MILL CREEK FISHERY DEVELOPMENT: EDUCATION, RESEARCH, AND RECREATION: A PROPOSAL TO DEVELOP A TROUT FISHERY IN MILL CREEK
PART III. AATU UNPUBLISHED REPORTS SUPPORTING PARTS I AND II.

A PROJECT OF THE ANN ARBOR CHAPTER OF MICHIGAN TROUT UNLIMITED

A REPORT PREPARED BY THE MILL CREEK FISHERY DEVELOPMENT COMMITTEE:
THOMAS EDSALL*, CARLOS FETTEROLF , WILLIAM PHILLIPS, AND GARY SLAUTER

1. **AATU (Ann Arbor Chapter of Trout Unlimited). 2007. A proposal to develop a trout fishery in Mill Creek, Washtenaw County, Michigan. Unpublished report submitted to the Board of Directors, AATU, November 23, 2007; 5 pages**.

PROPOSAL FOR DEVELOPING A TROUT FISHERY IN MILL CREEK, WASHTENAW COUNTY, MICHIGAN

Introduction

Trout Unlimited's primary mission is to conserve, protect, and restore North America's coldwater fishes and their watersheds. The Ann Arbor Area Chapter of Trout Unlimited (AAATU), which is located in the southeast quarter of Michigan's Lower Peninsula where there are few coldwater streams, supports Trout Unlimited's primary mission by performing habitat restoration work in coldwater streams in more northern portions of Michigan's Lower Peninsula. AAATU will continue this upstate involvement but is proposing herein to also develop a home stream focus that features Mill Creek, a tributary to the middle reach of the Huron River. AAATU bylaws name the middle reach of the Huron River and its watershed as the chapter's home stream and encourage the chapter to engage in stream improvement activities, demonstrations, and educational efforts there as these efforts might directly or indirectly benefit Trout Unlimited's primary mission.

Selection of Mill Creek as the Chapter's Home Stream

The Huron River between Flook Dam and Dexter, which receives substantial amounts of cold groundwater, has been classified as "second quality coldwater" habitat capable of supporting stocked trout (1). That reach and the waters

downstream to Barton Impoundment have also been described as "cool-water" habitat (2). In 2006 the chapter monitored water temperature in June-September at seven sites between Flook Dam and Barton Impoundment to search for areas of cold groundwater inflow that might provide thermal refugia for trout in midsummer (3). The study revealed no significant refugia and showed that water temperatures throughout the reach in July and August exceeded those tolerated by trout. However, the study also showed that summer water temperatures in Mill Creek where it discharged into the Huron River at Dexter, were substantially lower than in the main river and were in the range that would support trout for all but several days in July and August. Removal of the Dexter Dam, which is scheduled for 2008 (4), will make summer water temperatures more favorable for trout in this lower reach of the creek and perhaps also for a short reach of the Huron River downstream from the mouth of the creek. These temperature data, the pending dam removal, and unpublished reports assessing the habitat and water quality and the potential for ecological rehabilitation and restoration in Mill Creek (5, 6) narrowed the chapter's home stream focus from the Huron River and its watershed at large to the river's largest tributary, Mill Creek.

The Mill Creek System*

Mill Creek drains a bowl-shaped watershed covering 142 square miles in northwest Washtenaw County (Figure 1). The creek has four major branches. The Main Branch, which begins on the southwest edge of the watershed, is the largest. the North Branch is slightly smaller, and the South and East branches are the smallest. The Lower Main Branch, which has a width of 42 feet and a mean daily discharge of 32 cfs at Dexter, carries the combined flow of the four upper branches into the Huron River at Dexter.

Settlement of the watershed began in the 1820s and brought about substantial drainage enhancements in the creek system to benefit agriculture. Stream channels were straightened and deepened and a more extensive drainage network was created. The effect of these drainage improvements on the Main Branch has been to lower the water table, thereby increasing groundwater inflow (base flow yield) to the channel system, which in turn provides cooler water during summer low-flow periods.

Groundwater inflow is presently substantial in the Main Branch (0.07-0.13 cfs/km^2), lower in the Lower Main Branch (0.05-0.06 cfs/km^2s) and East Branch (0.05 cfs/km^2), and lower still in the North (0.02-0.05 cfs/km2) and South branches (<0.02cfs/km^2; Table 1).

Water temperature data from three sources are available for six locations (road crossings) on the Main Branch, three on the North Branch, and four on the Lower Mainstem (Table 1). Use of these data to present a fully coherent description of the thermal regime of the creek system is impeded because there are no data for

the South and East branches and because the data from each of the three sources has been summarized differently (i.e., as either weekly median, weekly maximum, or daily maximum). However, some useful generalizations can be made. The weekly median data show that the coldest water occurred in the Main Branch headwaters at the M-52 and Peckins crossings (59-67^{o}F) and that the water was only slightly warmer at the Main Branch, Sager and Guenther crossings (66-68 ^{o}F) and at the Lower Mainstem Steinbach crossing (67 ^{o}F). The Huron River Watershed Council (HRWC) weekly maximum data for 2000 also show that the temperature at Main Branch headwaters crossing at M-52 North (69 ^{o}F) was lower than elsewhere in the Mill Creek system (71-82 ^{o}F). These data also show that North Branch temperatures at Ivey and M-52 Letts did not exceed 74 ^{o}F and thus the creek there essentially met the MDNR criterion for a coldwater stream (< 74 ^{o}F). Temperature at the Fletcher crossing (75-77 ^{o}F) exceeded the MDNR criterion for a coldwater stream by only 2^{o}F. Temperatures at the Lower Mainstem Jackson crossing (71-72 ^{o}F) met the MDNR criterion for a coldwater stream, and virtually met the MDNR criterion for trout stocking (<72 ^{o}F). Temperatures at Shields crossing (71-77 ^{o}F) exceeded the MDNR criterion for a coldwater stream by 3^{o}F. The 2001 temperatures for the

This discussion of the Mill Creek System draws heavily on the material in references 1, 5, and 6.

M-52 Main Branch crossing (78-82 ^{o}F) greatly exceeded the 2000 temperatures for that location and potentially provide some insight into year-to-year variation, which may require further study.

The HRWC and AAATU temperatures for the Lower Mainstem at the Dexter-Pinckney crossing (Warrior Park) in 2006 are closely similar and exceed the 2000 temperatures at Shields crossing by 3-5 ^{o}F and the MDNR criterion for a coldwater stream by 6-8 ^{o}F. Removal of the Dexter Dam can be expected to lower the temperatures in Warrior Park to more closely resemble those at Shields crossing and perhaps also those at Jackson crossing.

Management recommendations and opportunities

The Main Branch offers cool and stable temperatures that are higher than the optimum, but within the tolerable range for brown trout, as can be shown from recent studies documenting the abundance of brown trout relative to stream temperatures in Wisconsin and Michigan (7, 8), and the development of a put-and-take fishery for brown trout in the headwaters and middle reach seems worthy of consideration (5).

Habitat improvement actions to support a brown trout fishery in the Main Branch would include streamside plantings to increase channel shading, in-channel

habitat development, narrowing and deepening the low-flow channel, and groundwater augmentation (5).

The cool water temperatures the North Branch at Ivey and M-52 Letts crossings and in the Lower Mainstem at Jackson crossing, suggest that temperatures at these locations be further monitored and evaluated for the potential of these reaches to support a put-and-take fishery for brown trout.

Removal of the Dexter Dam will create new habitat for stream fishes and consideration should be given to monitoring summer stream temperatures there after dam removal, to determine the potential of that habitat to support a put-and-take fishery for brown trout.

Stream improvement work will be required after removal of the Dexter Dam to reestablish and stabilize the stream channel and provide riffle, pool, and run fish-holding water. Developing a system of small public angler access points along the creek (5) would be desirable because virtually all of the land through which the creek flows is in private ownership and roadside vehicle parking at most road crossings is limited.

References

1. Hay-Chmielewski, E.M., P.W. Seelbach, G.E. Whelan, and D.B. Jester, Jr. 1995. Huron River Assessment . Fisheries Division Special Report. Michigan Department of Natural Resources., Lansing.
2. Bovee, K.D., T.J. Newcomb, and T.G. Coon. 1994. Relations between habitat variability and population dynamics of bass in the Huron River, Michigan. Biological Report 21, U.S. Department of the Interior, National Biological Survey, Washington D.C.
3. AAATU (Ann Arbor Area Chapter of Trout Unlimited). 2006. Huron River and Mill Creek water temperature study, June-September 2006. Unpublished report submitted to the Board of Directors, AAATU, September 22, 2006, by T. A. Edsall.
4. Ann Arbor News. Local News, Dexter. October 4, 2007. Bonds would pay for improvements.
5. Seelbach, P.W., and M.J. Wiley 1996. An assessment for the potential ecological rehabilitation and restoration in Mill Creek. Unpublished report to the Huron River watershed Council, November 17, 1996. Ann Arbor, Michigan.
6. Latimore, J.O. 2007. Stream quality assessment of Mill Creek, Washtenaw County, Michigan, a tributary of the Huron River 2004-2006. Results of the monitoring component of Mill Creek Blitz Project, MDEQ Section 319 Grant #2004-0169. Huron River Watershed Council, June 2007. Ann Arbor.

7. Wehrly, K.E., M.J. Wiley, and P.W. Seelbach. 2003. Classifying regional variation in thermal regime based on stream community patterns. Trans. Am. Fish. Soc. 132:18-38.
8. Wehrly, K.E., L. Wang, and M. Mitro. 2007. Field-based estimates of thermal tolerance limits for trout: incorporating exposure time and temperature fluctuation. Trans Am. Fish. Soc. 136:365-364.
9.

Table 1. Groundwater inflow (baseflow;cfs/km^2) and July water temperature (^{o}F) in Mill Creek (after Seelbach and Wiley, 1996; Latimore, 2006; and AAATU, 2006).

Stream Reach	Groundwater (Seelbach and Wiley)	Road crossing (temperature data)	Water temperature Weekly med (Seelbach and Wiley)	Weekly max (Latimore)	Daily max (AAATU)
Main Branch (Headwaters)	0.07-0.13	M-52 South	59		
		Peckins	64		
		M-52 North	67	69 [1] 78-82[2]	
Main Branch (Middle-lower)	0.09-0.11	Klinger		73-82[1]	
		Sager	68		
		Guenther	66		
North Branch	0.02-0.05	Ivey		71-74[1]	
		M-52 Letts		73-74[1]	
		Fletcher		75-77[1]	
South Branch	<0.02				
East Branch	0.05				
Lower Mainstem	0.05-0.06	Steinbach	67		
		Jackson	.	71-72[1]	
		Shields		71-77[1]	
		Dexter-Pinckney (Warrior		72-82[3]	74-80[3]

Park)

[1/] =2000, [2/] = 2001, [3/] = 2006.

All temperatures rounded to nearest whole degree.

MDNR maximum July temperature for coldwater stream = < 76°F; for trout stocking = < 72°F.

2. AATU. 2006. Huron River and Mill Creek water temperature study, June-September 2006. Unpublished report submitted to the Board of Directors, AATU, September 22, 2006, by T. A. Edsall; 9 pages.

Huron River and Mill Creek Water Temperature Study, June-September, 2006

This study was conducted by the Ann Arbor Area Chapter of Trout Unlimited to provide summer water temperature data for six discrete segments of the Huron River from Flook Dam, Livingston County, to the tail waters of Barton Impoundment near Ann Arbor (Figure 1). Of particular interest was whether or not there were detectable areas of coldwater inflow within any of these river segments that could create thermal refugia for trout during midsummer.

We selected this reach of the Huron River for study because it is has good access for wading or boating anglers, supports a popular fishery for smallmouth bass during summer, and because the waters between Flook Dam and the town of Dexter were classified by the DNR (Hay-Chmielewski et al. 1995) as ***second quality trout water, which could sustain significant trout populations, but probably could not support natural reproduction by trout.*** We included the reach between Dexter and Tubbs Road and the tailwaters of Barton Dam because monthly mean water temperatures in June-August at Delhi Metro Park and at the City of Ann Arbor water intake in Barton Impoundment were near or within the range tolerated by trout (Figure 2).

Although Hay-Chmielewski et al. (1995) presented no water temperature data to support their classification of the river as second quality trout water, their report showed that mean river discharge increased from about 287 cubic feet per second (cfs) at Hudson Mills to about 429 cfs at Dexter and that 31 cfs of the discharge at Dexter is contributed by Mill Creek, which enters the river in the town of Dexter. Thus the river discharge at Dexter, minus the contribution by Mill Creek, is about 38% higher than at Hudson Mills. Only one small, named tributary, Huron Creek, enters the river between Hudson Mills and Dexter, indicating the increase in Huron River discharge is a combination of surface runoff and groundwater. This result provides support for the ***second quality trout water*** classification because groundwater temperature in this area is about 50°F and its input to the river during low flow conditions could generally lower river water temperature and might also create localized thermal refugia that could help trout survive during the period of maximum water temperatures in midsummer. The need for thermal refugia to permit survival of trout over the summer in this river reach was suggested by the average weekly water temperatures in the river at Bell Road and Delhi Metro Park presented by Bovee et al. (1994).

We used Onset Computer Corporation (Bourne, MA) HOBO Pendant UA-002-08 temperature recorders to collect the temperature data (recorder accuracy, 0.85^{o}F), and HOBOware for windows and a HOBO Optic-USB Base Station with Coupler to program the recorders and download data from them into a PC for processing. We also used a small, mercury-filled stem thermometer with 1^{o}F graduations for spot recordings. We programmed each HOBO recorder to record water temperature at 0001, 0600, 1200, and 1800 hours daily and then wired the recorder inside a short piece of PVC pipe to protect it from physical damage during deployment. The pipe was coated with camouflage paint to make it less visible.

We installed one recorder in moving water at each of nine locations throughout the study area in early June (Table 1, Figure 1). One recorder was wired to a private dock support and the others were either wired to rubble-sized rocks and buried in cobble-boulder piles 1-2 yards offshore, or wired to the underside of living tree root masses and limbs submerged in the river. We checked the recorders in mid-to-late June to ensure they remained submerged as water levels dropped and moved those at sites 1, 9, and 13 to slightly deeper water at that time. We lifted the recorders in early September, returned them to Ann Arbor, immediately downloaded the temperature records, saved them in Excel for analysis and processing, and copied them to a CD for archiving.

We were unable to recover the recorders deployed at Hudson Mills, Dexter, and Delhi and their fate is unknown. All three recorders were firmly wired to the underside of submerged parts of living trees and were not visible to the casual viewer. The root and limb material to which the recorders were wired was present at the end of the study, but the recorders and associated wire were not. All three areas are popular fishing sites and the recorders may have been removed by persons searching under the submerged woody material for crayfish or other fishing bait.

In addition to deploying recorders, we also floated the river from Flook Dam to the Dexter-Huron Metro Park on July 14 in two kayaks and searched both banks for small, unnamed tributaries and other sites of obvious groundwater input. Each kayak towed a HOBO recorder programmed to record temperature at 30 second intervals. The temperature records showed localized, cross-channel differences of up to several degrees but were otherwise difficult to interpret and are not further included in the study. Several small, unnamed tributaries discharging cold water at about 0.5 cfs along the left bank of the river were observed between Huron Creek and Mill Creek.

Huron River water temperatures were about 68-75^{o}F at the start of the study on June 3, increased irregularly to a peak at about 78-85 ^{o}F in mid-July, declined briefly, before rising to a seasonal peak of about 81-88 ^{o}F during the first week in August, and thereafter decreased irregularly to about 66-75 ^{o}F on September 7 when the study ended (Figure 3). Water temperatures were higher in the Flook Dam-Bell Road reach, and in the Barton Dam tailrace than at the Dexter-Huron Metro Park, Zeeb Road, and Tubbs Road. Water temperature in Mill Creek followed a trend similar to that of the Huron River sites, but

was generally about 5 ^{o}F lower. The mean water temperatures for each of the sites for the period June 2-September 9 show these site differences more clearly (Figure 4).

Preliminary evaluation of the study results for the Huron River main stem show temperatures there could support trout during most of the year but that survival during the period of maximum water temperatures in July and early August probably would require the trout to reside in thermal refugia in the river created by groundwater inflow, small, groundwater-fed tributary inflows, or the outflows of Huron Creek and Mill Creek. Although water temperatures in Mill Creek rose into the lethal range for trout for 2-3 days in early August (Figure 5), the removal of the Dexter Dam on the creek, which has been approved and funded, should lower water temperatures in the lower reach of the creek into the range suitable for year-round residence by trout.

Acknowledgments

Mark Delaney assisted in recorder deployment and retrieval. William Phillips manned one of the kayaks during the float from Flook Dam to the Dexter-Huron Metro Park.

References

Bovee, K.D., Newcomb, T.J., and Coon, T.G. 1994. Relations between habitat variability and population dynamics of bass in the Huron River, Michigan. Biological Report 21, National Biological Survey, U.S. Department of the Interior, Washington, D.C.

Hay-Chmielewski, E.M., P.W. Seelbach, G.E Whelan, and D.B. Jester, Jr. 1995. Huron River assessment. Fisheries Division, Special Report No. 16, Michigan Department of Natural Resources. Lansing.

Appendix 1. The HOBO data base follows in a separate AAATU document..

Report submitted to the Board of Directors, Ann Arbor Chapter of Trout Unlimited, September 22, 2006 by Thomas A. Edsall.

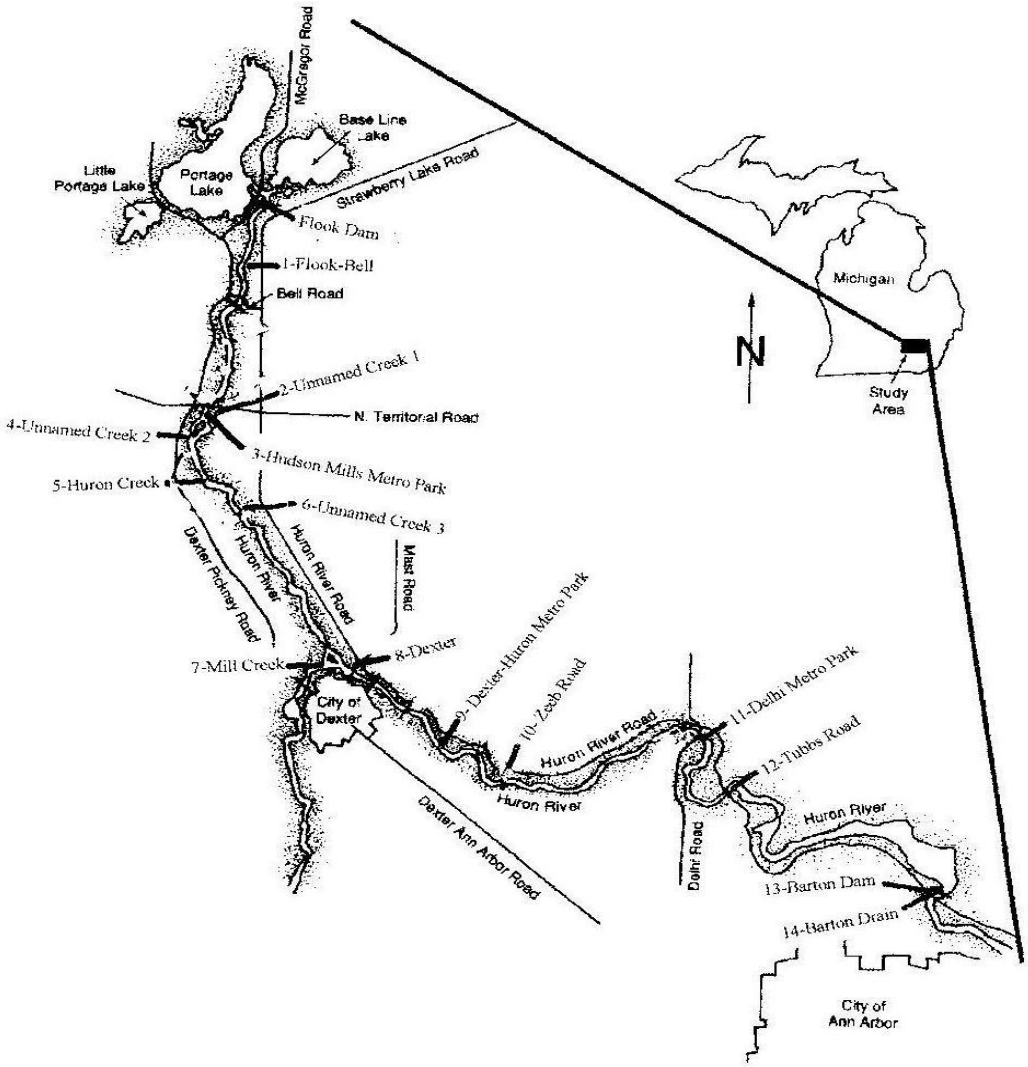


Figure 1. Map of the Huron River and Mill Creek study sites (adapted from Bovee et al. 1994).

Figure 2. Mean monthly water temperatures at Delhi, 1981-90 and the municipal water intake in Barton Impoundment, 2005 (data from Bovee et al. 1994 and the City of Ann Arbor).

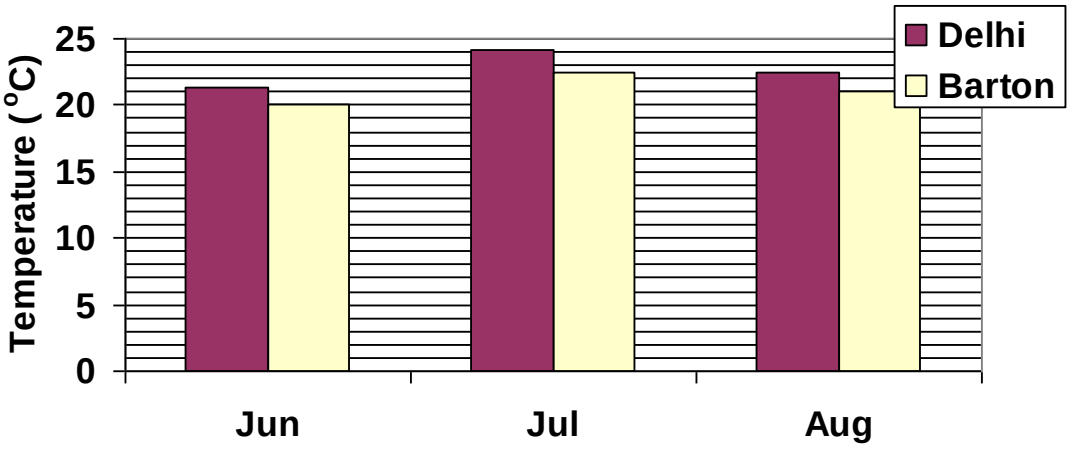


Figure 3. Huron River and Mill Creek water temperatures, June 3-September 7, 2006 (daily recordings at 0001, 0600, 1200, and 1800 hours).

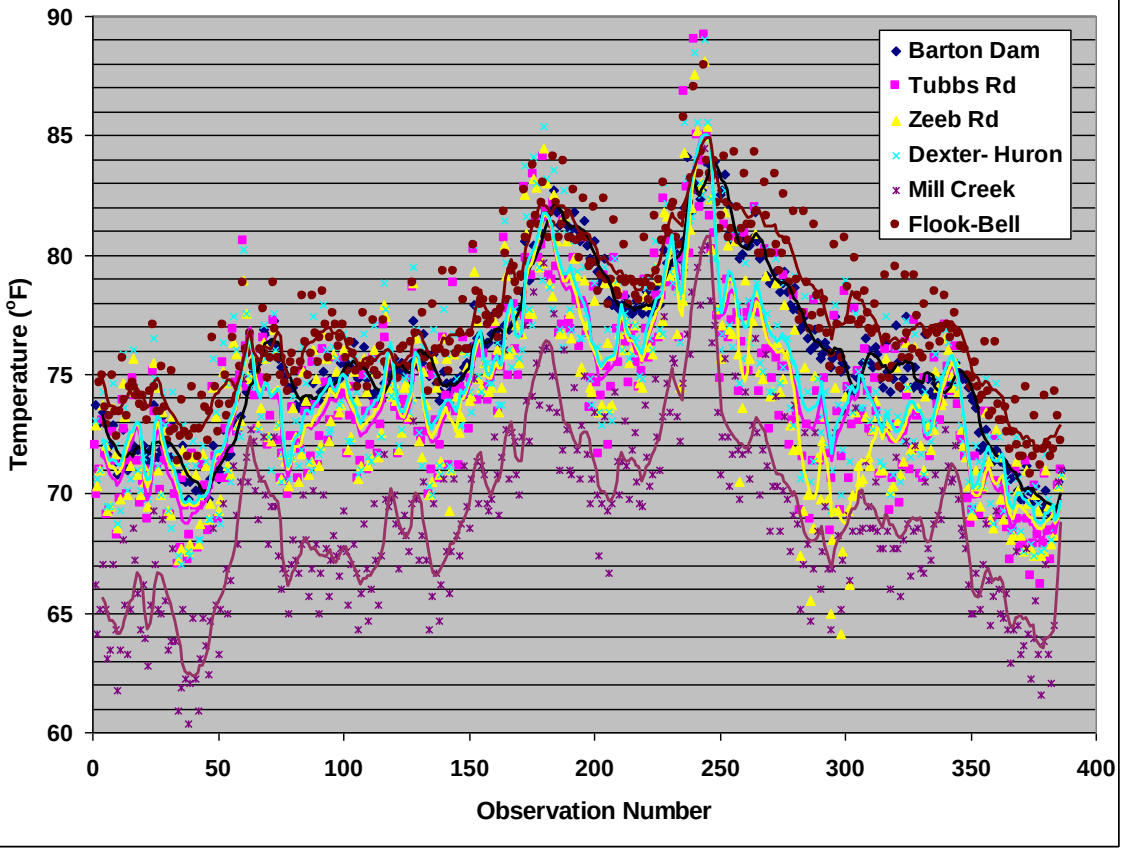
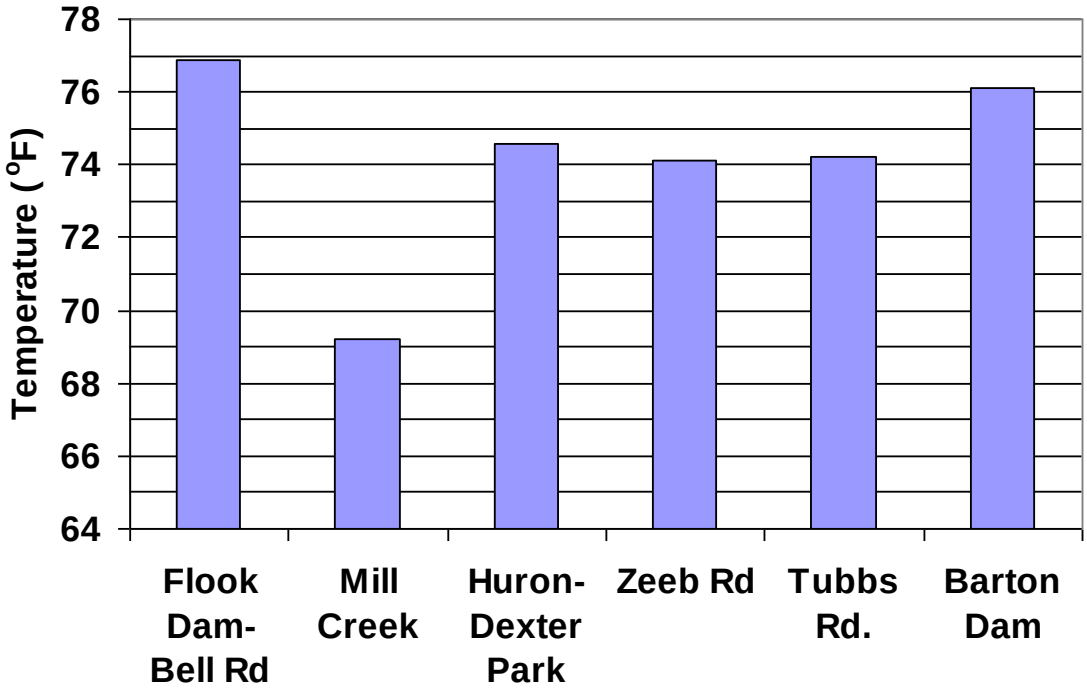


Figure 4. Mean Huron River and Mill Creek water temperatures, June 3-September 7, 2006.



3. Edsall, T. A. 2010. Analysis of MDNRE July 23, 2008 electro-fishing survey data for Mill Creek. A memorandum submitted to AATU by the Mill Creek Fishery Development Committee, February 5, 2010; 3 pages.

Date: February 5, 2010
From: Tom Edsall
To: AATU Mill Creek Committee
Subject: Analysis of MDNRE July 23, 2008 electrofishing survey data for Mill Creek

This analysis is based on the subject data that the DNR gave us on January 15. I am assuming these data represent the condition of the Mill Creek fish population **before** (or at the time of) dam removal. As I understand it, the DNR wants to conduct one more survey, presumably in July 2010, to represent the situation **after** dam removal.

My analysis is as follows:

1. The DNR's survey on July 23, 2008 collected 13 fish species at Shields Road, 16 at Steinbach Road, and 12 at Lima Center Road (Table 1). Seven of these species occurred at 1 site, 4 at 2 sites, and 9 at all 3 sites. Eleven of these were warmwater species, 8 were coolwater or transitional, and 1 (mottled sculpin) was coldwater.

2. The ratio of coldwater + coolwater species to warmwater species was 0.6 at Shields Road, 0.8 at Steinbach Road, and 1.0 at Lima Center Road (Table 1). Thus, the farther the site upstream from the Dexter Millpond, the greater the representation of coldwater + coolwater species in the fish community.

3. Coldwater + coolwater species were 94.6% of the total biomass, and warmwater species were 5.4%, and the coldwater + coolwater species biomass increased from 87.4% at Shields Road, to 96.2.% at Steinbach Road, and to 97.3% at Lima Center Road (Table 2). Thus, the farther the site upstream from the Dexter Millpond, the greater the biomass of coldwater + coolwater species in the fish community.

4. Warmwater game species collected during the study were bluegills, largemouth bass, pumpkinseed, and rock bass; northern pike and yellow perch were coolwater game species. Warmwater game fish biomass was 6.13 pounds, and coolwater game fish biomass was 2.1 pounds.

5. Game fish biomass was 8.23 pounds and 4.6% of the total biomass (180.75 pounds) and non-game fish biomass was 172.32 pounds and 95.4% of the total (Table 3).

6. The biomass of game fish species was 6.03 pounds at Shields Road, 1.95 pounds at Steinbach Road, and 0.25 pounds at Lima Center Road (Table 3). Thus, the farther the site upstream from the Dexter Millpond, the smaller the representation of game fish biomass species in the fish community.

7. Sucker biomass was 151.39 pounds and 83.9% of the total (Table 4). This coolwater, non-game fish clearly dominated the fish biomass in the creek.

I believe these DNR data suggest that the Dexter Mill Pond provided habitat that was favorable for warmwater fishes and allowed them to colonize creek upstream for some distance from the millpond; they also suggest that dam removal, which occurred in 2008, will cause the fish community in the creek to shift to one that is less strongly composed of warmwater species.

The effect of dam removal on angler use of the creek is unknown, but Mill Creek between Shield Road (or Dexter) and Lima Center Road offers at least limited angling opportunity for warmwater (bluegills, largemouth bass, pumpkinseed, and rock bass) and coolwater (northern pike and yellow perch) game fish. However, the data suggest it is unlikely that the size and abundance of these game species presently in the creek would attract much of an angler following, as the same species are generally abundant and

readily available in harvestable sizes elsewhere in lakes and larger streams throughout the county and southern Michigan.

The small, non-game species and the young of all species in the creek are a substantial forage base that could be readily exploited by piscivorous fishes, including brown trout.

Fish species present in the creek that might prey on small, yearling brown trout include northern pike, largemouth bass, rockbass, and perhaps large creek chubs. However it seems unlikely that these fishes would be present in sufficient numbers and size to constitute a significant threat.

DNR FISH SURVEY DATA FOR MILL CREEK, 7/23/08.

TABLE 1. NUMBER OF SPECIES BY THERMAL GUILD AND SITE

GUILD	SHIELDS RD	STEINBACH RD	LIMA CTR RD
COLD	1	1	1
COOL (TRANSITIONAL)	4	6	5
WARM	8	9	6
TOTAL	13	16	12
RATIO COLD+COOL TO WARM	0.6	0.8	1

TABLE 2. FISH BIOMASS (POUNDS) BY THERMAL GUILD AND SITE

GUILD	PERCENT	STEINBACH RD	LIMA CTR RD	TOTAL	PERCENT
COLD	0.3	0.2	0.92	1.42	0.8
COOL (TRANSITIONAL)	31.82	108.14	29.54	169.5	93.8
WARM	4.85	4.12	0.86	9.83	5.4
TOTAL	36.97	112.46	31.32	180.75	100
PERCENT COLD + COOL	87.4	96.2	97.3		

TABLE 3. FISH BIOMASS (POUNDS) BY GAME AND NON-GAME SPECIES

CLASSIFICATION	SHIELDS RD	STEINBACH RD	LIMA CTR RD	TOTAL	PERCENT
GAME	6.03	1.96	0.25	8.23	4.6
NON-GAME	30.94	110.31	31.07	172.32	95.4
PERCENT GAME	16.3	1.7	0.8		

TABLE 4. SUCKER BIOMASS (POUNDS) BY SITE

	SHIELDS RD	STEINBACH RD	LIMA CTR RD	TOTAL
NORTHERN HOG SUCKER	2.45	7.29	1.47	11.21
WHITE SUCKER	27.34	92.7	20.14	140.18
TOTAL	29.79	101.99	21.61	151.39
PERCENT TOTAL FISH BIOMASS	81	91	69	84

4. Edsall, T.A. and W.E. Phillips. 2009. Summer water temperatures in Mill Creek: A report to the Ann Arbor Chapter of Trout Unlimited; 5 pages.

SUMMER WATER TEMPERATURES IN MILL CREEK: A REPORT TO THE ANN ARBOR AREA CHAPTER OF TROUT UNLIMITED

By

Thomas A. Edsall and William E. Phillips

Introduction

Trout Unlimited's primary mission is to conserve, protect, and restore North America's coldwater fishes and their watersheds. The by-laws of the Ann Arbor Area Chapter of Trout Unlimited (AAATU) name the middle reach of the Huron River and its watershed, which includes Mill Creek, as the chapter's home stream area and encourage the chapter to engage in stream improvement activities, demonstrations, and educational efforts there as these efforts might directly or indirectly benefit Trout Unlimited's primary mission.

In 2006 AAATU monitored water temperature in June-September at seven sites in the middle reach of the Huron River and found that water temperatures in July and August exceeded those tolerated by trout (1). However, the study also showed that summer water temperatures in the lower reach of Mill Creek immediately below the Dexter Impoundment and near the creek's confluence with the Huron River at Dexter, were in the range that would support trout for all but several days in July and August. Removal of the Dexter Dam in 2008 increased the likelihood that future summer water temperatures in the lower reaches of Mill Creek and perhaps also in a short reach of the Huron River downstream from the mouth of the creek would be more favorable for trout.

Methods

To better determine the potential of Mill Creek's lower mainstream to support trout, we set temperature recorders (Hobo Onset Pendant temperature data loggers) at five sites in the creek in mid-June, 2009:

1. Steinbach Road, Main Branch, about 100 yards upstream from the bridge.

2 Steinbach Road, North Fork, about 100 yards upstream from the bridge and about 10 yards upstream from the confluence with the Main Branch.

3. Marshall Road, about 50 yards upstream from the bridge.

4. Shields Road, under the bridge.

5. Warrior Park, Dexter, under the railroad bridge, about 150 yards downstream from the Dexter-Pinckney road bridge.

The loggers were programmed to measure water temperature hourly and were and retrieved in mid-September. Programming the loggers and downloading their data was accomplished by inserting them in a HOBO Pendant Coupler attached to a USB port on a personal computer.

In the field, loggers were secured with plastic-coated solid copper wire inside a short, open-ended length of 1.5-inch diameter PVC pipe. The pipe protected the loggers from physical damage, while allowing water to circulate freely around them. The pipe was wired to a 10-pound cast-iron weight, which was either wired to bankside woody vegetation or buried in a loose pile of cobble-sized rock. Each logger rested several inches above the consolidated streambed substrate, in moving water about 2 feet deep, several feet from the stream bank.

Results and Discussion

Water temperatures fluctuated daily at all sites, June 17-September 17, and were generally highest in the afternoon and evening and lowest in early morning (Figs. 3-7; Appendix 1).

Figure 1.

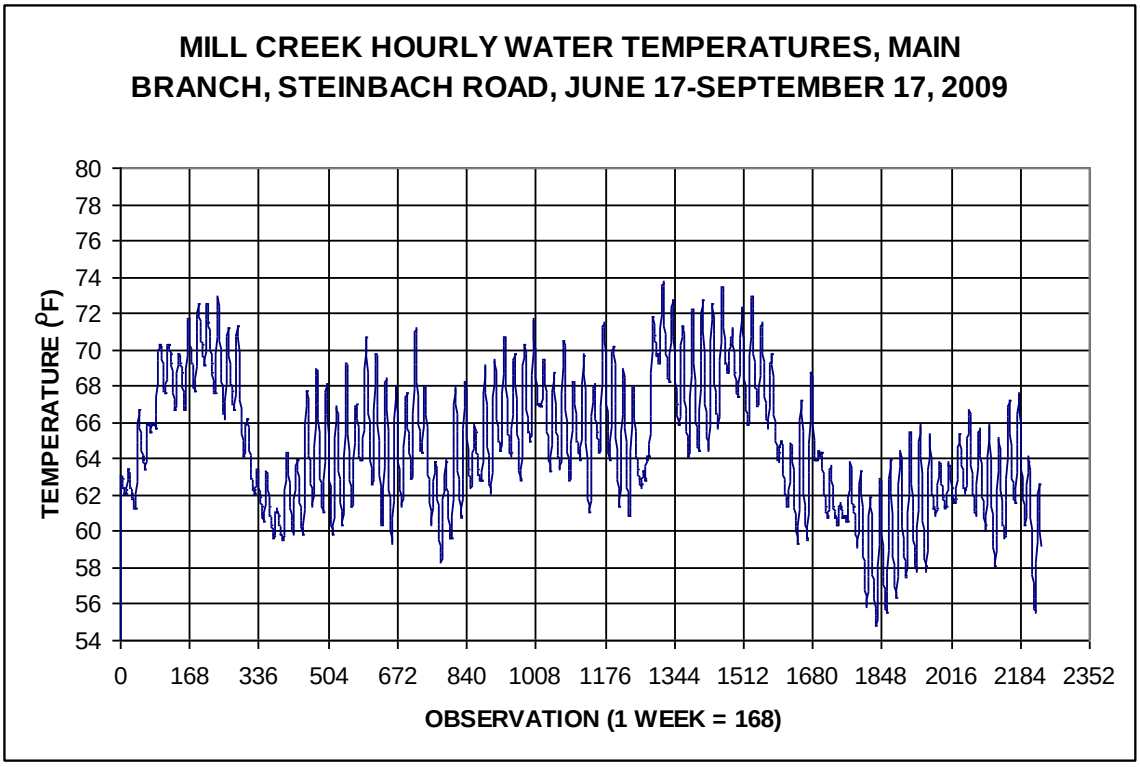

MILL CREEK HOURLY WATER TEMPERATURES, MAIN BRANCH, STEINBACH ROAD, JUNE 17-SEPTEMBER 17, 2009
TEMPERATURE (ºF)
80
78
76
74
72
70
68
66
64
62
60
58
56
54
0
168
336
504
672
840
1008
1176
1344
1512
1680
1848
2016
2184
2352
OBSERVATION (1 WEEK = 168)

Figure 2.

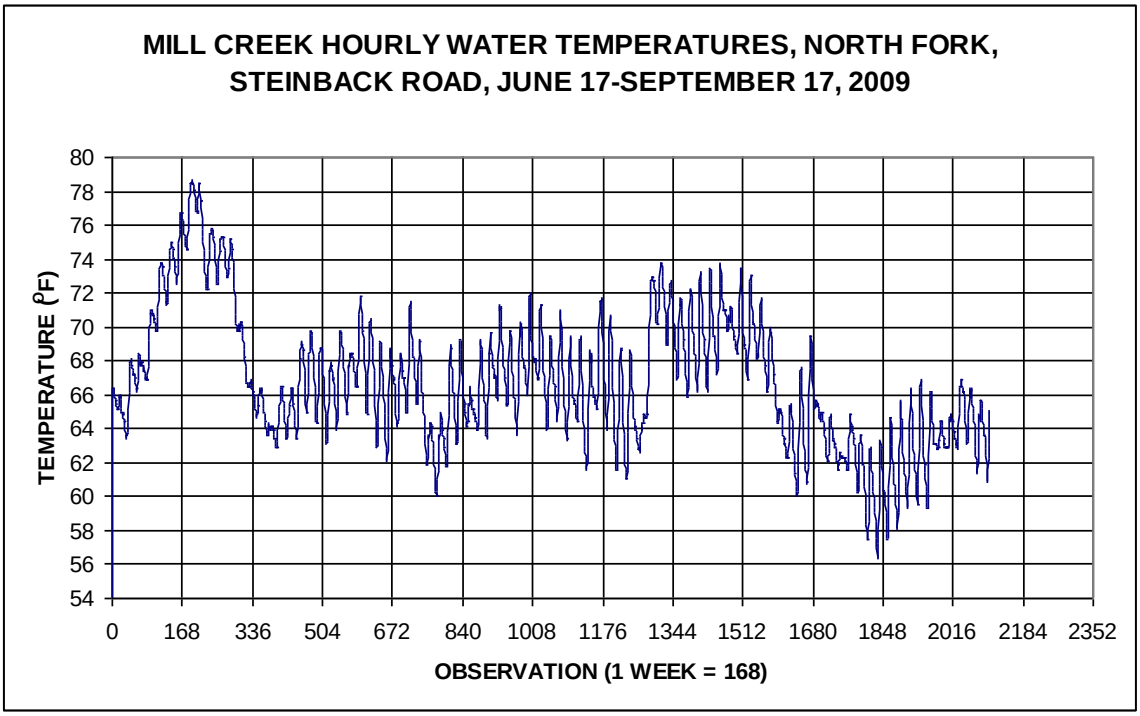

MILL CREEK HOURLY WATER TEMPERATURES, NORTH FORK, STEINBACK ROAD, JUNE 17-SEPTEMBER 17, 2009
TEMPERATURE (ºF)
80
78
76
74
72
70
68
66
64
62
60
58
56
54
0
168
336
504
672
840
1008
1176
1344
1512
1680
1848
2016
2184
2352
OBSERVATION (1 WEEK = 168)

Figure 3.

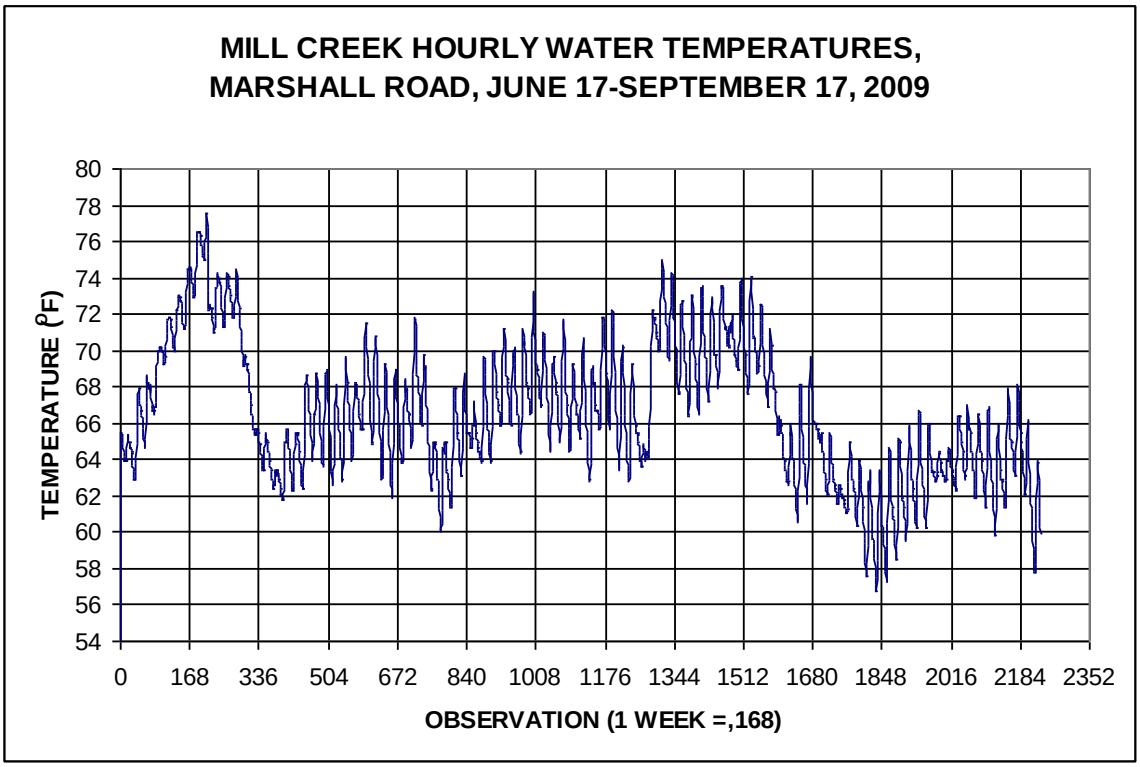


Figure 4.

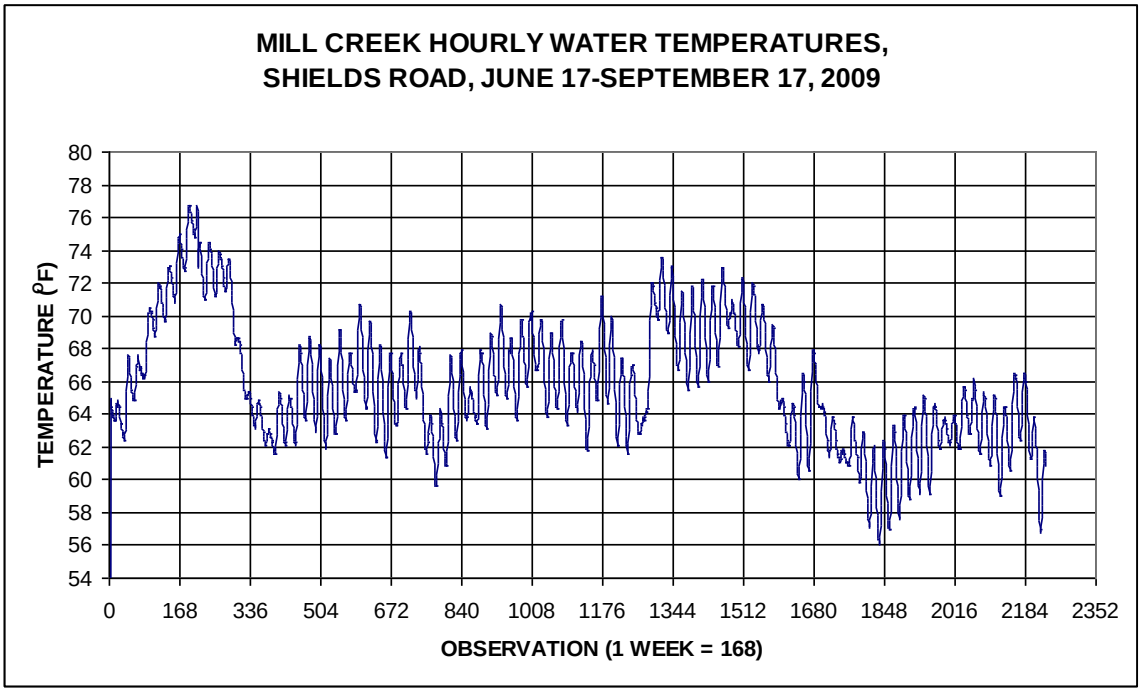
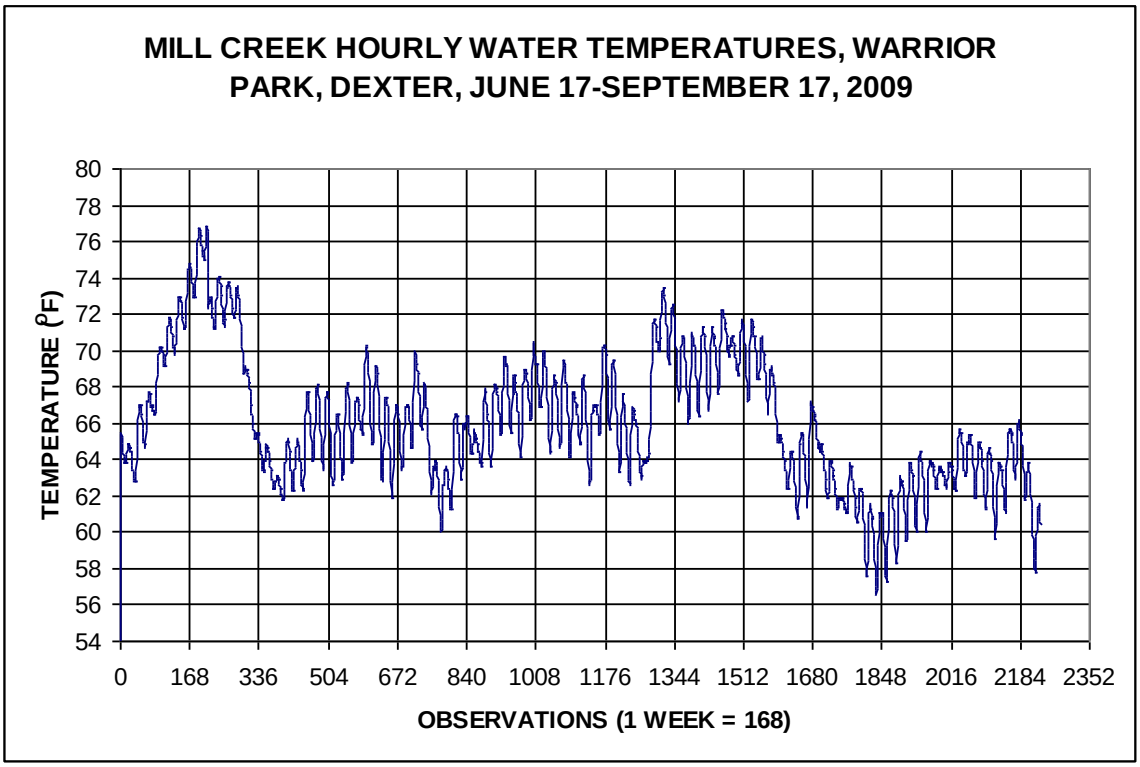


Figure 5.



Temperatures at all sites were generally highest in June (weeks 1-2; Figs 1-5), low in early July (week 3), rising in July (weeks 4-7) and August (weeks 7-11), and then lowest in September (weeks 12-14). Temperatures were closely similar across sites throughout the study. Mean temperatures for June 17-September 17 ranged from 65.4 ^{o}F at site 1 to 66.6 ^{o}F at site 4.

The slightly lower June water temperatures at site 1 than at sites 2-5 (Figs 1-5) probably reflects the greater groundwater component of discharge in the upper and middle reaches of the Main Branch than in the North Fork and lower Main Branch, as has been described elsewhere (2).

Conclusions

The results of this study show that summer water temperatures in 2009 in the lower reach of the Main Branch of Mill Creek between Steinbach Road and Warrior Park were above the optimum for trout (about 60^{o}F). However, water temperatures in July at all 5 sites (observations for weeks 3-7 in Figs. 1-5) met the coldwater stream designation used by the Michigan Department of Natural Resources (MDNR) for coldwater streams (July water temperature maximum temperature less than 75^{o}F). Water temperatures in July at sites 1, 4, and 5 also met the MDNR trout stocking criterion (July maximum temperature less than 72^{o}F); the other two sites failed to meet the criterion only on July 28 when the

water temperature reached 72 ^{o}F for one hour (site 2) and 72.1-73.2^{o}F for three hours (site 3; Appendix 1).

References

10. AAATU (Ann Arbor Area Chapter of Trout Unlimited). 2006. Huron River and Mill Creek water temperature study, June-September 2006. Unpublished report submitted to the Board of Directors, AAATU, September 22, 2006, by T. A. Edsall.

11. Seelbach, P.W., and M.J. Wiley 1996. An assessment for the potential ecological rehabilitation and restoration in Mill Creek. Unpublished report to the Huron River watershed Council, November 17, 1996. Ann Arbor, Michigan.

Appendix 1.

This appendix, which contains the hourly water temperatures for the study, is available in electronic form from AAATU and the first author.