A 2016 Evaluation of the Koshkonong Creek Watershed
Dane and Jefferson Counties

Targeted Watershed Evaluation Project: South TWA 2016, HUC 0709000204

Koshkonong Creek at County Trunk Highway O

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Koshkonong Creek: Newly formed stream channel in what was once an impoundment

About the Koshkonong

The Koshkonong Creek HUC 10 (0709000204) is part of two larger watersheds, Lower Koshkonong Creek (LR11) and Upper Koshkonong Creek (LR12).

The HUC 10 drains 108,230 acres (169 square miles) including a large portion of eastern Dane County with the communities of Sun Prairie, Cottage Grove, and Deerfield, a number of small subdivisions, and a glacial drumlin-marsh area (Figure 1). Portions of the stream are part of a drainage district. Land use is primarily agricultural and a large percentage of original wetlands have been drained for this purpose. This wetland loss, coupled with stream ditching and widespread use of field tiles, allows significant nutrient and sediment loads to reach surface waters in this and downstream watersheds (WDNR, 2002). A detailed study of the water quality in the Upper Koshkonong was conducted in 1981 by the University of Wisconsin Institute for Environmental Studies, which enumerated sources and causes of pollution affecting the creek. This watershed is experiencing rapid population growth in the City and Town of Sun Prairie and the Village and Town of Deerfield.

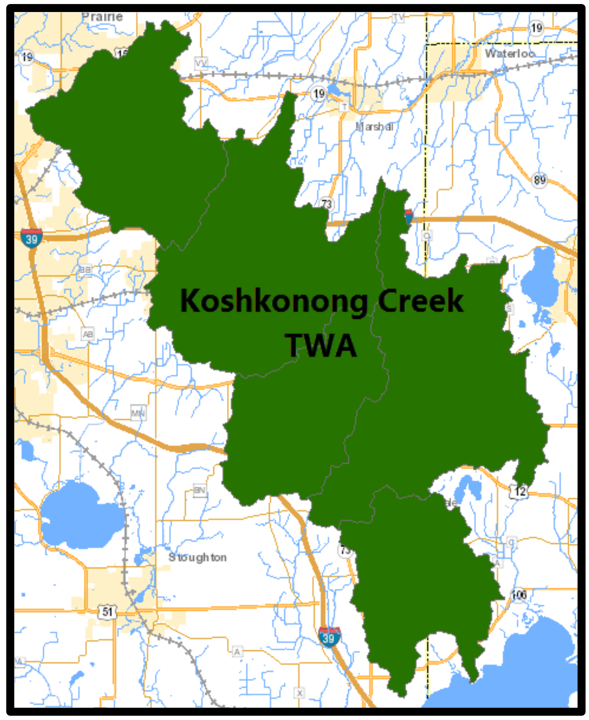


Figure 1. Koshkonong Creek TWA.

Koshkonong Creek itself is a 54-mile-long stream that begins in the City of Sun Prairie and flows southeast until it meets Lake Koshkonong in the southwestern corner of Jefferson County. The upper 6 miles from the headwaters down to CTH T is classified as Limited Aquatic Life (LAL). Downstream from there to the mouth it is classified as a warm water sport fishery. Much of the upper half of the stream has been ditched for agriculture. The lower third, downstream of Cambridge, still flows in its natural channel. The only impoundment on the creek at Rockdale was removed in 2001.

Historical accounts describe a stream that was plagued by hydrologic modification, clogged with “debris”, and having overall poor water quality in the form of high levels of phosphorus, chlorides, bacteria, ammonia and nitrogen. This was the result of runoff from agricultural fields as well as “sludge” from the wastewater treatment facility in Sun Prairie (WDNR, 1985). While improvements were made to the wastewater discharge, effects from historical point and nonpoint sources still affected the stream. It wasn’t until recently in 2016, however, that the stream was put on the state’s 303(d) list of impaired waters due to phosphorus levels exceeding the state’s criteria (WDNR, 2017). It is also proposed to be listed for temperatures exceeding the state’s criteria in 2018.

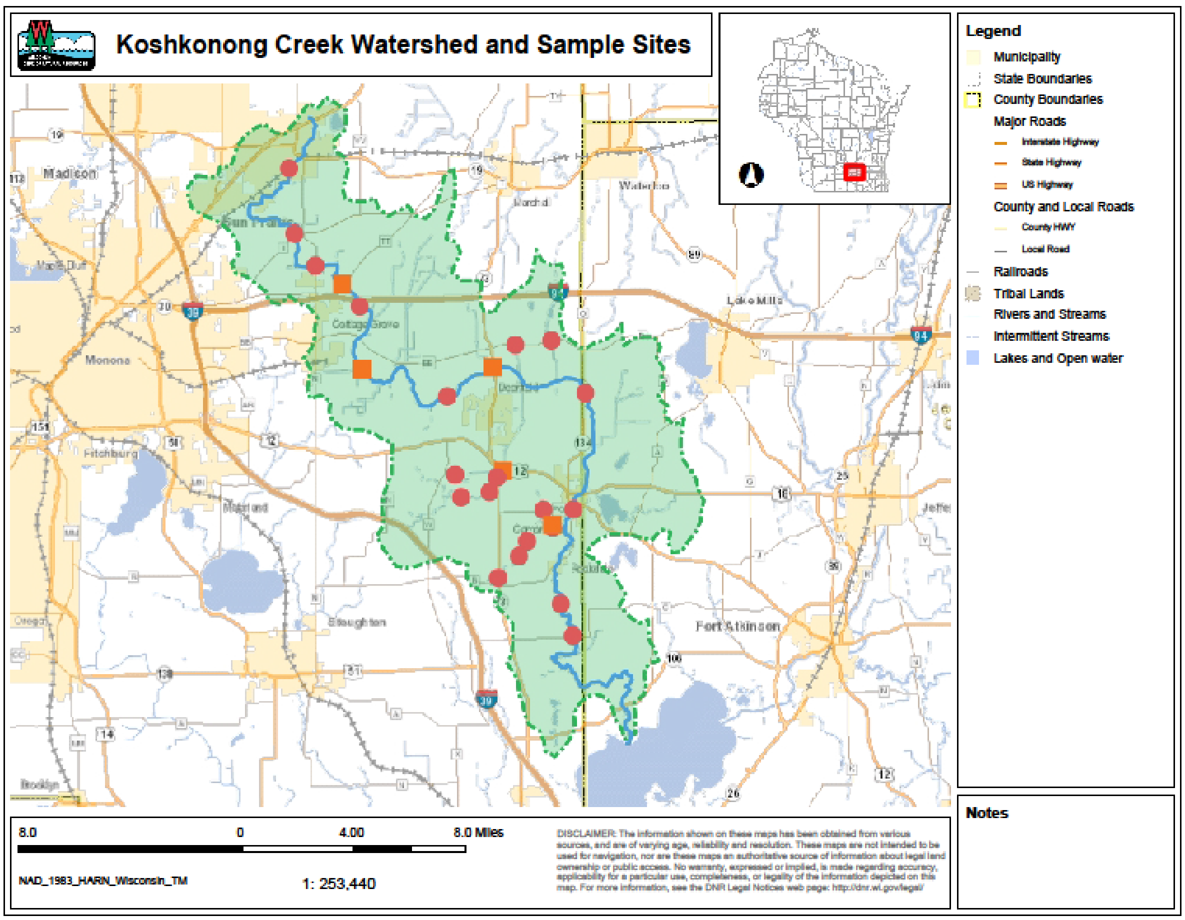
Many other tributaries drain into Koshkonong Creek and very few have not been hydrologically modified (channelized) to enhance drainage from fields. There are no designated trout streams or smallmouth bass streams in the watershed. While the majority of wetlands in the watershed have been drained for agricultural purposes, some significant wetlands remain. The City of Sun Prairie, as well as the villages of Deerfield, Cambridge, and Rockdale have wastewater discharges in the watershed.

This Targeted Watershed Assessment (TWA) monitoring project provided substantial data to analyze current conditions and to make recommendations for future management actions in the area. This plan is designed to present monitoring study results, identify issues or concerns in the area found during the project and to make recommendations to improve or protect water quality consistent with Clean Water Act guidelines and state water quality standards.

Methods

The 2016 watershed survey was conducted by water resources biologists on 20 sites in the watershed (Figure 2). Ten sites were surveyed on Koshkonong Creek itself, 3 on Mud Creek, 4 on an unnamed tributary (WBIC=5036882) and the remainder on other unnamed tributaries. Additionally, data from 5 other surveys conducted in the watershed within the past 6 years was included in the dataset.

Figure 2: Survey Sites in the Koshkonong Creek Watershed



The fisheries assemblage was determined by electrofishing 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. Some sites, particularly on Koshkonong Creek between Baxter Road and Oak Park Road, as well as downstream of CTH A, were not able to be sampled because they were too deep and/or mucky for wading. The same can be said for sites on Mud Creek downstream of STH 12. Macroinvertebrate samples were obtained at 17 sites by kick sampling and collecting using a D-frame net in fall, 2016 and sent to the University of Wisconsin – Stevens Point for analysis.

Results

The results of the fisheries surveys are summarized in Table 1. The Wisconsin Stream model (Lyons, 2008) predicted most of the waters in the watershed to be cool transitional waters or warm waters. The natural community verification process developed by Lyons (2015) showed the fishery assemblage to indicate a warm transitional (cool-warm) community a most sites except for the lower half of Koshkonong Creek, which had a warmwater assemblage. Therefore, the coolwater index of biotic integrity (IBI) developed by Lyons (2012) or the warmwater IBI (Lyons, 1992) was applied to the sites based on the community verification.

A total of 42 fish species were collected in the 2016 surveys. Brook stickleback, central mudminnow, creek chubs, fathead minnow, green sunfish, johnny darter and white sucker were the most widely distributed species. The great majority of species found in the watershed represent the warm thermal regime, with 10 species representing cool transitional temperatures. Several game species, including northern pike and largemouth bass were found in Koshkonong Creek. Most bass were young-of-the-year (YOY) at less than 3 inches in length and most northern pike were smaller specimens (less than 12 inches). The rock bass was the most prevalent panfish species found, especially in the lower sections of Koshkonong Creek. Black crappie, bluegill and yellow perch were also found in the creek. While the most common species in the watershed were those which are tolerant to low dissolved oxygen and environmental disturbance, there were several intolerant species found in Koshkonong Creek (and 1 tributary) that were quite common at certain sites. The tributaries generally contained a subset of the species found in the main creek.

Qualitative habitat scores (Table 2) ranged from 20 (poor) to 68 (good) with most between 30 and 50 or "fair". Riparian buffer width was good to excellent at most sites, owing to the fact most of the streams flow through current or former wetlands and/or are so entrenched that they had a de facto buffer. Likewise, bank erosion was fair to good at most sites because of the reed canary buffer. Wooded corridors generally had the worst bank erosion. Pools and riffles were scarce as were bends owing to the channelized nature of streams in much of the watershed. Fine sediments were common in the low

Table 1: Fish Assemblage, Natural Community and IBI for Streams in the Koshkonong Creek Watershed

Stream	Koshkonong Creek												Unnamed Trib (810500) to Koshkonong Crk	Unnamed Trib (810100) to Koshkonong Crk	Unnamed Trib (5036882) to Koshkonong Crk					Unnamed Trib (5036215) to Unnamed Trib (5036882)	Mud Creek				Unnamed Trib (810400) to Mud Crk
Site (Year if not 2016)	Learning Place Drive	CTH T	CTH N	CTH TT (2015)	Baxter Rd	Uphoff Rd (2011)	Oak Park Rd	STH 73 (2012)	CTH O	Water St (Cambridge)	Hoopen Rd (CTH C)	CTH A	CTH BB	CTH BB	STH 73	Koshkonong Rd	Clearview Rd	Highland Dr (2011)	Highland Dr	CTH PQ	Evergreen Dr	Hilcrest Rd	STH 73	STH 12 (2010)	W. Evergreen Dr.
SWIMS Station ID	10046989	133016	10046885		10022082	10033797	10046886	133020	283017	10013016	133024	133025	10045009	10010983	10045005	10045006	10045007	10033604	10033604	10045008	10045031	10010963	10046988	10031596	10045032
BANDED DARTER		2	3	29	48		11	48	53	140	43							4	3			1	3		
BANDED KILLIFISH													1	1											
BLACK BULLHEAD	1					5																			
BLACK CRAPPIE									1	2															
BLACKNOSE SHINER	61				3									30											
BLACKSIDE DARTER				34	35		34	3	16	38	15							3	3		3	1	7		
BLACKSTRIPE TOPMINNOW			6			5	12	26	60	2	64	10													
BLUEGILL	83		1			3				4	2	1					1	2							
BLUNTNOSE MINNOW		88	1	2	2	6	18	48	6	8	43							2						1	
BRASSY MINNOW	18																							1	
BROOK STICKLEBACK	50	19	5	8	2	4					2		25	9			11	5	7	2	1	15		14	1
CENTRAL MUDMINNOW	19	16	168	43	55	62		13	17	7	7		39	23				9	1		1	7		1	
CENTRAL STONEROLLER	10	77		28	1									1				17	1						
COMMON CARP						2												1							
COMMON SHINER										5															
CREEK CHUB	200	164	45	59	16		2	10		7			29	51		1	8	27	71	2	21	1	33	1	6
EMERALD SHINER						25						2						44							
FANTAIL DARTER																		15	20		20	13			
FATHEAD MINNOW	21	2		7		15		278	8	3			27	109			28	257	25		12	11	1	165	24
FRESHWATER DRUM									10	6	2				No Fish Captured										
GOLDEN REDHORSE										1															
GOLDEN SHINER		1						3										8							
GRASS PICKEREL										9	1														
GREEN SUNFISH	43	1		12	4	3	2	2	6	30	3					5	1	86	16			2	1		
HORNYHEAD CHUB										37	8														
IOWA DARTER	5		1		1									6											
JOHNNY DARTER	48	49	15	102	31		23	20	15	15	23		2					1	7		5	29	30	12	
LARGEMOUTH BASS	12	2								1															
LOGPERCH										3	11														
NORTHERN PIKE		1	22	2	15	1	1				2														
NORTHERN PEARL DACE	56							1					14	82								16	40		
PUMPKINSEED	2				2						10														
ROCK BASS							5	9	27	39	27	2													
SAND SHINER		2		1						5	1														
SHORTHEAD REDHORSE										2	1														
SOUTHERN REDBELLY DACE	10												6	26											
SPOTFIN SHINER				5	2	6	17	15	4	21	15	2						1							
STONECAT										3															
TADPOLE MADTOM		3	17			1	1	46	2																
WHITE SUCKER	145	17	555	76	143	10	13		22	31	15	5		2			1	89	75	1	15	10	26	17	
YELLOW BULLHEAD	1					2					3														
YELLOW PERCH						1																		1	
Modeled Nat. Community	WHW	WHW	WHW	WMS	WMS	CWMS	WMS	WMS	WMS	WMS	WMS	WMS	WHW	WHW	CCHW	CCHW	CCHW	CWHW	CWHW	CWHW	CCHW	CCHW	CCHW	CCHW	CWHW
Verified Nat. Commuity	CWHW	CWHW	CWMS	CWMS	CWMS	CWMS	WMS	WMS	WMS	WMS	WMS	WMS	CWHW	CWHW	N/A[2]	N/A[2]	CWHW	CWHW	CWHW	N/A[2]	CWHW	CWHW	CWHW	CWHW	CWHW
IBI[1]	80 (Excellent)	70 (Excellent)	40 (Fair)	80 (Excellent)	70 (Excellent)	60 (Good)	40 (Fair)	15 (V. Poor)	50 (Good)	72 (Excellent)	62 (Good)	25 (Poor)	30 (Fair)	70 (Excellent)	(Poor)	(Poor)	0 (Poor)	50 (Good)	40 (Fair)	(Poor)	40 (Fair)	80 (Excellent)	80 (Excellent)	10 (Poor)	0 (Poor)

1) IBI based on Natural Community, using either Lyons, 2012 for warm transitional sites, or Lyons, 1992 for warm sites
2) Not enough fish collected to determine Natural Community or IBI. Defaults to "poor" IBI.

Tolerant Species
Intolerant Species
Species names in italic indicates thermally transitional species

Table 2: Qualitative Habitat Assessment of Streams in the Koshkonong Creek Watershed

	Station Name	Swims Station Id	Date	Flow (cms)	Stream Width (m)	Ave Stream Depth (m)	Riparian Buffer Score	Bank Erosion Score	Pool Area Score	Width Depth Score	Riffle Riffle Ratio Score	Fine Sediments Score	Fish Cover Score	Habitat Score (Rating)	Comments
Small Stream QHI (< 10 m)	Koshkonong Creek at Learning Place Drive	10046989	08-Aug-16	-	5	0.3	10	5	3	5	10	10	5	48 (Fair)	
	Koshkonong Creek at Cth T	133016	20-Jul-16	0.101	6	0.5	5	5	0	10	0	0	5	25 (Fair)	CHANNELIZED, TILED. REPRESENTATIVE OF THE CHANNELIZED SECTIONS OF THE STREAM. AREAS DOWNSTREAM ARE MUCH DIFFERENT.
	Koshkonong Creek at CTH N	10046885	20-Jul-16	-	6	0.6	10	10	0	10	0	0	5	35 (Fair)	DITCHED (IN DRAINAGE DISTRICT). SILT/SAND BOTTOM. LOTS OF MACROPHYTES.
	Koshkonong Creek - at CTH TT	10010254	25-Aug-15	0.149	6	-	15	10	0	5	10	15	5	60 (Good)	
	Koshkonong Creek At Baxter Rd	10022082	18-Jul-16	0.434	7	0.5	10	15	3	10	10	10	10	68 (Good)	SOME RIP-RAP DONE. NICE LOOKING SITE. FLOW MAY BE IMPACTED BY MACROPHYTES.
	Koshkonong Creek at Oak Park Road	10046886	18-Jul-16	0.594	7	0.5	15	0	0	10	0	0	10	35 (Fair)	
	Koshkonong Creek at STH 73	133020	12-Jul-12	-	9	0.35	5	10	0	0	0	0	5	20 (Poor)	BOTTOM SAND, SOME GRAVEL/SILT; BANK 5-8FT FAIRLY STABLE; WET MEADOW ON RIGHT, ROW CROPS ON LEFT 2-3M BUFFER; SED HIGH;
	Koshkonong Creek at Cth O	283017	18-Jul-16	0.981	9.9	1	15	10	3	10	0	10	10	58 (Good)	MACROPHYTES MAY AFFECT FLOW
	Koshkonong Creek - Dwnstrm Water St. in Cambridge	10013016	24-Aug-16	1.2	9.5	0.6	10	5	0	10	0	5	10	40 (Fair)	SAND BOTTOM; VARIETY OF HABITATS; COARSE WOODY DEBRIS
	Unnamed Trib (5036882) to Koshkonong Cr at STH 73	10045005	09-Jun-16	-	2	0.1	15	5	0	5	5	5	0	35 (Fair)	HUGE DROP CULVERT AT KOSHKONOG RD.
	Unnamed Trib (5036882) to Koshkonong Cr at Koshkonong Rd	10045006	09-Jun-16	-	3	0.1	15	0	0	0	0	0	5	20 (Poor)	PERCHED CULVERT. VERY SHALLOW
	Unnamed Trib (5036882) to Koshkonong Cr at Clearview Rd	10045007	09-Jun-16	-	2	0.3	5	10	0	15	0	5	5	40 (Fair)	
	Unnamed Trib (5036882) to Koshkonong Cr at Highland Drive	10033604	21-Jun-16	-	5	0.3	15	5	7	5	15	10	10	67 (Good)	HIGH GRADIENT. GOOD BUFFER. ROCK, RUBBLE, GRAVEL BOTTOM. PROBABLY ONE OF THE NICEST SECTIONS OF STREAM IN EASTERN DANE CO.
	Unnamed Trib (5036215) to Unnamed Trib (5036882) at CTH PQ	10045008	09-Jun-16	-	1.5	0.15	5	10	0	10	0	0	5	30 (Fair)	STRAIGHT (CHANNELIZED), DEEPLY ENTRENCHED.
	Unnamed Trib (810100) to Koshkonong Crk at CTH BB	10010983	09-Jun-16	-	2	0.3	15	10	0	10	0	10	5	50 (Good)	
	Unnamed Trib (810500) to Koshkonong Crk at CTH BB	10045009	09-Jun-16	-	1.5	0.075	10	5	0	5	0	0	0	20 (Poor)	CHANNELIZED. HEAVY SEDIMENT.
	Mud Creek at Evergreen Drive	10045031	21-Jun-16	-	4	0.2	10	5	0	5	5	5	5	35 (Fair)	
	Mud Creek at Hillcrest Road	10010963	21-Jun-16	-	5	0.3	15	10	0	5	5	5	5	45 (Fair)	SAND/GRAVEL BOTTOM; DOWNED TREES AND WOODY COVER.
	Mud Creek at STH 73	10046988	08-Aug-16	-	5	0.2	15	0	0	5	5	0	5	30 (Fair)	WIDE AND SHALLOW
	Mud Creek at STH 12	10031596	06-Aug-10	-	5	0.4	15	10	0	5	0	0	5	35 (Fair)	
	Unnamed Trib (810400) to Mud Crk at W. Evergreen Dr	10045032	21-Jun-16	-	2.5	0.1	15	5	0	5	0	5	5	35 (Fair)	CHANNELIZED. WOODED CORRIDOR WITH RAW BANKS.

	Station Name	Swims Station Id	Date Time	Flow (cms)	Stream Width (m)	Ave Stream Depth (m)	Bank Stability Score	Maximum Thalweg Depth Score	Riffle Riffle Ratio Score	Rocky Substrate Score	Fish Cover Score			Habitat Score (Rating)	Comments
Large Stream QHI (>10 m)	Koshkonong Creek at Hoopen Road (CTH C)	133024	19-Jul-16	1.28	12	1	4	25	0	0	8			37 (Fair)	FLOWS THROUGH FORESTED FLOODPLAIN.
	Koshkonong Creek at Cth A Brg	133025	20-Jul-16	-	15	1	0	25	0	0	8			37 (Fair)	SITE WAS TOO DEEP TO SAMPLE PROPERLY.

gradient streams of this watershed. Fish cover varied by site and generally consisted of overhanging vegetation or macrophytes, with some coarse woody debris in wooded areas.

Macroinvertebrates collected in the fall were analyzed and the macroinvertebrate IBI (MIBI) developed by Weigel (2003) and Hilsenhoff Biotic Index (HBI) (Hilsenhoff, 1987) were applied to the data. As Table 3 shows, the MIBI ranged from 2.1 (poor) to 6.7 (good) with most values in the 3.5 to 4.5 or "fair" category based on WisCALM (WDNR, 2017) thresholds. The HBI was consistently "good" to "very good" indicating only slight organic pollution at most sites except for the upper sites of Koshkonong Creek.

Table 3: Macroinvertebrate Data for the Koshkonong Creek Watershed (2010-2016)

Station Name	Date	**MIBI** Score (Rating)	**HBI** Score (Rating)
Koshkonong Creek at Learning Place Drive	10/13/16	6.1 (Good)	7.4 (Fairly Poor)
Koshkonong Creek at Bailey Rd	10/13/16	2.1 (Poor)	7.7 (Poor)
Koshkonong Creek at CTH T	10/13/16	3.4 (Fair)	7.4 (Fairly Poor)
Koshkonong Creek at CTH TT	10/13/16	4.2 (Fair)	6.0 (Fair)
Koshkonong Creek at Baxter Rd	10/13/16	4.1 (Fair)	5.0 (Good)
Koshkonong Creek at Uphoff Rd	10/14/11	3.8 (Fair)	7.4 (Fairly Poor)
Koshkonong Creek at STH 73	9/24/12	3.4 (Fair)	5.7 (Fair)
Koshkonong Creek at Cth O	10/13/16	6.7 (Good)	4.8 (Good)
Koshkonong Creek at Water Street (Cambridge)	10/13/16	3.8 (Fair)	4.9 (Good)
Koshkonong Creek - Below (former) Rockdale Millpond	10/13/16	4.7 (Fair)	4.8 (Good)
Koshkonong Creek at Hoopen Road (CTH C)	10/13/16	3.9 (Fair)	5.3 (Good)
Unnamed Trib (5036882) to Koshkonong Cr at STH 73	10/24/16	4.7 (Fair)	3.8 (Very Good)
Unnamed Trib (5036882) to Koshkonong Cr at Koshkonong Rd	10/24/16	4.2 (Fair)	4.3 (Very Good)
Unnamed Trib (5036882) to Koshkonong Cr at Clearview Rd	10/24/16	4.1 (Fair)	5.2 (Good)
Unnamed Trib (5036882) to Koshkonong Crk at Highland Dr.	9/26/11	4.9 (Fair)	4.4 (Very Good)
Unnamed Trib (5036882) to Koshkonong Crk at Highland Dr.	10/24/16	5.2 (Good)	4.6 (Good)
Unnamed Trib (5036215) to Unnamed Trib (5036882) at CTH PQ	10/24/16	6.1 (Good)	4.5 (Very Good)
Mud Creek - Mud Creek At Hilcrest Rd	10/24/16	5.2 (Good)	5.0 (Good)
Mud Creek at STH 73	10/24/16	4.7 (Fair)	4.7 (Good)
Mud Creek at STH 12	10/25/10	5.3 (Good)	4.6 (Good)
Unnamed Trib (810400) to Mud Crk at W. Evergreen Dr	10/24/16	3.5 (Fair)	4.4 (Very Good)

Discussion

Despite being impaired by phosphorus and impacted by major hydrologic modification and sedimentation, Koshkonong Creek and tributaries actually has an impressive array of fish species. While tolerant species tend to make up the bulk of the assemblages, there are sites that have several intolerant species – some of which make up a significant part of the total fish numbers.

The blacknose shiner is a species not often encountered in southern central Wisconsin and the Koshkonong Creek watershed appears to be one of only several areas of southern Wisconsin where it is still regularly reported. It has apparently disappeared from a number of locations where it was originally reported back in 1935 (Becker, 1983). It requires clear and vegetated waters and prefers slower moving waters. Likewise, banded darters prefer clear streams with moderate to high gradient, preferring riffles or pools adjacent to riffles (Ibid). Despite these preferences, it was found quite commonly in the lower gradient waters of middle and lower Koshkonong Creek. Another darter species, the blackside darter, is common in medium to large size streams in southern Wisconsin but is seldom seen in large numbers. However, in the middle to lower section of Koshkonong Creek, it was one of the more common species.

Blackside Darter

Blacknose Shiner

Banded Darter

While it was interesting to find these more sensitive species in these hydrologically modified creeks, many of the most dominant species of the watershed were those tolerant to disturbed habitat and low dissolved oxygen. It was not surprising to find central mudminnows throughout the watershed. This species is known for inhabiting low gradient wetland streams. It is associated with clearer waters with moderate to dense vegetation and prefers water lacking flow. It can survive where dissolved oxygen levels are very low (Ibid). White suckers, creek chubs, and green sunfish are highly adaptable species that can thrive in the channelized, featureless types of systems that have little fish cover and are high in sediment. They tend to predominate in hydrologically modified areas.

The IBI tends to reflect the varied nature of the community that inhabits the streams of this watershed. On one hand, there are sites where the IBI is good to even excellent – owing to the variety of native species present. On the other hand, the predominance of tolerant species in certain sites tends to depress the scores in those sections. Interestingly, there doesn't appear to be any strong correlation between the IBI and the overall habitat score or any particular habitat metric. Certainly, the sites generally with the best overall scores tended to have higher IBIs, and the converse was generally true. In other words, sites with poor habitat did not have good fish assemblages. Overall 13 out of 24 sites had fair or lower IBI's. Eight sites had "excellent" IBIs and 3 sites were "good" in the IBI rating. For the sites with excellent IBI's, overall habitat scores ranged from 25 (fair) to 68 (good), with most between 30 and 50, or fair.

Five sites had poor or very poor IBI ratings. These sites either had very few fish present or the assemblage was dominated by tolerant species, and fathead minnow in particular. At 3 sites, fewer than 25 fish were collected, for which the default IBI is considered to be poor (Lyons, 2012). An exception to this is the site on Koshkonong Creek at CTH A. The low fish count may have been an artifact of the difficulty in sampling. The water was waste to chest deep in most areas with many obstacles (coarse woody debris) which dramatically reduced the effectiveness of the shocking crew. The fish assemblage on Unnamed Tributary (5036882) upstream of Koshkonong Road may be impacted by the perched culvert that exists at Koshkonong Road and may impact fish movement upstream of that point. Biologists did note that the species assemblage and fish numbers (and associated IBI) were lower than expected at Highland Drive on this same tributary. This assessment comes after biologists noted that this site "was probably one of the nicest looking sections of stream in eastern Dane County" from a habitat standpoint.

Overall habitat scores tended to be buoyed by the riparian buffer and width-to-depth metrics. Indeed, these 2 metrics tended to make up about 40 -75% of the overall score for all sites that scored lower than good. This is one reason the overall habitat score should be scrutinized. For instance, a dredged, channelized system with a good buffer may also have a good width-to-depth ratio. However, if it is a monotypic run which is high in fine sediment with little fish cover, the overall habitat score is not consistently going to be reflected by a higher fish IBI. This may explain the variability in the fish IBI vs. habitat score. Certain sites that had higher fish IBIs tended to have one or more areas of hard substrate (gravel, rubble/cobble or boulders) and/or some coarse woody debris, even if these features did not make up most of the site.

The macroinvertebrate data certainly indicate there is a significant amount of organic loading that occurs at the headwaters, likely from the Sun Prairie wastewater plant as well as urban runoff. This effect then appears to be diluted as one heads further downstream and the HBIs improve. The tributaries to Koshkonong Creek indicate very little organic loading. The MIBI scores are consistent in the "fair" category. In general, the macroinvertebrate IBI has shown the combination of watershed land cover and local riparian and instream conditions strongly influence one another (Weigel, 2003). The similarity between IBIs indicates similar land use and stressors throughout the watershed, with certain local stressors affecting a few specific sites. For instance, the IBI for Learning Place Drive was relatively high, despite its proximity to an urban area and its rocky bottom was the result of flashiness and scour during storm events. However, the next site down at Bailey Road showed a "poor" IBI, presumably because it is less than 400 meters downstream of a

Mud Creek

Mud Creek (WBIC = 810300) is a major tributary to Koshkonong Creek. Historically, the creek wove through interconnected wetlands. In the early 1900's, farmers organized to straighten the stream and drain the wetlands. The watershed is now primarily agricultural. Ground water recruitment is low, causing fluctuations in flow and water levels, especially after major storms. The Village of Deerfield discharges treated wastewater and storm sewer effluent to Mud Creek through a small tributary. Agricultural polluted runoff is the primary threat to existing water quality. Surveys in 1984 and 1988 showed the stream received an abundant silt load from agricultural fields, reducing aquatic and fish habitat. The stream was classified as an intermediate surface water, supporting a limited forage fishery, but was reclassified as a warm water forage fishery in 1988, indicating water quality improvement (WDNR, 1985). In the past, northern pike were observed moving up Mud Creek to spawn in the wetlands adjoining the stream, but it is not known if this still occurs. The primary species found in 2016 included a variety of non-game species including tolerant and intermediate tolerance species. The upper middle sections of the creek contained some of the best species, including banded darters and northern pearl dace. The lower half of the creek, downstream of STH 12, could not be sampled due to the fact it is too deep and/or contained too much soft sediment for wading.

This unnamed tributary (5036882) is typical of those in the watershed: channelized, entrenched, with a de facto buffer and well vegetated banks

WWTP discharge (a source of high nutrients) and habitat was less desirable. For the most part, however, those sites and tributaries without influence of point sources of pollution were similar in both IBI and HBI, indicating consistent watershed influences.

Management Actions

This brings up potential management actions for streams that have been dramatically altered. Some improvements have been noted in the stream compared to historical accounts. The removal of the Rockdale dam was studied by the University of Wisconsin-Madison to look at changes in sediment movement and biotic response. More details on this study can be found in the Appendix. The upper sections which are currently classified as Limited Aquatic Life are now full fish and aquatic life.

- *The natural resources codes need to be updated to reflect current conditions.* It is difficult to imagine an era in which one would put these streams back to their original meander pattern. Likewise, one cannot change gradient, or bottom substrate of these wetland systems.
- *We can control nutrient input from waste treatment systems and sediment/nutrient inputs from agricultural fields. Soil health and cover crop practices can be employed to minimize soil and nutrient loss from crop fields.*
- *The county should continue to work with individual farms to adopt whole farm planning.*
- *The county should also work with the drainage district to allow improvements in water flow while protecting habitat in the stream and the riparian area from erosion and wetland degradation.*

One point must be emphasized however: resource managers and the public must be realistic in understanding legacy sediment will continue to be to be an issue in this system because of the lack of scour due to low gradient. Given the extent and volume of sediment, it is unlikely a sediment removal project could be undertaken that would be financially feasible. Therefore, the stream and its associated biology will remain tied to its history. The fishery is good in some stretches that have high enough gradient or habitat to support a diversity of species. However, to think that major changes to the fishery will occur because of changes to on-land practice is probably unrealistic. It is a highly impacted resource that has certain nice sections which contain some quality species. It will likely remain that way for the foreseeable future.

References

Becker, George C. 1983. Fishes of Wisconsin. The University of Wisconsin Press. 1051 pp.

Hilsenhoff, William L. 1987. An Improved Biotic Index of Organic Stream Pollution. The Great Lakes Entomologist. 20: 31-39.

Lyons, John. 1992. Using the Index of Biotic Integrity (IBI) to Measure Environmental Quality in Warmwater Streams of Wisconsin. United States Department of Agriculture. General Technical Report NC-149.

Lyons, John, L. Wang, and T. Simonson. 1996. Development and Validation of an Index of Biotic Integrity for Coldwater Streams in Wisconsin. North American Journal of Fisheries Management. 16:241-256.

Lyons, John. 2008. Using the Wisconsin Stream Model to Estimate the Potential Natural Community of Wisconsin Streams (DRAFT). Wisconsin Department of Natural Resources Fish and Aquatic Life Research Section. November, 2008.

Lyons, John. T. Zorn, J. Stewart, P Seelbach, K Wehrly, and L. Wang. 2009. Defining and Characterizing Coolwater Streams and Their Fish Assemblages in Michigan and Wisconsin, USA. North American Journal of Fisheries Management. 29:1130-1151.

Lyons, John. 2012. Development and Validation of Two Fish-based Indices of Biotic Integrity for Assessing Perennial Coolwater Streams in Wisconsin, USA. Ecological Indicators 23 (2012) 402-412.

Lyons, John. 2015. Methodology for Using Field Data to Identify and Correct Wisconsin Stream "Natural Community" Misclassifications. Version 5. May 29, 2015.

Simonson, Timothy D., J. Lyons, and P.D. Kanehl. 1994. Guidelines for Evaluating Fish Habitat in Wisconsin Streams. U.S. Department of Agriculture. Forest Service. General Technical Report NC-164.

WDNR. 1985. Surface Water Inventory of Dane County. By Elizabeth Day, Gayle Grzebieniak, Kurt Osterby, and Clifford Brynildson. Lake and Stream Classification Project. Wisconsin Department of Natural Resources. Madison, WI.

WDNR. 2002. Rock River Water Quality Management Plan, Lower Rock River Appendix. Wisconsin Department of Natural Resources. PUBL#WT-668a-2002. May, 2002.

WDNR. 2017. Wisconsin 2018 Consolidated Assessment and Listing Methodology (WisCALM). Clean Water Act Section 305(b), 314, and 303(d) Integrated Reporting. Wisconsin Department of Natural Resources. Bureau of Water Quality Program Guidance. September, 2017.

Weigel, Brian. 2003. Development of Stream Macroinvertebrate Models That Predict Watershed and Local Stressors in Wisconsin. Journal of the North American Benthological Society. 22(1): 123-142.

Appendix: Removal of the Rockdale Dam on Koshkonong Creek

Photo Courtesy of Tom Hooyer, WI Geological and Natural History Survey

Koshkonong River Runs Free

On September 12, 2000, the Rockdale Dam on Koshkonong Creek was breached to grade (see above photo). The remainder of the structure (i.e., the lateral portion) was removed during late June 2001. A team of researchers subsequently studied the effects of dam removal on sediment and nutrient transport as well as biota.

Doyle et. al. (2003) found prior to dam removal, the reservoir was a sediment sink that had accumulated 287,000 m^3 of sediment. Sediment within the reservoir varied from 1 to 2 m thick. There was a distinct difference between the fine sediment at the surface and the underlying coarser sediment. Fine sediments also covered the channel upstream of the reservoir to a depth of 10-20 cm. Once the dam was removed, researchers noted a net export of fine sediment from the old reservoir. Initial fine sediment export was substantial, but had little effect on channel formation. Channel development was instead in the form of head cutting, which was significant within the 1st day, but decreased dramatically during the ensuing week. The sediment surface upstream of the head-cut remained undisturbed after the initial flush, while the channel downstream of the head cut changed substantially. There was very little in-channel deposition downstream of the former dam; however, vegetation colonized some of the soft sediment deposits up to 2600 m downstream and were not eroded by subsequent flows. In some cases, this sediment deposition coupled with rapid vegetation establishment narrowed the channel, which caused deepening of the thalweg. There was little downstream sedimentation through time due to limited reservoir sediment erosion.

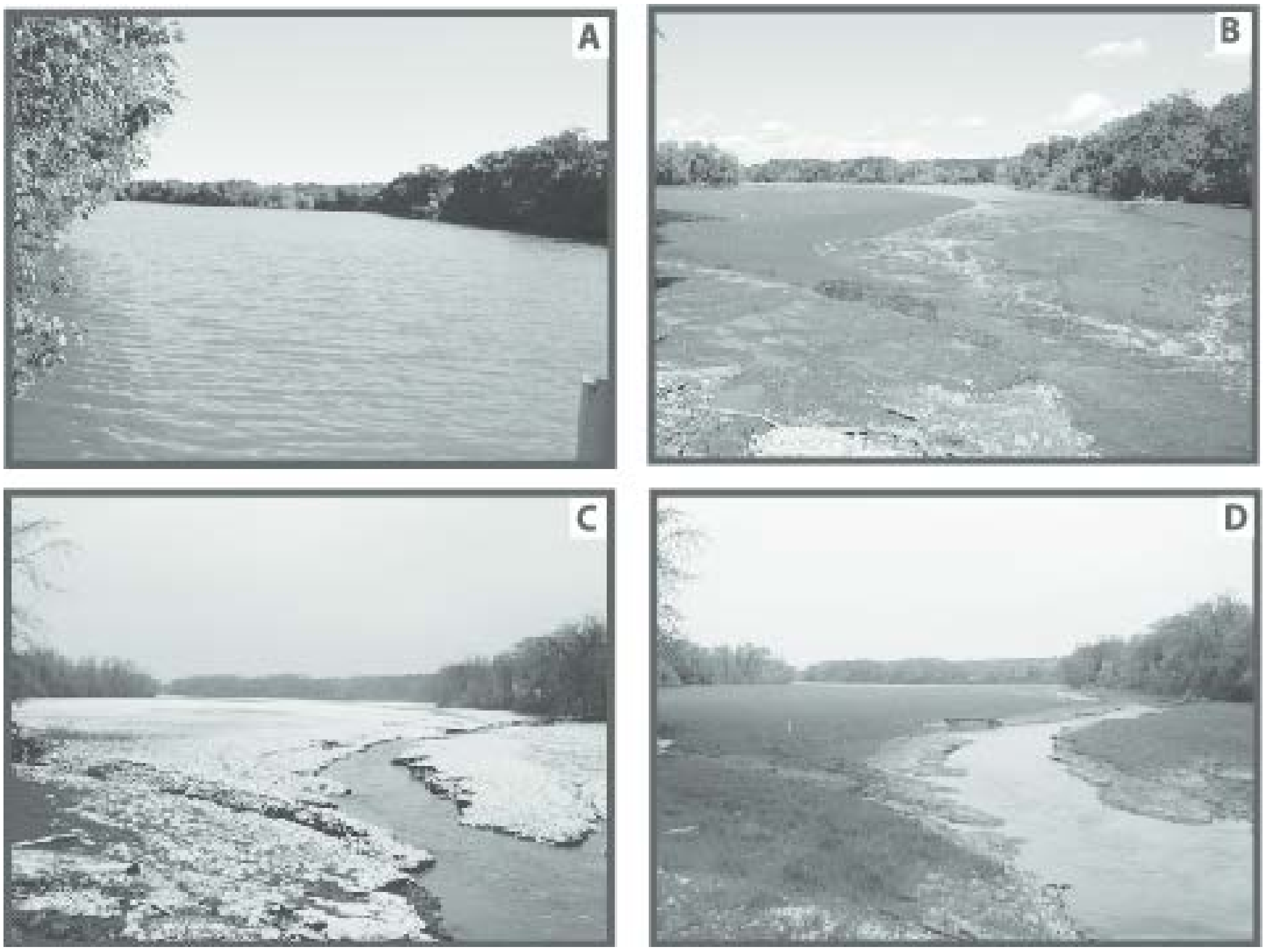
Because there were few fishery surveys of the stream and impoundment prior to removal, it is unknown what effect dam removal had on the fish community itself. The 2016 surveys conducted upstream at Cambridge and downstream at Hoopen Road showed a diverse fishery at both sites with a health biotic index, but of course this survey occurred 15 years post-removal.

The macroinvertebrate community showed similar characteristics at the removal site as well as throughout the watershed. Again, very little monitoring of macroinvertebrates was done prior to dam removal. However, based on studies of macroinvertebrate communities in response to dam removals on other streams (Stanley, et. al., 2002), one can assume the results were similar. In those cases, changes in macroinvertebrate assemblages over the course of dam removals were rapid in reaches upstream of the dams, and limited in reaches immediately below the dams. Lentic assemblages in the upstream impoundments such as tubificid worms and chironomids were replaced by more lotic assemblages (caddis and mayflies) within a year of removal, indicating rapid colonization and establishment of lotic fauna in these newly created habitats.

The biota most impacted by dam removal appeared to be in the mussel communities. Sethi et. al. (2004) conducted post-removal survey of mussels with the impoundment and downstream following removal of the dam. Within the reservoir, mortality rates were extremely high following removal due to desiccation and exposure. Mussel densities downstream from the dam declined immediately after dam removal. Mortality of mussels buried in deposited silt were observed up to 1.7 km below the dam. In the case of the mussel Q pustulosa, their populations vanished downstream of the dam after removal. Absence of mussels in the newly formed channel upstream of the old dam emphasizes the slow recovery of this group of organisms compared to fish and macroinvertebrates.

A study of nutrient dynamics (Stanley and Doyle, 2002) showed the backwater conditions created by the dam greatly enhanced nutrient retention and thus as the free-flowing water progressed through the reservoir, there was a downstream reduction in nutrient concentration. Removal of the dam and formation of a narrow channel in the lower impoundment worked greatly to increase flow velocity, reducing the potential for nutrient retention. However, upstream of the head cut, the reservoir remained mostly unaffected by the dam removal, so the nutrient retention trends are similar to when the dam was still in place. Final equilibrium conditions showed decreased, but still persistent nutrient retention. So, while dams are detrimental to many facets of a stream ecosystem, they can create conditions conducive to sediment and nutrient retention.

One final conclusion of study by Doyle, et. al, (2005) was that it is unlikely ecosystems will fully recover to pre-dam conditions, or be so slow to recover that it is imperceptible. This should not be perceived as a reason to forego dam removal, but merely a point that expectations should be measured.



Rockdale Dam on the Koshkonong River. (a) Rockdale reservoir pre-removal; view is facing upstream from dam, September 2000. (b) Rockdale reservoir, 24 hours post-removal. (c) Rockdale reservoir, November 2000. (d) Rockdale reservoir, May 2001. From: Doyle, et. al., 2003.

Photo Courtesy of Friends of Dane County Parks

Koshkonong Creek: Newly formed stream channel in what was once an impoundment

References

Doyle, M.W., E.H. Stanley, and J.M. Harbor. 2003. Channel adjustments following tow dam removals in Wisconsin. Water Resources Research. 39(1), 1011. doi:10.1029/2002WR001714, 2003.

Doyle, M.W., E.H. Stanley, C. H. Orr, A.R. Selle, S A. Sethi, and J.M. Harbor. 2005. Stream ecosystem response to small dam removal: Lessons from the Heartland. Geomorphology 71:227-244.

Sethi, S. A., et. al., 2004 IN Doyle, M.W. et. al., 2005.

Stanley, E. H., M. A. Luebke, M. W. Doyle, and D. W. Marshall. 2002. Short-term changes in channel form and macroinvertebrate communities following low-head dam removal. J. N. Am. Benthol. Soc. 21(1):172-187.

Stanley E.H., Doyle, M.W., 2002. A geomorphic perspective on nutrient retention following dam removal. Bioscience 52: 693-701.