Nottawa Creek

Calhoun, Branch, and St. Joseph Counties
St. Joseph River Watershed, 2012

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Environment

Nottawa Creek arises about 2 miles northwest of Homer and flows 46 miles southwesterly to its confluence with the St. Joseph River near the village of Mendon. The Nottawa Creek watershed encompasses 178 square miles and includes portions of Calhoun, Branch, Kalamazoo, and St. Joseph counties. Agriculture is the predominant land use in the watershed (Williams 1998). There are four registered dams on the main stem: Nottawa Lake, Athens, Leonidas Roller Mill, and Kings Mill (Figure 1). The portion of Nottawa Creek from the headwaters to the Calhoun-Branch county line currently is classified as a Type 4 trout stream.

The topography within the watershed is flat to gently rolling. Stream gradient averages 3 ft/mile from Nottawa Lake to the Alder Creek confluence, 5 ft/mile from Alder Creek to the Pine River confluence, and 2 ft/mile from the Pine River to the confluence with the St. Joseph River. The surficial geology of this area consists primarily of glacial outwash sand and gravel with end moraines of coarse-textured till near the Alder Creek confluence. Nottawa Creek flows through loamy soils in Calhoun County (Williams 1998) and loamy sands in St. Joseph County.

The portion of Nottawa Creek from the headwaters to the Pine River confluence is a designated county drain. Many of the tributaries also are designated drains and large sections of the river system have been affected by dredging and channelization. In addition, many wetlands within the watershed have been tiled and drained to facilitate agricultural operations. These human activities have dramatically altered stream morphology, groundwater delivery and flow patterns, and the abundance of large woody cover within the creek.

History

The Michigan Department of Natural Resources (MDNR) has stocked brown trout in the Calhoun County portion of Nottawa Creek nearly every year since 1948. Rainbow trout also were stocked during 1948-1964, 1969, and 1971. Stocking densities and locations have varied. Since 2005, yearling brown trout have been stocked annually at four locations from N Drive to 5 Mile Road (Table 1).

The first fisheries survey on Nottawa Creek was completed in 1969. Electrofishing in the St. Joseph County portion of the river yielded 13 species, including smallmouth bass and bluegill, but no trout were captured. In 1986, electrofishing was conducted at five stations in Calhoun County from M Drive to 5 Mile Road (Figure 1; Table 2). The combined sampling distance was 2,000 ft. Thirteen brown trout (total length = 3-12 inches) were collected including one naturally reproduced young-of-year fish at 7 Mile Road.

MDNR staff completed fish community surveys at 4 Mile Road (station length = 554 ft) and Olney Road (St. Joseph County; station length = 431 ft) in 1987. Rotenone (a natural fish toxicant) was

applied at each site. Block nets were set to collect dead fish and potassium permanganate was used to detoxify the rotenone at the downstream end of each station. Seventeen fish species were collected at 4 Mile Road, whereas 33 species were collected farther downstream at Olney Road (Towns 1988). White suckers composed the bulk of the catch during the 1987 survey. One brown trout was captured at 4 Mile Road, and no brown trout were captured at Olney Road. Smallmouth bass and bluegills were the most common game fish sampled at the Olney Road site. Few game fish were collected at 4 Mile Road.

Several electrofishing surveys were conducted on Nottawa Creek during the 1990s. An electrofishing survey completed at 7 Mile Road in 1991 yielded 27 brown trout (total length = 4-14 inches). In 1998, electrofishing was conducted at four stations from 17 Mile Road to Q Drive. The total sampling distance was 1,950 ft. Twenty-nine brown trout were captured during this sampling effort. Brown trout catch per effort (CPE) was greatest at the 17 Mile Road and N Drive stations (Table 2). Additional electrofishing surveys were completed at 6 Mile Road and 4 Mile Road in 1999. Twenty-seven brown trout were collected in 1,500 ft of sampling effort. Catch-per-effort was higher at 6 Mile Road than at 4 Mile Road. Aside from one age 2 fish (total length = 13 inches), the catch consisted entirely of yearling brown trout. The mean growth index for yearling brown trout was +1.2, which is indicative of above average growth. Overall, surveys conducted during the 1990s revealed no consistent spatial pattern in relative abundance of brown trout and there was substantial inter-annual variation in brown trout CPE at most of the sites. This variation probably was caused by changes in the upstream and downstream boundaries of sampling locations, variation in large woody cover abundance (e.g., due to drain maintenance activities), and stream discharge fluctuations.

Temperature loggers were deployed at two locations on Nottawa Creek in 1999. Mean July water temperatures were 70.6 F at 6 Mile Road and 70.3 F at 4 Mile Road. Maximum water temperatures were 76.9 F at 6 Mile Road and 76.5 F at 4 Mile Road.

In an effort to increase holding cover for brown trout, volunteers installed 60 half-logs in Nottawa Creek near 6 Mile Road after the 1999 survey. Electrofishing at this site in 2000 yielded only two brown trout (total length = 6-11 inches) in a 1,000 ft station. At least 50% of the half-logs were partially or completed filled with sand within one year of installation.

Michigan Department of Environmental Quality (MDEQ) personnel performed fish, macroinvertebrate, and habitat sampling on Nottawa Creek near 10 Mile Road in August 2005 (Walterhouse 2007). One brown trout and 19 other fish species were collected during the survey. The macroinvertebrate community was rated as acceptable. Habitat was rated as marginal (or moderately impaired) primarily because this stream reach consisted of a straight dredged channel without a well-vegetated buffer strip along the stream banks.

Current Status

A stream shocker (250 V DC, 5A, three probes) was used to capture fish in Nottawa Creek on July 16, 2012 as part of MDNR's Status and Trends program (Wills et al. 2006). This program involves standardized sampling on randomly selected stream segments to provide information on spatial and temporal trends in Michigan fish communities. The sampling station began 800 ft downstream of the 7 Mile Road crossing and extended upstream for a distance of 1,400 ft. A single electrofishing run was completed while moving in an upstream direction. Total length was recorded for all brown trout

captured. Scale samples were collected from each brown trout for age determination. For non-game fish species, all fish were counted and total lengths were recorded for the first 30 individuals. Weights for all fish species were calculated using the length-weight regression coefficients compiled by Schneider et al. (2000b). Fish habitat and riparian bank conditions within the sampling station were assessed using the methods outlined by Wills et al. (2006). An Onset Hobo Temp Pro v2 temperature logger was deployed 150 ft upstream of 7 Mile Road on March 14, 2012. The logger was programmed to record water temperatures every hour and was retrieved on March 13, 2013.

Electrofishing (250 V DC stream shocker with 3 probes) was conducted at two additional stations on July 17, 2012 to evaluate survival and growth of stocked brown trout. The first station began at the N Drive crossing and extended 1,000 ft upstream. The second station began 50 ft upstream of 5 Mile Road and extended 580 ft upstream. At each site, a single electrofishing run was completed while moving in an upstream direction. Total length was recorded for all brown trout captured. Scale samples were collected from each brown trout for age determination. The presence of other fish species was noted, but these fish were not measured or counted. Quantitative habitat surveys were not completed at these stations. Habitat evaluations were limited to qualitative observations by the survey crews.

Forty-six brown trout (CPE = 32.8 fish per 1,000 ft) were captured at the 7 Mile Road sampling station. The total length range for these fish was 3.9-9.4 inches (Figure 2). Analyses of scale samples revealed the presence of two year classes. Age 1 fish composed 87% of the catch, whereas age 2 fish made up 13% of the sample. Nineteen additional fish species were captured during the survey at 7 Mile Road (Table 3). Coldwater and transitional fish species composed 48% of the catch by number and 62% of the total fish biomass.

Only two brown trout (CPE = 2.0 fish per 1,000 ft) were collected at the N Drive sampling station. Both of the brown trout captured at N Drive were yearlings. The total length range for these fish was 4.1-5.1 inches. Sixteen other fish species were observed at this station (Table 4).

Thirty-six brown trout (CPE = 62.1 fish per 1,000 ft) were captured at the 5 Mile Road sampling station. Two of these fish (6%) exceeded the minimum size limit of 10 inches (Figure 2). One age 3 fish was collected at this site. The remainder of the brown trout catch consisted of yearlings (67%) and age 2 fish (31%). Twelve additional fish species were observed at this station (Table 4).

Mean lengths-at-age were similar for brown trout captured at 5 Mile Road and 7 Mile Road, and the sample size at N Drive was too small to facilitate evaluation of growth rates. Thus, the length-at-age data for all sites were pooled to generate growth indices. (Growth indices are calculated by subtracting the statewide average length-at-age from the mean length-at-age for a given population [e.g., Nottawa Creek brown trout]. Negative growth indices indicate that fish are smaller than the statewide average at a given age, whereas positive growth indices indicate that fish are larger than average.) The mean growth index for Nottawa Creek brown trout was -0.2 (Figure 3). Brown trout growth in Nottawa Creek is considered average because the mean growth index was between -1 and 1.

Based on the ratio of age 2 brown trout to yearling brown trout, annual survival from age 1 to age 2 appeared to be 23%. However, the number of fish stocked in Nottawa Creek was lower in 2011 than in 2012 (Table 1). When adjusted for stocking levels, the annual survival of brown trout from age 1 to

age 2 was estimated to be 33%. This is a rough approximation as annual survival depends on several factors including the size and health of the fish at stocking.

Sand (46%) and gravel (30%) were the most common substrate types at 7 Mile Road with about 90% of the gravel embedded in sand. Large woody cover was sparse except for a few log jams at the downstream end of the station. The channel was deeply incised due to past dredging activity, and bank stability was rated as "very poor" (>75% of streambank within 30 ft of the transect = bare soil) at most of the measurement locations. The estimated discharge at the time of the survey was 16.5 cfs.

At N Drive, the channel was deeply incised due to past dredging activity. The stream bed was covered with deposits of shifting sand. Undercut banks were moderately abundant, whereas large woody cover, deep pools, and boulders were sparse.

The channel was less incised at 5 Mile Road and the stream was still connected with its floodplain. Deciduous forests lined both banks of the stream. Log jams and deep pools were more abundant at 5 Mile Road than at the other two sampling locations.

Southwest Michigan experienced unusually warm weather in March 2012. Water temperatures in Nottawa Creek at 7 Mile Road rose rapidly and frequently exceeded 60 F during the last half of the month (Table 5). Water temperatures decreased in April with the return of cooler weather before increasing to the peak in July. During July 2012, the mean water temperature was 71.6 F and the mean daily maximum temperature was 74.2 F. The mean water temperature during the hottest week (July 1-7) was 73.9 F.

Analysis and Discussion

A variety of factors influence brown trout population dynamics in Nottawa Creek. Some of these factors involve physical modifications that have long-term effects on the aquatic ecosystem, whereas other factors are continually changing (e.g., discharge and water temperature). Dredging, channelization, and large woody cover removal create physical changes that affect fish habitat in the Nottawa Creek watershed for years or even decades after the projects are completed. On most stream reaches, fish cover (e.g., log jams or undercut banks) is scarce. Stream banks in the dredged channels are steep and often are poorly vegetated. The sediment that erodes from the raw stream banks covers spawning gravel and reduces habitat heterogeneity in the stream bottom and thus production of macroinvertebrates. Sedimentation also increases turbidity, which can reduce brown trout foraging efficiency (Stuart-Smith et al. 2004). The physical changes caused by drain construction and maintenance activities affect fish indirectly by influencing water temperatures and discharge patterns within the river. The removal of trees along the stream bank reduces shading which, in turn, increases summer water temperatures. Dredging, channelization, and draining of wetlands alter the hydrology of the system, resulting in a flow regime characterized by rapid increases in discharge followed by equally rapid decreases in flow.

Southwest Michigan experienced a severe drought in 2012, and summer air temperatures were about 3 F above average (Marino 2012). Droughts can affect fish populations in multiple ways; for example as water levels decline, the quantity of available habitat decreases. Lobón-Cerviá (2007) found that mean stream depth was an important determinant of the carrying capacity for riverine fish populations, and

Stoneman and Jones (2000) demonstrated that the quantity of pool habitat influences trout biomass in southern Ontario streams.

Summer water temperatures also tend to be higher under drought conditions (Elliott 2000), which has important consequences for the brown trout fishery in Nottawa Creek. Brown trout growth occurs when water temperatures are between 39 F and 67 F (Elliott 1993), and McMichael and Kaya (1991) observed that brown trout catch per angler hour decreased when water temperatures exceeded 66 F. Similarly, brown trout in Jocassee Reservoir exhibited a preference for water < 68 F (Barwick et al. 2004) and Zorn et al. (2011) reported that Michigan streams with mean July temperatures (MJTs) > 68 F rarely supported sizeable brown trout populations. Unusually hot weather, coupled with the drought conditions, resulted in abnormally high water temperatures in Nottawa Creek in 2012.

The ultimate lethal water temperature for brown trout is 85.8 F (Elliott 1981). At this temperature, brown trout will perish in approximately 10 minutes. The maximum water temperature recorded in Nottawa Creek during 2012 was 80.1 F. The incipient lethal temperature for brown trout is 76.5 F (Elliott 1981; Elliott 2000) as this is the maximum temperature brown trout can tolerate for a 7 day period. During July 1-7, 2012, the mean water temperature at 7 Mile Road was 73.9 F. Thus, water temperatures in Nottawa Creek in 2012 were below lethal levels. However, the thermal conditions within the stream probably had sub-lethal effects on the physiology, growth, and behavior of brown trout in this system.

Of the three stations surveyed in 2012, the 5 Mile Road station had the best brown trout habitat. Deep pools and large woody cover were abundant at this station. Despite the adverse weather conditions, the brown trout CPE at this station was between the 25th and 50th percentiles for stream reaches surveyed as part of MDNR's Fixed Status and Trends Program during 2002-2007 (T. Wills, MDNR - Fisheries Division, unpublished). By contrast, holding cover for brown trout was scarce at N Drive. The shifting sand substrate at this location also limited macroinvertebrate (i.e., trout food) production.

The 2012 sampling efforts provided no evidence of natural recruitment, and only one young-of-year brown trout was captured during all previous surveys on Nottawa Creek. Multiple factors appear to be limiting natural recruitment in this system. Spawning gravel is scarce, and shifting sand deposits likely suffocate most trout eggs during incubation. Straightening of the river channel for drain construction has resulted in abnormally high current velocities in this low gradient stream. Strong currents (e.g., during storms or spring snowmelt) may dislodge brown trout eggs or push fry downstream (Nuhfer et al. 1994; Spina 2001). As noted previously, thermal stress and the paucity of holding cover in most stream reaches further reduces the possibility of natural recruitment in Nottawa Creek.

Estimated annual survival of brown trout from age 1 to age 2 was below average but slightly above the 25th percentile for Fixed Status and Trends stream reaches (T. Wills, MDNR - Fisheries Division, unpublished). Annual survival of brown trout from age 2 to age 3 appeared to be low, as only one age 3 brown trout was collected during the 2012 survey. The observed age distribution may not accurately reflect carryover potential for brown trout in Nottawa Creek. Wild Rose strain brown trout were stocked in 2010 (i.e., potential age 3 fish), whereas Gilchrist Creek strain brown trout have been stocked in this system since 2011. Wills (2006) conducted paired stocking evaluations of these brown trout strains in four Michigan rivers and found that Gilchrist Creek strain fish exhibited significantly

higher survival than Wild Rose strain fish. Thus, the switch to the Gilchrist Creek strain is expected to increase the abundance of age 3 and older fish in Nottawa Creek beginning in 2013.

Nottawa Creek is a marginal trout stream, and it is a difficult stream to wade under normal flow conditions. However, trout fishing opportunities are limited in Calhoun County, and fishing reports indicate that anglers have been successful at catching brown trout in Nottawa Creek. Continued stocking is warranted to maintain the existing trout fishery. On the other hand, there are opportunities to improve the benefit/cost ratio by making some alterations to the stocking program.

Reclassifying Nottawa Creek as a Type 1 trout stream would reduce the minimum size limit for brown trout from 10 inches to 8 inches and would increase harvest opportunities for this species. No fishing is allowed on Type 1 trout streams during October 1 through the Friday before the last Saturday in April. Reclassifying this stream as Type 1 would eliminate the spring sucker fishery, which is a concern given that suckers composed 78% of the biomass at 7 Mile Road in 2012. Reclassification also would eliminate catch-and-release fishing opportunities for brown trout outside of the possession season. For these reasons, the existing Type 4 trout stream regulations should be retained.

Irrigation is commonly used to enhance agricultural production within the Nottawa Creek watershed. Since July 9, 2009, Part 327 of Public Act 451 requires all large-quantity withdrawals (defined as 70 gallons per minute [100,000 gallons per day] or greater) to be registered with MDEQ. A water withdrawal assessment tool was created to facilitate estimation of the ecological effects of proposed withdrawals (Hamilton and Seelbach 2011). If a proposed withdrawal is predicted to have adverse effects on the fish community, the applicant is directed to pursue alternative options (e.g., digging a deeper well, finding a different location for a well, or acquiring water from other farmers within the sub-watershed that are not using all of their permitted withdrawal capacity). One factor that influences withdrawal allotments is the thermal classification of the stream. Nottawa Creek currently is classified as a "cool" stream. Cool streams have MJTs between 67.1 F and 69.8 F. The MJT at 7 Mile Road in 2012 exceeded this range, but 2012 was an abnormally hot, dry year. The fish community in Nottawa Creek consists of a mixture of coldwater, transitional, and warmwater species, which is typical of a cool stream (Lyons et al. 2009). Additional temperature monitoring is necessary to thoroughly evaluate thermal classifications within this river system.

Management Direction

Five fisheries management goals have been developed for Nottawa Creek as follows: (1) Evaluate current thermal classifications for stream segments within the watershed. (2) Reduce rapid fluctuations in stream discharge. (3) Reduce erosion and sedimentation. (4) Increase fish cover within Nottawa Creek and tributary streams. (5) Maintain or enhance the existing trout fishery in Nottawa Creek.

Fisheries Division already has made progress toward accomplishing Goal 1. Nineteen potential temperature logger deployment sites on Nottawa Creek and tributary streams have been identified (Figure 4). If a sufficient number of temperature loggers are available, loggers will be deployed at each of these sites in 2014.

A variety of methods will be used to accomplish Goal 2. One approach for reducing stream flashiness is to slow the movement of runoff into the river through restoration of wetlands. The Friends of the St. Joe River (Friends) received funding from the United States Environmental Protection Agency to

conduct a functional assessment of all historic and existing wetlands within the St. Joseph River watershed and the assessment is nearly completed. The Friends and partner organizations have used this tool to identify high quality wetlands for protection (e.g., conservation easements) and potential sites for wetland restoration. This information will be relayed to local units of government so that they can incorporate wetland conservation and restoration planning into their zoning and ordinances. The wetlands tool also has been used to identify and invite landowners to wetland protection and restoration workshops, and some wetland restoration projects already are underway as a result of these efforts. Another method to reduce stream flashiness is to restore connectivity between the river and its floodplain. This could be accomplished by cutting berms or creating a floodplain within the banks (i.e., a two-stage ditch). As much of the Nottawa Creek system consists of designated drains, such projects would require collaboration with the Calhoun County drain commissioner.

Throughout much of the watershed, stream banks are steep and sparsely vegetated. In some areas livestock have unrestricted access to streams, resulting in further sedimentation and nutrient inputs. Fisheries Division personnel found three of these sites in the Nottawa Creek watershed in February 2013 and reported them to MDEQ and the Michigan Department of Agricultural and Rural Development (MDARD). Since that time, MDARD staff have worked with the landowners to address these issues. Fisheries Division will continue to work with MDARD, MDEQ, riparian landowners, and the Calhoun County drain commissioner to identify problem areas and implement appropriate soil erosion and sediment control practices. Goals 2 and 3 are inter-related, and the measures discussed for Goal 2 also will facilitate progress toward accomplishing Goal 3.

Large woody cover has been cleared from many stream reaches to facilitate rapid downstream movement of water. The removal of large woody cover directly affects trout by reducing habitat complexity and abundance of holding cover and affects trout indirectly by reducing abundance of macroinvertebrates. Fisheries Division will work with the Calhoun County drain commissioner to develop options for retaining fish cover while meeting the needs of the adjacent landowners.

The measures outlined for Goals 2-4 will assist with attainment of Goal 5 by improving habitat for brown trout. Fisheries Division will continue annual stocking of 1,425 yearling brown trout (Gilchrist Creek strain) at 5 Mile Road, 6 Mile Road, and 7 Mile Road. The total number of brown trout stocked annually will be approximately 4,275 fish (200 fish/acre). Stocking will be discontinued at N Drive due to poor habitat conditions and low survival of stocked trout.

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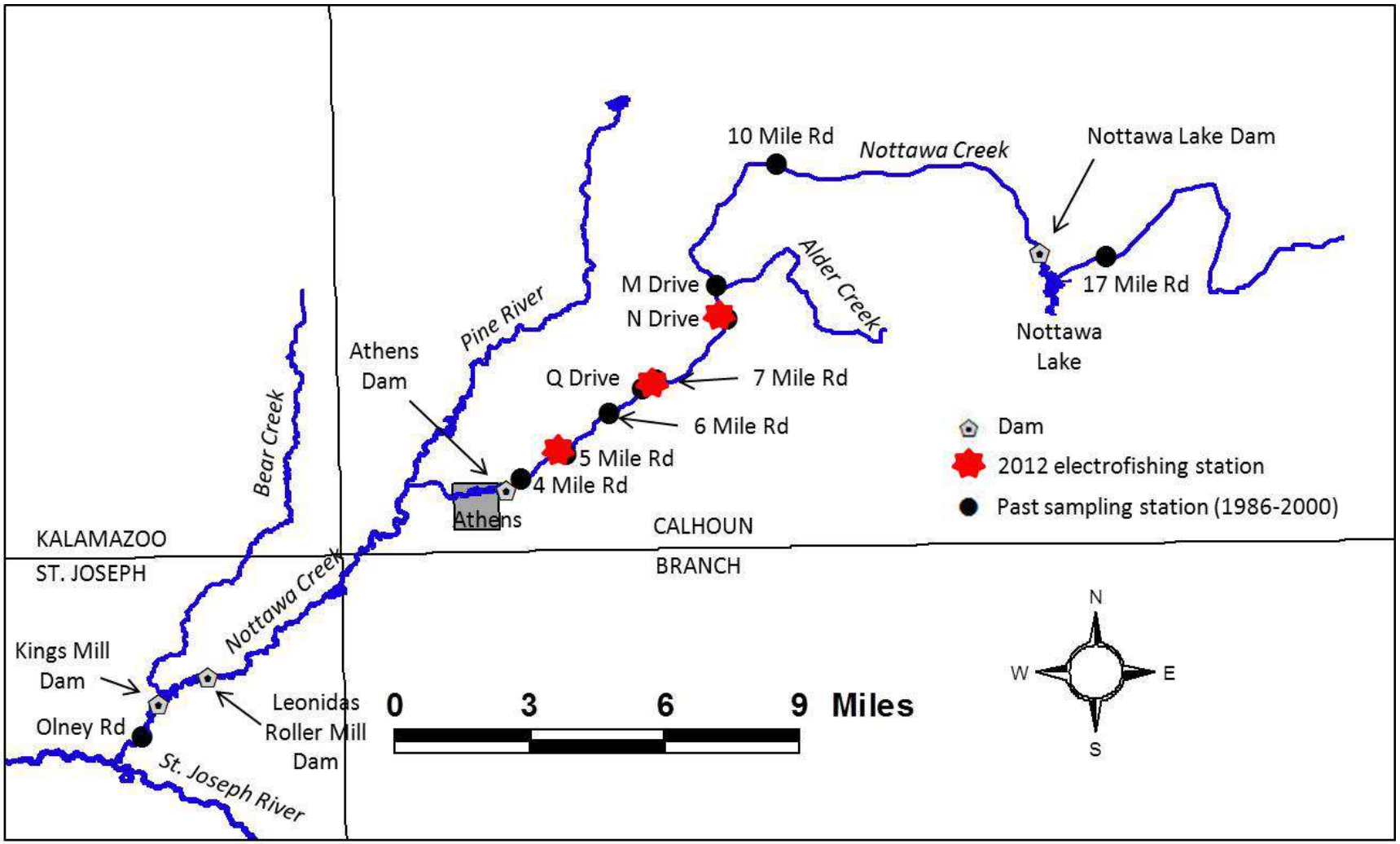

Figure 1.–Nottawa Creek watershed, showing major tributaries, dams, 2012 electrofishing stations, and sampling stations for fisheries surveys conducted during 1986-2000.

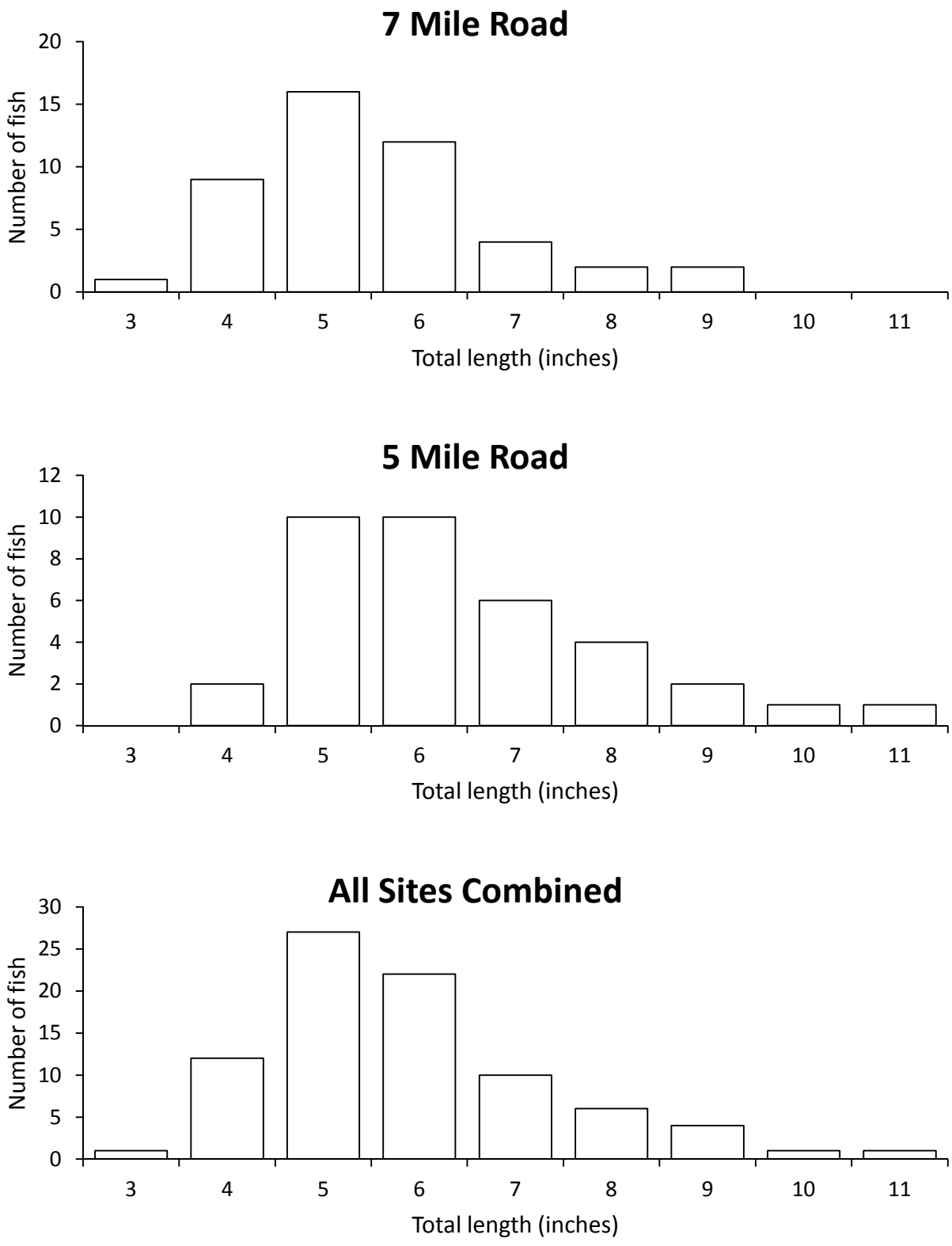

Figure 2.–Length frequency distributions for brown trout captured at the 7 Mile Road sampling station, the 5 Mile Road sampling station, and all sampling stations on Nottawa Creek during July 16-17, 2012.

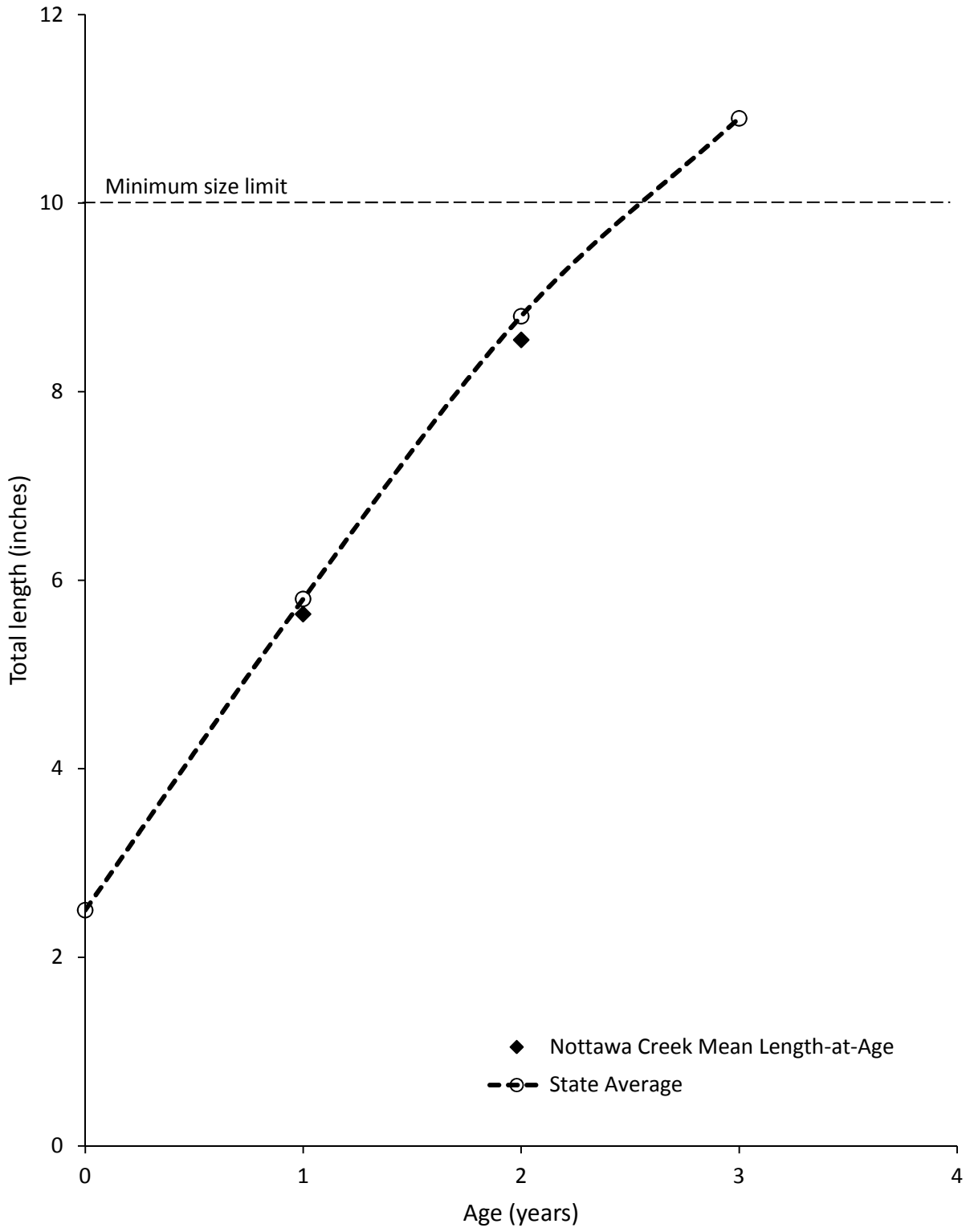

Figure 3.–Growth of brown trout in Nottawa Creek, as determined from scale samples collected at the 7 Mile Road, N Drive, and 5 Mile Road sampling stations on July 16-17, 2012. State average lengths for June-July are from Schneider et al. (2000a).

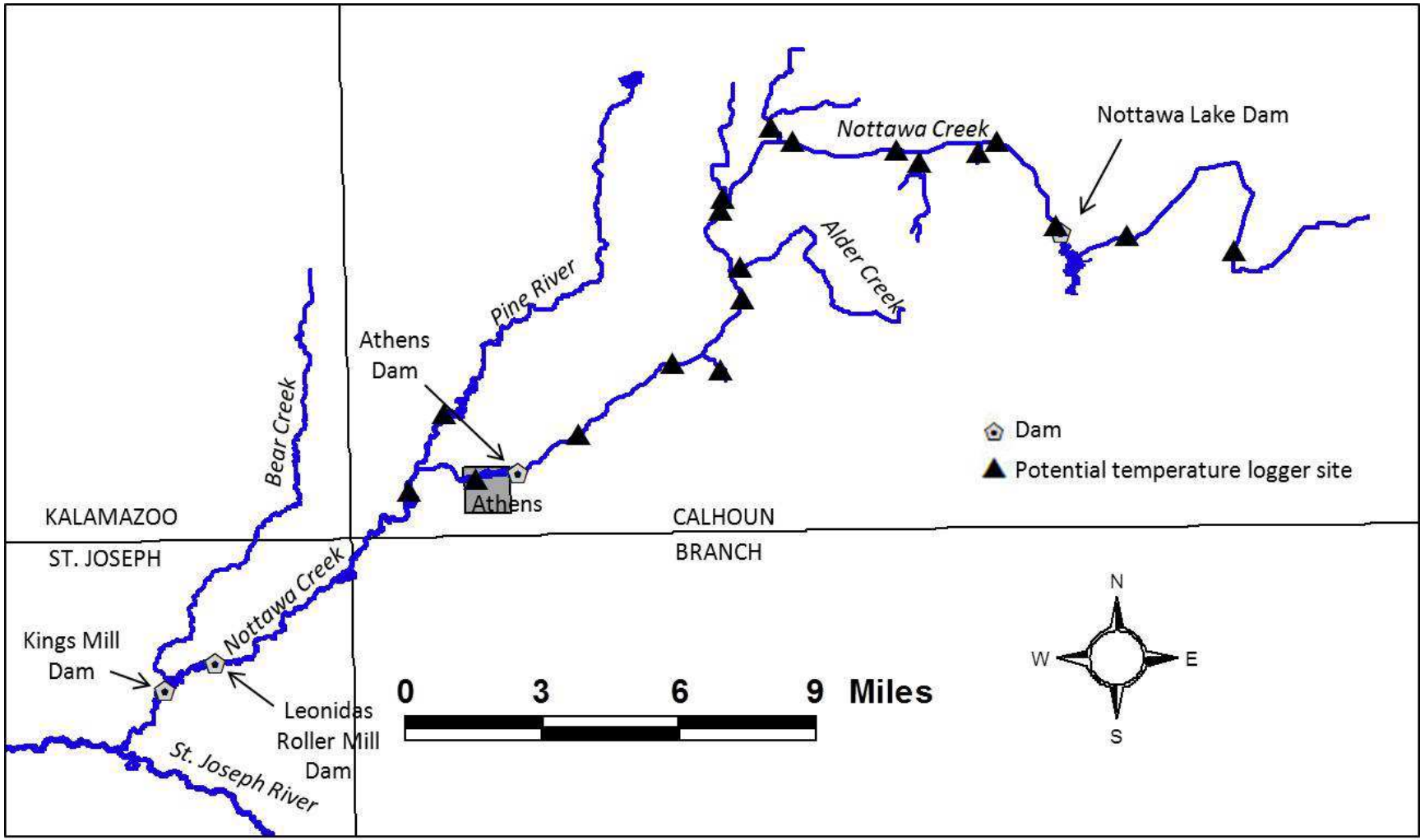

Figure 4.–Potential temperature logger deployment sites on Nottawa Creek and tributary streams in 2014.

Table 1.–Brown trout stocking in Nottawa Creek, 2005-2012. Yearling brown trout were stocked annually at four sites: N Drive, 7 Mile Road, 6 Mile Road, and 5 Mile Road.

Year	Strain	Number of fish stocked per site	Total number of fish stocked	Average length (inches)
2005	Gilchrist Creek	1,425	5,700	5.86
2006	Seeforellen	1,500	6,000	6.04
2007	Wild Rose	481	1,924	6.60
2008	Wild Rose	1,425	5,700	6.61
2009	Seeforellen	1,350	5,400	5.86
2010	Wild Rose	1,500	6,000	7.02
2011	Gilchrist Creek	1,283	5,132	4.68
2012	Gilchrist Creek	1,661	6,644	4.26

Table 2.–Brown trout catch per effort and mean total lengths of brown trout captured in Nottawa Creek during electrofishing surveys conducted by the Michigan Department of Natural Resources, 1986-2000. The upstream and downstream boundaries of the sampling sites varied across sampling years.

Sampling site	Year	Station length (ft)	Number of brown trout captured	Brown trout catch per 1,000 ft	Mean total length of brown trout (inches)
17 Mile Road	1998	500	15	30.0	8.1
M Drive	1986	400	0	0.0	---
N Drive	1986	400	3	7.5	9.5
	1998	100	9	90.0	8.2
7 Mile Road	1986	500	6	12.0	6.8
	1991	750	27	36.0	7.0
	1998	750	2	2.7	9.0
Q Drive	1998	600	5	8.3	7.5
6 Mile Road	1986	300	1	3.3	8.7
	1999	600	14	23.3	6.0
	2000	1,000	2	2.0	10.1
5 Mile Road	1986	400	3	7.5	9.1
4 Mile Road	1999	900	13	14.4	8.7

Table 3.–Numbers, calculated weights, total lengths, and thermal classifications for fish species collected at the 7 Mile Road electrofishing station on Nottawa Creek on July 16, 2012. Thermal classifications from Lyons et al. (2009).

Species	Number	Percent by number	Weight (lb)	Percent by weight	Total length range (inches)	Thermal classification
Green sunfish	49	16.8	1.4	3.1	1-4	Warmwater
Brown trout	46	15.8	4.1	8.9	3-9	Coldwater
White sucker	44	15.1	21.0	46.3	1-17	Transitional
Common shiner	21	7.2	1.7	3.8	3-6	Warmwater
Golden redhorse	16	5.5	12.0	26.4	9-16	Warmwater
Rock bass	16	5.5	0.7	1.5	2-7	Warmwater
Central mudminnow	15	5.1	0.1	0.3	1-4	Transitional
Blackside darter	13	4.5	0.1	0.3	1-3	Warmwater
Johnny darter	12	4.1	0.1	0.1	1-2	Transitional
Creek chub	10	3.4	0.5	1.0	1-7	Transitional
Bluegill	10	3.4	0.3	0.7	2-4	Warmwater
Grass pickerel	8	2.7	0.4	0.9	3-7	Warmwater
American brook lamprey	7	2.4	0.1	0.2	3-6	Transitional
Northern hog sucker	6	2.1	2.4	5.3	7-12	Transitional
Largemouth bass	6	2.1	0.0	0.0	1-1	Warmwater
Stonecat	4	1.4	0.3	0.7	4-6	Warmwater
Hybrid sunfish	3	1.0	0.2	0.4	4-4	Warmwater
Rainbow darter	2	0.7	0.0	0.0	2-2	Warmwater
Bluntnose minnow	2	0.7	0.0	0.0	1-1	Warmwater
Pumpkinseed	1	0.3	0.1	0.2	4	Warmwater
Yellow bullhead	1	0.3	0.0	0.0	3	Warmwater
Total	292		45.4			

Table 4.–Fish species observed at the N Drive and 5 Mile Road sampling stations on Nottawa Creek on July 17, 2012. Thermal classifications from Lyons et al. (2009).

N Drive		5 Mile Road	
Species	Thermal classification	Species	Thermal classification
Bluegill	Warmwater	Bluegill	Warmwater
Brown trout	Coldwater	Brown trout	Coldwater
Blackside darter	Warmwater	Blackside darter	Warmwater
Central mudminnow	Transitional	Central mudminnow	Transitional
Chestnut lamprey	Warmwater	Common shiner	Warmwater
Common shiner	Warmwater	Creek chub	Transitional
Creek chub	Transitional	Golden redhorse	Warmwater
Golden redhorse	Warmwater	Green sunfish	Warmwater
Green sunfish	Warmwater	Hornyhead chub	Warmwater
Johnny darter	Transitional	Johnny darter	Transitional
Northern hog sucker	Transitional	Northern hog sucker	Transitional
Northern pike	Transitional	Rock bass	Warmwater
Rainbow darter	Warmwater	White sucker	Transitional
Rock bass	Warmwater		
Stonecat	Warmwater		
White sucker	Transitional		
Yellow bullhead	Warmwater		

Table 5.–Monthly mean, minimum, and maximum water temperatures (in degrees Fahrenheit) in Nottawa Creek at 7 Mile Road. Water temperatures were recorded hourly with an Onset Hobo Temp Pro v2 temperature logger which was deployed on March 14, 2012 and retrieved on March 13, 2013.

Month	Year	Mean temperature	Minimum temperature	Maximum temperature
March[1]	2012	56.1	45.7	64.6
April	2012	52.7	45.0	60.0
May	2012	62.1	53.6	71.6
June	2012	66.5	53.6	74.0
July	2012	71.6	65.2	80.1
August	2012	67.3	60.3	74.8
September	2012	61.1	51.2	70.7
October	2012	52.4	42.5	62.0
November	2012	42.8	36.3	54.0
December	2012	40.3	33.5	52.8
January	2013	36.4	32.1	45.9
February	2013	36.6	32.1	41.9
March[2]	2013	39.9	35.4	45.9

[1] Only includes data for March 14-31

[2] Only includes data for March 1-13