An Assessment of

Water Quality

in

The Lower Middle and Lower Sugar River Watershed

(HUC 0709000406)

2013

Green County, Wisconsin

Project SCR_20_CMP13

Searles Creek looking upstream from Prairie Road

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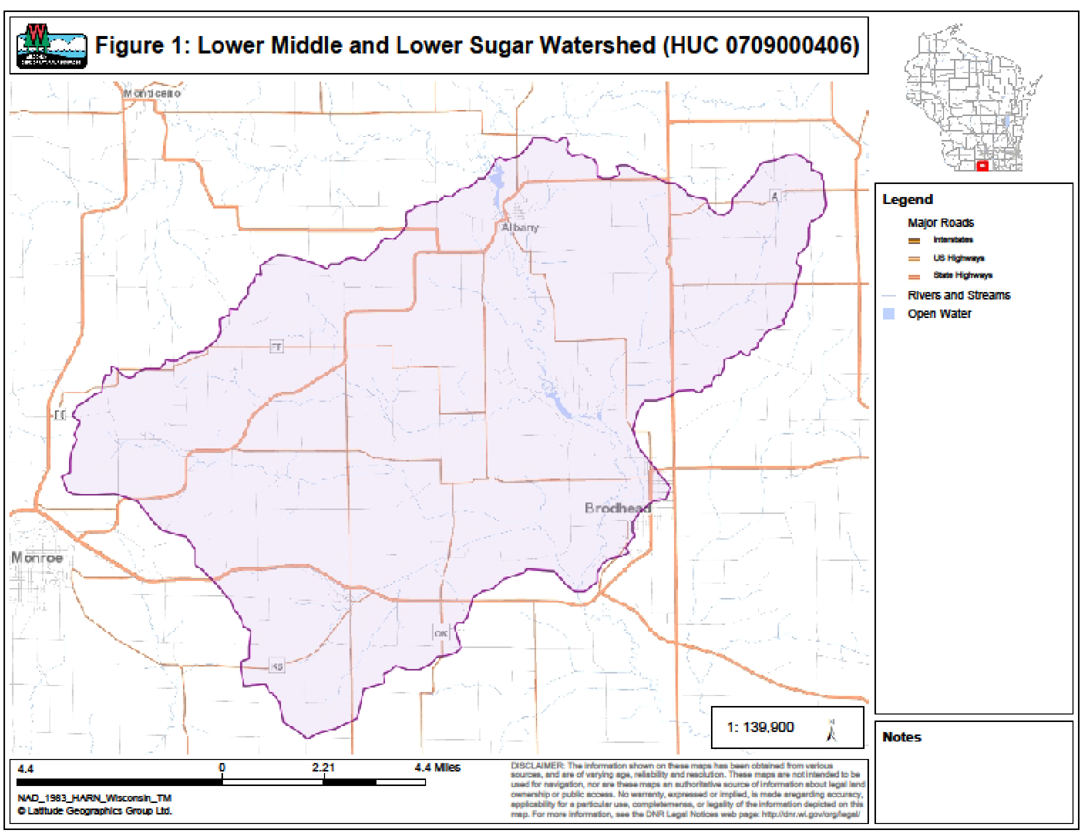
Introduction

The Lower Middle Sugar River Watershed includes a portion of the Sugar River and tributaries from the dam at Albany downstream to the Decatur Lake dam. It encompasses a 57 square mile drainage area. The Lower Sugar River Watershed is much larger, draining 214 square miles. In 2013, a monitoring project looked at streams in a hydrologic unit code (HUC) 10 which encompassed the Lower Middle Sugar River Watershed, and the northwest 1/4 of Lower Sugar River Watershed (Figure 1).

Both watersheds are similar in land use in that their rolling hills and broad valleys are dominated by agriculture. Fifty to 60 percent of the land use is in row crops with another 20 percent in pastureland. Only about 6 percent of the watershed is in forest (WDNR, 2003). Habitat loss due to sedimentation and hydrologic modification (channelization) are the main stressors for streams in this area. Searles Creek and North Fork Juda Branch are on the state's 303(d) list of impaired waters. Although Norwegian and Sylvester Creek are on the state's list of Exceptional Resources Waters and the upper 4 miles of Sylvester Creek is listed as a Class III trout water, they also are impacted by many of the same issues as other waterbodies in these watersheds. Norwegian Creek, Sylvester Creek, and Juda Branch are part of a Green County Drainage district. As such, many sections have been straightened to enhance movement of water from fields. Portions of these streams are straight and deeply entrenched. Tree growth along the banks has exacerbated erosion of the steep banks. The drainage board has recently tried to address this latter issue by requiring landowners to remove nuisance trees along the banks. This is good for the banks, but also tends to remove the only habitat in the streams. Manure application and tile drainage are other potential sources of nutrient input.



Methods
The 2013 watershed survey was conducted by water resource biologists on 28 sites in the watershed. Sites were selected to cover named streams or major unnamed tributaries in the HUC 10. The fisheries assemblage was determined by electroshocking a section of stream with a minimum station length of 35 times the mean stream width (Lyons, 1992). A stream tow barge with a generator and two probes was used at most sites. A backpack shocker with a single probe was used at sites generally less than 2 meters wide. All fish were collected, identified, and counted. All gamefish were measured for length. At each site, qualitative notes on average stream width and depth, riparian buffers and land use, evidence of sedimentation, fish cover and potential management options were also recorded. A qualitative habitat survey (Simonson, et. al., 1994) was also performed at each site. Macroinvertebrate samples were obtained by kick sampling and collecting using a D-frame net at these same sites in the watershed in fall, 2013 and sent to the University of Wisconsin-Stevens Point for analysis.

Additionally, water samples were collected once per month throughout the growing season (May through October) by volunteer monitors at the pour points of the five HUC 12's which make up the HUC 10. These samples were analyzed for phosphorus. Continuous water temperature loggers were also placed at various sites on streams and programmed to take hourly water temperatures throughout the "summer" (June – August) period.

Results
Results of the fisheries surveys are summarize in Table 1. Because the natural communities model (Lyons, 2008) indicates most of the waters in these watersheds to be cool transitional waters, the coolwater IBI (Lyons, 2012) was applied to all streams. A total of 35 species were found throughout the watershed. White sucker, creek chub, brook stickleback and johnny darters, which are coolwater transitional species, were the most widely distributed species. Most species found were either coolwater transitional species or warmwater species (Ibid). Brown trout, rainbow trout, and mottled sculpin, which are all stenothermal coldwater species, were found at 8 sites but limited almost exclusively to Sylvester Creek.

Qualitative habitat surveys (Table 2) showed the overall habitat rating at most sites to be "fair" to "good". Riparian buffer width was generally "good" to "excellent", while pool scores and riffle to riffle scores were typically "poor" to "fair". Bank erosion was prevalent at most sites with a majority of sites "poor" to "fair". Fish cover varied widely between "poor" and "good", even within the same stream. Slightly greater than half the sites scored "poor" or "fair" for fish cover, while only 1 site scored "excellent".

Phosphorus data is summarized in Table 3. The average concentrations ranged from 0.05 to 0.19 mg/l and the median concentration ranged from 0.05 to 0.16 mg/l. The median growing season concentration is compared with the department's phosphorus criteria of 0.075 mg/l for streams and 0.1 mg/l for rivers (WDNR, 2013).

Temperature data, collected hourly from May to October at 6 sites, showed the instantaneous temperatures to be less than 25^{o} C and the daily mean temperatures were

Table 1: Fisheries Assemblage, IBI, and Natural Community Analysis for sites in the Lower-Middle and Lower Sugar River Watersheds (HUC 0709000406) - 2013

	Juda Branch				Marsh Creek		North Fork Juda Branch			Norwegian Creek			Riley School Branch		Searles Creek					Sylvester Creek							Unnamed Trib	
Species	Giese Road	CTH S	Bagley Road	CTH O.K.	Bump Road	CTH E	STH 11	Juda Park	CTH S	CTH B	STH 104	Golf Course Rd	Giese Road	Bagley Road	CTH FF	CTH S	Decatur-Sylvester Rd	Prairie Road	CTH F	STH 59	Balls Mill Road	Upstream CTH S	Dwnstream CTH S	Greenbush Road	CTH O.K.	Ten Eyck Road	Balls Mill Rd	CTH S
Banded Darter				1								15										1				3		
Bigmouth Shiner			10		2													55	6					1	10			
Black Bullhead																	1											
Blackside Darter				1								4											1		5			
Bluntnose Minnow			10	20	16	22			3	59	1	270				1	14	155	390					5	17	9	1	
Bluegill												2																
Brook Stickleback	15	46	13	3		1	1	3	5		2	2	10	1	17	58	102	42	6	5		6	2	14	15	23	7	38
Brown Trout				3																7	1	11	20	1	6	8		
Central Mudminnow			1				7												1						1			
Central Stoneroller										30	70	77					33	161	221			12	39	4	2		1	1
Common Shiner	8	70	38	50			2	12	26											24	9	70	145	52	156	28		
Creek Chub	73	65	50	28	42		15	31	79	67	9		12		1	42	128	171	82	39	40	112	83	38	110	18	60	102
Fantail Darter			2	4						6	27	7				3	144	47	93			13	9		13		3	4
Fathead Minnow	1				2	2									1		1	2	1									
Golden Redhorse												5																
Golden Shiner												1																
Grass Pickerel																										1		
Green Sunfish	3	6	6						1										2									
Hornyhead Chub				2																		25	7	6	30	7		
Johnny Darter	25	10	5	10					6	2	14	49	5	1		1	18	87	130			3	13		23	23	31	14
Largemouth Bass												2																
Mottled Sculpin																				36	13	55	100	69	9			
Northern Pike			1									7																
Pumpkinseed																								1				
Quillback												7																
Rainbow Trout																					2							
Rock Bass												13																
Sand Shiner			55	105	28	22				1		20						50	62					2	7	12		
Shorthead Redhorse				1																		2			2	10		
Smallmouth Bass												5													1	5		
Spotfin Shiner			10	188	7	6			13			5						1	39				5	2	35	2		
Southern Redbelly Dace										64	15						52	98	83		1	45	20	38	96	3		17
Suckermouth Minnow																						1						
(Western) Blacknose Dace											1																	
White Sucker	5	134	40	80			3		13		24	35				4	154	98	151	90	77	250	205	100	232	148		15
Cool-Cold IBI / Cool-Warm IBI[1]	**40** / 40	**60** / 10	60 / **60**	90 / 70	20 / **50**	30 / 30	30 / **40**	30 / **40**	50 / **40**	50 / **60**	80 / **70**	90 / 80	**50** / 20	N/A	N/A	**50** / 30	70 / **60**	70 / **60**	70 / **50**	**80** / 20	**50** / 20	90 / **70**	80 / **80**	80 / **70**	90 / **90**	90 / **70**	**50** / 50	**40** / 40
Modeled Natural Community[2]	CCHW	CCHW	CCHW	CCMS	CWHW	CWHW	CCHW	CCHW	CCHW	Cold	Cold	CCHW	CCHW	CCHW	CCHW	CCHW	CCHW	CCHW	CCHW	CCHW	CCHW	CCHW	CCHW	CCMS	CCMS	CCMS	CCHW	CCHW
Verified?	Yes	No	No	No	No	No	No	No	No	No	No	No	Yes	N/A	N/A	Yes	No	No	No	No	No	No	No	No	No	No	Yes	Yes
Verification Natural Community[3]		CCMS*	CW*HW*	**Warm *MS***	CW*HW*	Warm *HW*	CWHW	CWHW	CWHW	**CWHW***	**CWHW**	**Warm Main**		N/A	N/A		CWHW	CWHW	CWMS	CCMS	CCMS	CWMS	CWMS	CWMS	CWMS	CWMS		
Other IBI (where appropriate)				44 (Fair)[4]	50 (Fair)[5]	40 (Fair)[5]	40 (Fair)[5]	30 (Poor)[5]		80 (Good)[5]		27 (Poor)[4]	20 (Poor)[5]		40 (Fair)[5]													
% Tolerants	75	76	50	26	62	45	68	74	69	55	23	58	81	50	100	96	62	48	50	67	82	61	45	45	49	66	66	81

Stenothermal Coldwater Species
Tolerant Species
Intolerant Species
Species names in italics indicate warmwater species

1) Coolwater IBI: Poor < 20 ; Fair 21 - 40 ; Good 41 - 60 ; Excellent 61 - 100
2) Lyons, John. 2013. DRAFT Methodology for Using Field Data to Identify and Correct Wisconsin Stream "Natural Community" Misclassifications. Version 4. May 16, 2013.
3) Natural Community suggested by the methodology. **Bold** items indicate significant difference from modelled community. See discussion for further details.
4) Warm Water IBI (Lyons, John. 1992)
5) Small and Intermittent Stream IBI (Lyons, John. 2006)

Table 2: Qualitative Habitat Surveys of sites in the Lower-Middle and Lower Sugar River Watersheds (HUC 0709000406) – 2013

Station Name	Date	Flow (CMS)	Stream Width (M)	Stream Depth (M)	Riparian Buffer Score	Bank Erosion Score	Pool Area Score	Width Depth Score	Riffle Riffle Ratio Score	Fine Sediment Score	Fish Cover Score	Qualitative Habitat Score	Qualitative Habitat Rating
JUDA BRANCH AT GIESE RD	05-Jun-2013		3.00	.20	15	10	3	10	10	10	10	68	Good
JUDA BRANCH-UPSTREAM CTH S	05-Jun-2013		3.00	.50	15	10	0	15	0	0	10	50	Good
JUDA BR, UPSTREAM BAGLEY RD	22-Jul-2013	.200	5.00	.40	10	0	0	5	0	0	5	20	Poor
JUDA BRANCH-US OF CTH OK	22-Jul-2013	.330	7.00	.30	10	0	0	5	5	0	5	25	Fair
NORTH FORK JUDA BR AT STH 11 (FURTHEST DWNSTRM CROSSING)	10-Jul-2013	.059	2.50	.30	10	5	7	10	10	10	10	62	Good
NORTH FORK JUDA BRANCH IN JUDA PARK 20M US OF DISCHARGE	10-Jul-2013	.100	3.00	.15	5	5	0	5	5	10	5	35	Fair
N. FORK JUDA BR-CTH S UPSTREAM	10-Jul-2013	.125	3.50	.20	5	5	3	5	5	0	5	28	Fair
MARSH CREEK UPSTREAM BUMP RD	24-May-2013		2.50	.50	15	15	3	15	5	0	10	63	Good
MARSH CREEK UPSTREAM CTH E BRIDGE	07-Jun-2013		4.00	.15	15	10	0	0	5	5	5	40	Fair
NORWEGIAN CREEK - UPSTREAM CTH B	07-Jun-2013		1.50	.15	15	15	0	10	5	15	5	65	Good
NORWEGIAN CREEK UPSTREAM (AT) HWY 104/H	07-Jun-2013		4.00	.20	15	5	7	0	10	15	10	62	Good
NORWEGIAN CREEK AT GOLF COURSE RD	09-Aug-2013	.140	9.00	.60	15	10	3	10	5	5	10	58	Good
RILEY SCHOOL BR AT GIESE RD	05-Jun-2013		3.00	.05	15	0	0	0	5	10	0	30	Fair
RILEY SCHOOL BR AT BAGLEY RD	05-Jun-2013		3.00	.15	10	5	0	5	0	0	0	20	Poor
SEARLES CR AT CTH FF	24-May-2013		1.00	.10	15	15	3	10	5	5	0	53	Good
SEARLES CR AT CTH S	24-May-2013		2.00	.20	15	15	7	10	5	10	10	72	Good
SEARLES CREEK AT DECATUR-SYLVESTER RD	25-Jul-2013	.140	4.00	.50	15	15	0	10	5	5	10	60	Good
SEARLES CREEK-US PRAIRIE RD	25-Jul-2013	.120	5.00	.40	10	5	0	5	0	0	5	25	Fair
SEARLES CREEK UPSTREAM CTH F	25-Jul-2013	.190	4.00	.20	0	5	0	5	5	10	5	30	Fair
UNNAMED TRIB (879600) TO SEARLES CR AT BALLS MILL RD	24-May-2013		3.00	.20	15	0	0	5	0	0	5	25	Fair
UNNAMED TRIB (879600) TO SEARLES CR AT CTH S	24-May-2013		2.50	.50	10	10	3	15	5	5	10	58	Good
SYLVESTER CREEK AT STH 59	22-Jul-2103	.140	3.50	.50	10	10	0	10	5	0	5	40	Fair
SYLVESTER CREEK - BALLS MILL RD	10-Jun-2013	.260	5.00	.50	0	0	3	10	5	5	10	33	Fair
SYLVESTER CREEK-UPSTREAM CTH S	26-Jul-2013	.330	5.00	.30	10	5	0	5	10	15	5	50	Good
SYLVESTER CREEK-DOWNSTREAM CTH S	09-Aug-2013	.330	4.00	.50	5	5	7	10	10	10	10	57	Good
SYLVESTER CREEK AT GREENBUSH ROAD	26-Jul-2013	.400	7.00	.50	10	5	0	10	0	5	5	35	Fair
SYLVESTER CREEK AT CTH OK	26-Jul-2013	.440	7.00	.50	15	5	3	10	5	10	15	63	Good
SYLVESTER CREEK - TEN EYCK RD	10-Jun-2013	.940	8.00	.30	10	5	0	5	0	5	5	30	Fair

generally less than 20°C. The exception to this was Norwegian Creek. Stream specific temperature graphs are found in the individual streams narratives located in Appendix 1.

Macroinvertebrate data can be found in Table 4. The macroinvertebrate IBI (MIBI) (Weigel, 2003) varied from "poor" to "excellent" with most scores in the "fair" rating. The Hilsenhoff Biotic Index (HBI) (Hilsenhoff, 1987) ranged from "poor" to "excellent" with most sites in the "good" or "very good" rating indicating slight to some organic pollution.

Table 3: Monthly Phosphorus Concentrations: May – October, 2013

Site	Ave. P (mg/l)	Median P (mg/l)	Site	Ave. P (mg/l)	Median P (mg/l)
Juda Branch – CTH S	0.19	0.061	**Riley School Br –** Bagley Road	0.19	0.071
Juda Branch – CTH O.K.	0.086	0.089	**Searles Creek –** Park Rd	0.057	0.060
Marsh Creek – CTH E	0.063	0.066	**Sylvester Creek –** CTH O.K.	0.061	0.056
N. Fork. Juda – Balls Mill Rd	0.047	0.047	**Sylvester Creek –** Ten Eyck Road	0.069	0.062
N. Fork. Juda – Juda Park	0.12	0.11	**Sugar River –** Decatur-Albany Rd	0.12	0.12
N. Fork. Juda Br. – CTH S	0.18	0.16	**Sugar River –** Millrace	0.16	0.14
Norwegian Creek – Golf Course Rd	0.059	0.057	**Sugar River –** Ten Eyck Rd	0.11	0.11

Discussion

There are many similarities between the streams that reflect the overall conditions in the watershed. There are many segments which are channelized and deeply entrenched, with a fair amount of bank erosion and sedimentation. Individual stream narratives can be found in Appendix 2. There is a fair amount of diversity of nongame species in most of these systems, but most species assemblages are heavily populated by tolerant species generally making up 50 to 75% of the total population. Most streams in this HUC 10 are modelled to be cool-cold transitional waters (Lyons, 2008). The department has recently developed a draft method to determine whether or not the modeled natural community is accurate based on the fishery assemblage and climate conditions (Lyons, 2013). Almost universally, the thermal composition of species (cold, warm, or transitional) indicated that most of the systems resemble cool-warm systems rather than cool-cold systems, with several trending toward warm systems. Coldwater species are virtually absent while transitional and warmwater species are common. The great majority of the transitional species (brook stickleback, creek chubs, and white sucker) found in these streams are tolerant to low dissolved oxygen and/or disturbed habitat. These particular species tend to be more widespread throughout the state, including south central Wisconsin, as opposed to other more intermediate or low tolerance species which are not found in this area (Becker, 1983). Sylvester Creek, whose upper 1/3rd is classified as a trout stream,

Table 4: Macroinvertebrate data for the Lower and Lower Middle Sugar R. Watersheds (2013)

Station Name	**MIBI (Rating)**	**HBI (Rating)**
Juda Branch – Giese Road	2.11 (Poor)	4.07 (V. Good)
Juda Branch – CTH S	5.52 (Good)	5.68 (Fair)
Juda Branch – Bagley Road	3.64 (Fair)	4.77 (Good)
Juda Branch – CTH OK	3.35 (Fair)	4.93 (Good)
North Fork Juda Br – STH 11	2.85 (Fair)	4.39 (V. Good)
North Fork Juda Br – Juda Park	-0.72 (Poor)	4.03 (V. Good)
North Fork Juda Br – CTH S	1.94 (Poor)	4.78 (Good)
Marsh Creek – Bump Road	3.52 (Fair)	6.39 (Fair)
Marsh Creek – CTH E	3.00 (Fair)	4.08 (V. Good)
Norwegian Creek – CTH B	4.01 (Fair)	5.51 (Fair)
Norwegian Creek – STH 104	3.08 (Fair)	4.59 (Good)
Norwegian Creek – Golf Course Road	5.31 (Good)	7.96 (Poor)
Riley School Branch – Giese Road	1.63 (Poor)	4.01 (V. Good)
Riley School Branch – Bagley Rd	4.43 (Fair)	5.36 (Good)
Searles Creek – CTH S	4.31 (Fair)	3.96 (V. Good)
Searles Creek – CTH Decatur-Sylvester Rd	3.41 (Fair)	5.33 (Good)
Searles Creek – Prairie Road	3.31 (Fair)	5.65 (Fair)
Searles Creek – CTH F	2.55 (Fair)	5.12 (Good)
Sylvester Creek – STH 59	7.20 (Good)	4.71 (Good)
Sylvester Creek – Balls Mill Rd	4.14 (Fair)	4.95 (Good)
Sylvester Creek – CTH S	4.10 (Fair)	5.02 (Good)
Sylvester Creek – Greenbush Road	4.48 (Fair)	5.23 (Good)
Sylvester Creek – CTH OK	2.91 (Fair)	5.18 (Good)
Sylvester Creek – Ten Eyck Rd	7.84 (Excellent)	4.46 (V. Good)
Unnamed Trib (879600) at Balls Mill Rd	3.61 (Fair)	4.01 (V. Good)
Unnamed Trib (879600) at CTH S	4.31 (Fair)	4.21 (V. Good)

contained the only cold water indicator species save for one site on the lower end of Juda Branch (these trout likely migrated up from Sylvester Creek). One could argue this is evidence of environmental degradation which is lending itself to the presence of more warmwater species and an absence of coldwater ones (Lyons, et. al., 1996). However, with the exception of Sylvester Creek, which contains brown trout and mottled sculpin, streams in this area have historically been devoid of coldwater indicator species (Becker, 1983).

Environmental degradation can sometimes explain the discrepancy between the modelled and actual community where there is a lack of intolerant species and a dominance of tolerant ones (Lyons, 2013). For most systems in this HUC 10, the percentage of tolerant fish fall with expected ranges for cool-cold transitional systems, and therefore a degraded community is not the principle reason for the discrepancy. The exception to this was Norwegian Creek at CTH B, where no intolerant species were found and tolerant ones exceeded the threshold for the (modelled) coldwater system. In this case, however, and based on the fish community found at other sites on the creek, it is more likely the model is in error and that the verified natural community is more likely a cool-warm system. It should be noted that the communities were also not subject to climatic conditions (air temperature and precipitation) that would be considered extreme (Ibid) and therefore likely are not strong causative reasoning for the difference either.

Actual water temperature data collected in the watershed shows summer temperatures to be within the realm of cold to cool-cold transitional systems (Lyons, 2008). Daily mean temperatures were below 22°C. The exception was Norwegian Creek, which was modelled to be a coldwater and cool-cold system, but interestingly had the warmest water temperatures of the 6 sites sampled in the watershed. As noted above, this was consistent with the fishery assemblage which showed Norwegian Creek to be a cool-warm to warm system.

The coolwater IBIs (Lyons, 2012), when applied to the natural community indicated by the fishery assemblage, rates the fishery of most of these systems to be "good" to "excellent", despite the prevalence of species that are tolerant to habitat disturbance and lower water quality. This prevalence of transitional tolerant species may be a factor of water temperature and/or environmental disturbance, but likely influenced by both. The fishery is only one environmental indicator and for this reason, the quality of the resources should be looked at in the context of overall conditions including habitat and macroinvertebrates.

Given the land use, hydrologic modifications, and biologists' observations of conditions in this watershed, there are suggestions of environmental perturbation. Overall habitat scores were fair to good, but were buoyed by several metrics that were favorable in this watershed. The buffer width was favorable at many sites although it must be acknowledged that some of this is coincidental with the streams being deeply entrenched with steep banks, making farming up to the stream edge impractical if not impossible. There is also very limited grazing along the banks of the streams. The width-to-depth ratio of these channelized systems was also generally good. Conversely, many of the stream sites contained a predominance of silt and sand on the bottom which inhibited the percent fines metric. This was very dependent on the gradient at a particular site. Juda Branch and the Unnamed Tributary (879600) to Searles Creek had mainly silt bottoms, while Norwegian Creek had mostly a gravel bottom. Sylvester and Searles Creek contained varied bottom substrate ranging from silt to gravel. Because of the straightening of the stream channels to augment drainage from agricultural fields, the pool area and bend to bend ratio are almost negligible.

In the absence of severe water quality issues, fisheries correspond positively to the abundance of habitat. In the case of the surveyed streams, overhanging vegetation and a good width/depth ratio were the most common factors affecting the fish cover score. Coincidentally, the Green County Drainage Board has been requiring landowners to remove muisance trees from along the banks of streams within their jurisdiction. This practice has had mixed results on the streams. In many of these systems, prior to cutting the trees, the woody debris and overhead cover provided the only habitat for fish. Once the trees were removed, this habitat was gone. However, removal of the shade cover has allowed for the growth of grass along the steep banks and subsequent stabilization. Some slumping of banks into the creek has allowed for a small scale "remeandering" of the streams within the channel footprint. This has begun to narrow some of the streams leading to a better width-to-depth ratio as well as promoting scouring of the sand bottoms down to gravel. The small irregularities in the otherwise straight channel have created holes and quiescent habitat features with overhanging vegetation for the fish to inhabit (Figure 2).

Figure 2: Slumping banks create narrowing and "remeandering" of channelized streams

Sylvester Creek upstream of CTH OK

The macroinvertebrate IBI has shown the combination of watershed land cover and local riparian and instream conditions strongly influence one another (Weigel, 2003). While watershed and local variables explain a significant portion of variance among sites, Weigel found that in the driftless region, localized stressors were of greater importance to explain the IBI than in other parts of the state. The scores are remarkably similar between streams and the modest macroinvertebrate IBIs appear to reflect the overall condition of the watershed in that these streams are highly modified systems flowing through an intensively agricultural landscape. The HBIs indicate there is little organic loading to these streams.

Growing season phosphorus concentrations were very similar for many of the sites collected in 2013. The department's listing methodology for impaired waters (WDNR, 2013) recommends listing sites where the median phosphorus concentration exceeds 0.075 mg/l on wadable streams and 0.1 mg/l on rivers. The methodology also calls for all 6 of the samples to exceed the criteria before listing. This guidance was exceeded only on the North Fork Juda Branch and Sugar River sites. The North Fork Juda Branch is already on the state's list of impaired waters due to phosphorus and the Sugar River, as it flows through Green County, has been recommended for addition to the states list of impaired waters due to phosphorus (WDNR, 2014). While this information is encouraging in that baseflow concentrations from these tributaries to the Sugar River are relatively low, it should not be used to imply that there is not a significant amount of phosphorus available in the bedload of sediment of these streams nor that the overall phosphorus loads being delivered from these subwatersheds is minimal.

Biologists noted that Searles Creek contained a large amount of macrophytes and filamentous algae relative to other streams in the watershed. Sedimentation was moderate but not atypically high for streams in this area. The flow and gradient is lower than some streams and legacy phosphorus levels in the sediment could provide a nutrient source for plant and algal growth. It is unknown how much tile drainage adds nutrients to the system, but phosphorus concentrations, as indicated by grab samples taken once per month during the growing season (May through October) show no appreciable difference in concentration relative to other streams. At this time, there is nothing definitive to explain this observation.

Summary and conclusions

Streams of the Lower Middle Sugar River and (upper) Lower Sugar River watershed tend to contain fish resembling a cool-warm thermal regime. The streams typically have 6 to 10 species, many of them transitional or warmwater species and in general, the majority of the total numbers of fish are tolerant to environmental degradation. The streams themselves have many sections that have been straightened to enhance drainage from agricultural fields. This lends itself to degraded habitat within the individual streams and advanced sediment delivery to larger systems like the Sugar River.

As one attempts to think of ways to improve these streams, it is unrealistic to think that re-meandering of the stream channels is cost-effective or practical, especially in the contemporary agricultural economy. Therefore it is imperative to work with landowners and the Green County Drainage District to encourage management of woody vegetation to prevent overgrowth along banks, to control regrowth and use management practices that avoid destabilization of banks (i.e. cutting and grubbing of the shoreline with no shaping, sloping or mulching). This would allow for stabilization in grasses, embrace natural “re-meandering” within the channel footprint, strive to keep some buffers in place. Where possible, encourage landowners to slope banks 3:1 to prevent erosion. Control nutrient loading through development and implementation of nutrient management plans and proper manure management.

The department should work with watershed organizations such as the Lower Sugar River Watershed Association and Decatur Lake Management and Rehabilitation Association on outreach efforts with landowners in the watershed, environmental programs in the Juda and Brodhead school districts, and research opportunities for harvestable buffers to provide economic incentives for maintaining buffers along streams.

It is recommended that Juda Branch downstream from CTH S to its confluence with Sylvester Creek be added to the state’s 303(d) list of impaired waters because of low [20 (poor) to 25 (nearly poor)] qualitative habitat scores in the lower two stations monitored. While the appropriately applied fish IBIs are fair to good, it is difficult to ignore the fact that the lower half of Juda Branch is straight, unnaturally wide, shallow, and deeply entrenched with steep eroding banks and a high amount of soft sediment.

The entire length of Riley School Branch should be added to the state's 303(d) list of impaired waters. A combination of poor biology - both a poor macroinvertebrate sample, and poor fish (indicated by the small stream IBI at one site and a community so devoid of fish that an IBI could not be calculated at the other site), and poor (or nearly poor) habitat scores make this stream a candidate for listing using only 1 year of data.

Fisheries management should consider expansion of the trout designation on Sylvester Creek to include waters from Balls Mill Road downstream to Ten Eyck Road. Fisheries management should also explore what additional habitat would do for carry-over of trout, especially in the area between CTH O.K. and Ten Eyck Road.

Fisheries management should consider removing the Class III trout designation from Marsh Creek since it is no longer stocked and there has been no evidence of trout in the stream for many years.

The natural community designation for Norwegian Creek should be formally changed from cold and cool-cold headwaters to cool-warm headwaters upstream of STH 104 and warm mainstem downstream of STH 104 to the confluence with the Sugar River.

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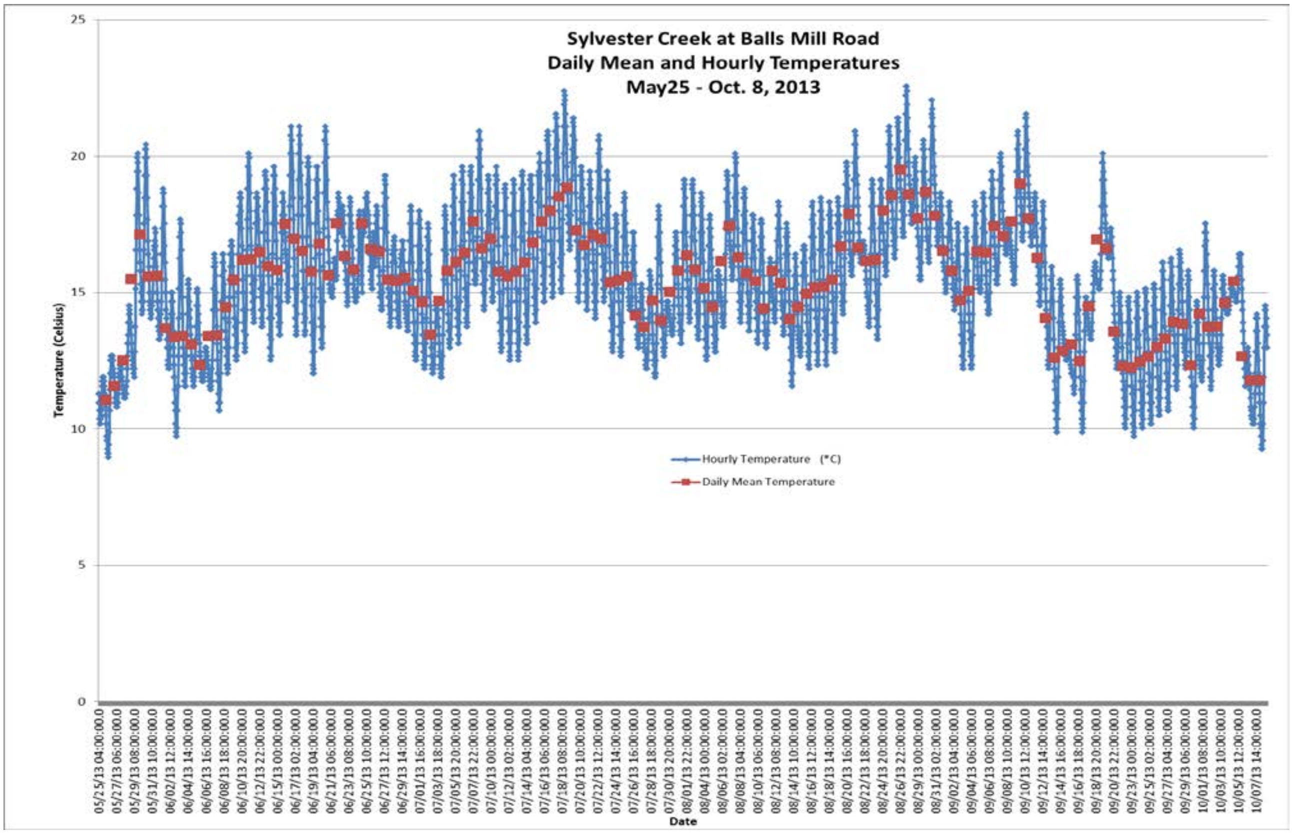
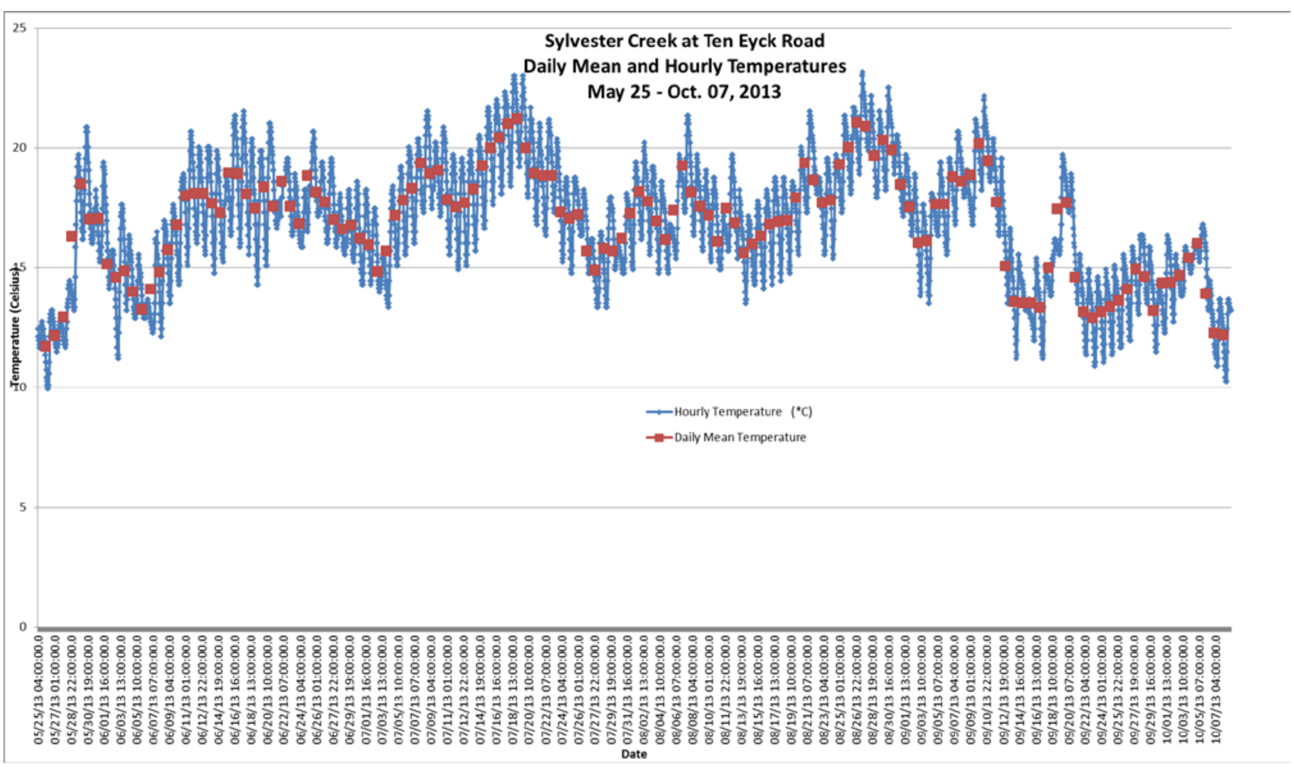
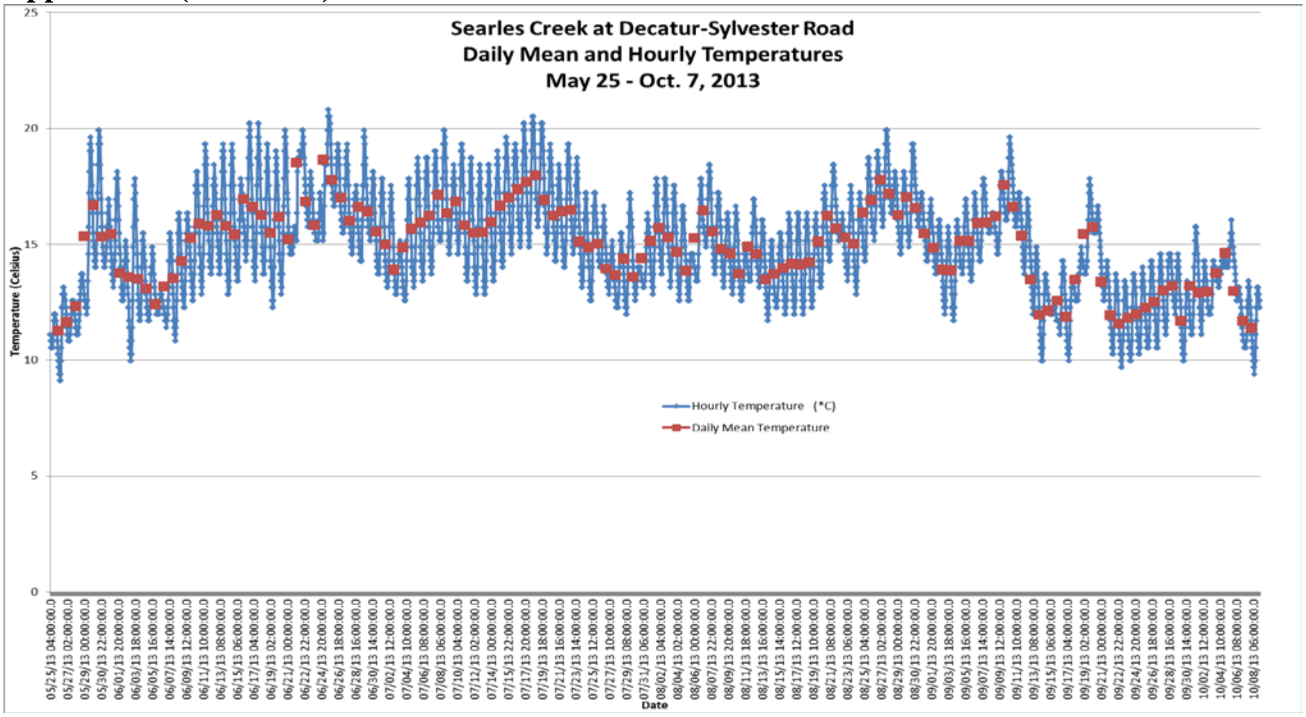
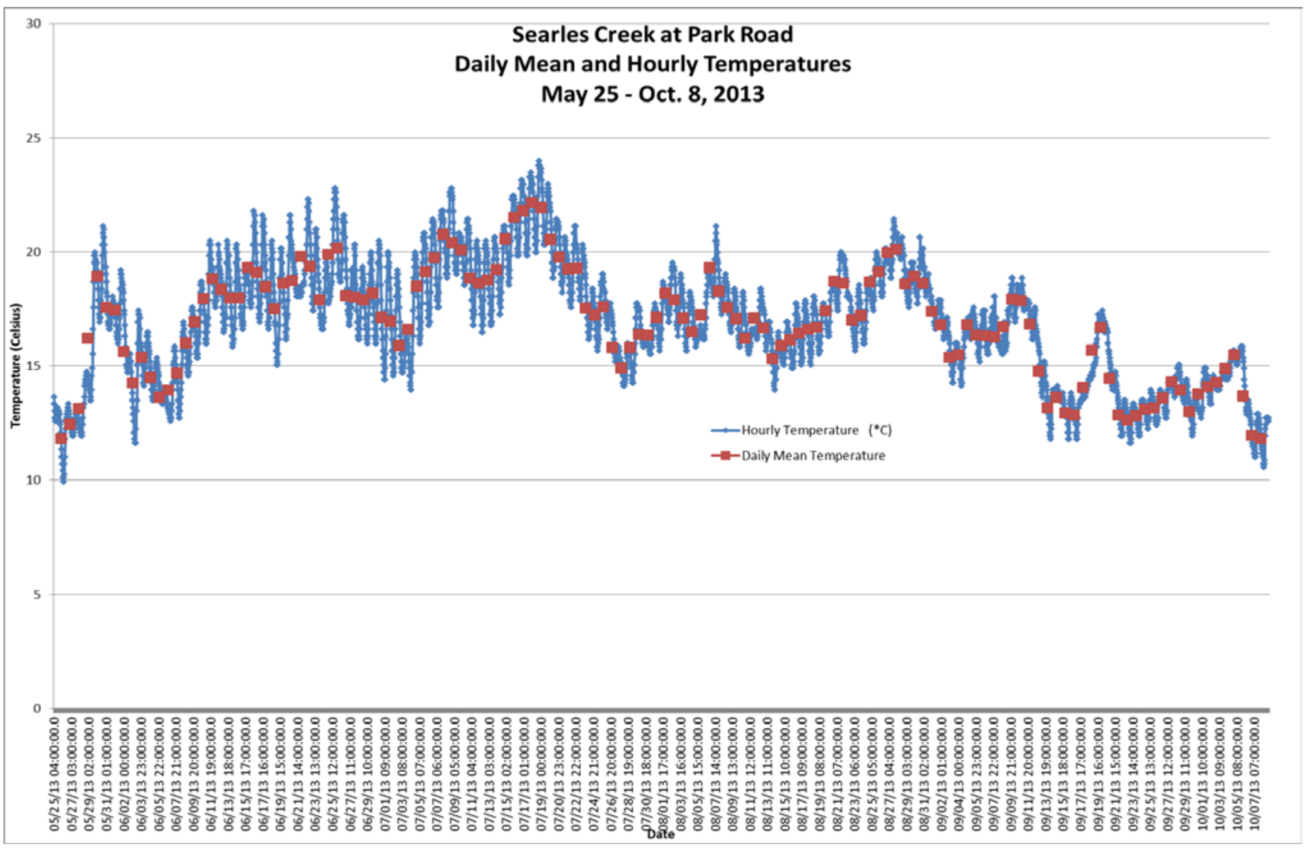
Appendix 1: Stream Temperatures in the Lower-Middle and Lower Sugar Watershed



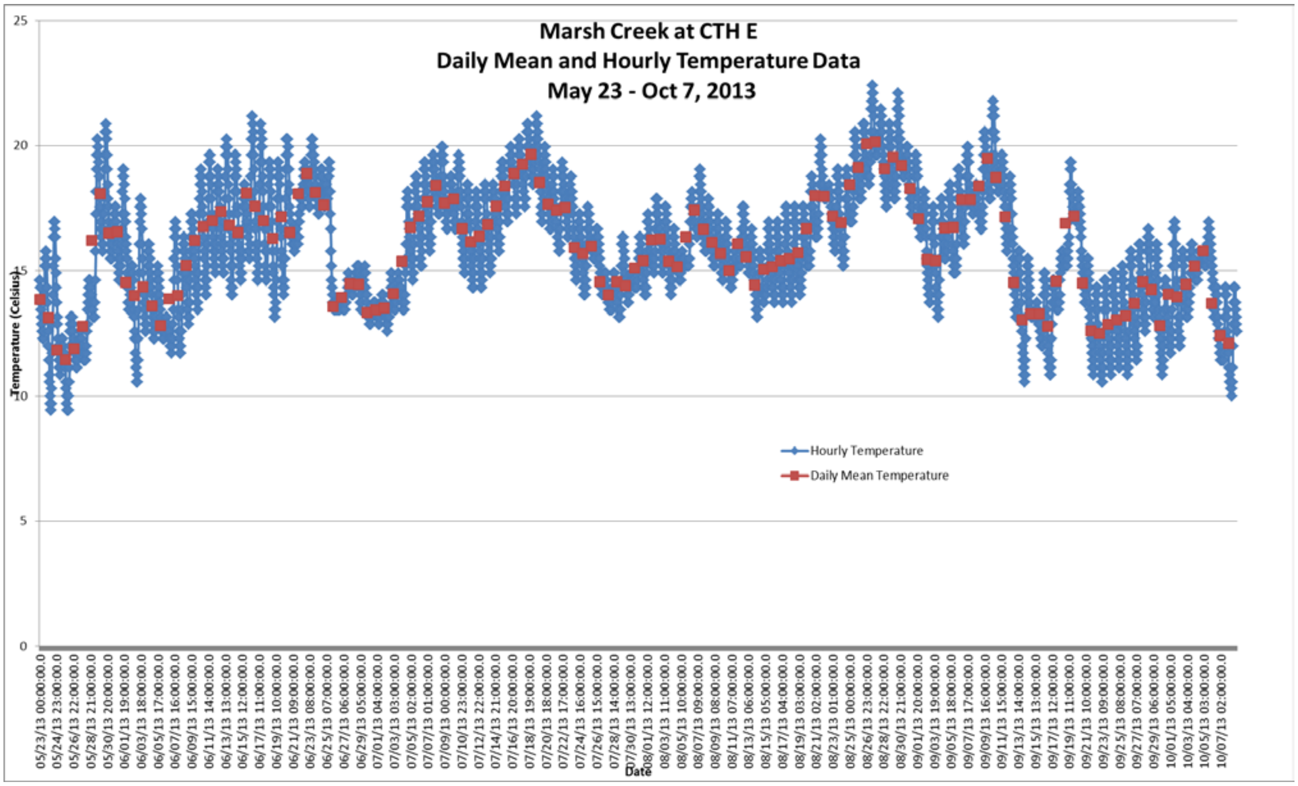


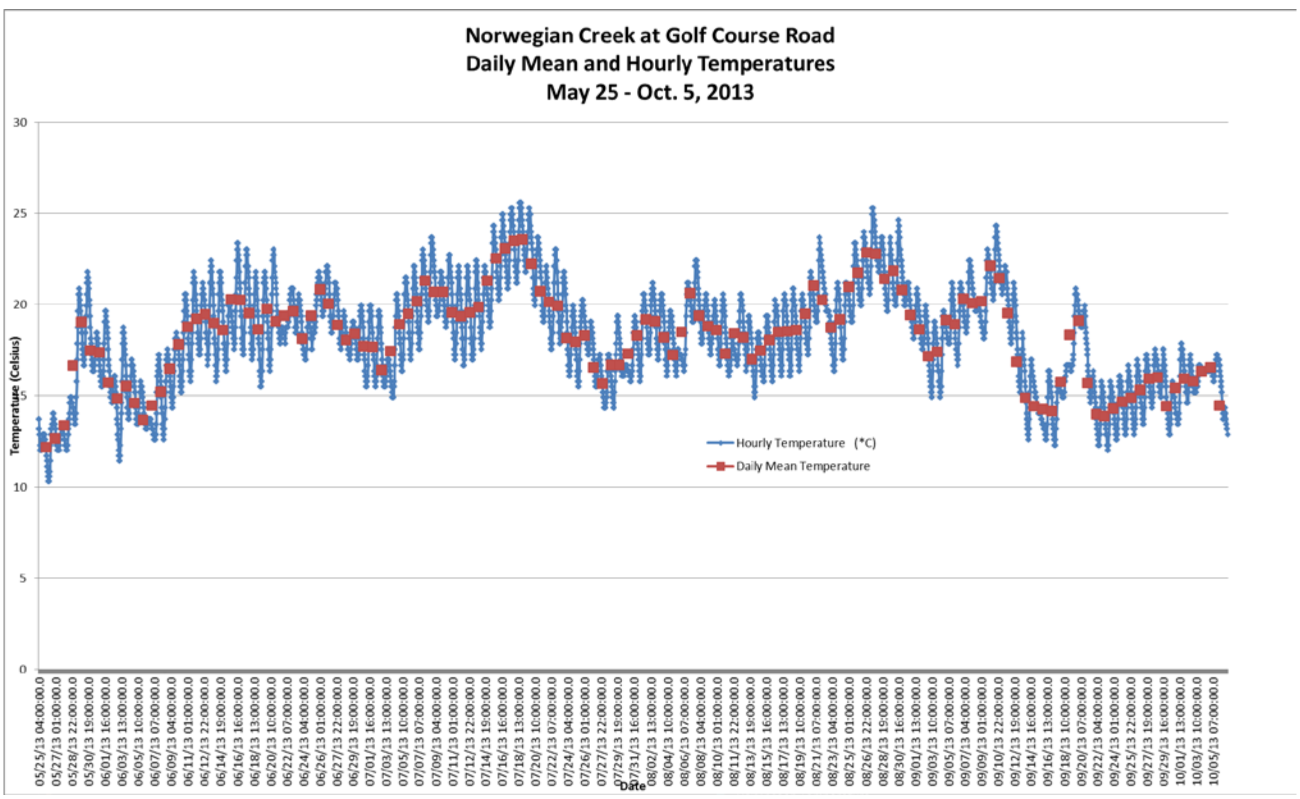
Appendix 1: (Continued)





Appendix 1: (Continued)





Appendix 2: Stream Narratives

Juda Branch
This 7 mile long, fairly low gradient stream originates west of Juda, flows eastward and joins Sylvester Creek. It has fairly low flow in the upper half of the stream as if meanders southeastward following CTH KS. It picks up flow as it enters the sedge meadow and is joined by an unnamed tributary (WBIC = 877800) just southwest of the village of Juda. The remaining 4 miles downstream from CTH S in Juda are almost entirely channelized and follow a railroad line.

In 2013, the stream was sampled at 4 locations (from upstream to downstream): Giese Road, CTH S, Bagley Road, and CTH O.K. Juda Branch is modeled to be a cool-cold transitional stream for its entire length (Lyons, 2008). The draft verification model (Lyons, 2013) showed that to be essentially true, save for the lower section at CTH O.K. Small numbers of brown trout have historically been found in the stream (WDNR, 1980) and were found in a survey conducted at CTH S in 2004 and at CTH O.K. in 2013. In 2006, a specimen of redfin shiner, a state threatened species, was found in the creek. The upper two sites at Giese Road and CTH S were dominated by tolerant species, creek chubs and white suckers in particular. Interestingly, the lower half of the stream had poorer habitat, but contained a higher number of species and trended toward a more warm water environment. One could argue this is a result of environmental degradation; however, the percent tolerant species at these lower two sites was within the range of this metric. Despite this and the fact that the appropriately applied IBIs are fair to good, there is no way to ignore the fact that the lower half of Juda Branch is straight, wide, shallow, and deeply entrenched with steep eroding banks and a high amount of soft sediment. This is reflected in the habitat scores.

Therefore, it is recommended that Juda Branch from CTH S downstream to its confluence with Sylvester Creek be added to the state's 303(d) list of impaired waters. One item of note: the Green County Drainage District has been emphasizing the removal of trees along the banks. This has been occurring periodically over the past 5 years on different sections of this stream. *The department should work with the county, the drainage district, and landowners to emphasize good management practices such as stabilizing the banks when removing trees from the banks.*

Marsh Creek
Originating from a spring, this small stream flows southwest and joins the Sugar River below Albany. The water is clear as the stream meanders between wet meadows in the upper portions, upstream of Bump Road and transitions to wooded areas downstream from there (WDNR, 1980; Amrhein pers. obs.) A stream improvement project completed some fencing and bank repair in an effort to increase the streams trout potential was completed sometime prior to 1980 (WDNR, 1980). Today, an old sign indicating the area of improvement remains on the downstream side of County HWY E (Ibid). The lower 2 miles of this 3 mile stream are classified as a Class III trout fishery, but it is no longer stocked with trout. Trout have not been found in any of the studies conducted since 2002.

Marsh Creek is modelled to be a cool-warm transitional headwater (Lyons, 2008). The species collected in 2013 indicate a cool-warm to even warm system.

The fish IBI indicates "fair" quality of this stream. Species diversity was fairly low, around half a dozen species with tolerant fish making up about half of the total population. Habitat of this stream was "good" at Bump Road and "fair" downstream at CTH E.

The department should remove the Class III trout designation from Marsh Creek as it is no longer stocked with trout and none have been found in the surveys conducted over the past 12 years.

North Fork Juda Branch
In 2013 a survey was conducted at 3 sites in the North Fork Juda Branch The surveys were conducted at STH 11 (lowest crossing); at Juda Park (upstream of Grande effluent discharge) and at CTH S (downstream of the discharge). Physical water quality parameters of temperature, dissolved oxygen, pH, specific conductivity, transparency and flow were taken as well as a qualitative habitat evaluation was conducted (Table A). Each site was also shocked using a backpack shocker to determine fishery assemblage (Table B).

Figure: Survey Locations

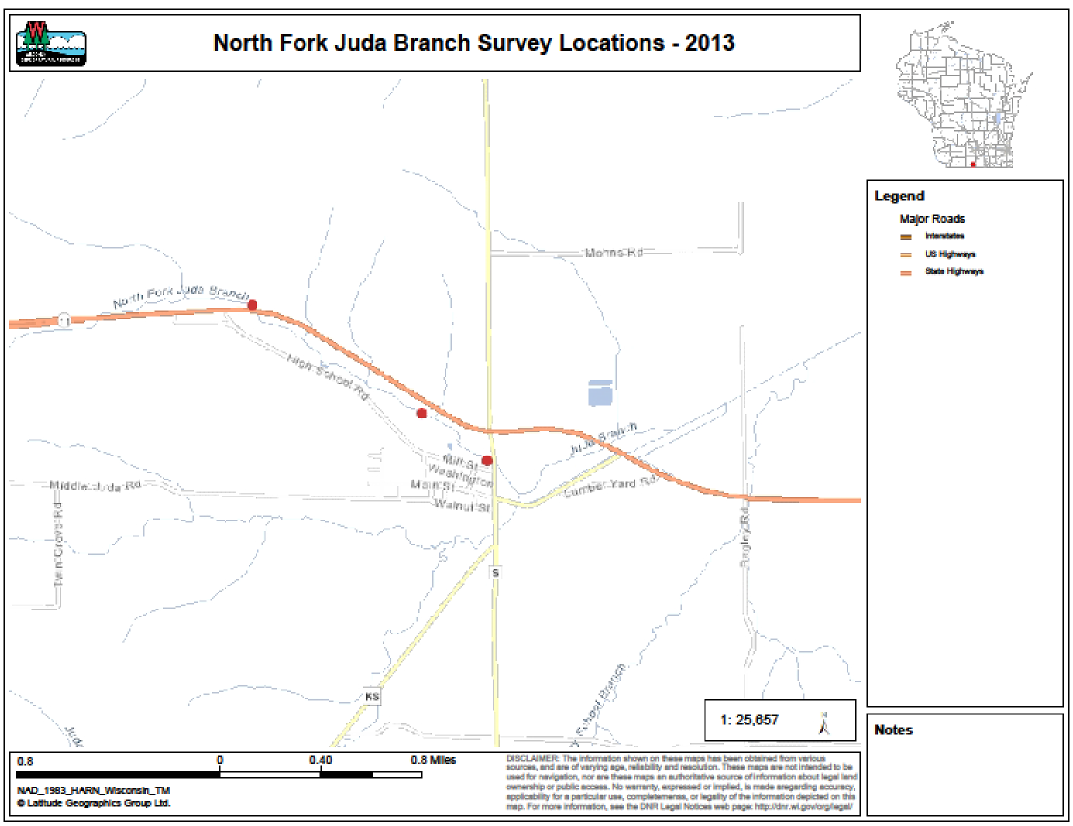


Table A: Water Quality Parameters

		Juda Park	CTH S

Site	STH 11	(Upstream of Discharge)	(Dwnstrm of Discharge)
Temperature (^{o}F)	61.0	64.0	66.0
D.O. (mg/l)	9.65	9.56	8.60
pH	7.07	7.70	7.56
Sp. Cond (uS)	735	699	966
Transparency (cm)	34	24	34
Habitat Score	62 (Good)	35 (Fair)	28 (Fair)
Flow (cfs)	2.08	3.53	4.41

Table B: Fisheries Assemblage – North Fork Juda Branch, 2013

Site	STH 11	Juda Park	CTH S
Creek Chub	13	31	79
Common Shiner	2	12	26
White Sucker	3		13
Bluntnose Minnow			3
Johnny Darter			6
Brook Stickleback	1	3	5
Spotfin Shiner			13
Green Sunfish			1
Central Stoneroller	7		

Species highlighted in yellow are tolerant to habitat disturbance and/or low D.O.

Creek chubs and common shiner were the predominant species. Species diversity and numbers increased as one proceeded downstream. It should be noted that volunteer monitors reported the stream dried up at Balls Mill Road (approx. 2 miles upstream of the discharge) during the drought of 2012. This may have affected (limited) the fishery assemblage at the most upstream location (STH 11).

The fishery assemblage at the CTH S site is quite different from the 2004 survey which showed johnny darter as the most prevalent species with only a few specimens of creek chub, stickleback, and white sucker. It also noted that the habitat was very poor in the upper 2/3 of the station. This was not noted by biologists in the 2013 survey. Qualitative habitat surveys showed the best habitat (good) at STH 11, while the sites upstream and downstream from the effluent discharge were similar as low “fairs”.

The addition of the effluent does not appear to influence the fishery assemblage downstream of the discharge point as more species and higher numbers are present. However, many of the species present, including creek chubs, white sucker, bluntnose minnow, brook stickleback, and green sunfish, are considered tolerant to disturbed habitat and/or low dissolved oxygen.

It should be noted that the North Fork Juda Branch is on the state’s 303(d) list of impaired waters due to phosphorus and low dissolved oxygen. A continuous dissolved oxygen study was conducted at CTH S in August 4 - 14, 2006 and showed dissolved oxygen readings below 3.5 mg/l for the duration of the study period. Since then, the effluent discharge has changed and a dredging project was conducted in 2007 to remove flocculent material that had accumulated in the stream channel immediately downstream of the effluent discharge. It is unknown what effects these changes have had on downstream dissolved oxygen readings.

The biology as indicated by the poor macroinvertebrate scores and modest fish IBIs and habitat scores indicate that North Fork Juda Branch is still an impaired system. It should remain on the list of impaired waters. *The DNR should continue to work with partners in the watershed to improve conditions so that the stream can meet its full attainable use and be removed from the state's 303(d) list of impaired waters. The DNR should conduct continuous temperature monitoring to determine if low dissolved oxygen is still an issue.*

Norwegian Creek
With its headwaters in western Rock County, this stream flows into Green County and enters the Mill Race Arm of the Sugar River at Decatur Lake. Much of the stream has been straightened by ditching. The stream holds some sport fish near its mouth mainly due to the influence of Decatur Lake. It is also home to forage fish, including the least darter, a species on the state's special concern list. The stream is classified as an Exceptional Resource Water (ERW) from the mouth up to the Green/Rock county line. A narrow wetland buffer exists along the streams lower reaches.

Interestingly, the natural community streams model predicts Norwegian Creek to be a cold water system for much of its length, from the headwaters downstream to just above CTH E. From there on down it is purported to be a cool-cold headwater. However, the fishery assemblage collected both historically and at the 3 sites in the 2013 survey resembles a cool-warm to warm regime. Tolerant species made up about half of the fish population except for the STH 104 site, which was only made up of 23% tolerants. The upper segments are ditched and flow through wet meadow converted to agriculture. The banks are grassed and stable in many areas. The middle and lower sections contain segments of wooded corridor. The bottom is comprised of gravel and the overall habitat scores are good. Not surprisingly, the lower station at Golf Course Road contained the most variety of species, including several game and panfish species. This is not surprising given its proximity to the Sugar River. The least darter was not found in any of the 2013 surveys. *The department should consider that the natural community model which predicts a coldwater community is in error and should be changed to reflect actual conditions.*

Riley School Branch
This small, 3 mile long stream is a tributary to Juda Branch. It has a relatively good gradient, but is flow limited and suffers from habitat degradation due to bank erosion. Almost 90% of the watershed is in agriculture. Buffer width varies throughout stream length. There are many areas where the stream runs through a wooded corridor and is plagued by eroding banks, making this flow limited stream even wider and shallower. Shocking surveys conducted at Giese Road and Bagley Road revealed a depauperate fish population which scored poor for the IBI. Habitat scores were poor or a low fair. One macroinvertebrate sample was poor and the other fair. A combination of these scores reflect the poor condition of this stream and make it a candidate for 303(d) listing using only 1 year of data.

It is recommended that Riley School Branch be added to the state's 303(d) list of impaired waters due to habitat degradation caused by sedimentation.

Searles Creek
This 9-mile, low gradient stream flows eastward and joins the Sugar River at the north end of Decatur Lake. The creek's watershed is a broad, flat-bottomed basin which is heavily tilled for crops. A great deal of the stream has been straightened to augment drainage from the fields. Some areas are buffered by quite well by reed canary and the incidentally because of the steepness of the banks, while other areas have little buffer. Removal of nuisance trees along the banks has been a common practice over the past 5 years even though this area is not part of the drainage district. The lower mile and a half of the stream runs through a forested wetland area just upstream from the confluence with Decatur Lake and provides habitat for wildlife. The stream consists of an abundant and relatively diverse population of warm and transitional non-game species. Searles Creek is listed on the state's list of impaired (303d) waters because of habitat degradation caused by nonpoint source pollution.

When this survey was conducted in 2013, the stream was dry upstream of CTH FF and contained intermittent pools immediately below it but picked up volume considerably downstream at CTH S, presumably augmented by flow from a spring pond located just upstream of STH 59. Interestingly, the Surface Waters of Green County (WDNR, 1980) reports, "instream vegetation and aquatic invertebrates are scarce." In 2013, biologists noted an overabundance of macrophytes and filamentous algae, especially in lower gradient areas where sediment has accumulated (see figure at right). Habitat in the upper stations is marginally good, but gradually degrades as one proceeds downstream. Water temperatures in Searles Creek are cool to cold with instantaneous maximum water temperatures measured in 2013 at 24^{o}C and the mean daily temperatures generally around 20^{o}C.

The natural communities' model predicts Searles Creek to be a cool-cold headwater for all but the last ½ mile of its length. The draft verification methodology showed the stream to resemble a cool-cold headwater upstream of CTH S and a cool-warm headwater at Decatur Sylvester Road and Prairie Road. The species assemblage transitions to a cool-warm mainstem by the time one reaches CTH F.

Searles Creek is currently on the state's list of impaired waters because of habitat degradation caused by excessive sedimentation. Sediment, as defined by the percent fines in the qualitative habitat survey varied by site and may be related to gradient at each relative site. This survey showed that the stream contains good numbers of fish. However, contrary to the conventional thinking that more fish equates to a healthier system, the enhanced abundance of fish is actually a sign of nonpoint source pollution impact. While the fishery itself may not necessarily show impairment, it does indicate excessive eutrophication of these systems. Given that there are many areas of Searles Creek that are channelized, wide, shallow, and deeply entrenched, *the stream should remain on the 303(d) list at this time.*

Sylvester Creek
This 14-mile long stream flows eastward throug a broad, flat valley and enters the Sugar River south of Brodhead. It is designated as an Exceptional Resource Water (ERW). The upper 4 miles, upstream of Balls Mill Road, is managed as a Class III trout water and is stocked annually with brown and rainbow trout (WDNR, 2003). The lower portion, down by Ten Eyck Road contains low numbers of smallmouth bass, and occasional northern pike and a handful of brown trout. It is the only stream in the watershed with mottled sculpin, a coldwater indicator species.

The natural communities' model predicts the stream to be a cool-cold transitional system throughout its length. The verification process (Lyons, 2013) as defined by the fishery assemblage showed this to be the case upstream of Balls Mill Road, but it appeared to be more of a cool-warm system downstream from there.   As noted earlier, it is classified as a trout water upstream of Balls Mill Road. Interestingly, in the 2013 survey, the numbers of trout and sculpin encountered increased downstream of Balls Mills Road.With the exception of the site at Balls Mill Road, all coolwater IBI scores were "excellent".

Still, stream habitat is impacted by agricultural nonpoint source pollution, stream bank erosion, and channelization. Much of the stream is within the Green County Drainage district and has been channelized to augment drainage of agricultural fields. The Green County Drainage Board has been requiring landowners to remove nuisance trees from along the banks of streams within their jurisdiction. This practice has had mixed results on the streams. In many of these systems, prior to cutting the trees, the woody debris and overhead cover provided the only habitat for fish. Once the trees were removed, this habitat was gone. However, removal of the shade cover has allowed for the growth of grass the steep banks and subsequent stabilization. Some slumping of banks into the creek has allowed for a small scale "remeandering" of the streams within the channel footprint. This has begun to narrow some of the streams leading to a better width-to-depth ratio as well as promoting scouring of the sand bottoms down to gravel. The small irregularities in the otherwise straight channel have created holes and quiescent habitat features for the fish to inhabit (see figure below).

Where possible, encourage landowners to slope banks 3:1 to prevent erosion. Control regrowth of woody vegetation to prevent overgrowth and destabilization of the banks.

Fisheries management should consider expansion of the trout designation on Sylvester Creek to include waters from Balls Mill Road downstream to Ten Eyck Road. Fisheries management should also explore what additional habitat would do for carry-over of trout, especially in the area between CTH O.K. and Ten Eyck Road.

Bank slumping creating “remeandering” of channelized streams


Sylvester Creek looking downstream from Greenbush Road