White River Watershed Status of the Fishery Resource Report

Muskegon, Oceana and Newaygo Counties
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Environment

Geography
The White River is a tributary of Lake Michigan and is located in west-central Lower Michigan. The entire watershed is contained within Newaygo, Oceana, and Muskegon counties (Figure 1). Figure 2 displays locations of landmarks in the watershed that will be discussed in this report. The mainstem (South Branch) of the river begins in Newaygo County just upstream of Elm Avenue then flows 84.3 miles in a south-westerly direction through Oceana and Muskegon counties to White Lake, then another 5.5 miles across White Lake and discharges to Lake Michigan. The total length of the river from the headwater to Lake Michigan is 89.8 miles.

Twenty principal tributaries discharge into the White River. The largest tributary is the North Branch of the White River that is 26.2 miles long and joins with the mainstem 18.4 miles from White Lake or 23.9 miles from Lake Michigan.

The mainstem flows through three municipalities including White Cloud, Hesperia, and Whitehall-Montague located on the upper portion of White Lake (Figure 1). Dams are located on the mainstem at White Cloud and Hesperia. White Cloud dam is located 63.7 miles from White Lake. The head of the dam is 14 feet high and the 50 acre impoundment is shallow with a maximum depth of about 8 feet. Hesperia dam is located 36.6 miles from White Lake. The head of the dam is 7.7 feet high and the 50 acre impoundment is shallow with a maximum depth of about 4 feet. Neither White Cloud Dam nor Hesperia Dam is presently equipped with turbines for generating electricity.

Channel Gradient
Channel gradient or slope is a good indicator of fisheries habitat within a river system. Generally, as gradient increases the hydraulic diversity of the stream increases providing better habitat for various life stages and species of fish. Channel slopes in Michigan typically range within the low to moderate gradient classes (Table 1). Slopes greater than 70 ft/mi are more typical of mountain streams. In Michigan, higher channel slopes are usually associated with glacial moraines and have some riffle areas with stone substrate that provide spawning habitat for trout and salmon. These areas of higher gradient usually also provide higher groundwater inflows that help maintain colder water temperatures in the stream. Gradient classes greater than 3 ft/mi will be considered the best fisheries habitat in this report because these slopes provide moderate hydraulic diversity with some riffles that are used for spawning and nursery habitat by coldwater fish.

The mainstem (south branch) of the river begins in Newaygo County 1,965 feet upstream of Elm Avenue at elevation 1066.3 feet then flows 84.3 miles in a south-westerly direction through Oceana and Muskegon counties to White Lake at elevation 580.7 feet, then another 5.5 miles across White Lake and discharges to Lake Michigan (O'Neal 2011; Figures 3 & 4). The total length of the river from the headwater to Lake Michigan is 89.8 miles and the river drops 485.6 feet in elevation from the headwaters to White Lake for an average gradient of 5.8 feet/mile (range = 0.0 to 33.4 feet/mile). Channel slope is highest in the 20.6 mile upper river segment from Elm Avenue to White Cloud Dam, averaging 11.1 ft/mile (Table 1). Channel slope in the 27.0 mile middle segment of river between White Cloud Dam and Hesperia Dam averages 4.4 feet/mile. There are two relatively flat portions of the river in the middle section. These include an 8.1 mile segment located near the mouths of Rattlesnake and Robinson Creeks with gradients from 2.0 to 3.2 feet/mile, and another 10.1 mile segment located from near the mouth of Mena Creek to Hesperia Dam with gradients from 2.3 to 3.4 feet/mile (Figure 4). Channel slope in the lower White River between Hesperia Dam and White Lake averages 3.8 feet/mile. Gradient is relatively low in the 17.1 mile lower segment from near the confluence of Skeel Creek to just downstream of the confluence of Sand Creek, averaging 1.7 to 3.7 feet/mile. The 6.2 mile river segment downstream of the mouth of Sand Creek to White Lake has no gradient and water levels are affected by White Lake and Lake Michigan water levels.

The North Branch of the White River drains from McLaren Lake in Oceana County and is 26.2 miles long and joins with the mainstem 18.4 miles from White Lake or 23.9 miles from Lake Michigan (Figures 3 & 5). The change in elevation from McLaren Lake to the mouth is 170.6 feet and the river has an average slope of 6.5 feet/mile (range = 0.0 to 16.7 feet/mile; Table 1). The North Branch of the White River has one relatively flat portion of river that is a 1.4 mile segment extending downstream of McLaren Lake.

River Discharge

Water discharge can vary in different areas of a stream and is a function of precipitation, geology, soils and land-use in local areas. Streams supporting coldwater fish generally have stable flows with low flood flows and high summer base flows (90% exceedence flows). Streams with stable flows generally have substantial amounts of permeable soils in the watershed and high groundwater inflows. Water yield at any point in a river can be determined by dividing water discharge by drainage area. Low flow water yield is determined by dividing the 90% exceedence (summer) discharge by drainage area. Low flow water yield values are related to fish production (Zorn et al. 2010) and will be used later in the discussion of fisheries potential within the White River watershed.

River discharge was measured at 10 stations on the mainstem of the White River during July 1995 and August 1996 when the river was near base flow conditions (O'Neal 2011; Table 2). The pattern of discharge was similar for both years (Figure 6). Discharge generally increased from upstream to downstream with the exception of two segments where discharge decreased. The two river segments where discharge decreased in 1995 and 1996 were between M-37 and Echo Drive, and between Dickinson Road and Hesperia Dam. Neither the City of White Cloud nor the Village of Hesperia withdraws water from the river for municipal use. The reason for the decrease in discharge is uncertain and would require more evaluation to determine. One possible reason for the decrease at Hesperia would be evaporation from the 50 acre impoundment. Evaporation losses can increase with more surface water area exposed to the atmosphere within the impounded area of the river. Losses in river discharge were found in an impounded river segment in the Middle Branch River in Michigan where evaporation was suspected as the cause (O'Neal 2006).

Low flow water yield values were determined for each sampling station in 1995 and 1996 (Table 2). Water yield ranged from 0.45 to 0.73 ft3/mi2 in 1995 and from 0.26 to 0.70 ft3/mi2 in 1996.

Water Quality

Water quality is an important habitat component for stream fish. Water temperatures determine the types and production level of fish that will be present in Michigan streams (Zorn et al. 2010). Nutrient levels can also affect habitat quality by changing algal and rooted plant communities in streams. Nutrient levels also are indicators of high human development and excessive storm water runoff that generally degrade fish habitat in streams.

Summer water temperatures were collected on the mainstem of the White River in 1993 and 1996 (O'Neal 2011; Table 3). During 1993, water temperatures were collected every two hours at ten stations in June and nine stations in July and August over a long section of the mainstem between 6-mile Road and Cleveland Road. Monthly mean water temperatures for June through August displayed a similar pattern (Figure 7; Table 3). Water temperatures were relatively stable or cooling in the 8.5 mile river segment from 6-mile Road to Fivemile Creek Mouth upstream of White Cloud Impoundment, and then increased sharply in the 1.9 mile river segment across White Cloud Impoundment to M-37. Temperatures gradually increased slightly in the 25.3 mile river segment from White Cloud Dam to Dickinson Road, then increased sharply in the 2-mile river segment across Hesperia Dam to Loop Road. They decreased slightly in the 9.7 mile river segment downstream to Cleveland Road.

During 1996, water temperatures were collected hourly at four stations from June through August over a 13.9 mile section of the mainstem between 6-Mile Road and Echo Drive. Monthly mean water temperatures for June through August displayed a similar pattern as in 1993 (Figure 8; Table 3). Water temperatures were relatively stable or gradually increased in the 8.5 mile river segment from 6-mile Road to Fivemile Creek Mouth upstream of White Cloud Impoundment, and then increased sharply in the 1.9 mile river segment across White Cloud Impoundment to M-37. They increased slightly in the 3.5 mile river segment from M-37 to Echo Drive.

The coldest minimum water temperatures were always found upstream of White Cloud Impoundment and the highest maximum water temperatures were most often found in the middle or lower river sections. This was true for both 1993 and 1996 (Table 3).

The complete set of hourly water temperatures collected for July 1996 at Fivemile Creek Mouth, M-37, and Echo Drive are displayed in Figure 9. The daily pattern was consistent throughout the month of July. Water temperatures displayed 24-hour fluctuations that represent the effects of warm day periods and cool night periods at Fivemile Creek Mouth upstream of White Cloud Impoundment. At M-37, just downstream of White Cloud Impoundment, water temperatures were consistently warmer and more stable with 24-hour periods exhibiting little fluctuation. Water temperatures at Echo Drive displayed the typical 24-hour daily fluctuation but at higher temperatures due to the temperature increases caused by White Cloud Impoundment. This information indicates that the true water temperature increases caused by White Cloud Impoundment should be determined from the water temperatures at Echo Drive because that is where the normal 24-hour fluctuation pattern was reestablished. The warmer, very stable 24-hour daily fluctuation pattern found downstream of White Cloud Impoundment is the result of the larger volume of slow moving water in the impoundment that has lower daily fluctuations (i.e., readily absorbs, but slowly releases heat). Similar water temperature patterns were found in the Muskegon River downstream of Croton Dam (O'Neal 1997).

The White Cloud Dam was built with a bottom draw structure when reconstruction took place in 1990. The bottom draw structure was operating during water temperature collections conducted in this survey. To better determine the effects of the dam and bottom draw structure on water temperatures in the White River, water temperatures in the impoundment were collected at 1:00 pm on August 9, 1996. Water temperatures in the impoundment (near the discharge) ranged from 72.3 F at the surface to 64.9 F at the bottom (Figure 9). At the same time, water temperatures upstream of the impoundment were 61.0 F and water temperatures downstream of the impoundment were 70.2 F. The bottom draw structure had little effect at moderating increased water temperatures from water discharged through the White Cloud Dam.

De Mol (2009) provides detailed information regarding nutrient loading in the White River Watershed. Overall, the watershed is receiving increased phosphorous and nitrogen loading resulting from increased development. Both agriculture and residential development is causing increased nutrient levels in the watershed. Sub-watersheds with the highest concern for nutrient loading include Robinson Creek for residential development in Robinson Lake; Black Creek, Skeel Creek, Cushman Creek and Brayton Creek for agricultural runoff; the upper portion of the North Branch for residential development on McLaren Lake, Pierson Drain near White Lake for agricultural runoff; and the White Lake area for residential runoff.

Land Cover and Use

The White River Watershed was heavily logged during the mid-to-late 1800s. Historical photographs of this general area showed that few trees were left standing after logging occurred. The logs were transported to White Lake using the stream channels which resulted in severe degradation of habitat for aquatic life. Historical and current logging may presently be affecting in-stream wood habitat in the watershed.

Prior to European settlement in the 1800s, the White River Watershed was 96% forested with the remaining area composed of lakes, rivers and wetlands (Table 4). In 2001, the watershed was 66% forested with about 2.5% composed of lakes, rivers and wetlands. About 18% of the land was used for agriculture and 3% was urbanized (this includes all roads). Most of the agricultural lands were found in the middle and lower portions of the watershed (Figure10). About 11% of the land was covered in herbaceous open land that includes abandoned farm land. De Mol (2009) found that since 1978 the upper portion of the watershed had converted some crop land to open fields and forest. In the middle and lower portions of the watershed, more residential and specialty crop land had developed. About 23% of the watershed is contained within the Manistee National Forest and managed for the protection of woodland and wildlife.

Special Jurisdictions

A large portion of the White River is classified Designated Trout Stream under the Michigan Natural Resources and Environmental Code, Public Act 451, Part 487, 1994. Designated Trout Streams generally provide cold water fish habitat and have different fishing regulations and more restrictive water quality regulations than streams supporting cool or warm water fish. All of the mainstem from the mouth at White Lake to the headwaters (84.3 miles) is Designated Trout Stream. All of the North Branch upstream to 192nd Avenue (24.3 miles) in Oceana County is a Designated Trout Stream. The 1.9 mile river segment upstream from 192nd Avenue to McLaren Lake is not Designated Trout Stream due to the warm water discharged from the lake during summer. Most of the tributaries in the watershed are also Designated Trout Streams.

The White River was designated a Natural River in June 1975 under the Michigan Natural Resources and Environmental Code, Public Act 451, Part 305, 1994. The associated private land zoning ordinances were certified by the Secretary of State in February 1979. Most of the mainstem and principal tributaries are regulated under these ordinances. The Natural Rivers ordinances were designed to protect Michigan Rivers from unwise use and development.

History

Trout and salmon were not native to the White River, with the possible exception of lake trout or whitefish spawning runs from Lake Michigan. There are no available records that indicate spawning runs of these fish occurred in the White River, or that grayling were present. Brook trout generally were considered to have a natural distribution in Michigan only as far south as Traverse City.

The White River has an extensive history of fisheries management. As described above, fish stocking has occurred for many years and continues today. The section of stream between 3-Mile Road and Monroe Street, upstream of White Cloud, was used for rearing brook trout during the 1930s and early to mid-1940s. There was considerable public input on how to manage the upper section of the river beginning as early as the 1930s. Most of this discussion was focused on stocking either brook trout or brown trout in the upper river.

Fish stocking in the mainstem and North Branch will be summarized below but stocking in tributaries will not be discussed. Consistent records of fish stocking in the White River watershed began in 1936. Brook trout were stocked during most years between 1936 and 1964 upstream of White Cloud (Table 5). However, stocking had occurred before that time as brook trout were collected in this river section during 1929 (Schultz 1953). Fisheries Division files show there was a brook trout rearing station in this section of river during the 1930s. Schultz (1953) also found that only brook trout were present in this section of river in 1929 and that brown trout were found in 1932 and had increased substantially by 1938 with no stocking. Fisheries Division files indicate there is uncertainty about how brown trout initially entered the upper section of the White River but it was suspected they were brood stock from the Paris hatchery, or they were stocked because a stocking truck lost oxygen and the fish were stocked to prevent them from dying. Stocking of fish into this river section was discontinued in 1965 because natural reproduction was sufficient to maintain the population.

Brown trout were the primary species of fish stocked into the river between White Cloud and Hesperia from 1936 through 2010 (Table 6). Some brook trout were stocked during 1937 to 1940 and rainbow trout were stocked sporadically (six years) from 1940 to 1974. Stocking of brown trout continues in this river section because survival of juvenile and adult fish is low due to high water temperatures.

The winter run (Michigan) strain of steelhead has been stocked into the river downstream of Hesperia during most years from 1968 through 2010 (Table 7). Several strains of summer run steelhead were stocked from 1984 through 1990. Summer run steelhead stocking was discontinued based on evaluations of angler catches that indicated low returns to the river in comparison to winter run steelhead. Limited stocking of brown trout and rainbow trout (resident strains) occurred sporadically (four years) from 1957 through 1991. Walleye stocking in White Lake began in 1981 and continues on an alternate year schedule. Steelhead and walleye stocking continues in the lower river section because natural reproduction is not sufficient to maintain the populations. Presently, the lower river has significant spawning runs of steelhead and walleye. White Bass were native to White Lake and the lower river and these populations provided significant fisheries. Some adult white bass were stocked in 1983 and 1984 in an attempt to restore a spawning population of this species in White Lake and the lower river. Very low numbers of white bass are found in White Lake presently and a stocking program to help restore this population has been a management objective for more than 10 years. Great Lakes muskellunge were native to the White River Watershed but few, if any, remain. Stocking of muskellunge to restore a population in White Lake and the lower river has been a management objective for a number of years.

The North Branch of the White River was stocked with fish from 1936 through 1964 (Table 8). Brook trout, rainbow trout and brown trout were stocked inconsistently during this period. Stocking was discontinued in this river segment in 1965 because natural reproduction was sufficient to maintain the fish populations.

A selected summary of information from Department of Natural Resources (DNR) Fisheries Division files is provided in Table 9. Fisheries surveys at various locations in the watershed were conducted during 1926, 1929, 1932, 1938, 1952, 1960, 1969, 1971, 1972, 1973, 1976, 1978, 1989, 1991, 1992, 1993, 1998, 2002, and 2004. Schultz (1953) conducted a fisheries survey of the entire watershed in 1952 and information from this survey was summarized in Table 10. Lincoln (1976) repeated this survey for the mainstem downstream of Hesperia and the North Branch. A list of the 58 fish species collected in these two surveys is provided in Table 11. The distribution of trout and salmon in the White River Watershed is shown in Figure 11, based on fish collections made in DNR surveys from 1952 through 2004. The distribution of trout and salmon indicates cold water fish habitat exists throughout most of the watershed. Brook trout, brown trout, steelhead (rainbow trout), Chinook salmon and coho salmon were all found in the mainstem and tributaries downstream of Hesperia and in the North Branch. Brown trout and brook trout were found upstream of Hesperia, and steelhead were found after dam failures. It is suspected that some anglers have transplanted steelhead upstream of Hesperia Dam to increase recruitment of juveniles. The river does not have coldwater habitat in the North Branch upstream of 192nd Avenue due to the natural warm water drainage from McLaren Lake. Some tributaries provide primarily warmwater habitat due to natural lake drainages and include Coonskin Creek, Robinson Creek, and Rattlesnake Creek (Table 10). Other tributaries have degraded coldwater habitat in all or part of the stream from man-made impoundments and include Silver Creek, Sand Creek, Cleveland Creek, and Mena Creek. Several tributaries also have degraded coldwater habitat due to agricultural land use and include Black (DeLong) Creek, Brayton Creek, and Skeel Creek (De Mol 2009; Schultz 1953; Table 10).

Sea lampreys were first discovered in Lake Michigan in 1936 and spawning runs were documented in every major watershed in the Lake Michigan basin by 1949. Schultz (1953) collected sea lamprey larvae in the White River downstream of Hesperia in 1952. A prospective site for an electric barrier on the White River was identified near the Fruitvale Road crossing but was never constructed due to limited effectiveness of these structures on other streams (Jeff Slade, USFWS, personal communication). The lampricide 3-trifluoromethyl-4-nitrophenol (TFM) was first applied to the White River in May 1965. Since 1965, the White River has been treated 14 times (Table 12). During a three year treatment interval this watershed has been estimated to produce up to two million sea lamprey larvae that would migrate to Lake Michigan if they were not killed. A substantial portion of the larvae are killed during a TFM treatment and treatments in the White River are part of the lake-wide lamprey control program in Lake Michigan. In 1983, DNR Fisheries Division proposed construction of a sea lamprey barrier in the North Branch of the White River (Table 9). This barrier was never constructed.

A number of water quality related biological surveys were conducted from 1981 through 2007 by the State of Michigan (Table 9). Invertebrate and fish data from these surveys generally agree with Fisheries Division data in that the watershed provides primarily coldwater aquatic communities.

Stream habitat improvement structures designed to increase the carrying capacity of fish were installed during 1955 in the mainstem upstream of White Cloud, Fivemile Creek and Martin Creek. During 1979, repair and installation of structures was conducted in these same stream segments and also Flinton Creek and Minnie Creek. Generally, stream improvement has been targeted at the section of the mainstem upstream of White Cloud and the smaller coldwater tributaries because these areas have the best, naturally sustaining trout populations.

The U.S. Forest Service (USFS) contracted with Grand Valley State University to conduct a mussel survey of the White River during summer 2003. The report found that Unionid mussel abundance had decreased significantly during recent years (Luttenton et al. 2003). He suggested the decline was the result of the loss of the adult breeding population in White Lake due to the invasion of zebra mussels. The loss of the adult breeding population resulted in the loss of juveniles that can be transported to upstream locations by fish.

Impoundments have been degrading coldwater habitat in the White River watershed since the early 1900s (Schultz 1953). Although brook trout were reared in the mainstem upstream of White Cloud during the 1930s and early 1940s, there were some instances of fish mortalities and these occurred intermittently through the early 1970s (Table 9). These mortalities were suspected to be the result of high water temperatures caused by numerous beaver dams and heavy agricultural development at that time. There have been no reports of fish mortalities in this section of river since the mid-1970s and only one beaver dam was reported since that time. Some reforestation of old agricultural land has also occurred in the upper section of the river (DeMol 2009).

In 1949, it was noted that Ferry Dam on the North Branch had washed out several years earlier (Table 9). Fisheries Division recommended that the Village of Ferry not rebuild the dam, and the dam was never reconstructed.

Dams on the mainstem of the White River have a long history of adverse fishery effects. Schultz (1953) and Lincoln (1976) described the effects of dams on the fish community of the mainstem and tributaries and that coldwater fisheries were degraded as a result of increased water temperatures downstream of the impoundments. Prior to 1950, fishery biologists had recognized that stocked brook trout would not survive downstream of White Cloud Dam and that neither brook trout nor brown trout would survive downstream of Hesperia. In 1951, Consumers Power Company was no longer generating electricity at either White Cloud or Hesperia Dams and they were looking for someone to take over ownership of the dams. Fisheries Division recommended against ownership of these dams due to maintenance costs and recommended removal of these structures because of the water quality degradation and fish passage issues. Ownership was eventually transferred to the local governments at the Village of Hesperia and City of White Cloud. Some water temperature evaluations were made by Fisheries Division in 1955 and an under-spill structure was built into White Cloud Dam in 1958. This under-spill was still in operation in 1973. A water temperature survey in 1972 - 1973 by the White River Watershed Council indicated significant water temperature increases were occurring across White Cloud impoundment. Another water quality and water temperature survey was conducted in 1975 by the White River Watershed Council and the Oceana County Planning Commission. In 1972, a steep pass designed to pass fish was installed at Hesperia Dam but was unsuccessful. A flood occurred in September 1975 and the City of White Cloud breached the northern side of the earthen dike to save the dam. The earthen portion of the Hesperia Dam was also washed out or intentionally breached during this flood. Both dams were rebuilt. Another flood occurred in September 1986, and both the City of White Cloud and Village of Hesperia cut channels through the earthen embankments to save the dam structure. There was considerable sediment transport to downstream areas of both dams. Both the DNR and angler groups challenged the reconstruction of White Cloud dam and the DNR offered to help rehabilitate and make recreational improvements to the old impoundment area. White Cloud Dam was reconstructed with federal funding in 1990 and equipped with an under-spill structure. Hesperia Dam was also reconstructed and was equipped with new aluminum stop logs in 1995, and improvements to the sill in 1997 to help prevent sea lamprey passage. The U.S. Fish & Wildlife Service (USFWS) helped fund the lamprey barrier work.

Hesperia Dam and White Cloud Dam were breached during the 1975 and 1986 floods and lamprey treatments began upstream of Hesperia in 1976. Larval sea lampreys were found upstream of White Cloud in 1990 and 1991. Structural improvements to Hesperia Dam appeared to have successfully blocked the upstream migration of spawning phase sea lamprey from 2002 through 2006, but additional year-class of sea lampreys were produced between Hesperia and White Cloud in 2007 and 2008. The 2010 treatment also included the river section upstream of Hesperia. Additional structural improvements on the dam were completed in 2010 to prevent lamprey migration upstream of Hesperia. Evaluations over the next two years will determine if the 2010 barrier repairs were effective at blocking lamprey migrations upstream of Hesperia. Tributary streams in the watershed where sea lamprey larvae have been found include Silver Creek, Carlton Creek, the North Branch of the White River, Bear Creek, Knutson Creek, Swinton (Cobmoosa) Creek, Skeel Creek, Cushman Creek, Brayton Creek, Taylor Creek, and Martin Creek.

Current Status

Summer water temperatures (June-August) in the White River increase significantly due to the presence White Cloud Impoundment. Average monthly water temperatures in 1993 increased from 2.3 F to 5.0 F from the Fivemile Creek Mouth sampling station upstream of White Cloud Impoundment to the Echo Drive sampling station downstream of the Impoundment (Table 13; Figure 7). During 1996, average monthly water temperatures increased from 3.7 F to 6.3 F between these two stations (Table 13; Figure 8). The highest water temperature increase occurred during July 1996 when average air temperatures were 3.9 F cooler than the long term average. The highest water temperature increase in 1993 also occurred during July when average air temperatures were near the long term average. The 2║F water temperature increase allowed by Michigan Surface Water Quality Standards was exceeded during July and August of 1993 and 1996.

The rate of water temperature warming per mile of river was six or more times higher across White Cloud Impoundment than in the stream segment immediately upstream of the Impoundment (Figures 7 and 8). During July and August of 1993 and 1996, average monthly water temperatures across White Cloud Impoundment increased from 0.89‖F/mi to 1.17‖F/mi, while the upstream river segment from 6-Mile Road to Fivemile Creek Mouth increased from 0.06‖F/mi to 0.18‖F/mi.

Hesperia Impoundment (from Dickinson Road to Loop Road) had average monthly water temperature increases of 0.5 F in June and 0.7 F in July and August of 1993 (Table 13). This temperature increase occurred over a 2.0 mile length of river and is significant when compared to the 21.8 mile river segment immediately upstream of the impoundment, from Echo Drive to Dickinson Road (Figure 7). The much longer upstream river segment had water temperature increases of 0.9 F in June, 1.2 F in July, and 1.3 F in August of 1993.

During July and August of 1993 and 1996, average monthly water temperatures increased from 0.25‖F/mi to 0.35‖F/mi across Hesperia Impoundment, a rate several times higher than adjacent river segments (Figure 7). The upstream river segment from Echo Drive to Dickinson Road increased from 0.04‖F/mi to 0.06‖F/mi. In the 9.7 mile river segment from Loop Road (Hesperia) downstream to Cleveland Road, summer water temperatures decreased from 0.2 F to 0.4 F. Because of the high rate of water temperature warming across Hesperia Impoundment and cooling of water in the downstream section, it is likely that Hesperia Dam would have more substantial effects on water temperatures in the White River if White Cloud Impoundment was not present. Water temperatures would be cooler near Hesperia if White Cloud Dam was not present.

Zorn et al. (2010) established relationships between average fish densities and low-flow (90% exceedence flow) yield and catchment area in Michigan streams. This information was used to evaluate potential habitat areas for coldwater fish in the White River. Low-flow water yield and catchment area values from 1993 and 1996 indicated suitable trout and salmon habitat should exist as far downstream as Cleveland Road, about ten river miles downstream of Hesperia Dam, if the river was not impounded (Figure 12).

Zorn et al. (2010) also established relationships between average fish densities and water temperatures for Michigan streams. The 1993 and 1996 data indicated a significant reduction in the river's potential for trout and salmon downstream of White Cloud Dam due to water temperature increases caused by the impoundment (Figure 13). Similar decreases were evident when comparing White River water temperatures to average numerical density of brown trout (Figure 14).

The water temperature and fish density relationships were consistent with present fish community information for the White River (Table 14). The estimated biomass of trout and salmon (from Figure 13) upstream of White Cloud Impoundment compared to downstream was 1.6 (1996) to 5.3 (1993) times greater, while actual fish collections from 1978 to 1993 were 3.6 to 3.9 greater based on averages (from Table 14). The predicted numerical density (from Figure 14) of trout and salmon upstream of White Cloud Impoundment compared to downstream was 2.7 (1996) to 8.5 (1993) times greater, while actual fish collections from 1978 to 1993 were 4.8 to 5.7 times greater based on averages. The brook and brown trout fisheries upstream of White Cloud Dam are self-sustaining, but the stream is stocked with trout downstream of White Cloud due to poor survival of juveniles. Greater densities of trout larger than 8 inches and larger than 13 inches occur upstream of White Cloud Dam than in downstream areas (Table 14). Trout are absent from the river downstream of Hesperia during summer. Steelhead are stocked downstream of Hesperia Dam.

Hydraulic diversity in the White River and North Branch of the White River is low (0.0 - 2.9 feet/mile) in 31.3 miles (28%) of the river (Table 1). There are 40.6 miles (37%) of river with moderate (3.0 - 5.9 feet/mile) hydraulic diversity and 38.6 miles (35%) of river with good (6.0 - 70.9 feet/mile) hydraulic diversity. There are no areas of the river with slopes greater than 71 feet/mile. These very high slopes are more typical of mountain streams.

Fish and other aquatic life are typically most productive in streams with greater hydraulic diversity because they provide more habitat diversity and support various life stages for multiple species. The best hydraulic diversity is found in streams with well established riffle, pool, and run sequences. In the White River system, higher slopes and greater hydraulic diversity are also often found in glacial moraine depositional areas that also have more gravel and cobble substrate and provide better spawning areas for fish. The best fisheries habitat (moderate and higher channel slopes) in the White River and North Branch of the White River account for 72% (79.2 miles) of total stream miles. Of this total, only the 31 % (24.8 miles) found in the North Branch are in a relatively natural condition unaffected by the two dams on the mainstem. The White River upstream of White Cloud Dam contains 26% (20.6 miles) of the moderate and good gradient habitat, the middle river section between White Cloud Dam and Hesperia Dam contains 23% (17.7 miles), and the lower river downstream of Hesperia Dam contains 20% (16.1 miles).

Analysis and Discussion

Established relationships between fish densities and low-flow water yield and catchment area in Michigan streams indicate the White River, without impoundments, has coldwater fish habitat from the headwaters near Elm Avenue downstream to Cleveland Road near the Pines Point Campground. When combined (excluding tributaries), the White River and North Branch of the White River have a length of 110.5 river miles. The moderate and higher channel slopes that provide the best fishery habitat account for 72% (79.2 miles) of total stream miles. Of this total, only the 31 % (24.8 miles) found in the North Branch are in a relatively natural condition unaffected by the two dams on the mainstem. The White Cloud and Hesperia Impoundments have significant negative effects on the production of coldwater fish and other aquatic life in 54.4 miles (69%) of the best habitat through water quality degradation (thermal) or prevention of seasonal fish migrations from Lake Michigan. Water quality degradation from water temperature warming is affecting fish production in 37.9 miles of the river from White Cloud Impoundment to Cleveland Road. Lake Michigan fish are prevented from migrating to 47.7 miles of stream from Hesperia Dam upstream to Elm Avenue in the headwaters. This represents significant, broad scale ecosystem effects that are degrading the overall health of aquatic communities within the watershed as well as Lake Michigan. Important species of fish that are affected include brown trout, steelhead, Chinook salmon, suckers, small forage fish and possibly lake sturgeon in the lower river.

The deleterious effects of these two dams on natural resources are as important as the system wide effects of land-use change that include urban and agricultural development within the White River Watershed. Substantial improvements in restoring natural ecosystem function and condition, fish community structure, coldwater fish production and angler-use could be obtained by removing the White Cloud and Hesperia Dams. The potential for restoration of natural ecosystem condition and providing significant, self-sustaining fisheries in the White River watershed is limited without removing the deleterious effects of these two dams.

Providing improved access and habitat for coldwater fish will also benefit sea lamprey spawning in the White River. Any proposal to make fisheries improvements to this system need to include consideration of expanded sea lamprey spawning and rearing habitat.

Presently, self-sustaining populations of brook trout and brown trout occur in the 20.6 miles of river upstream of White Cloud Dam, but Lake Michigan fish production does not occur because the dams block migrations of fish to this river segment. Species of fish affected in this section of river include steelhead, brown trout, Chinook salmon, coho salmon and suckers. In the middle river section between White Cloud and Hesperia Dams, resident brown trout production is presently reduced by water quality degradation from White Cloud Impoundment. Lake Michigan migratory fish are prevented access to this section of river by Hesperia Dam. If Lake Michigan migratory fish gained access to this section of river, juvenile production would also be affected by thermal water quality degradation from White Cloud Impoundment. Species of fish affected in this river section include brown trout, steelhead, Chinook salmon, coho salmon and suckers (various species). In the section of river from Hesperia Dam to Cleveland Road, water quality degradation from White Cloud and Hesperia Dams is presently affecting the production of brown trout, steelhead, and possibly lake sturgeon. A self-sustaining population of Chinook salmon presently exists in this river section. This is possible because juvenile Chinook salmon migrate to Lake Michigan from May to early June and are not affected by the high summer water temperatures in this river section.

Some fishing occurs in White Cloud Impoundment as there have been occasional reports of northern pike speared or caught by hook and line during the past 20 years. There have been no angler surveys conducted on either impoundment. DNR Fisheries Division files from the 1950s indicate White Cloud Impoundment was used primarily for swimming although there were public requests for stocking the impoundment. There have been no recent (since 1987) reports of fishing on Hesperia Impoundment and also no file records. Both of these impoundments are very shallow with maximum depths of less than 8 feet. These types of impoundments typically have very limited fisheries and generally support warm water species that were not native to the local area of the river. Northern pike are one species that typically have some survival in these shallow impoundments and are considered detrimental to coldwater fisheries because they prey on trout. Any loss in fishing activities from removal of the dams would be insubstantial compared to the overall ecological benefits and restoration of coldwater fishing to the watershed.

Fish community and population abundance surveys are limited in some areas of the watershed and should be updated in other areas. On the mainstem, the river segment from 6-Mile Road upstream to the headwaters needs to be surveyed. On the North Branch, the segment of river from Arthur Road upstream to the headwaters needs to be surveyed. Some of the tributaries have recent surveys but only in one location on the stream. Most of the tributary streams in the watershed should have surveys conducted from the headwater to the mouth. Surveys along the entire length of stream will help develop estimates of fish production and fish community types for the whole watershed.

Evaluation of fish community information should always be combined with collection of habitat information. Two of the most important habitat variables that should be evaluated are summer water temperatures and 90% exceedence-flow water yield (approximated by base flows discharge). This information is very useful for assessing the stream's potential for fish species and determining if habitat conditions in a stream are degraded. Whenever possible, Michigan DNR Fisheries Division Status and Trends sampling protocols (Wills et al. 2008) should be used to evaluate other habitat variables, especially wood cover in the river. Other habitat variables that can significantly affect fish communities in the White River Watershed are nutrients, dissolved oxygen, and stream flow (including storm flows).

Generally, all habitat components in the river are related to land use and its effects on the hydrology of the watershed. Maintaining stable hydrology is one of the most important criteria in maintaining the natural ecosystem functions of a river. Stable ground water inputs are important for maintaining coldwater aquatic habitat in the White River watershed. Changes in land use can result in increased or decreased ground water inflows and increased surface water inflows. Changing forested land to grassland, cropland, or pavement affects hydrology in different and complicated ways. For example, increases in grasslands can increase ground water inflows that increase river flows that destabilize the channel and cause increased erosion. Increases in cropland and paved areas can increase surface water runoff, more dramatically destabilize the channel, and decrease groundwater inflows. This can increase bank erosion, summer water temperatures, and the input of nutrients and other pollutants. Both agricultural and urban development usually involves the development of drains and the ditching of streams that changes stream flow patterns and can severely degrade channel habitat.

About 18% of the watershed was being used for agriculture and 3% for urban use in 2001. De Mol (2009) noted that since 1978 some agricultural land had reverted back to open fields and forests. Pijanowski (2002) found similar trends in the Muskegon River watershed that is located adjacent the White River watershed. He also found that future trends indicated more agricultural land will be converted for urban land use that may also occur in the White River watershed. De Mol (2009) listed a number of White River sub-watersheds that currently have degraded water quality due to agricultural and urban development.

New methods are under development in Michigan for evaluating and mitigating the effects of land use changes on Michigan rivers. These methods generally involve detailed analyses of the hydrology of the system and appropriate application of corrective measures. Information necessary to complete these analyses are currently not available for the White River. Fisheries Division should work with various agencies and partner organizations to begin hydrologic evaluations of the White River watershed.

Enforcement of the Natural Rivers ordinances should continue to provide protection of natural vegetation buffers from over development. Installation of wood structure in the watershed to restore cover for fish has been conducted since 1955 and continues presently. These types of projects should continue in the high quality sections of the river and tributaries where self sustaining populations of trout and salmon occur. Stream protection projects that include improved road crossings and establishing minimum 30 foot natural river buffers, and protecting river banks from erosion caused by cattle and human access should continue.

White bass were originally very abundant in White Lake and the lower river, but are found in very low numbers presently. Stocking of white bass should be conducted to help restore this population.

Genetic analysis of white bass from Lake St. Claire and Lake Macatawa (Ottawa County) indicate that Lake Macatawa fish should be used as the brood stock for stocking in Lake Michigan tributaries.

Great Lakes muskellunge were originally present in the White River watershed but few, if any, remain. This species should be stocked to restore a population in White Lake and the lower river. Fisheries Division is currently attempting to develop a brood stock of Great Lake Muskellunge, so it will be some time before muskellunge stocking will occur.

Management Direction

Habitat protection and restoration designed to restore natural ecosystem function in the White River watershed is the key objective that fisheries management should focus on. Changes in habitat are the primary reason for degradation of fisheries resources throughout this system.

The broad scale effects of dams in the river and land use change for agriculture and urban development throughout the watershed has affected the White River since the late 1800s and continues today. Management objectives necessary to protect and restore natural habitat conditions and fisheries resources include the following:

Objective 1. Conduct evaluations of pre-settlement, current, and future hydrologic conditions throughout the watershed. Use this information to apply appropriate corrective measures within each sub-watershed to restore hydrologic conditions to targeted levels currently under development by Fisheries Division.

Objective 2. Conduct targeted surveys of fish, water temperatures, and stream flow. These surveys should be designed to determine the natural distribution of coldwater and coolwater/warmwater habitats throughout the watershed.

Objective 3. Continue to enforce the Natural River ordinances to help protect natural vegetation buffers from development.

Objective 4. Continue stream protection projects including establishment of 30 foot minimum natural stream buffers; improving road crossings to reduce stormwater runoff and pollutants, and reduce blockage of fish migrations; and protecting river banks from erosion caused by cattle and human access. Evaluate and restore forests within the watershed to protect groundwater resources and steam flows.

Objective 5. Continue stream improvement projects to restore wood cover in the channel and natural tree cover in the stream corridor.

Objective 6. Rear and stock white bass from the Lake Macatawa population to help restore this fishery to White Lake and the lower river.

Objective 7. Rear and stock Great Lakes muskellunge to help restore this fishery to White Lake and the lower river.

Objective 8. Develop a plan to address the long-standing water quality degradation and migratory fish blockage caused by Hesperia and White Cloud Dams. Planning activities should involve multiple partners including resource agencies, the Village of Hesperia, the City of White Cloud and interested stakeholder organizations. Several potential options are listed below.

Option 1. Restore the White River by removing White Cloud and Hesperia Dams
This option would provide the greatest amount of ecosystem benefits to the aquatic community in the White River and includes removing both of the barriers blocking Lake Michigan fish migrations as well as eliminating the degrading water temperature effects of the dams. This option would restore Lake Michigan fish migrations to the 47.6 miles of stream from Hesperia to the headwaters that contain 38.3 miles of the best fisheries habitat in the river. Sea lamprey would also gain access to this river segment. Water quality degradation from water warming caused by dams would be eliminated in 36.8 miles of river from White Cloud to Cleveland Road (Pines Point) downstream of Hesperia. This segment contains 33.8 miles of the best habitat in the river. Abundance, survival and natural reproduction of resident brown trout would improve in the 36.8 mile river segment. Natural reproduction of Lake Michigan migrating steelhead, Chinook salmon, brown trout and suckers would significantly improve in the entire 57.3 miles of stream from the headwaters to Cleveland Road downstream of Hesperia. Fishing would substantially improve for Lake Michigan migrating suckers, steelhead, salmon, and brown trout in this entire section of river. Fish stocking would likely not be needed in the White River due to substantial increases in natural reproduction of all species.

Option 2. Remove Hesperia Dam.
This option would allow access of Lake Michigan migratory fish to 27.0 miles of river, expanding fishing opportunities in that area. Lake Michigan fish that would use this river segment during fall, winter and spring include suckers, steelhead, Chinook salmon, and brown trout. Natural reproduction of these species would not increase (except for reproduction of Chinook salmon, suckers and other non-salmonid species), with the exception of some small coldwater tributaries, because water temperature warming from White Cloud Impoundment would prevent survival of juveniles salmonids. Sea lamprey would also have access to this section of river.

Option 3. Remove White Cloud Dam.
This option would not provide any additional river access to Lake Michigan migratory fish. Water quality degradation from water warming caused by White Cloud Dam would be eliminated in 27.0 miles of river from White Cloud downstream to Hesperia. Abundance, survival and natural reproduction of resident coldwater fish would improve and stocking brown trout most likely would not be needed to maintain a fishery. All species of resident fish would be able to move feely in the upper 47.6 miles of river from Hesperia to the headwaters. Coldwater fish survival downstream of Hesperia would not improve due to the water warming effects of Hesperia Impoundment.

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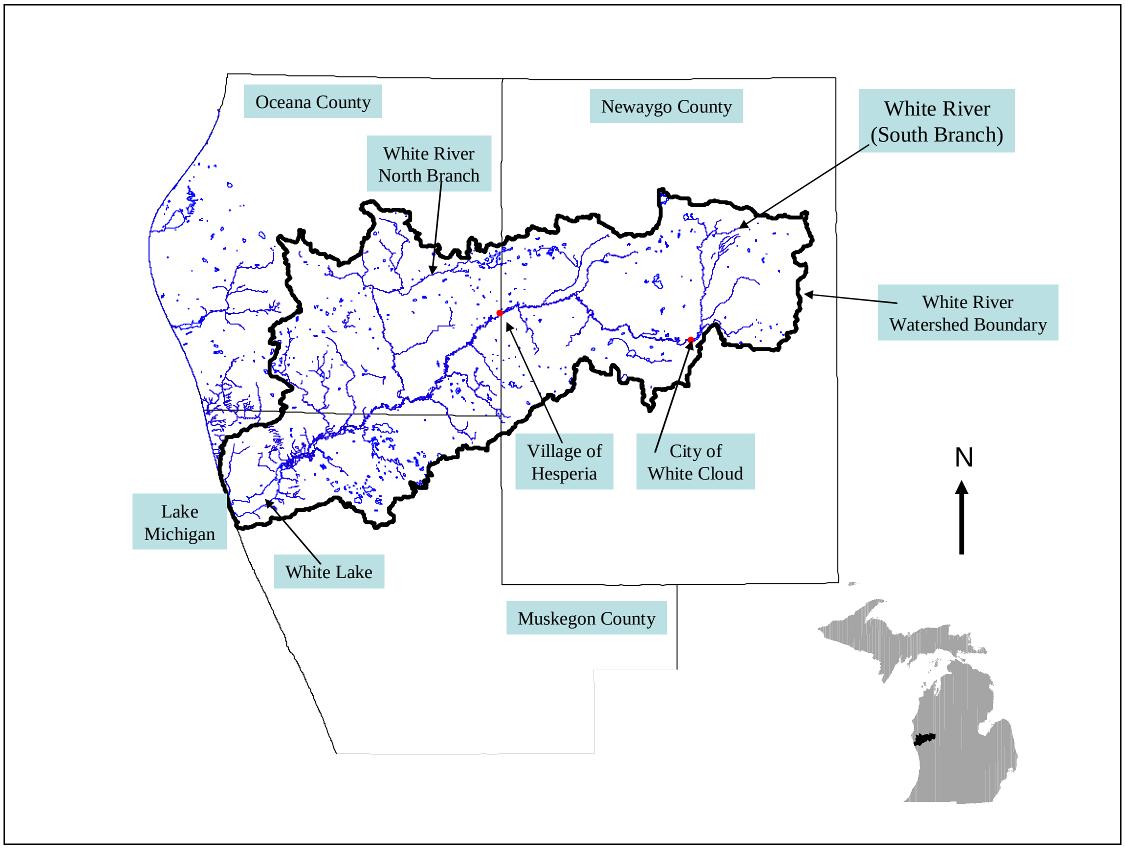


Figure 1. Map of the White River watershed with some principal landmarks.

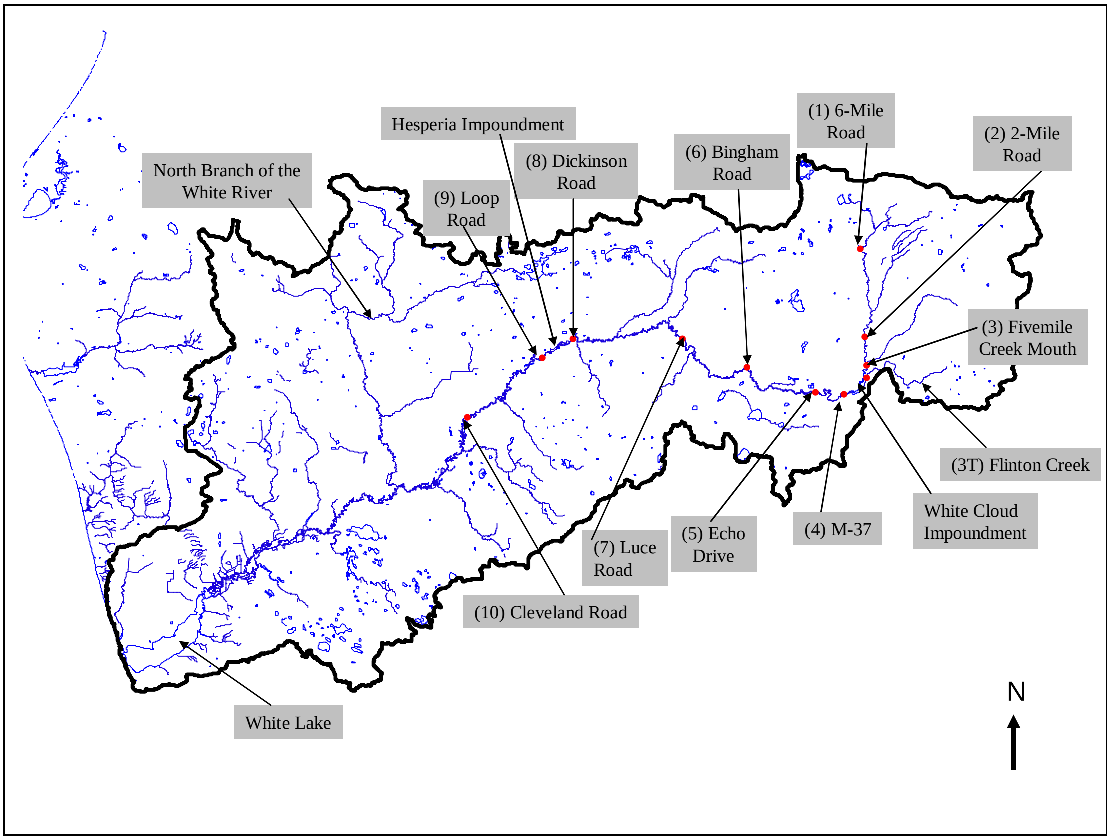


Figure 2. Map of the White River watershed showing specific site locations discussed in this report.

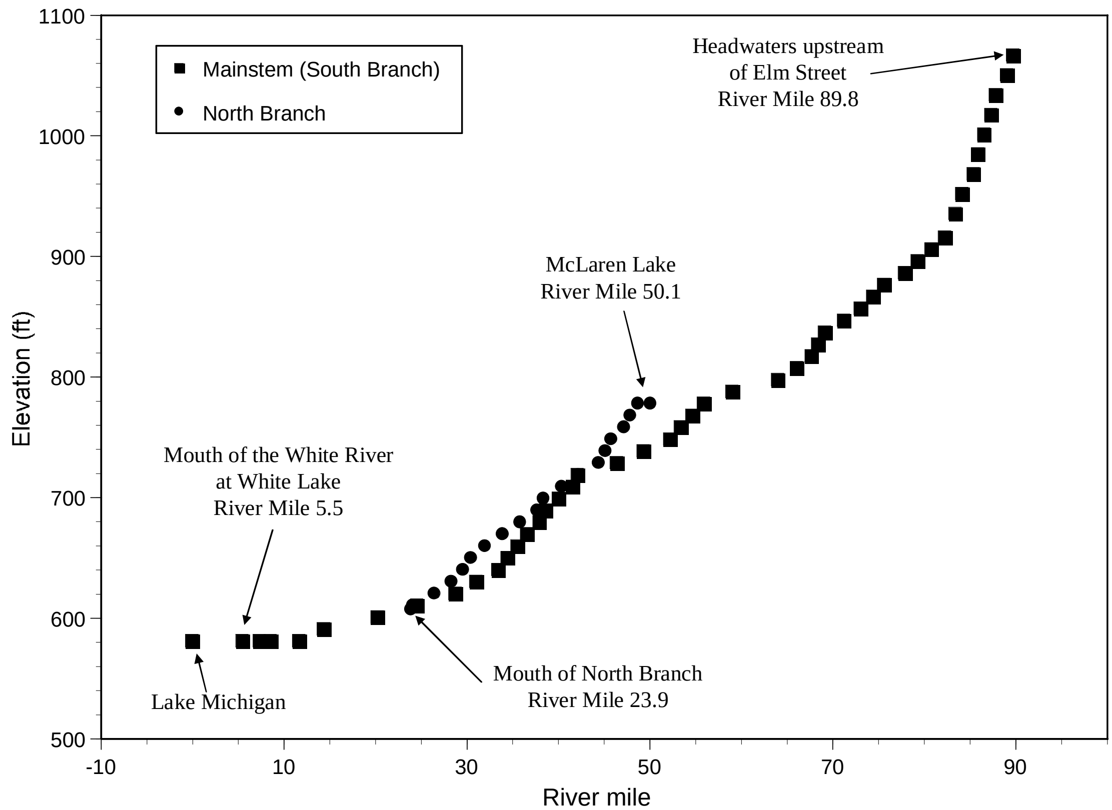


Figure 3. Gradient profiles of the White River and North Branch of the White River.

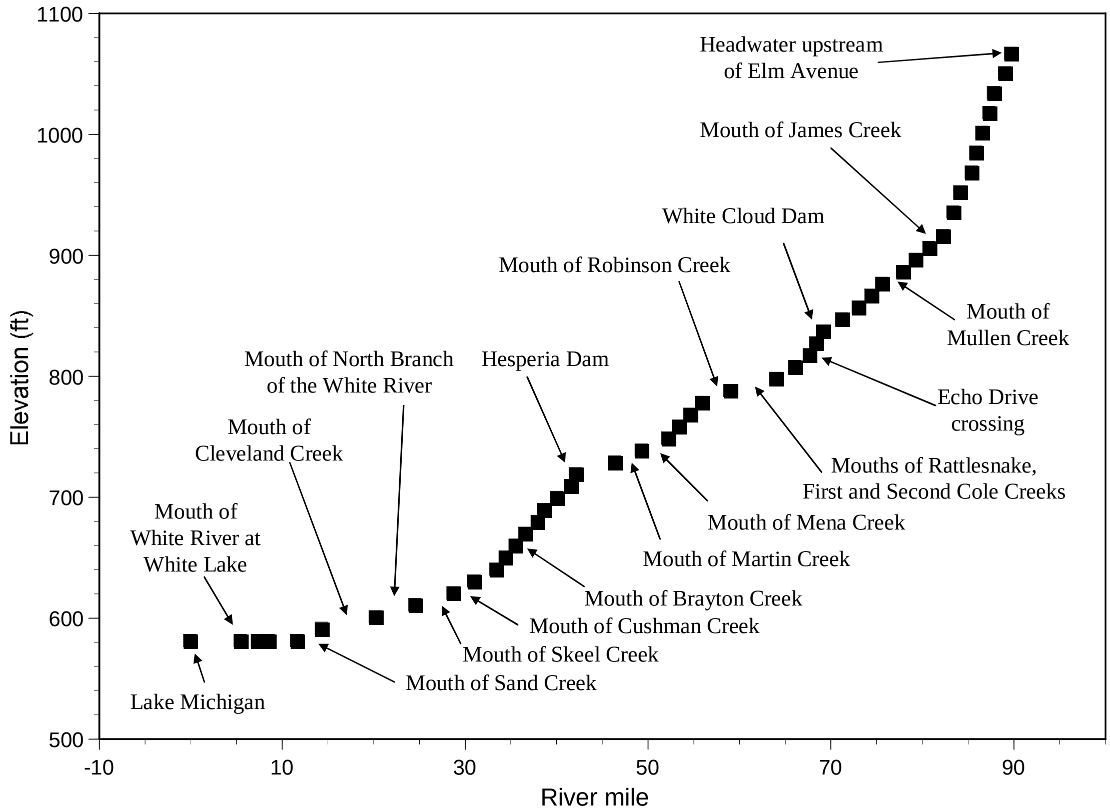


Figure 4. Gradient profile of the White River showing confluence locations of principal tributaries and some landmarks.

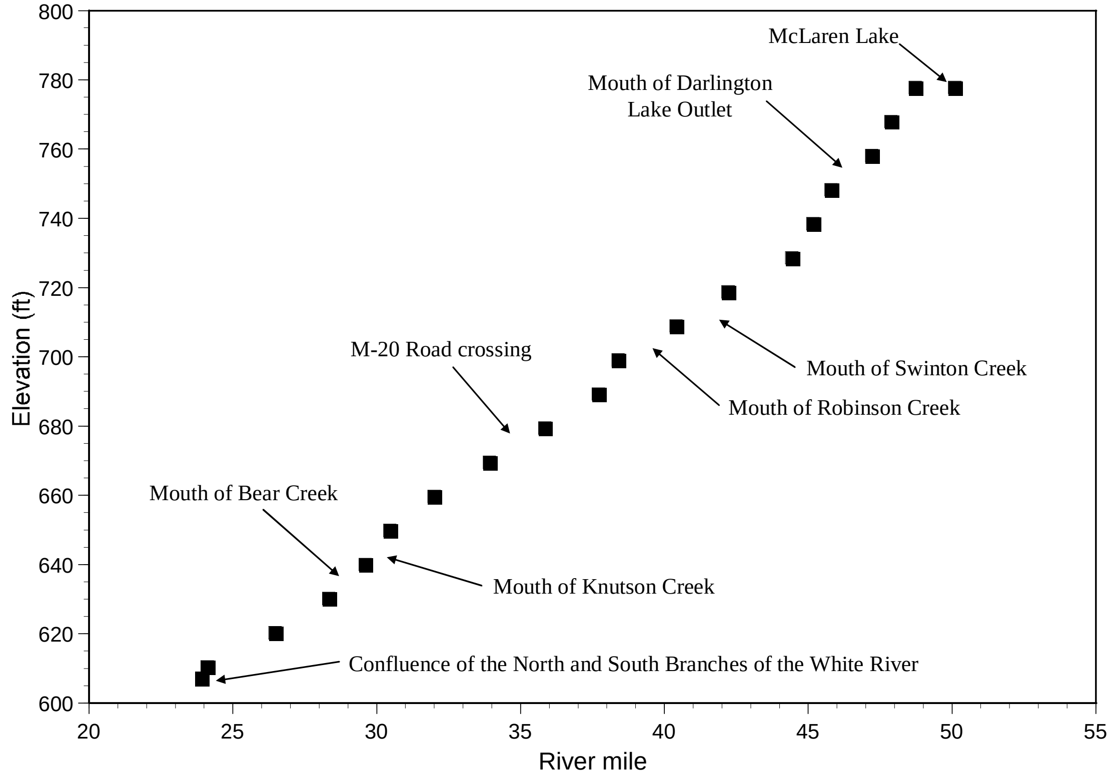


Figure 5. Gradient profile of the North Branch of the White River showing confluence locations of principal tributaries and some landmarks.

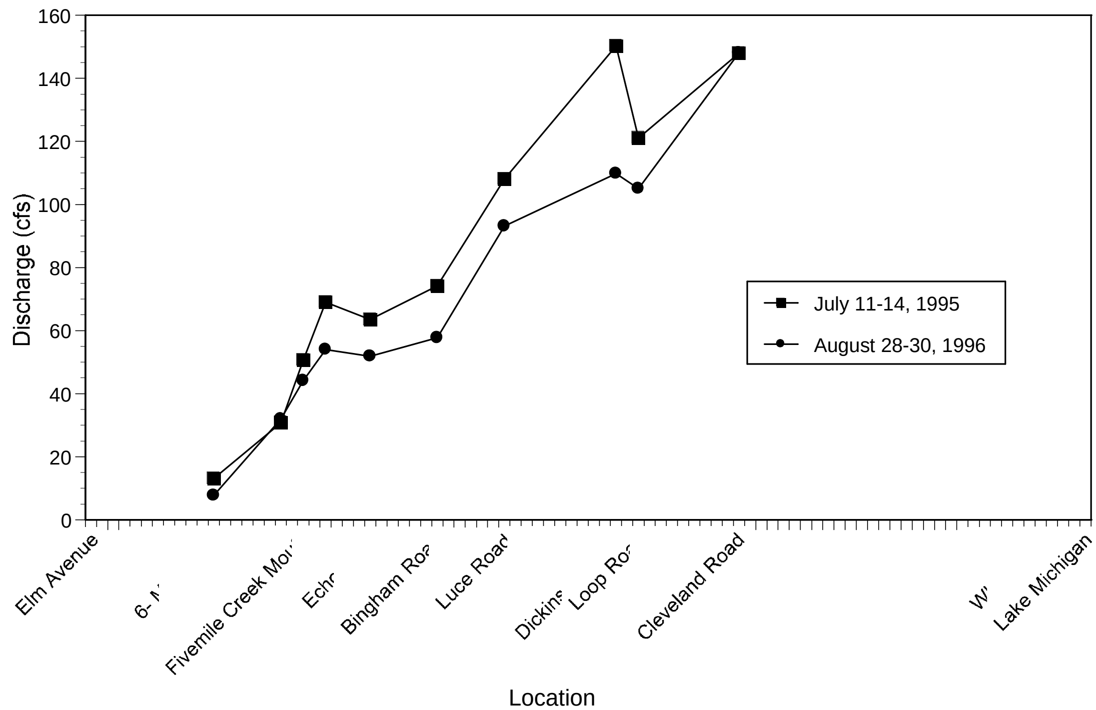


Figure 6. Water discharge measurements from July 11-14, 1995 and August 28-30, 1996 for ten stations on the White River. The locations (X-axis) are scaled to reflect appropriate river mile distances between sites.

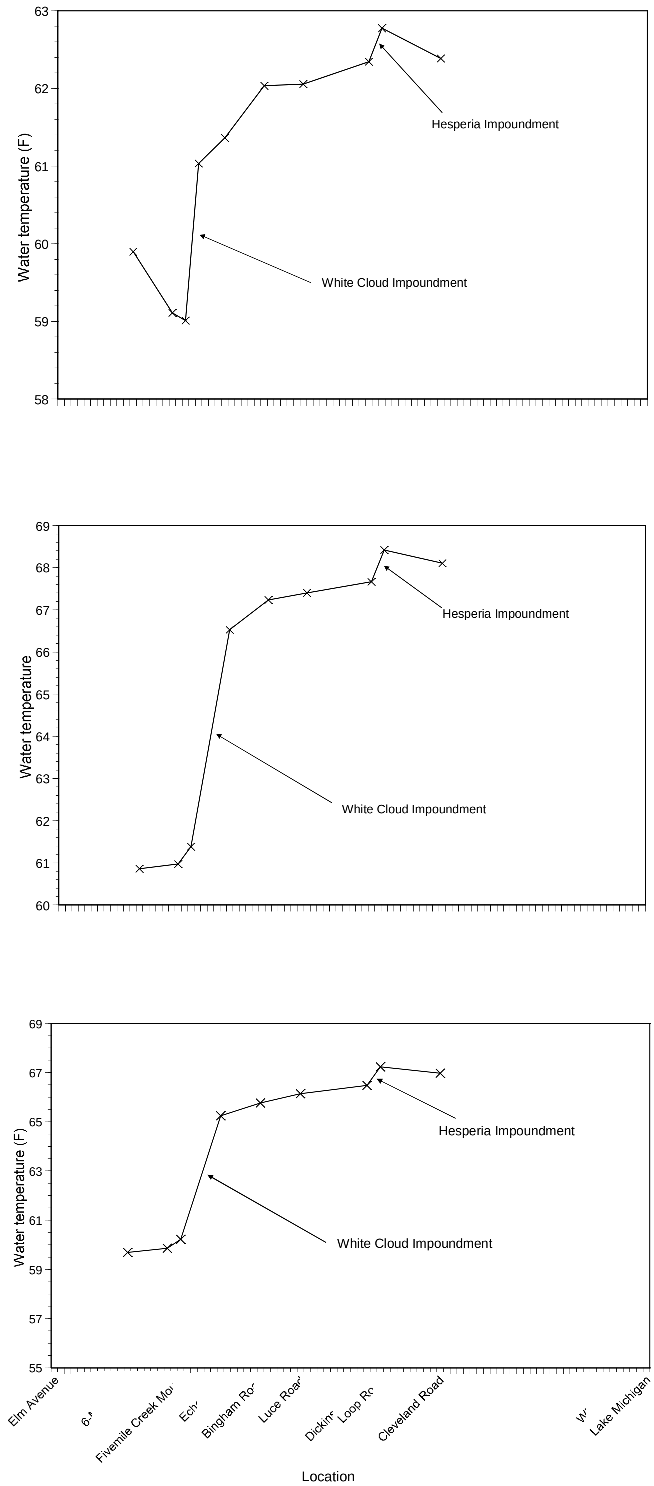


Figure 7. Average water temperatures at nine locations on the White River for June (upper), July (middle), and August (lower) 1993. The locations (X-axis) are scaled to reflect appropriate river mile distances between sites.

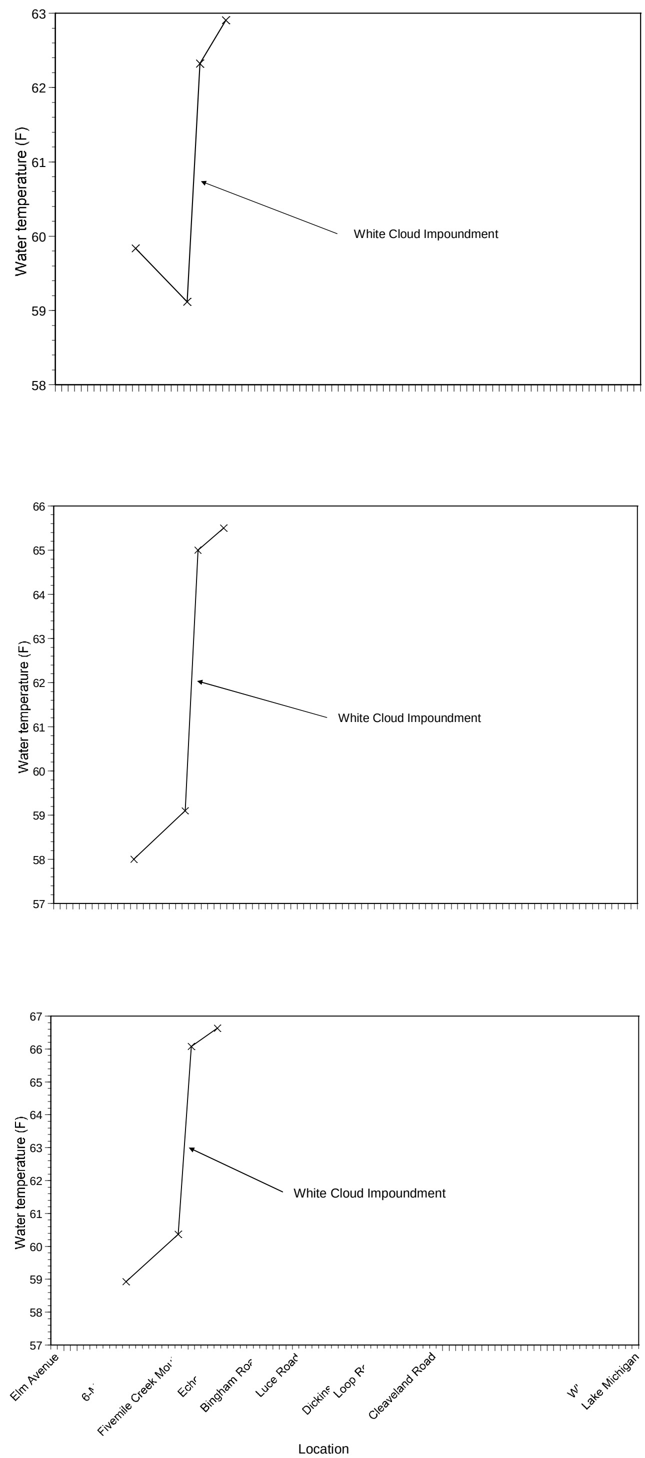
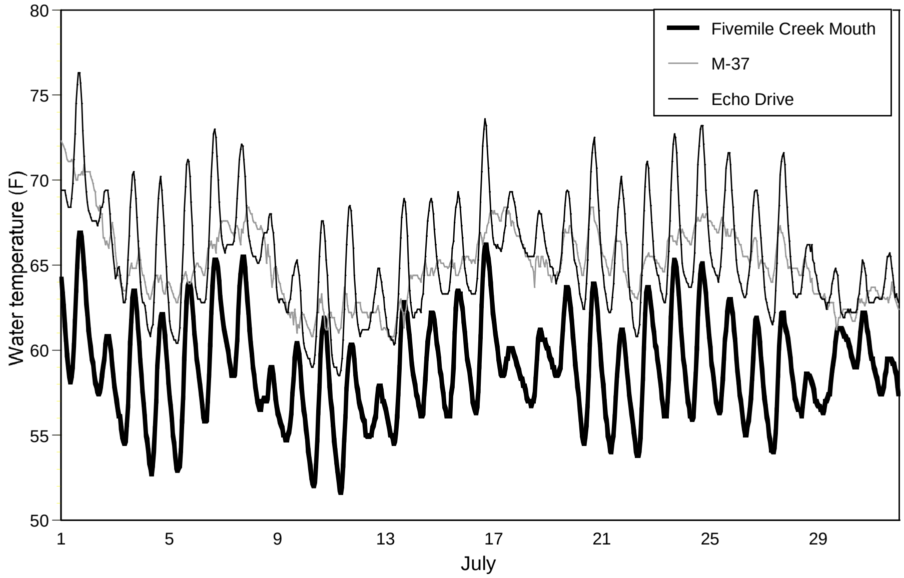


Figure 8. Average water temperatures at four locations on the White River for June (upper), July (middle), and August (lower) 1996. The locations (X-axis) are scaled to reflect appropriate river mile distances between sites.



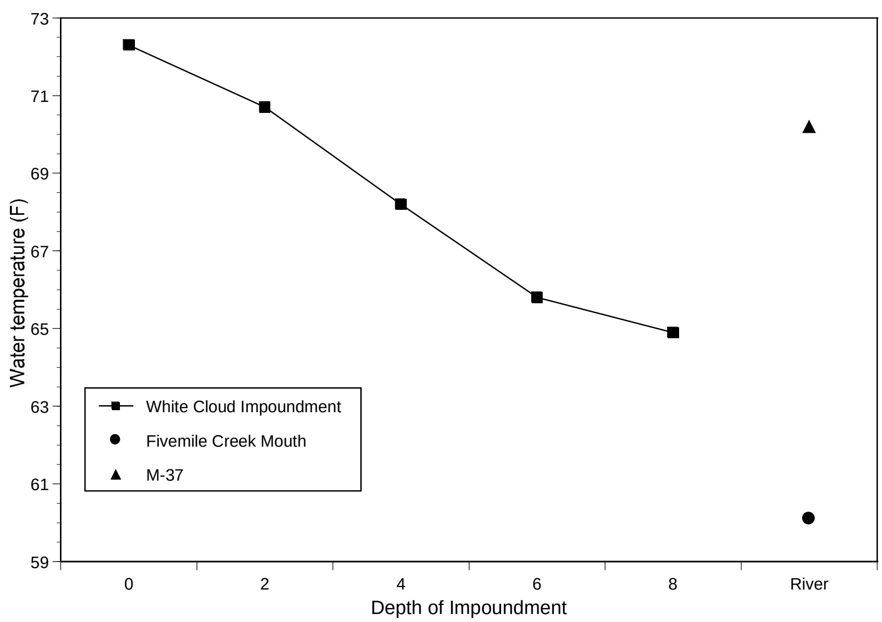


Figure 9. Water temperatures measured in the White River during July 1996 at the Fivemile Creek Mouth, M-37 and Echo Drive stations (upper graph); and water temperatures measured at various depths in White Cloud Impoundment at 1:00 pm on August 9, 1996 (lower graph). Water temperatures measured at the same time upstream of the impoundment (Fivemile Creek Mouth) and downstream of the impoundment (M-37) are shown for comparison.

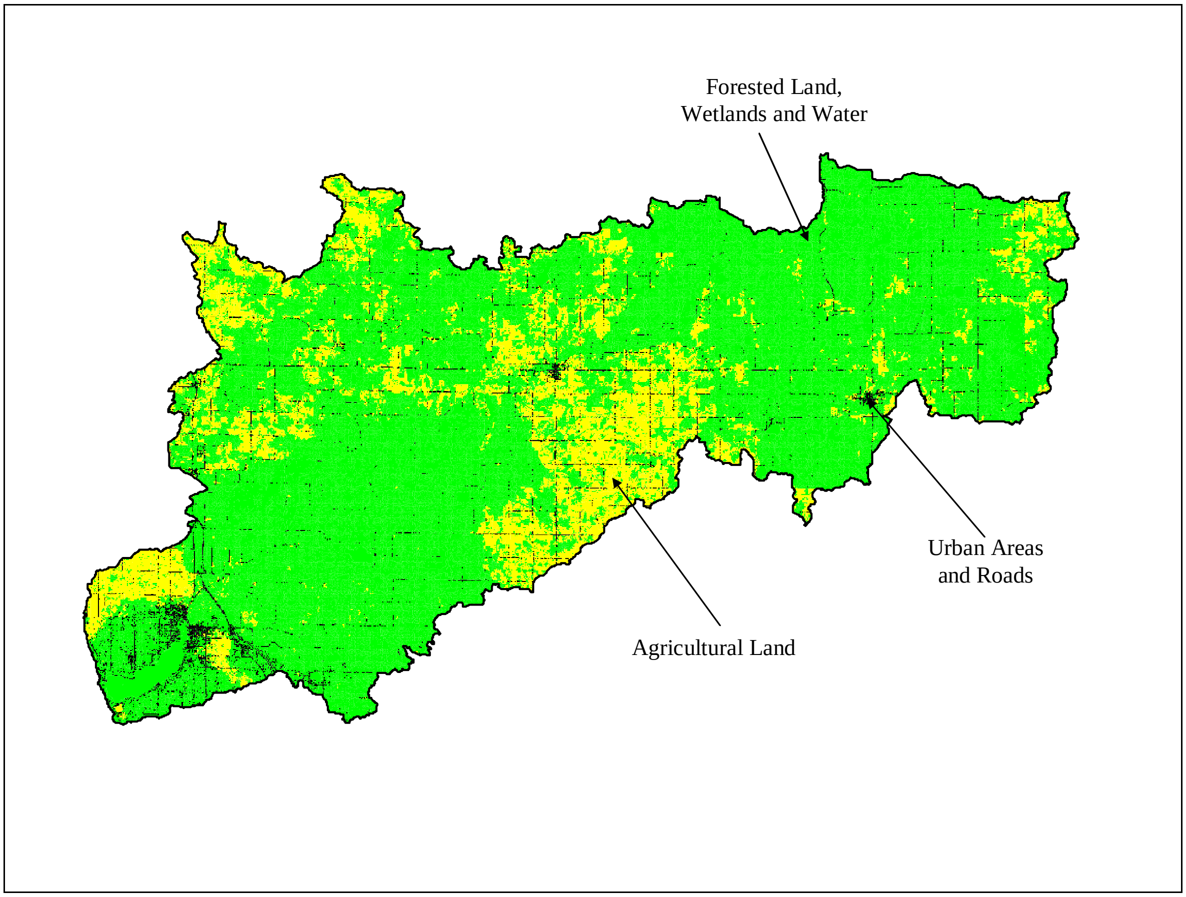


Figure 10. Land cover types in the White River Watershed in 2001. Green areas designate forest, wetlands and water; yellow areas designate agriculture, and black areas designate urban sites and roads.

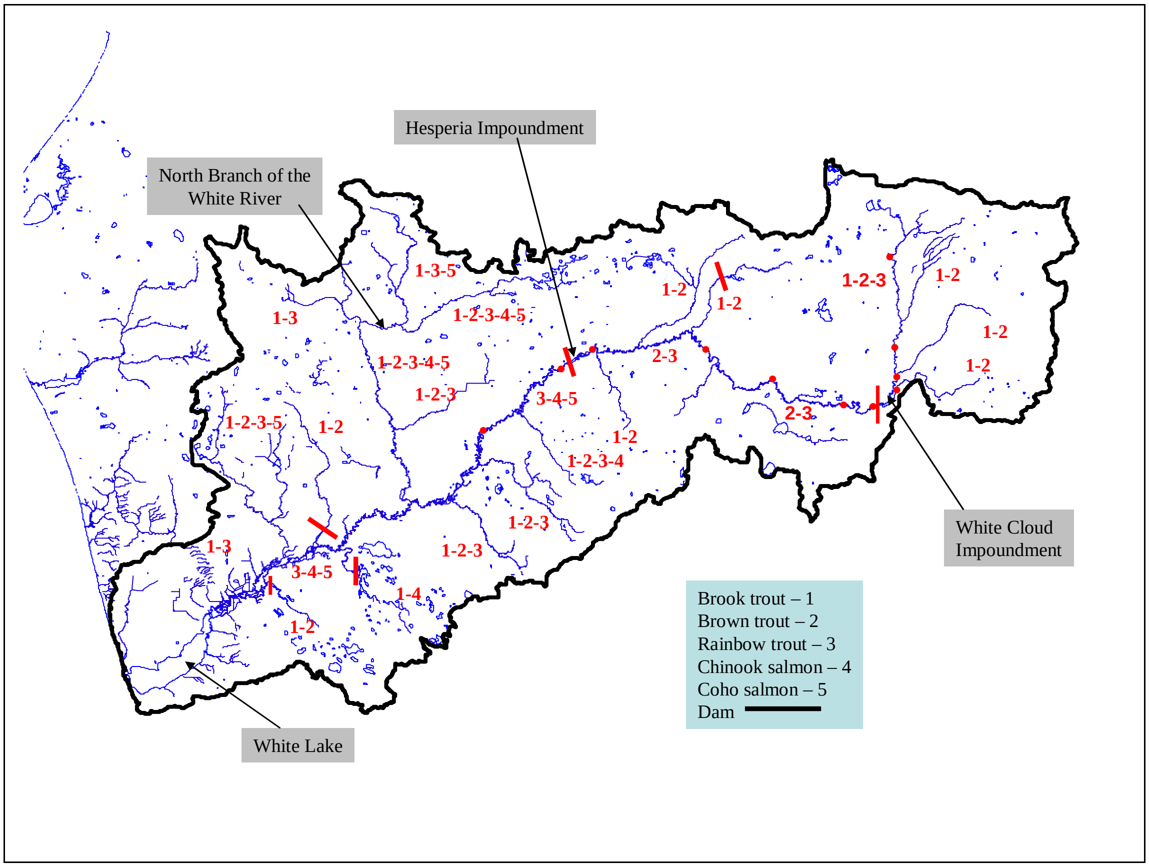
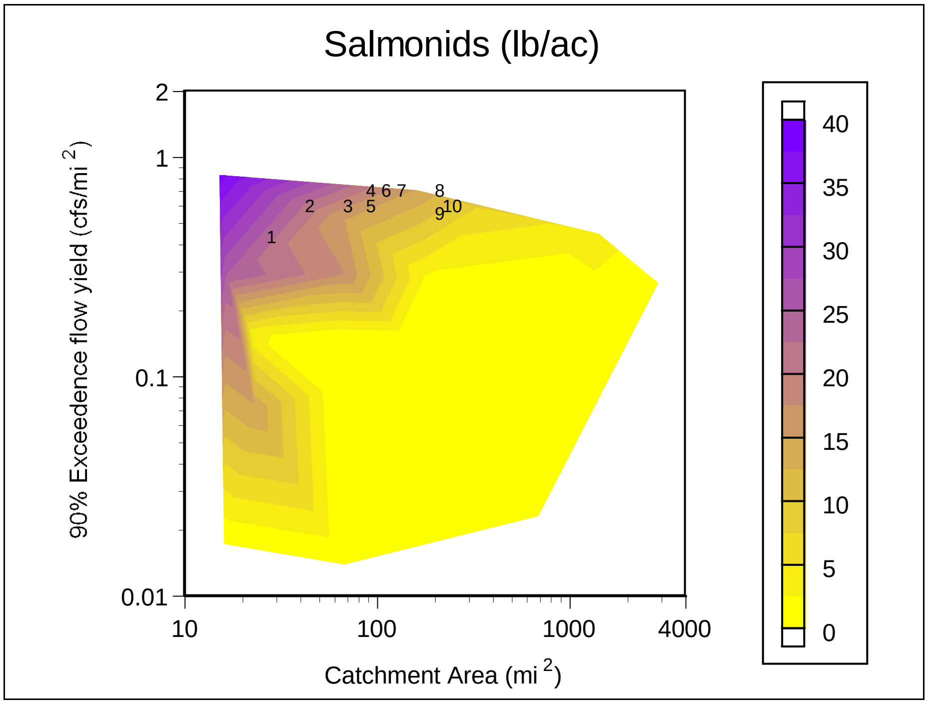


Figure 11. Distribution of trout and salmon in the White River Watershed determined from fish collections made in DNR surveys from 1952 through 2004. Known dam locations present in the watershed through 2010 are indicated by a bar.



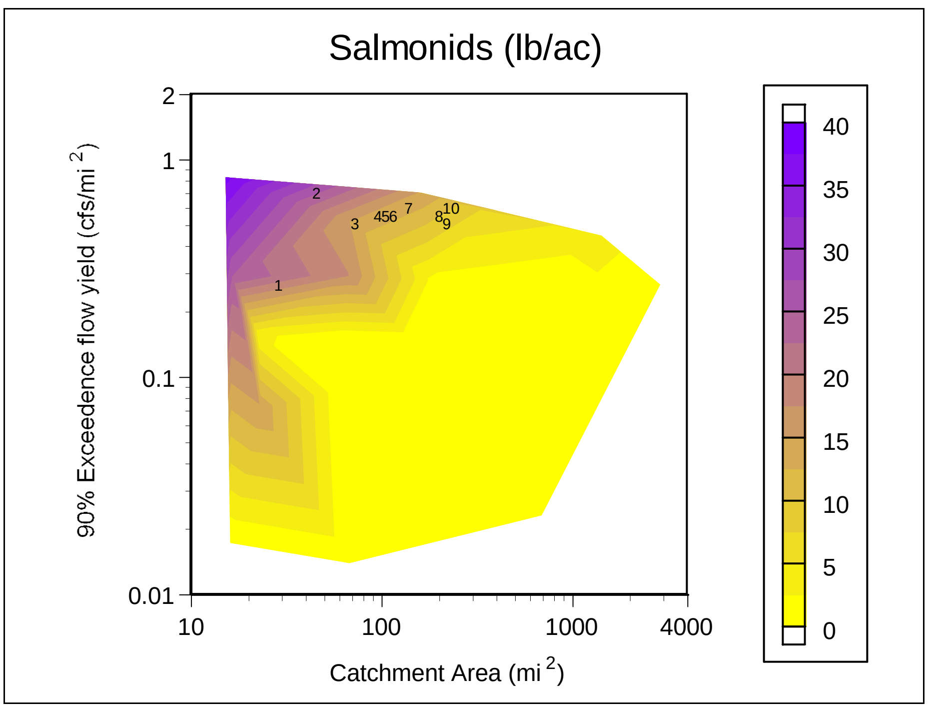
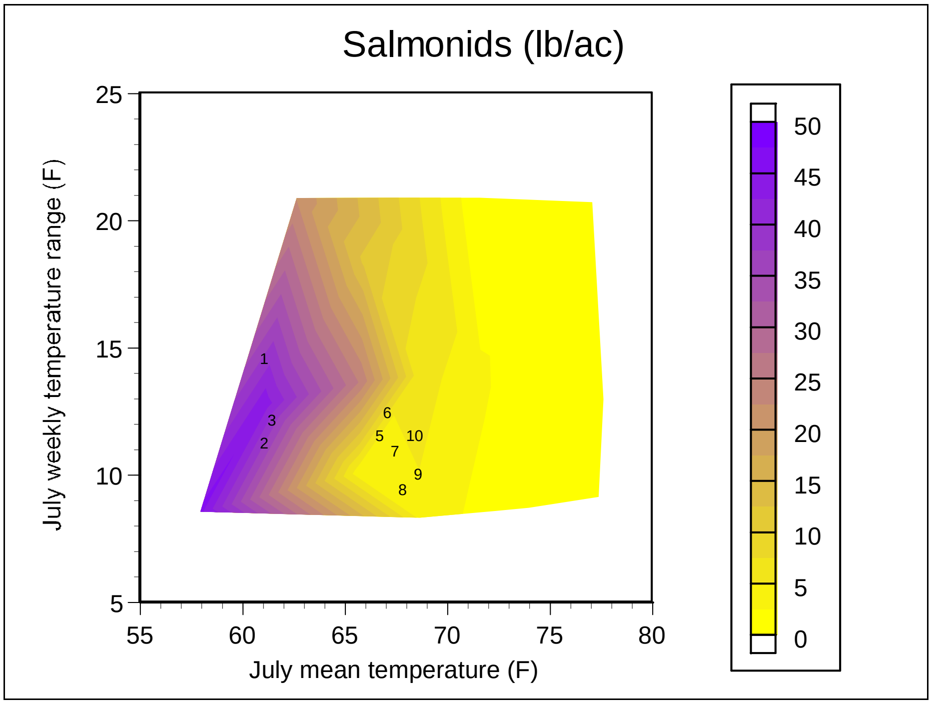


Figure 12. Average trout and salmon biomass in Michigan streams in relation to catchment area and 90% exceedence flow yield. Numbers show observed catchment area and 90% exceedence flow yield values for ten locations on the White River in 1995 (upper graph) and 1996 (lower graph). Stations 1 - 3 were located upstream of White Cloud Impoundment, stations 4 – 8 were located between White Cloud and Hesperia Impoundments, and stations 9 – 10 were located downstream of Hesperia Impoundment (Figure 2).



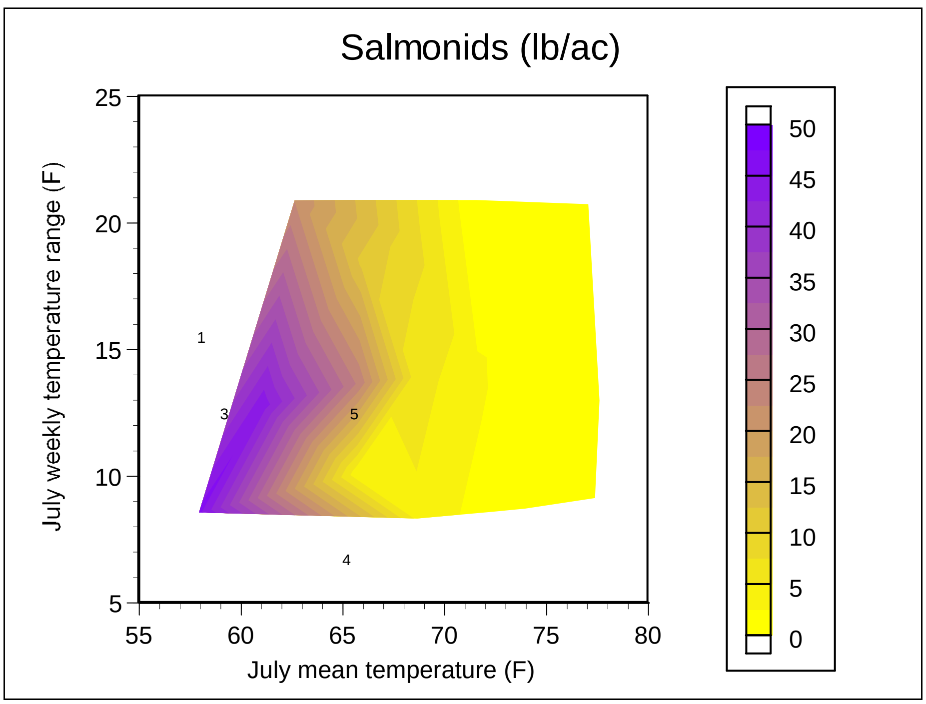
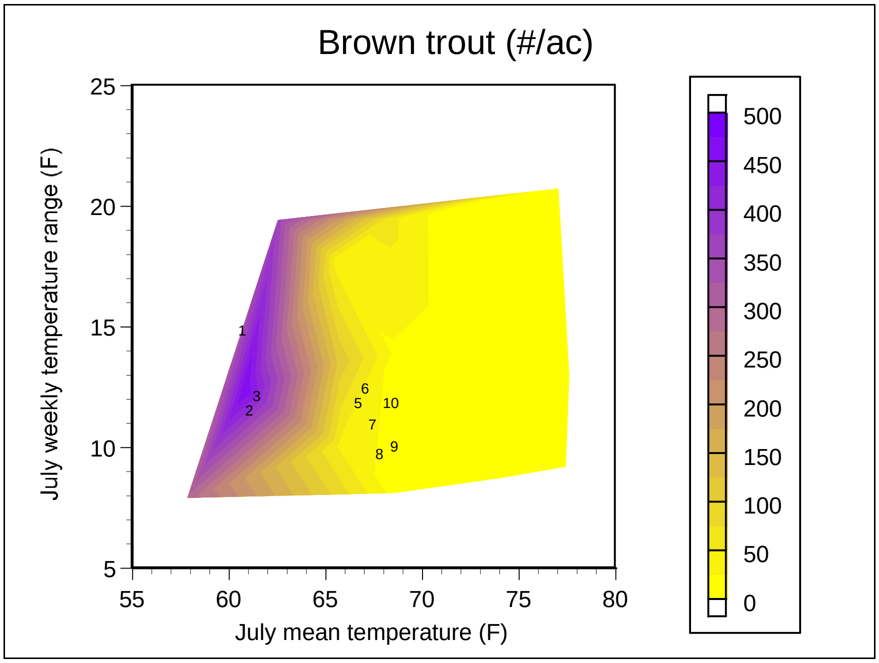


Figure 13. Average trout and salmon biomass in Michigan streams in relation to the mean and weekly range in July water temperature. Numbers show observed mean and weekly range in July water temperatures for locations on the White River in 1993 (upper graph) and 1996 (lower graph). Stations 1 - 3 were located upstream of White Cloud Impoundment, stations 4 – 8 were located between White Cloud and Hesperia Impoundments, and stations 9 – 10 were located downstream of Hesperia Impoundment (Figure 2). Graphs represent average statewide values and patterns can be extrapolated to data points lying off the edges.



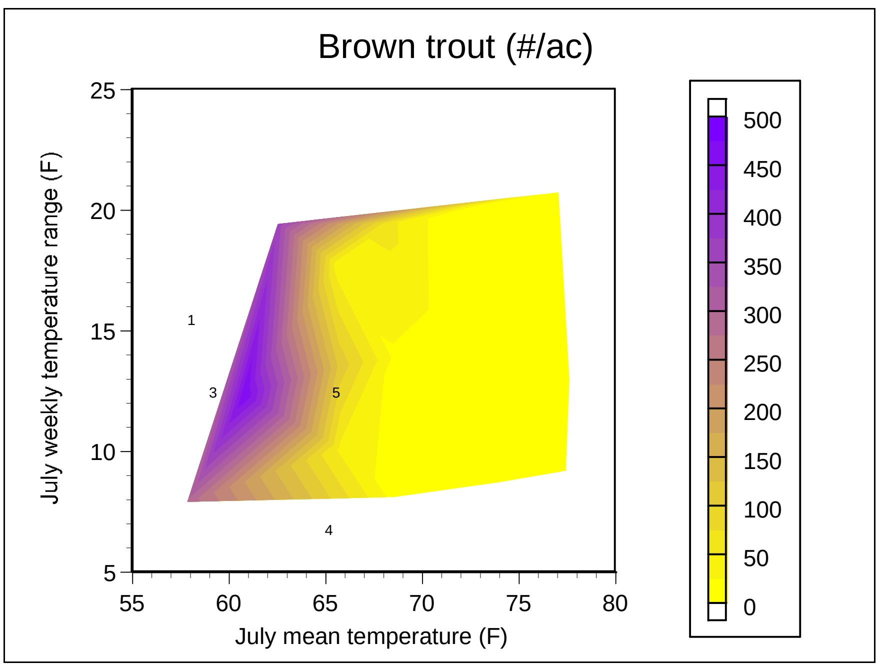


Figure 14. Average brown trout density in Michigan streams in relation to the mean and weekly range in July water temperature. Observed mean and weekly range in July water temperature values for the White River are plotted for nine stations in 1993 (upper graph) and four stations in 1996 (lower graph). Stations 1 - 3 were located upstream of White Cloud Impoundment, stations 4 – 8 were located between White Cloud and Hesperia Impoundments, and stations 9 – 10 were located downstream of Hesperia Impoundment (Figure 2). Graphs represent average statewide values and patterns can be extrapolated to data points lying off the edges.

Table 1. Channel slope characteristics of the White River and the North Branch of the White River. Miles of river are shown within each gradient class.

Gradient class (ft/mi)	Elm Avenue to White Cloud Dam	White Cloud Dam to Hesperia Dam	Hesperia Dam to White Lake	Main Branch total	North Branch of the White River	Main Branch and North Branch total
0.0 – 2.9	0	9.3	20.6	29.9	1.4	31.3
3.0 – 5.9	6.2	11.0	7.4	24.6	16.0	40.6
6.0 – 10.9	7.0	5.3	7.5	19.8	4.2	24.0
11.0 – 70.9	7.4	1.4	1.2	10.0	4.6	14.6
71.0 – 150.0	0	0	0	0	0	0
> 150.0	0	0	0	0	0	0
Elevation change (ft)	229.7	118.1	137.8	485.6	170.6	
Total distance (mi)	20.6	27.0	36.7	84.3	26.2	110.5
Average gradient (ft/mi)	11.1	4.4	3.8	5.8	6.5	
Gradient range (ft/mi)	4.3 – 33.4	2.0 – 13.9	0.0 – 18.7	0.0 – 33.4	0.0 – 16.7	

Gradient class descriptions:

0.0 – 2.9 ft/mi – mostly run habitat with low hydraulic diversity.
3.0 – 5.9 ft/mi – some riffles with moderate hydraulic diversity.
6.0 – 10.9 ft/mi – riffle pool sequences with good hydraulic diversity.
11.0 – 70.9 ft/mi – well established riffle-pool sequences with excellent hydraulic diversity.
71.0 – 150.0 ft/mi – chute and pool habitat with fair hydraulic diversity.
> 150.0 ft/mi – falls and rapids with poor hydraulic diversity.

Table 2. Stream discharge, water yield values (near base flow) and catchment area for ten stations on the White River on July 11-14/1995 and August 28-30/1996.

Location	Discharge (ft^3/s)		Water yield ($ft^3/s/mi^2$)		Catchment area (mi^2)
	1995	1996	1995	1996	
6-Mile Road	13.1	7.7	0.45	0.26	29.4
2-Mile Road	30.8	31.9	0.67	0.70	45.9
Fivemile Creek Mouth	50.6	44.1	0.59	0.49	76.5
M-37	69.0	54.0	0.73	0.57	94.1
Echo Drive	63.5	51.8	0.65	0.53	97.7
Bingham Road	74.2	57.7	0.68	0.53	108.8
Luce Road	108.1	93.1	0.71	0.61	152.9
Dickinson Road	150.2	109.8	0.72	0.53	207.4
Loop Road	121.1	105.0	0.57	0.50	212.0
Cleveland Road	148.0	148.0	0.62	0.62	240.0

Table 3. Summer water temperatures collected on the White River during 1993 and 1996. Figures represent the monthly mean, maximum and minimum water temperature at each sampling station. The Max-Min column for July indicates the average of weekly difference between maximum and minimum water temperatures for the period from July 1 through July 28.

Station and Year	June			July				August		
	Maximum	Minimum	Mean	Maximum	Minimum	Mean	Max-Min	Maximum	Minimum	Mean
1993										
6-Mile Road	70.0	47.3	59.9	70.3	52.7	60.9	14.8	69.4	50.5	59.7
2-Mile Road	67.3	47.7	59.1	68.5	54.9	61.0	11.4	66.6	52.2	59.9
Fivemile Creek Mouth	67.3	47.8	59.0	69.4	55.0	61.4	12.2	67.5	52.0	60.2
M-37	68.0	51.4	61.0	-	-	-	-	-	-	-
Echo Drive	69.8	51.1	61.4	74.3	58.8	66.5	11.7	73.4	57.4	65.2
Bingham Road	71.1	50.5	62.0	75.6	59.5	67.2	12.3	72.5	57.7	65.8
Luce Road	70.2	50.4	62.1	75.0	59.7	67.4	11.0	73.0	58.5	66.1
Dickinson Road	69.8	51.3	62.3	75.0	60.3	67.7	9.6	72.0	59.0	66.5
Loop Road	69.8	51.8	62.8	76.1	60.8	68.4	10.1	73.8	59.5	67.2
Cleveland Road	70.2	51.1	62.4	76.8	60.1	68.1	11.8	73.2	59.0	67.0
1996										
6-Mile Road	71.2	50.0	59.8	67.8	50.0	58.0	15.5	69.4	52.2	58.9
Fivemile Creek Mouth	70.5	51.6	59.1	67.1	51.7	59.1	12.3	70.1	54.3	60.4
M-37	73.0	56.1	62.3	72.3	60.6	65.0	6.6	73.2	60.1	66.1
Echo Drive	77.4	56.1	62.9	76.3	58.5	65.5	12.5	77.7	59.5	66.6

Table 4. Land cover in the White River Watershed in 2001 and the 1800s (pre-European settlement). Data from State of Michigan Geographic Information System (personal communication, T. Havelka, Fisheries Division).

Land cover type	2001		1800	
	Acres	Percent	Acres	Percent
Forest	225,827	65.6	332,249	96.5
Herbaceous open land	37,706	11.0	85	0.0
Wetland	2,866	0.8	4,405	1.3
Water	5,957	1.7	7,320	2.1
Agriculture	60,637	17.6	0	0.0
Urban	10,235	3.0	0	0.0
Non-vegetated	944	0.3	0	0.0
Unknown	0	0.0	109	0.0
Total	344,173		344,168	

Table 5. Numbers of fish stocked into the White River upstream of White Cloud, 1936 – 2010. In addition, brown trout (1,000) were stocked in 1971.

Year	Brook trout
1936	10,000
1937	38,000
1938	22,000
1939	24,000
1940	16,000
1941	23,000
1942	1,200
1943	2,000
1944	3,400
1945	6,400
1946	0
1947	0
1948	1,948
1949	3,000
1950	2,550
1951	3,300
1952	4,000
1953	5,550
1954	2,900
1955	3,000
1956	0
1957	3,100
1958	20,000
1959	10,000
1960	10,000
1961	7,500
1962	7,500
1963	7,500
1964	7,500

Table 6. Numbers of fish stocked into the White River between White Cloud and Hesperia, 1936 – 2010. In addition, a total of 22,125 brook trout were stocked during 1937 – 1940; and rainbow trout were stocked in 1940 (5,000), 1941 (6,000), 1957 (3,000), 1958 (4,500), 1959 (4,500), and 1974 (7,645). All fish were yearlings from 1971 through 1989 unless designated otherwise. Trout sizes were not available prior to 1971. An SF indicates spring fingerling and an FF indicates fall fingerling.

Year	Brown trout	Year	Brown trout	Year	Brown trout
1936	44,000	1961	3,000	1986	7,400 (+15,000 FF)
1937	20,000	1962	3,000	1987	7,520
1938	4,000	1963	3,000	1988	8,000 (+15,000 FF)
1939	4,000	1964	3,000	1989	8,000
1940	3,000	1965	0	1990	8,000
1941	5,000	1966	5,000	1991	11,049
1942	1,000	1967	0	1992	39,398
1943	260	1968	5,000	1993	29,494
1944	70	1969	0	1994	39,995
1945	800	1970	5,000	1995	36,318
1946	0	1971	500	1996	38,180
1947	0	1972	12,577	1997	39,983
1948	5,500	1973	10,810	1998	38,880
1949	5,200	1974	11,500	1999	40,000
1950	4,500	1975	8,000	2000	41,500
1951	4,500	1976	8,000 (+7,500 SF)	2001	40,000
1952	5,500	1977	1,000	2002	40,000
1953	3,300	1978	13,000	2003	40,000
1954	3,500	1979	5,000	2004	40,000
1955	3,000	1980	7,000	2005	40,000
1956	0	1981	7,000	2006	40,000
1957	0	1982	3,800	2007	31,698
1958	1,500	1983	8,000	2008	40,000
1959	1,500	1984	8,000	2009	41,200
1960	5,500	1985	7,200	2010	42,300

Table 7. Numbers of fish stocked into the White River downstream of Hesperia, from 1936 through 2010. In addition there were rainbow trout stocked in 1957 (4,000) and 1965 (2,000), brown trout stocked in 1990 (3,999) and 1991 (3,980), and adult white bass stocked in 1983 (615) and 1984 (1,674). All trout were yearlings from 1971 through 1989 and all walleye were fingerlings unless designated otherwise. Trout size data were not available prior to 1971. A FF indicates fall fingerling, SK indicates Skamania, MI indicates Michigan strain, and SU indicates summer strain.

Year	Steelhead-MI	Steelhead-SU	Walleye	Year	Steelhead-MI	Steelhead-SU	Walleye
1968	25,000	0	0	1990	14,650	11,551 (SK)	41,287 (+202,000 Fry)
1969	20,000	0	0	1991	14,000	0	0
1970	19,000	0	0	1992	17,500	0	26,5158 (+403,600 Fry)
1971	20,000	0	0	1993	21,300	0	35,323
1972	20,361	0	0	1994	22,000	0	49,384 (+720,000 Fry)
1973	37,500	0	0	1995	23,500	0	43
1974	33,092	0	0	1996	21,300	0	12,727 (+971,000 Fry)
1975	10,120	0	0	1997	24,000	0	156,923
1976	0	0	0	1998	20,505	0	195,670
1977	0	0	0	1999	22,187	0	307,970
1978	20,000 (+70,000 FF)	0	0	2000	25,001	0	249,997
1979	30,081	0	0	2001	21,998	0	260,155
1980	20,020	0	0	2002	23,100	0	0
1981	20,000	0	2,000	2003	24,900	0	250,077
1982	25,000	0	27,534	2004	22,300	0	0
1983	15,000	0	0	2005	22,000	0	226,273
1984	10,000	20,000 (Siletz)	1,004	2006	24,429	0	0
1985	0	0	5,325	2007	22,207	0	0
1986	0	26,000 (Rogue)	120,675	2008	23,600	0	0
1987	0	17,507 (Rogue)	4,938	2009	22,000	0	138,314
1988	20,867 (FF)	0	35,938 (+960,000 Fry)	2010	24,208	0	0
1989	100,875 (Fry)	15,000 (SK) (+15,000 SK, FF)	53,569 (+421,000 Fry)				

Table 8. Numbers of fish stocked into the North Branch of the White River from 1936 through 2010. Stocking has neither been necessary nor has occurred since 1964. Trout size data were not available.

Year	Brown trout	Rainbow trout	Brook trout
1936	4,000	4,000	3,500
1937	0	6,000	10,000
1938	0	9,500	12,000
1939	0	6,000	6,000
1940	2,000	7,000	0
1941	0	5,000	3,000
1942	1,000	0	1,000
1943	0	0	0
1944	200	0	400
1945	500	0	500
1946	0	0	0
1947	0	0	0
1948	2,800	0	450
1949	0	0	1,100
1950	0	0	650
1951	0	0	348
1952	0	0	500
1953	0	0	600
1954	0	0	0
1955	0	0	0
1956	0	0	0
1957	0	1,000	0
1958	0	6,000	0
1959	0	6,000	0
1960	0	4,000	0
1961	0	3,000	0
1962	0	3,000	0
1963	0	3,000	0
1964	0	3,000	0

Table 9. A selected summary of DNR Fisheries Division files for the White River watershed.

Date	Comment
4/22/1949	Letter indicating the Ferry Dam had washed out several years earlier but some of the dam structure was still present in the stream and blocking fish movements.
1951-1952	DNR letters discussing the potential removal of White Cloud and Hesperia Power Dams due to water temperature increases and blockage of fish passage. These dams were not producing power anymore and were later transferred to local government ownership from Consumers Power Company.
1952	DNR biological and physical survey of the White River in 1952 (Schultz 1953). He also summarized information from prior surveys in 1926, 1929, 1932, and 1938.
2/11/1955	DNR Upper White River Watershed Report (includes water temperature evaluation).
1955	DNR stream habitat structures installed in the upper section of the White River, Fivemile Creek and Martin Creek.
1958	DNR letter indicating an under-spill structure had been installed in White Cloud Dam.
1960	DNR fisheries survey of the upper section of the White River.
1969	DNR fisheries survey of the upper section of the White River.
1971	DNR fish survey of the upper section of the White River to monitor trout mortalities.
1972	DNR fisheries survey to monitor fish mortalities in the upper section of the White River and assess fisheries in the middle section of the White River. Water temperature data collected.
1972	Steep pass was installed at Hesperia Dam to pass steelhead but was unsuccessful.
4/1973	A functional under-spill was in operation at White Cloud Dam.
1973	DNR fish survey of the upper section of the White River to monitor trout mortalities.
7/31/1974	Letter summarizing 1972 and 1973 water temperature evaluations in the upper and middle sections of the White River by the White River Watershed Council. Results indicated that White Cloud Impoundment caused a significant increase in water temperatures of the river.
4/1975	A report by Robert Pearce contracted by the White River Watershed Council and Oceana County Planning Commission titled, A selected baseline survey of the White River in Oceana County (includes water temperatures, dissolved oxygen and nutrients).
6/1975	The White River was designated a Michigan Natural River. The associated private land ordinances were certified by the Secretary of State in February 1979.
9/10/1975	A file memo stated the City of White Cloud cut a new channel through the swimming hole area of the earthen dike on the north side of the dam to prevent the dam from washing out in the Labor Day flood.
3/3/1976	A file memo stated that bedload sediment from the washout of Hesperia Dam was affecting habitat in the White River. The Village of Hesperia was to receive federal funds to repair the dam and route the water back over the dam.
3/1976	DNR report on the 1975 Inventory of the Fisheries and Aquatic Habitat of the Lower White River Drainage (Lincoln 1976).
1978	DNR survey to estimate population abundance of trout in the upper section of the river.
1979	Stream habitat structures were repaired and installed in the upper section of the White River, Fivemile Creek, Flinton Creek, Minnie Creek and Martin Creek.
6/24/1981	DNR Water Quality Division report on the Impacts of the White Cloud Wastewater Treatment Plant on the White River at White Cloud (Creal and Kenaga 1982). Results showed water quality was significantly degraded up to 400 meters downstream of the outfall.

Table 9. Continued

Date	Comment
9/16/1983	DNR Water Quality Division Benthic Macro invertebrate Survey of the White River at White Cloud in the vicinity of the abandoned wastewater treatment plant (Kenaga and Wycheck 1984). Results showed the stream had been restored to conditions similar to adjacent river sections.
1983	DNR Fisheries Division proposes construction of a sea lamprey barrier in the North Branch of the White River
9/1986	A file memo stated that from 9/9-11/1986 approximately 5 – 12 inches of rain fell in west Michigan. The White Cloud Dam failed on September 11 and was assisted by the City of White Cloud by trenching the earthen portion of the dam on the south side. The Village of Hesperia also cut a trench through the earthen portion of the dam to save the dam structure on September 11. Significant sediment deposition occurred in downstream areas and sand traps were installed downstream of White Cloud by the DNR. White Cloud Dam was reconstructed in 1990 with federal funding, following challenges by the DNR and angler groups, and offers by the DNR to assist in dam removal and recreational improvements at impoundment sites. Hesperia Dam was equipped with new aluminum stop logs in 1995 and the sills of the dam were improved in 1997 to help prevent sea lamprey passage. The USFWS assisted with funding.
7/1989	DNR fisheries survey of the middle and upper sections of the White River.
10/1989	DNR fisheries survey of the North Branch of the White River.
2/1991	DNR Fisheries Division - White River Status of the Fishery Report with Management Plan – 1991, Newaygo, Muskegon, Oceana Counties.
8/1991	DNR fisheries survey of the middle section of the White River.
8/1992	DNR fisheries abundance estimates in the middle section of the White River.
1/1993	Federal White River Wild & Scenic River Study Committee established.
7/9/1993	DNR Surface Water Quality Division Survey of the North Branch of the White River.
9/1993	DNR fisheries abundance estimates in the middle section of the White River.
7/14/1998	DNR fisheries status and trends sampling in the middle section of the White River.
6/2002	DEQ Water Quality Assessment Section Biosurvey (Procedure 51) of the upper section of the White River in Newaygo County.
6-7/2002	DEQ Water Quality Assessment Section Biosurvey (Procedure 51) of the lower section of the White River in Oceana and Muskegon Counties.
9/2002	DNR status and trends fisheries survey of the North Branch of the White River.
7/27/2004	DNR fisheries status and trends sampling in the middle section of the White River.
12/15/2003	Assessment of the Unionid Mussels of the White River (Luttenton et al. 2003). A report contracted by the USFS. The report suggested Unionid mussel abundance had decreased significantly in recent years.
6-7/2007	DEQ Water Bureau biological survey of the White River and Flower Creek watersheds in Oceana, Muskegon, and Newaygo Counties.
2009	White River Watershed Management Plan (De Mol 2009) provides a detailed water quality evaluation of the White River Watershed.
6/2011	DNR evaluations of physical and biological characteristics of the White River watershed.

Table 10. Species of coldwater fish collected and selected notes on the 1952 survey of the White River from Schultz (1953). Abbreviations for coldwater fish are as follows: Brook trout – BKT, brown trout – BNT, rainbow trout – RBT, Coho salmon – Coho, and Chinook salmon – CHS.

Location	Fish species	Comments
Mainstem – Mouth to confluence with North Branch	Suckers, smallmouth bass, walleye, northern pike, RBT, CHS	Four larval sea lamprey collected
Landford Creek	BKT, RBT	
Silver Creek	BKT, BNT	Impounded
Carlton Creek	BKT, BNT, RBT, Coho	
Little Carlton Creek	Coolwater fish	
Sand Creek	BKT above impoundment	Impounded since lumber era
Cleveland Creek	BKT	Impounded in 1949
Blue Lake outlet	BKT at mouth	
Skeel Creek	BKT, BNT, RBT	Heavy agricultural area
Cushman Creek	BKT, BNT, RBT	Drains from lakes
Brayton and Dragoa Creeks	Warmwater	Tributary with BKT
North Branch of the White River	BKT, BNT, Coho, but warmwater two to five miles downstream from McLaren Lake.	Ferry Dam no longer present, headwaters from lake drainage, few trout collected upstream of Ferry during 1928 and 1952.
Newman Creek	BKT, BNT, RBT	
Knutson Creek	BKT, BNT	
Robinson Creek	BKT	
Swinton & Osborn Creeks	BKT	
Mainstem – Hesperia Dam to White Cloud Dam	Stocked BNT, white sucker, blacknose dace, creek chub, some RBT found in 1926 survey	No sea lamprey collected
Wrights Creek	White sucker, creek chub	
Martin and E. Br. Heald Creeks	BKT, BNT	
Mena Creek	BKT	Impounded
Black (Delong) Creek	Warmwater fish	Largely agricultural drainage
Coonskin & Robinson Creek	Warmwater fish	Drains from lakes
First Cole Creek	BKT, BNT	
Second Cole Creek	BKT	
Rattlesnake Creek	Warmwater fish	
Mainstem – White Cloud Dam to 6-Mile Road	BKT, BNT, In 1929 only BKT but BNT found in 1932 increasing in 1938 with no stocking	Considerable deforestation, open farm land and impounding by beaver (15 dams present)

Table 11. Species of fish collected in the White River during 1952 and new species collected in the lower river during 1976. An asterisk (*) indicates the species is non-native. The endangered redside dace may be a misidentification because this species has records from only the southeast side of Michigan (Bailey et al. 2004).

Common name	Scientific name	Year	Common name	Scientific name	Year
American brook lamprey	*Lampetra appendix*	1976	Lake chubsucker	*Erimyzon sucetta*	1952
Black bullhead	*Ameiurus melas*	1976	Largemouth bass	*Micropterus salmoides*	1952
Black crappie	*Pomoxis nigromaculatus*	1976	Least darter	*Etheostoma microperca*	1952
Blackchin shiner	*Notropis heterodon*	1952	Longnose dace	*Rhinichthys cataractae*	1952
Blacknose shiner	*Notropis heterolepis*	1952	Mimic shiner	*Notropis volucellus*	1952
Blackside darter	*Percina maculate*	1952	Mottled sculpin	*Cottus bairdii*	1952
Bluegill	*Lepomis macrochirus*	1952	Northern hog sucker	*Hypentelium nigricans*	1952
Bluntnose minnow	*Pimephales notatus*	1952	Northern logperch	*Percina caprodes semifaciatus*	1952
Bowfin	*Amia calva*	1952	Northern longear sunfish	*Lepomis peltastes*	1976
Brook stickleback	*Culaea inconstans*	1952	Northern pearl dace	*Margariscus nachtriebi*	1952
Brook trout	*Salvelinus fontinalis*	1952	Northern pike	*Esox lucius*	1952
Brown bullhead	*Ameiurus nebulosus*	1952	Northern redbelly dace	*Phoxinus eos*	1952
Brown trout	*Salmon trutta*	1952	Pumpkinseed	*Lepomis gibbosus*	1952
Burbot	*Lota lota*	1952	Rainbow darter	*Etheostoma caeruleum*	1952
Central mudminnow	*Umbra limi*	1952	Rainbow trout *	*Oncorhynchus mykiss*	1952
Central stoneroller	*Campostoma anomalum pullum*	1976	Redhorse spp.	*Moxostoma spp.*	1952
Chestnut lamprey	*Ichthyomyzon castaneus*	1976	Redside dace (En)	*Clinostomas elongatus*	1976
Chinook salmon *	*Oncorhynchus tshawytscha*	1976	River chub	*Nocomis micropogan*	1976
Coho salmon *	*Oncorhynchus kisutch*	1976	Rock bass	*Ambloplites rupestris*	1952
Common carp *	*Cyprinus carpio*	1952	Sea lamprey *	*Petromyzon marinus*	1952
Common shiner	*Luxilus cornutus*	1952	Smallmouth bass	*Micropterus dolomieu*	1952
Creek chub	*Semotilus atromaculatus*	1952	Tadpole madtom	*Noturus gyrinus*	1952
Finescale dace	*Phoxinus neogaeus*	1952	Threespine stickleback *	*Gasterosteus aculeatus*	1952
Golden shiner	*Notemigonus crysoleucas*	1952	Warmouth	*Lepomis gulosus*	1976
Grass pickerel	*Esox americanus vermiculatus*	1952	Western banded killifish	*Fundulus diaphanous menona*	1952
Green sunfish	*Lepomis cyanellus*	1952	Western blacknose dace	*Rhinichthys obtusus*	1952
Hornyhead chub	*Nocomis biguttatus*	1952	White sucker	*Catostomus commersonii*	1952
Iowa darter	*Etheostoma exile*	1952	Yellow bullhead	*Ameiurus natalis*	1952
Johnny darter	*Etheostoma nigrum*	1952	Yellow perch	*Perca flavescens*	1976

Table 12. Lampricide (TFM) treatment dates in various sections of the White River. Information provided by Jeff Slade from the USFWS Biological Station in Ludington Michigan.

Date	Hesperia to White Lake	North Branch of White River	White Cloud To Hesperia
May 1965	X	X	
May 1969	X	X	
June 1973	X	X	
June 1976	X	X	X
August 1979	X	X	X
July 1983	X	X	X
September 1987	X	X	X
July 1991	X	X	X
August 1995	X	X	X
August 1999	X	X	X
August 2001	X	X	X
August 2005	X	X	
August 2007	X	X	
July 2010	X	X	X

Table 13. Average monthly water temperature differences found in the White River between the sampling site upstream of White Cloud Impoundment (Fivemile Creek Mouth) and two stations downstream of White Cloud Impoundment (M-37 and Echo Drive). Figures represent the difference between the monthly averages at each site. The average air temperature departure from normal was determined by subtracting the annual monthly average from the long term (1900-1996) monthly average from Grand Rapids, Michigan.

Year & Month	Average air temperature - departure from normal (°F)	Fivemile Creek Mouth to M-37 (°F)	Fivemile Creek Mouth to Echo Drive (°F)
1993			
June	-2.2	1.9	2.3
July	0.5	-	5.0
August	1.2	-	4.8
1996			
June	0.3	3.1	3.7
July	-3.9	5.8	6.3
August	2.0	5.5	6.1

Table 14. Estimated densities of brown, brook and rainbow trout combined in the White River upstream and downstream of White Cloud Impoundment. Rainbow trout were absent from collections upstream of White Cloud Impoundment and brook trout were absent from collections downstream of White Cloud Impoundment.

Year	Site	Brown and Rainbow Trout		Brown trout	
		Number/acre	Pounds/acre	≥ 8 inches	≥ 13 inches
Upstream Sites					
1978	6-Mile Road	263	32	4	0
1978	Van Buren Road	300	55	18	14
1978	3-Mile Road	298	63	60	22
1978	2-Mile Road	1,151	68	54	20
	Average	503	54	34	14
Downstream sites					
1992	M-37	100	18	18	4
1992	Echo Drive	106	17	34	0
1992	M-120	78	13	21	3
1992	Warner Road	69	8	10	1
	Average	88	14	21	2
1993	M-37	122	18	16	1
1993	Echo Drive	81	10	7	0
1993	M-120	176	15	10	0
1993	Warner Road	42	15	19	3
	Average	105	15	13	1