only two common carp were collected in the three ten minute electro-fishing stations but numerous specimens were observed during the more intensive October, 2007 electro-fishing assessment. The roiling behavior of carp undoubtedly contributes to high turbidity in the reservoir. Other non-sport fish species observed in low numbers included brook silverside, green sunfish, johnny darters, spotfin shiners, white suckers, and yellow bullhead.

Analysis and Discussion

The fish community of Holloway Reservoir has experienced significant changes over the past twenty years. One of the primary changes has been a shift in forage fish composition and abundance. In 1999, gizzard shad were abundant and believed to be the primary forage for most predator fish. Netting efforts in 1999 collected 503 gizzard shad averaging 11.5 inches. Under similar seasonal conditions, not a single gizzard shad was collected in 2008. While it is possible adult gizzard shad had ascended the river for spawning and avoided capture, it seems more apparent the adult population has decreased. In fall of 2007, fisheries personnel observed numerous young of the year gizzard shad which may suggest sufficient numbers of adults are present and, due to their prolificacy, are able to

annually produce substantial numbers of young. The decline in gizzard shad is believed to be associated with the high abundance of channel catfish and to a lesser degree walleye and other predatory species. Round gobies and emerald shiners showed up as new alternative forage species in the 2008 assessment. During seining operations in 2008, fisheries personnel observed a particularly high abundance of young of the year round gobies. Instead of a high abundance of a single species (gizzard shad), the primary forage base of Holloway Reservoir now appears to be diversified between gizzard shad, round gobies, and emerald shiners.

Channel catfish were found in extremely high abundance in the 1999 assessment. A total of 902 channel catfish averaging 18.0 inches were collected with trap net gear. Catch per lift was 30 fish. In 2008, average size and catch per lift declined to 15.5 inches and 19 fish. Age and growth analysis for channel catfish is tenuous because Michigan does not have established seasonal averages (Schneider 2000). However, middle growing season averages used for growth index indicates stunted growth occurred in 1999 and was more prevalent in 2008. In 1999, the mean growth index for channel catfish was -2.2 compared to -7.1 in 2008. Although stunting is still apparent, channel catfish growth rates are more comparable to channel catfish from Saginaw Bay. Using Saginaw Bay averages from Lorantus (1982) growth indexes would be +2.4 in 1999 compared to -3.3 in 2008. The trend of declining channel catfish growth appears to coincide with the decline in gizzard shad abundance. In 1999, when gizzard shad abundance was high, channel catfish growth was reasonable. In absence of gizzard shad, 2008 growth rates significantly declined. Lower relative abundance and catch rates experienced in 2008 may suggest increased mortality due to forage depletion. Currently, channel catfish remain in high abundance in Holloway Reservoir and appear vastly under harvested by recreational anglers. It seems the popularity of channel catfish for table fare among Michigan anglers is significantly lower than the southern region of the United States where they are more so valued.

Since 1993, assessments of yoy walleye in Holloway Reservoir have continually shown a high level of natural reproduction. Growth rates of these fish have varied depending on density. In 1993, with a density of 14/acre, yoy walleye averaged 6.2 inches. In 1999, with a density of 4/acre, yoy walleye averaged 10.1 inches. The results of the October, 2007 yoy indexing indicated a very strong year class with a yoy density of 12/acre and average size of 6.0 inches. In the 2007 assessment, concern was expressed whether 4 and 5 inch walleye, which typically should be 6 or 7 inches by fall, had the energy reserves to survive over winter. Data from the 2008 assessment suggests winter survival of these fish was good with 132 yearling walleye averaging 5.5 inches being captured in three ten minute stations.

The relatively low catch of adult walleye in 2008 compares similarly to historical catches collected in mid-May or early June (Table 5). Compared to the more recent assessment of 1999, catch per lift was identical with a value of 0.9 walleye. Average size of the trap net catch in 1999 was 18.6 inches compared to 22.3 in 2008. It is not unusual for adult walleye catches to appear low in surveys conducted in mid-May or in June as water temperatures are warming and the fish avoid net capture by staying deeper in the water column. Higher catch rates are typically experienced in spring and fall when water temperatures are cooler and constant throughout the water column and the fish are more active. In that regard, the October, 2007 walleye assessment provides a better outlook of the adult walleye fishery. Adult walleye were more prevalent with a collection of 110 fish > 12 inches (Table 9). Walleye in the 14 and 17 inch groups were common. Age and growth analysis in 2007 demonstrated better growth rates compared to 2008, particularly with adult walleye, having a mean growth index of 0.0 (Table 10). However, walleye growth is declined from 1995 when a mean growth

index of +2.6 was observed. Walleye recruiting to the harvestable fishery appears to occur at age three. The 2007 assessment also indicates a more balanced age distribution with good representation of all ages up to five years (Table 11). Although longevity extends to 12 years, walleye older than five years appear scarce and are likely targeted for harvest.

The combined data from 2007 and 2008 assessments indicates a respectable self-sustaining walleye fishery exists in Holloway Reservoir. Survival and abundance appears to be less effected by high channel catfish abundance. Young walleye growth appears to be greatly influenced by density and, although adult walleye growth remains adequate, its declining trend may be directly related to declines in the forage base, particularly with gizzard shad.

Further testament to the adult walleye fishery of Holloway Reservoir is provided from the results of the annual catch-release Chapman Walleye Tournament held May 18, 2008. Thirty-two of 64 two person teams caught their limit of 5 walleye under adverse weather conditions. A total of 210 walleye averaging 2 lbs. were presented to the weigh-in tables. The Holloway Reservoir continues to produce one of Michigan's finest inland walleye fisheries. Anecdotal angler reports often indicate most harvested walleye are in the 15-19 inch range with an abundance of sub-legal fish.

To an unknown extent, black crappie decline may be attributed to the habitat restrictions of Holloway Reservoir. Black crappie typically favor clear, warm water bodies and are almost always associated with abundant growths of aquatic vegetation (Becker 1983, Scott and Crossman 1973). Currently, this type of habitat is limited in Holloway Reservoir which is often turbid and has relatively low abundance of aquatic vegetation. Data is not available describing conditions in the 1970's and 1980's but it is possible habitat was more favorable for black crappie when eutrophication was less progressed. However, the decline in black crappie abundance observed between 1989 and 1999 appears to correspond with the increase in channel catfish abundance and gizzard shad collapse. This suggests the high density channel catfish population is suppressing black crappie survival, most likely as a result of predation. This same trend was observed in Mott Lake, located just downstream of Holloway Reservoir, for the period between 1988 and 1995. Although the 2008 assessment indicated slight reduction in channel catfish abundance and a small increase in black crappie abundance, it is unlikely crappie will ever achieve abundance levels experienced in the 1980's and early 1990's without drastic reductions of channel catfish. Currently black crappies appear in numbers and size sufficient to provide a reasonably good fishery.

Bluegill have shown a similar trend as observed with black crappie. A significant decline in abundance was observed between 1989 and 1999 (Table 5). This same trend was also observed in Mott Lake between 1988 and 1995. As with black crappie, the decline in abundance may be attributed to habitat conditions. Typically, bluegill favor clear water bodies with moderate levels of aquatic vegetation, which is limited in Holloway Reservoir. However, it is likely the high abundance of channel catfish is also suppressing bluegill abundance. Although the 2008 assessment showed a slight increase in bluegill abundance, it is unlikely they will achieve abundance levels experienced in the 1980"s without drastic reductions of channel catfish. Currently, because of their low abundance, bluegill offer only a marginal fishery for recreational anglers.

Smallmouth bass have always been a small but consistent component of the Holloway Reservoir fish community. They appear more prevalent than largemouth bass. Otherwise, the 2008 assessment gives

little insight to smallmouth bass abundance and size structure. A known fishery exists and several anglers repeatedly tout them as being an unexplored fishery despite their low representation in any MDNR assessment.

Other important sport fish including northern pike, yellow perch, and pumpkinseed sunfish were collected in low abundance in the 2008 assessment and do not allow for detailed analysis of their current status. Intensive netting in 1999 collected 29 northern pike averaging 26.1 inches suggesting a marginal fishery exists. Occasionally a few yellow perch are reported harvested but previous assessments indicate low abundance and a size structure where few fish exceed 6 inches in length. Pumpkinseed sunfish are low in abundance and do not appear to offer much in terms of a recreational fishery.

Management Direction

Eutrophication is a primary driving force determining species diversity and abundance in Holloway Reservoir and must be considered in management of the fishery resource. Current conditions favor species tolerant of the habitat degradation associated with accelerated nutrient and sediment loading. High fertility, turbidity, and sedimentation are common characteristics for impoundments which function as traps within the river ecosystem. The fish community of Holloway Reservoir must also be adaptive to the low oxygen concentrations observed during summer months. Improvements to slow the eutrophication process are long term and rely on implementation of Best Management Practices (MDNR 1992) throughout the upper watershed.

Habitat management is best served through riparian education and through MDNR Fisheries review of DEQ permit applications requesting shoreline modification and other aquatic habitat alterations. Shoreline erosion, which is greatly exacerbated by high speed boating, has been identified as a concern for the GCPRC and riparian homeowners. Corrective actions should implement strategies which consider accumulative ecosystem affect. O'Neil and Soulliere (2006) provide conservation guidelines which should be considered. Fisheries managers should continue to maintain a strong working relationship with the Holloway Reservoir Lake Association and with GCPRC to promote best management practices and conservation guidelines. Monitoring of potential groundwater contamination from Richfield Landfill is also recommended.

Current operating procedures for maintaining water levels in Holloway Reservoir have been generally accepted by the public. The May 1 and November 1 manipulation dates allows sufficient time for riparian's to maintain their docks and seawalls and provides protection of the shoreline and Holloway Dam from ice damage. Effects of the 4 foot winter drawdown on the fishery resource have not been studied but appear minimal. However, it is important for dam operators (City of Flint) and riparian's to understand the benefits of maintaining a minimum flow (run of river) during summer months and the necessity of early spring full pool levels which coincide with spawning periods of several fish species.

Mechanical devices, such as Holloway Dam, require routine and, at times, large scale maintenance. In 1998, MDEQ denied a permit from the City of Flint for a complete drawdown to address dam maintenance. Permit denial was partially based on MDNR Fisheries concern for the fishery resource. A modified permit was issued for a 1 foot drawdown beyond winter level and the City of Flint was able to perform maintenance on the upper portion of the dam. Lower dam maintenance is more

complicated due to potential effects on the fishery above and below the dam and economic impacts on the GCPRC and some local businesses. Lower dam maintenance, facilitated by a complete drawdown, requires careful planning and advanced public notice. A strategic plan for dam maintenance which is publicly supported and minimizes fisheries resource impact is needed.

Fisheries management of Holloway Reservoir should continue to focus on walleye as the primary sport fish. The walleye fishery is extremely popular and receives considerable angler effort which contributes significantly to the local economy. Since the walleye population is self-sustaining, no specific management actions are warranted. A strong 2007 year class should enter the harvestable fishery in 2009 or 2010 and will likely provide some excellent angling opportunities.

An over abundant channel catfish population is a problem for Holloway Reservoir. Data suggests channel catfish are suppressing abundance of gizzard shad, black crappie, and bluegill. Reduction or control of the population is problematic for fisheries managers. Channel catfish have few natural predators and conventional management practices involving chemical reclamation or manual removal are probably not economically justified, sociologically acceptable, or realistically attainable. Promoting recreational harvest has been attempted with newspaper articles but their value as food fare remains low in this area of the State. The slight abundance decline observed in 2008 may indicate self-regulating factors associated with available forage may be a work. Currently, no management actions appear available to manipulate their abundance artificially.

Carp appear in high abundance and biomass but do not seem to be as problematic as channel catfish. Common carp are omnivores consuming algae and small insects and rely less upon fish for dietary needs. Two previous attempts to reduce carp numbers by chemical reclamation met with little success and it appears little can be done to effectively control their numbers.

Although black crappie and bluegill populations appear suppressed, both species are exhibiting good growth and have shown small increase in abundance compared to that collected in 1999. Both species are providing recreational angling opportunities for those anglers targeting them. It is doubtful significant changes in abundance of either of these species will occur while channel catfish remain in abundance. No specific management recommendations are presented at this time.

Fisheries management should continue to monitor the Holloway Reservoir fish community with regularity. Changes in the forage base will likely trigger responses from other fish species and understanding those changes will be valuable with future management. Should funding become available, a creel census would provide additional insight to angler harvest, and attitude and is highly recommended.

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Figure 1. Holloway Reservoir located in Genesee and Lapeer counties.

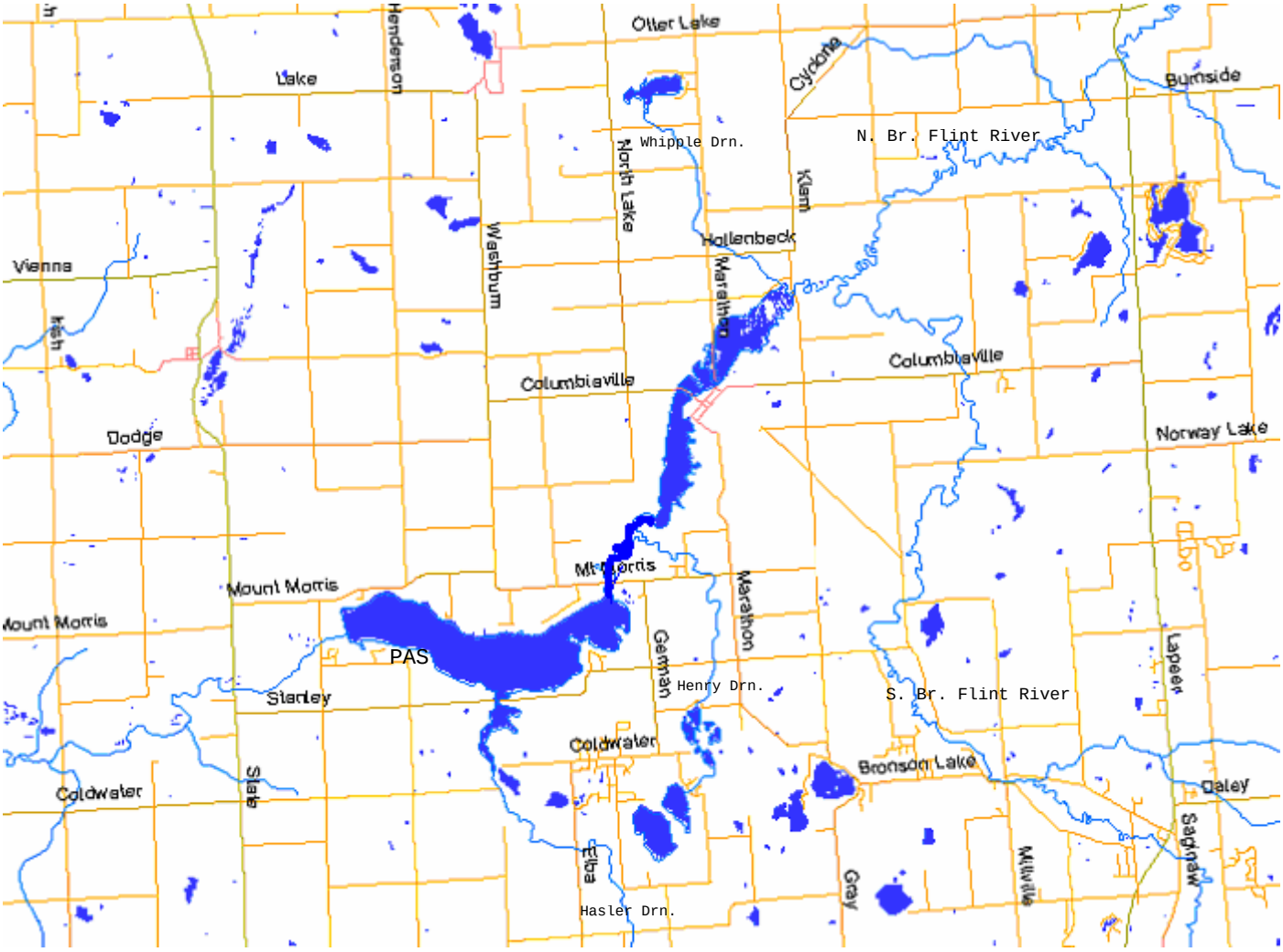

Table 1. Temperature, oxygen, and pH profile from the deep basin of Holloway Reservoir, Genesee and Lapeer counties. Data collected September 2, 2008 by MDNR, Fisheries Division.

Depth (ft)	Temperature (F)	Oxygen (ppm)	pH
1	76	13.4	8.3
2	76	13.5	8.2
3	76	13.5	8.2
4	76	13.5	8.2
5	76	13.4	8.2
6	76	13.3	8.2
7	76	13.2	8.2
8	76	13.2	8.2
9	76	13.1	8.2
10	76	12.7	8.1
11	75	12.0	8.0
12	74	9.4	7.9
13	74	7.8	7.7
14	73	4.6	7.6
15	73	2.8	7.5
16	73	2.0	7.5
17	73	1.4	7.5
18	73	1.2	7.5
19	73	1.1	7.5
20	73	1.0	7.3

Table 2. Water chemistry parameters from Holloway Reservoir, Genesee and Lapeer counties. Data collected by MDEQ, Land and Water Management Division.

Parameter	Surface	Mid-depth	Bottom	Sample date
Calcium, total		73.6 mg/l		04/14/03
Chlorides		48.0 mg/l		04/14/03
Chlorophyll a		11 ug/l		04/14/03
Conductivity	487 umho/cm	489 umho/cm	510 umho/cm	08/18/03
Hardness, carbonate		281 mg/l		04/14/03
Hardness, non-carbonate		113 mg/l		
Magnesium, total		23.5 mg/l		04/14/03
Nitrogen, ammonia as NH3	0.04 mg/l	0.04 mg/l	2.00 mg/l	08/18/03
Nitrogen, ammonia + organic	1.12 mg/l	0.918 mg/l	2.00 mg/l	08/18/03
Nitrogen, ammonia as N	0.029 mg/l	0.032 mg/l	0.049 mg/l	08/18/03
Nitrogen, nitrate + nitrite	0.01 mg/l	0.01 mg/l	0.01 mg/l	08/18/03
Nitrogen, organic	1.09 mg/l	0.89 mg/l	1.95 mg/l	08/18/03
pH	8.3	8.1	7.4	08/18/03
Phosphorus, total	0.061 mg/l	0.052 mg/l	0.065 mg/l	08/18/03
Secchi	0.6 m			
Sodium, total		19.1 mg/l		04/14/03
Sulfur, total		63.0 mg/l		04/14/03

Table 3. Fish stocking in Holloway Reservoir, Genesee and Lapeer counties, 1976 to present. Data from MDNR, Fisheries.

Year	Species	Number	Size Range (inches)
1976	Black crappie	1,535	7.0
	Bluegill	410	6.0
	Channel catfish	36,488	1.5 – 16.0
	Fathead minnow	90,000	2.0
	Largemouth bass	24,572	2.5 – 12.0
	Northern pike	79	26.0
	Pumpkinseed sunfish	32,950	1.0
	Steelhead	231,014	2.3
	Tiger muskellunge	2,975	8.8
	Walleye	8	20.0
1977	Channel catfish	30,000	3.0
	Largemouth bass	26,000	3.2
	Tiger muskellunge	12,006	6.8
	Walleye	1,750,000	fry
	Walleye	14,145	3.2
1978	Channel catfish	60,000	1.5
	Tiger muskellunge	4,000	6.8
1979	Channel catfish	20,000	2.6
	Largemouth bass	2,800	2.7 – 3.0
	Smallmouth bass	6,023	4.7
	Tiger muskellunge	4,000	5.4
1980	Tiger muskellunge	4,000	6.9
1981	Tiger muskellunge	3,000	6.7
1982	Tiger muskellunge	1,848	6.7
	Walleye	4,100,000	fry
1983	Walleye	9,822	1.9 – 3.1
1984	Tiger muskellunge	7,000	6.9
1985	Walleye	2,835,000	fry
1986	Tiger muskellunge	4,000	8.0
1988	Tiger muskellunge	3,400	9.7
1990	Tiger muskellunge	5,400	10.3
1991	Walleye	11,100	2.0
1992	Walleye	60,000	1.5

Table 4. List of fishes in Holloway Reservoir, Genesee and Lapeer counties. Origin: N= native, I= introduced, C= colonized. Status: P= recent observations. E=extirpated. Data from: Michigan Department of Natural Resources, Fisheries Division records.

Common name	Scientific name	Origin	Status
Black crappie	*Pomoxis nigromaculatus*	N	P
Bluegill	*Lepomis macrochirus*	N	P
Bowfin	*Amia calva*	N	P
Brook silverside	*Labidesthes sicculus*	N	P
Brown bullhead	*Ameiurus nebulosus*	N	P
Channel catfish	*Ictalurus punctatus*	N,I	P
Common carp	*Cyprinus carpio*	C	P
Common shiner	*Luxilus cornutus*	N	P
Emerald shiner	*Notropis atherinoides*	N,I	P
Gizzard shad	*Dorosoma cepedianum*	N,I	P
Green sunfish	*Lepomis cyanellus*	N	P
Johnny darter	*Etheostoma nigrum*	N	P
Largemouth bass	*Micropterus salmoides*	N	P
Northern pike	*Esox lucius*	N	P
Pumpkinseed	*Lepomis gibbosus*	N	P
Rainbow trout	*Oncorhynchus mykiss*	I	E
Rock bass	*Ambloplites rupestris*	N	P
Round goby	*Neogobius melanostomus*	C	P
Smallmouth bass	*Micropterus dolomieu*	N	P
Spotfin shiner	*Cyprinella spiloptera*	N	P
Tiger muskellunge	*Esox lucius x Esox masquinongy*	I	E
Walleye	*Sander vitreus*	N,I	P
White sucker	*Catostomus commersoni*	N	P
Yellow bullhead	*Ameiurus natalis*	N	P
Yellow perch	*Perca flavescens*	N	P

Table 5. Comparison of trap net catches (percent of total) from four Holloway Reservoir surveys, 1983 - 2008. Data from MDNR, Fisheries Division files.

Species	**1983**	**1989**	**1999**	**2008**
Black crappie	80	74	8	19
Bluegill	12	15	5	11
Bowfin		< 1		
Channel catfish		2	40	46
Common carp	5	4	16	13
Gizzard shad			22	
Largemouth bass	< 1	< 1	< 1	< 1
Northern pike	< 1	< 1	1	1
Pumpkinseed	< 1		<1	< 1
Rock bass			< 1	
Smallmouth bass	2	1	3	2
Tiger muskellunge	< 1	< 1		
Walleye	< 1	2	1	2
White sucker	1	1	2	4
Yellow bullhead	< 1	< 1	< 1	< 1
Yellow perch	< 1	< 1	< 1	< 1
Total fish captured	2,399	4,064	2,272	483

Table 6. Number, weight, and length range of fishes collected with trap net, seine, and electro-fishing gear from Holloway Reservoir, Genesee and Lapeer counties, May, 2008. Data from MDNR, Fisheries Division records.

Common name	Number	Percent by number	Length range (in)	Weight (lb)	Percent by weight	Percent legal size	Average size (in)
Black crappie	99	12	3-14	44.1	6	77	8.7
Bluegill	76	9	2-9	22.0	3	78	7.2
Brook silverside	4	<1	2-4	<0.1	<1		3.5
Channel catfish	230	28	7-26	302.7	42	87	15.5
Common carp	66	8	15-24	231.6	32		19.3
Emerald shiner	72	9	1-4	0.2	<1		1.7
Green sunfish	1	<1	3.5	<0.1	<1		3.5
Johnny darter	1	<1	2.5	<0.1	<1		2.5
Largemouth bass	1	<1	14.5	1.6	0.2	100	14.5
Northern pike	7	<1	20-24	15.9	2.2	14	21.8
Pumpkinseed	2	<1	5-6	0.3	<1	50	6.0
Round goby	50	6	1.5	0.1	<1		1.5
Smallmouth bass	14	2	3-15	15.1	2	4	11.9
Spotfin shiner	1	<1	3.5	<0.1	<1		3.5
Walleye	143	17	4-28	51.7	7	8	6.9
White sucker	27	3	4-17	38.2	5		14.8
Yellow bullhead	1	<1	12.5	<1	<1	100	12.5
Yellow perch	25	3	3-7	1.3	<1	4	4.9

Table 7. Weighted mean length (in inches) at age, and growth relative to the State average for fish sampled from Holloway Reservoir with trap nets and electro-fishing gear, May, 2008. Number of fish aged is in parentheses. Data from MDNR, Fisheries Division records.

	Age/Length															
Species	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**Mean growth index[1]**
Black crappie	4.1 (11)	6.8 (15)	8.0 (10)	9.7 (17)	10.5 (11)	12.7 (2)	14.4 (2)									+0.7
Bluegill	2.9 (3)	3.8 (14)	7.0 (25)	8.0 (10)	8.7 (3)	9.0 (4)	9.1 (2)									+1.9
Channel catfish				9.4 (2)	12.2 (9)	12.3 (8)	14.2 (14)	14.2 (13)	15.5 (45)	15.8 (22)	19.0 (19)	23.8 (5)	19.9 (2)	23 (1)	23.3 (1)	-7.1*
Smallmouth bass	4.2 (2)	8.0 (1)	12.8 (6)	13.4 (3)	14.2 (2)	13.5 (1)										
Northern pike		20.4 (3)	22.0 (2)	24.0 (1)	22.5 (1)											
Walleye	5.5 (28)		15.8 (2)	20.4 (4)		22.1 (1)	25.6 (1)		26.4 (1)		27.4 (1)	28.4 (1)				-1.6
Yellow perch	4.2 (12)	6.1 (6)														

[1] Mean growth index is the average deviation from the state average length at age.

* State average growth rate based on mid-year season average.

Table 8. Weighted age frequency (percent) of five fish species collected May, 2008 from Holloway Reservoir, Genesee and Lapeer counties. Data from MDNR, Fisheries Division records.

	Age/Percent															
Species	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**Number caught**
Black crappie	10	20	16	33	16	2	2									99
Bluegill	2	16	50	20	5	5	2									76
Channel catfish				1	5	7	11	10	35	16	11	2	1	<1	<1	230
Smallmouth bass	15	8	40	16	15	5										14
Walleye	92		1		3	<1	<1		<1		<1	<1				143

Table 9. Walleye catch from October, 2007 electro-fishing assessment of Holloway Reservoir, Genesee and Lapeer counties. Data from MDNR, Fisheries Division files.

Inch group	Number caught
0	
1	
2	
3	
4	78
5	65
6	47
7	44
8	22
9	4
10	3
11	
12	3
13	12
14	33
15	8
16	7
17	22
18	13
19	5
20	3
21	
22	3
23	
24	
25	
26	
27	1
Total	373

Table 10. Weighted mean length (in inches) at age, and growth relative to the State average for walleye sampled from Holloway Reservoir, October, 2007 and May, 2008. Number of fish aged is in parentheses. Data from MDNR, Fisheries Division records.

	Age/Length													
Species/ Date	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Mean growth index[1]**
Walleye/ Oct., 2007	6.1 (60)	11.1 (8)	14.1 (16)	15.9 (23)	17.6 (11)	19.3 (15)	19.4 (3)	20.5 (1)		27.2 (1)				0.0
Walleye/ May, 2008		5.5 (28)		15.8 (2)	20.4 (4)		22.1 (1)	25.6 (1)		26.4 (1)		27.4 (1)	28.4 (1)	-1.6

[1] Mean growth index is the average deviation from the state average length at age.

Table 11. Weighted age frequency (percent) of catch for surveys conducted in October, 2007 and May, 2008 from Holloway Reservoir, Genesee and Lapeer counties. Data from MDNR, Fisheries Division records.

	Age/Percent													
Species/ Date	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Number caught**
Walleye/ Oct., 2007	68	2	8	10	4	4	1	<1		<1				373
Walleye/ May, 2008		92		1		3	<1	<1		<1		<1	<1	143