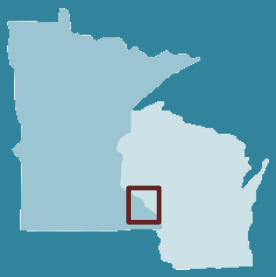
Upper Mississippi River Clean Water Act Monitoring



Minnesota-Wisconsin Pilot Condition Assessment

January 2019

Acknowledgements

The Water Quality Condition Assessment was produced in collaboration with the members of the Minnesota-Wisconsin Pilot project team. This includes the following individuals:

- **Metropolitan Council Environmental Services:** Kent Johnson and Jack Barland
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Cover Photo: The cover photo is provided courtesy of Wisconsin Department of Natural Resources (WIDNR).

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Introduction

The purpose of the Minnesota and Wisconsin Upper Mississippi River Clean Water Act (UMR CWA) Pilot project (*the Pilot*) was to test the sampling and assessment approach as prescribed in the *Provisional Methodology for Clean Water Act Assessment of the Upper Mississippi River* (*Provisional Methodology)*, developed in 2015 by the Upper Mississippi River Basin Association (UMRBA) Water Quality Task Force (UMRBA, 2016). The objective of this condition assessment was to test the mechanics of the methodology as well as its ability to generate understandable and valid results within the spatial and temporal limits of the project. The Pilot was employed in UMR CWA assessment reaches 0-3, extending from Upper St. Anthony Falls to the Root River (Table 1.1 and Figure 1.1).

This exercise was not intended to provide a definitive statement on water quality condition. A more robust assessment would require long term monitoring and would likely include some modifications to both the monitoring and assessment protocols reflecting lessons learned in the pilot (see the *Pilot Project Evaluation Report* for further discussion; UMRBA, 2019). The Pilot was not intended as a replacement for CWA 303(d)/305(b) assessments. However, states can choose to integrate the results discussed here into their CWA assessment process.

Table 1.1: Geographic Extent of the Pilot, UMR Assessment Reaches 0 through 3
[Note: Reaches are organized based on geomorphic distinction.]

Reach Number	**Reach Name** (Description/8-digit HUC code)	**River Miles**	**Segment Length (miles)**
0	**Assessment Reach 0** (Upper St. Anthony Falls to St. Croix River)	**854-811.5**	**42.5**
1	**Assessment Reach 1 (Rush-Vermillion)** (St. Croix River to Chippewa River/ HUC 07040001)	**811.5-763.4**	**48.1**
2	**Assessment Reach 2 (Buffalo-Whitewater)** (Chippewa River to Lock and Dam 6/ HUC 07040003)	**763.4-714.2**	**49.2**
3	**Assessment Reach 3 (La Crosse-Pine)** (Lock and Dam 6 to Root River/HUC 07040006)	**714.2-693.7**	**20.5**

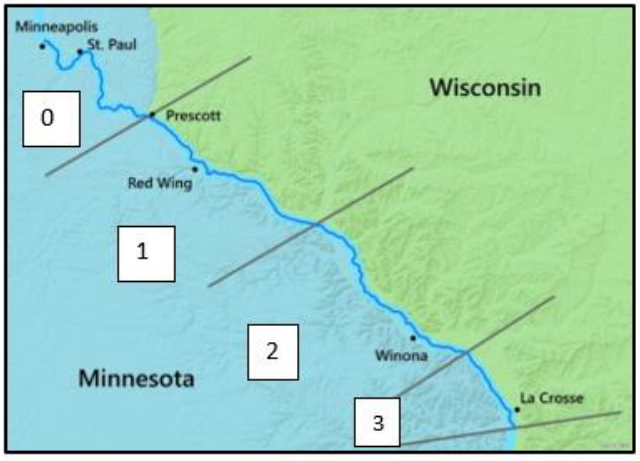


Figure 1.1: Reaches 0-3 Pilot Geographic Extent

Unusually high discharge conditions occurred on the UMR throughout the 2016 Pilot's sampling period, and the physical, chemical, and biological parameters collected were likely influenced by high water conditions. Since 1993, 2016 was one of the highest discharge years when measured as a June – September mean discharge value at the United States Geological Survey's (USGS) Prescott, Wisconsin gage (Figure 1.2). The mean value for 2016 was 37,698 cubic feet per second (cfs). This represented the third highest value since 1993 and approached the 90th percentile.

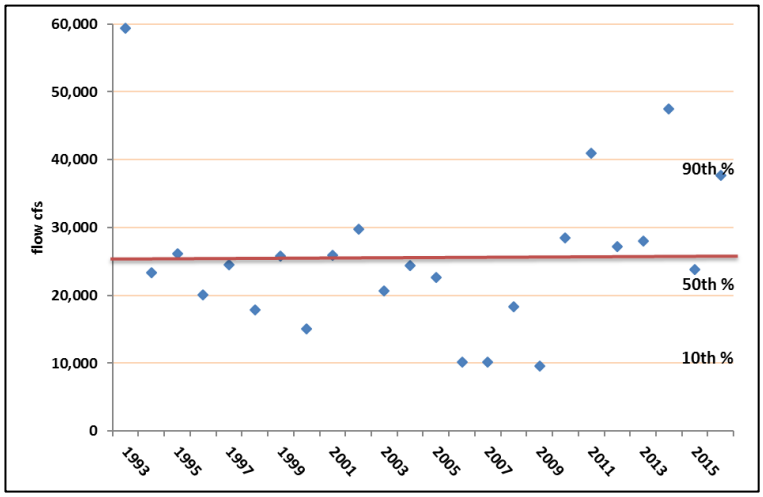


Figure 1.2: June-September Mean Discharge from 1993 to 2016 at USGS' gauge in Prescott, Wisconsin

Aquatic life Use Condition

An aquatic life use condition assessment refers to the ability of a reach to support native fish and other aquatic life. In large part, the Pilot and the *Provisional Methodology*'s approach to determining aquatic life use relies on direct measures of aquatic communities rather than relying solely on chemical or physical measures to make inferences. Water quality is one of the primary drivers affecting aquatic life, as it impacts aquatic organisms throughout their lifespans. This means the health and abundance of aquatic life may be indicative of water quality conditions throughout past times, not only at the time of sampling. Thus, biota provide a more robust evaluation of the UMR's aquatic life condition rather than traditional chemical and physical measures. The *UMR Biological Assessment Implementation Guidance* (Yoder et al., 2011) describes the advantages of utilizing biology for CWA assessments and recommends doing so for the UMR. Total suspended solids (TSS) was the only physical parameter directly considered in the aquatic life condition assessment because scientific research on the UMR suggests a strong, direct relationship between TSS and aquatic communities (Giblin, 2017).

The aquatic life condition status for each of the four study reaches is described by three assessments: dual assemblage, submerged aquatic vegetation (SAV), and TSS. The condition integrates the health of fish and macroinvertebrate communities at each sampling station into a dual assemblage evaluation as a primary assessment. SAV community scores and TSS concentrations were supplementary indicators. Aquatic life conditions are considered over varying temporal scales and acknowledge individual species' sensitivities and environmental preferences. The assessment is reflective of all aquatic communities – i.e., an assessment is only classified as "good" if all communities are adequately supported, including sensitive species. Using multiple aquatic community assemblages allows for greater confidence in aquatic life assessments.

Dual Assemblage

The *Provisional Methodology's* primary aquatic life assessment tool is a dual-assemblage evaluation that incorporates multimetric index scores for both fish and macroinvertebrates (Table 2.1). Both fish and macroinvertebrate scores must meet the aquatic life use thresholds adopted in the *Provisional Methodology* for a sample site to be considered supporting aquatic life – i.e., a Great River Fish Index (GRFIn) score of 38 and a Wisconsin Large River Macroinvertebrate Index of Biotic Integrity ("Large River IBI") score of 50. However, a site can be evaluated using just one assemblage if data for the other assemblage is not available – e.g., macroinvertebrate sampler lost. The overall condition of a reach is determined by the percent of sample sites found as supporting aquatic life, and is used as a proxy for the number of river miles supporting the aquatic life use.

Table 2.1: Dual assemblage Use Assessment at Site and Reach Scales

	Determining assemblage level condition for aquatic life use	**Determining site-level condition class for aquatic life use**		**Determining reach-level condition class for aquatic life use**		
Assemblage	**Impounded River Biocriterion**	**Supporting**	**Non-supporting**	**Good**	**Fair**	**Poor**
Fish	GRFIn (fish index) score of 38 or greater	Both assemblages meet their respective biocriterion	One or both assemblages fail to meet their respective biocriterion	Greater than or equal to 75% of the river miles* within the reach are reflective of a condition in which both assemblages meet their respective biocriterion	Greater than or equal to 50% and less than 75% of the river miles* within the reach are reflective of a condition in which both assemblages meet their respective biocriterion	Less than 50% of the river miles* within the reach are reflective of a condition in which both assemblages meet their respective biocriterion
Macro-invertebrate	Large River Macroinvertebrate IBI score of 50 or greater					

*Percentage of sites in a reach is used as a proxy for river miles.

Condition class was calculated for each of the Pilot reaches, based on fish and macroinvertebrate assemblages (Table 2.2). In many cases, only the fish assemblage score was available for a site given that many of the macroinvertebrate samplers were washed away during high discharge conditions. Supplementary data sets for SAV and TSS were also considered in determining the overall aquatic life use condition class, as described in the *Supplementary Indicators* section detailed later in this report.

*Table 2.2: Dual Assemblage Aquatic Life Condition Classes by Reach**

Reach	*Pool*	*River Mile*	*Site*	*GRFIn Score (threshold is 38)*	*Macroinvertebrate IBI Score (threshold is 50)*	*Does Site Meet Both Biocriteria?*	*% of Sites Meeting Both Biocriteria (reach mean scores)*	*Reach Condition Class*
0	01	853	369	44.72	70	Yes	**88%** (15 of 17) *Reach Mean GRFIn Score = 58.69* *Reach Mean Macroinvertebrate IBI score = 67.14*	**Good**
		852	373	75.99	85	Yes		
		849	365	78.87	85	Yes		
	02	843.5	375	67.71	No Sample	Yes		
		842.5	361	57.04	No Sample	Yes		
		842.5	361	44.2	No Sample	Yes		
		841	366	31.13	No Sample	No		
		835	362	70.71	No Sample	Yes		
		835	362	32.31	No Sample	No		
		833	372	69.14	No Sample	Yes		
		827	368	60.63	No Sample	Yes		
		824	364	57.16	No Sample	Yes		
		823	371	65.77	60	Yes		
		819	367	61.52	No Sample	Yes		
		818	363	71.81	55	Yes		
		812.5	374	52.25	55	Yes		
		812	370	56.71	60	Yes		
1	03	805	316	72.28	No Sample	Yes	**100%** (17 of 17) *Reach Mean GRFIn Score = 64.89* *Reach Mean Macroinvertebrate IBI score = 55* [**The macroinvertebrate sampling results in Lake Pepin are not included in the condition assessment.]	**Good**
		803.5	312	51.67	No Sample	Yes		
		801	310	60.35	No Sample	Yes		
		808	308	56.25	55	Yes		
	04	794	306	64.1	55	Yes		
		790	314	68.99	No Sample	Yes		
		786.5	303	57.52	No Sample	Yes		
		786.5	303	59.53	No Sample	Yes		
		784	304	53.75	30**	Yes		
		780	315	73.7	35**	Yes		
		776	307	47.89	25**	Yes		
		774.5	311	70.18	30**	Yes		
		771	301	82.56	20**	Yes		
		771	301	78.64	No Sample	Yes		
		770	305	75.15	No Sample	Yes		
		768	309	65.9	15**	Yes		
		765	313	64.62	No Sample	Yes		

* *Replicate samples are included in the above calculations.*

(Table 2.2 continued on next page)

Table 2.2: Dual Assemblage Aquatic Life Condition Classes by Reach[*]
(Continued)

Reach	Pool	River Mile	Site	GRFIn Score (threshold is 38)	Macroinvertebrate IBI Score (threshold is 50)	Does Site Meet Both Biocriteria?	% of Sites Meeting Both Biocriteria (reach mean scores)	Reach Condition Class
2	04	761.5	72	63.01	35	No	**88%** (15 of 17) *Reach Mean GRFIn Score = 67.84* *Reach Mean Macroinvertebrate IBI score = 51.67*	**Good**
		755.5	69	79.48	No Sample	Yes		
		754	62	65.74	60	Yes		
		754	62	51.54	60	Yes		
	05	751	66	72.85	50	Yes		
		745.5	73	77.17	No Sample	Yes		
		744	70	66.9	55	Yes		
		739	68	52.75	50	Yes		
	5A	734	64	78.61	55	Yes		
		731.5	75	82.07	No Sample	Yes		
	06	728	67	62.53	No Sample	Yes		
		726	63	59.6	55	Yes		
		724	74	70.98	45	No		
		723	71	76.6	No Sample	Yes		
		718	61	56.49	No Sample	Yes		
		718	61	68.68	No Sample	Yes		
		717	65	68.23	No Sample	Yes		
3	07	713.5	250	68.04	No Sample	Yes	**82%** (14 of 17) *Reach Mean GRFIn Score = 72.36* *Reach Mean Macroinvertebrate IBI score = 50.63*	**Good**
		712	254	69.95	50	Yes		
		709.5	242	72.45	No Sample	Yes		
		709.5	242	74.86	45	No		
		708	246	70.22	No Sample	Yes		
		708	247	75.09	No Sample	Yes		
		707.5	243	72.47	No Sample	Yes		
		706	244	70.19	60	Yes		
		705	251	72.03	40	No		
		703	255	57.96	No Sample	Yes		
	08	702	241	75.9	45	No		
		702	241	71.24	55	Yes		
		702	245	75.88	No Sample	Yes		
		701	249	87.71	No Sample	Yes		
		699.5	253	63.96	No Sample	Yes		
		698	248	77.79	50	Yes		
		696	252	76.39	60	Yes		

[*] *Replicate samples are included in the above calculations.*

Fish Assemblage — Despite the challenges related to high discharge, fish assemblage sampling was completed successfully (Table 2.3). A primary concern regarding fish assemblage data accuracy is that high discharge levels did not allow for a truly representative condition. Several potential flow-related impacts could have also affected the results. For example, increased water depth can make it difficult to detect fish near the substrate, increased current velocity can make precise boat control more difficult, and inundation moves shorelines upland and often creates obstacles (e.g., trees) that prevent access to "true" shorelines during sampling.

Table 2.3: Summary of Fish Assemblage Sampling

	MPCA	WIDNR
Sample Sites	30	30
Sample Visits	34	34
Sample Dates	August 8 – October 4	July 6 – September 12
Fish Collected	18,904	12,278
Species Collected	63	58

Overall, the vast majority of mean GRFIn scores exceeded the threshold score of 38 on a scale of 100 (Yoder et al., 2011). Only two of the 68 site GRFIn scores calculated for the Pilot failed to meet this threshold. Mean reach scores generally increased as sampling proceeded downriver, with Reach 0 having the lowest mean score and Reach 3 the highest mean score (Figure 2.1.) The results aligned with the understanding that upper impounded reaches are impacted by urban stressors as well as sediment and nutrient inputs from the Minnesota River, while lower reaches benefit from Lake Pepin's trapping of sediment and pollutants.

The two site GRFIn scores below the 38-threshold occurred in Reach 0 (UMR Pool 2). Of these two, one was a replicate sample (site 362) that had an initial result well above the threshold value. An explanation for this discrepancy was that a significant precipitation event occurred between the initial and replicate samples, raising discharge beyond already elevated levels.

The threshold score of 38 was termed a "minimum" threshold (Yoder et al., 2011). It roughly corresponds to a biological condition gradient (BCG) level 4, where level 1 represents best conditions and level 6 most impacted conditions. Following the Pilot, and perhaps any additional implementation of the *UMR CWA Recommended Monitoring Plan*, the states may wish to revisit the question of threshold values, potentially establishing an "upper tier" threshold corresponding to a BCG level 3 – though more monitoring likely needs to take place before the question of an upper tier threshold is revisited.

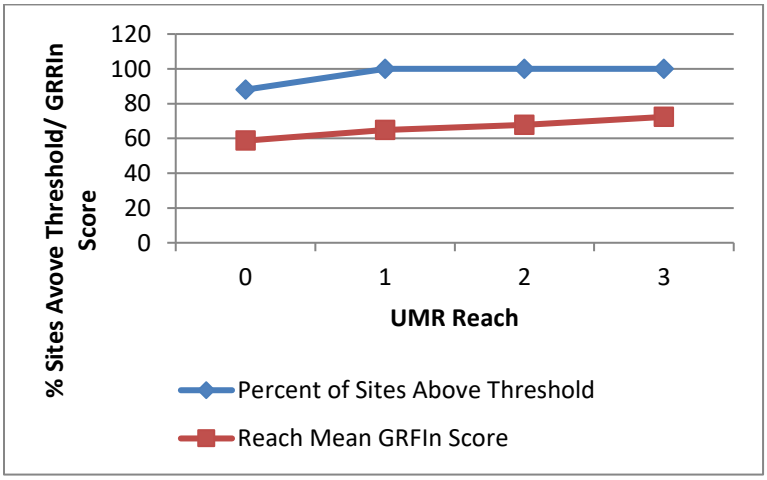


Figure 2.1: Percent of Sites Meeting Threshold and Mean GRFIn Scores per Reach

As this was a pilot project, there was not a previous data set against which to make a precise comparison. However, 2004-2006 monitoring under USEPA Environmental Monitoring and Assessment Program-Great Rivers Ecosystems (EMAP-GRE) did provide one point of comparison. The same collection methods and scoring approach were used, however, sampling was structured around one state as an assessment unit and was generally less spatially intensive than the Pilot. EMAP-GRE samples were scattered across three index periods in 2004-2006, compared to one index period for the Pilot in 2016. Mean discharge during each year of the EMAP-GRE study, 2004-2006, was 50, 45, and 10 percentiles, respectively.

Nonetheless, a comparison can be made between the Pilot and EMAP-GRE results (Table 2.4 and Figure 2.2). Overall, the EMAP-GRE and Pilot results were roughly congruent and both showed similar downstream GRFIn score increases. With this comparison in mind and the relatively high scores in general, it was concluded that the high discharges in 2016 did not result in decreased GRFIn scores.

Table 2.4: Comparison of EMAP-GRE (2004-2006) and Pilot (2016) Fish Assemblage Results

Reach	Number of EMAP-GRE Samples	Number of Pilot Samples	Percent of Sites Above Threshold for EMAP-GRE	Percent of Sites Above Threshold for Pilot	Reach Mean for EMAP-GRE	Reach Mean for Pilot
0	6	17	50%	88%	35.78	58.69
1	13	17	85%	100%	51.33	64.89
2	19	17	100%	100%	72.86	67.84
3	4	17	100%	100%	78.27	72.36

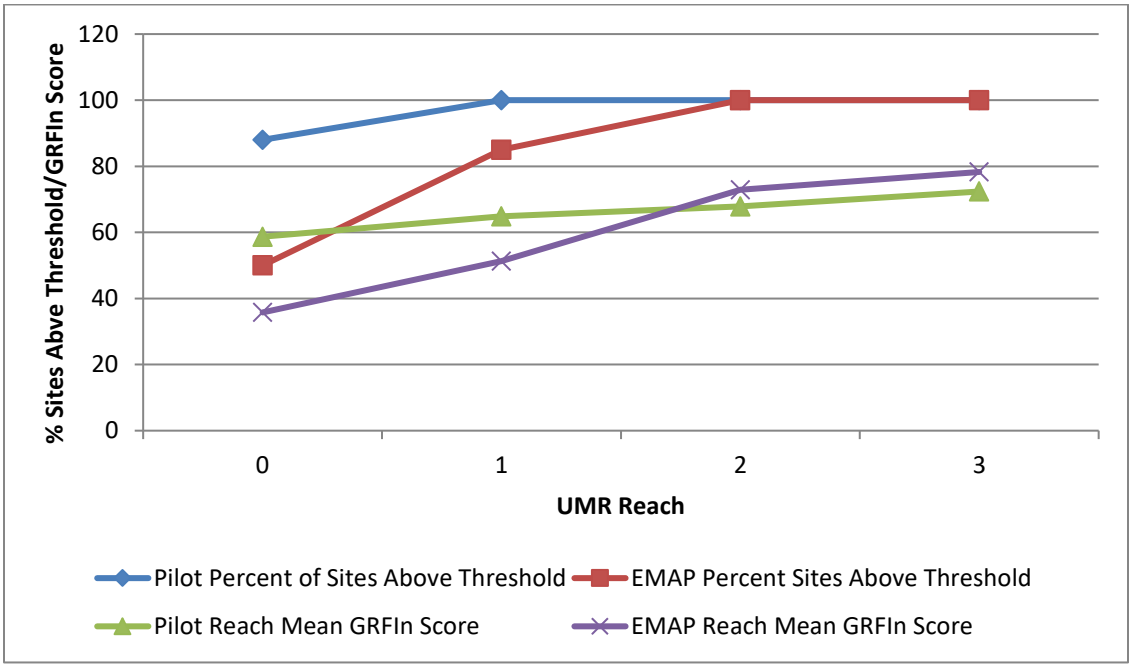


Figure 2.2: Comparison of EMAP-GRE (2004-2006) and Pilot (2016) Fish Assemblage Results per Reach

Despite similar overall scores, more subtle impacts from high flows may have occurred. One way to further assess impacts is to examine trends in the metrics underlying the GRFIn score. A cursory analysis of the Pilot study GRFIn metric scores combined for all sites across all reaches shows that some metrics were consistently higher than others (Figure 2.3). In particular, four of the five proportional metrics outscored all of the numeric metrics. This same pattern existed during the EMAP-GRE program, but to a lesser degree. It is possible that the high discharge affected fish distributions enough to skew these metrics as they are intended to examine functional health of the fish community and place higher values on native riverine specialists. Native riverine specialists would be less likely than alien (non-native) species to be displaced by high water and faster current velocities.

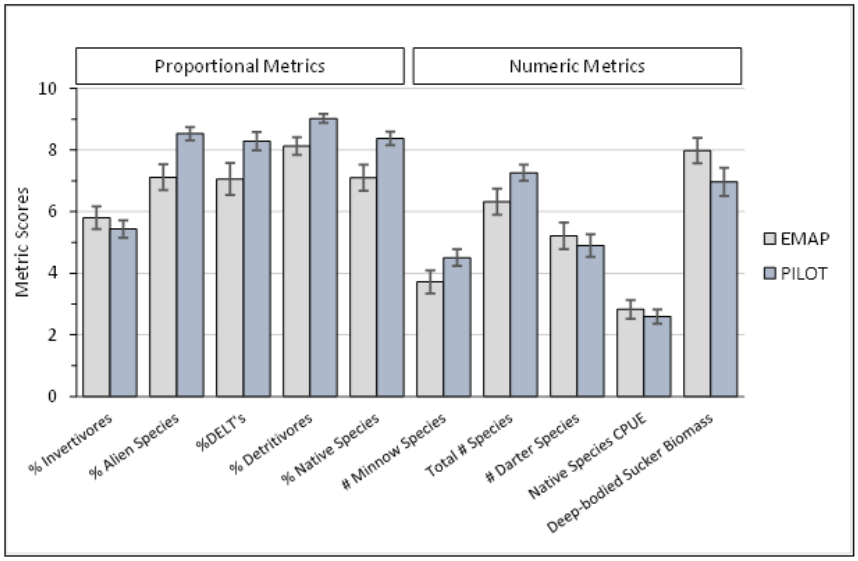


Figure 2.3: Mean metric scores of the 2016 Pilot and EMAP-GRE sites in 2004-2006 (A. Bartels, WIDNR)

Conversely, three of the five numeric metrics scored lower during the Pilot sampling than during EMAP-GRE scored lower during the Pilot, likely because of reduced sampling efficacy or altered fish distributions. The two Pilot metrics that scored higher than the EMP-GRE study were number of minnow species and total number of species. Intuitively, the number of darter species would score higher than the number of minnow species. In high flow conditions metrics featuring small-bodied fishes might be decreased because those fishes may have been displaced by high current velocities or not as easily spotted by dip-netters under difficult sampling conditions. Darters are most often associated with the substrate and minnows are generally pelagic.

The major theme regarding fish metric values is that extreme sampling conditions can influence individual multimetric index scores and guidelines generally suggest that fish sampling should be avoided when possible during periods of high discharge. This study was performed in a series of river reaches that support a high-quality fish community. In reaches where the fish community is less robust, sampling under high discharge conditions might yield bioassessments that incorrectly assign failing grades, simply because of reduced sampling efficiency.

Macroinvertebrates — Unusually high discharge conditions impacted macroinvertebrate sampling during the Pilot. The recovery rate for the samplers was approximately 50% due to high flow and downstream movement of large snags resulted in the loss of many samplers. Another potential loss of samplers may have been attributed to vandalism. Nonetheless, good colonization of the recovered samplers was

observed. Macroinvertebrate experts working on the Pilot determined that enough data were available to utilize the Large River IBI and to calculate scores for each reach (Table 2.5).

Table 2.5: Summary of Macroinvertebrate Assemblage Sampling

	MPCA	WIDNR
Sample Sites	15 (of 30 due to sampler loss)	15 (of 30 due to sampler loss)
Sample Visits	42	30
Sample Dates	July 11 – October 4	July 11 – September 9
Macroinvertebrate Taxa Collected	73	65

Water velocity within Lake Pepin did not meet the minimum requirements for macroinvertebrate sampling (i.e., water velocity greater than 0.09 m/s) and those samples were removed from the condition calculations. For reference, IBI scores from the Lake Pepin area were the lowest of all results for the Pilot (Table 2.2). Without Lake Pepin scores, the majority of macroinvertebrate results (21 of 26) were above the threshold score of 50 (Figure 2.4). The highest IBI scores were observed in Reach 0 with a mean score of 67.14. Mean IBI scores in the other reaches were between 50 and 55.

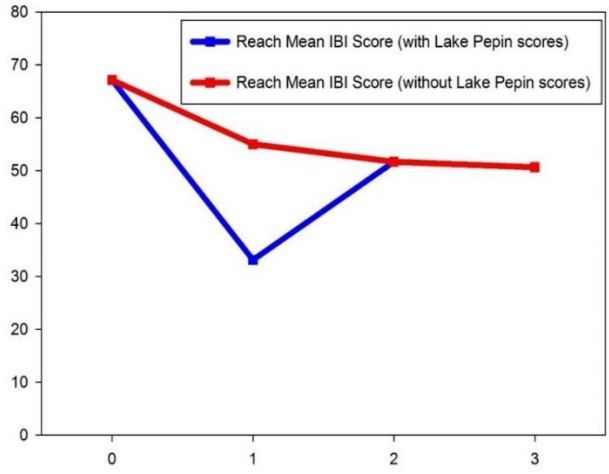


Figure 2.4: Mean Large River IBI Scores per Reach

Supplementary Indicators

While the dual-assemblage assessment is the primary tool recommended in the *Provisional Methodology* to determine aquatic life condition, two additional metrics are also included in the methodology: SAV and TSS. These metrics are considered alongside the dual-assemblage results in evaluating the overall condition of a reach.

Submerged Aquatic Vegetation — A separate, stand-alone report by Lund and Drake offers a full discussion of the vegetation results. Modified findings are summarized from that report.

Like fish and macroinvertebrate monitoring, SAV monitoring was implemented using a probabilistic design. However, a more intensive spatial design was employed with 100 sites sampled per reach. Site data were gathered into four aggregates per assessment reach for calculation of the submersed macrophyte index (SMI) scores (Figure 2.5).

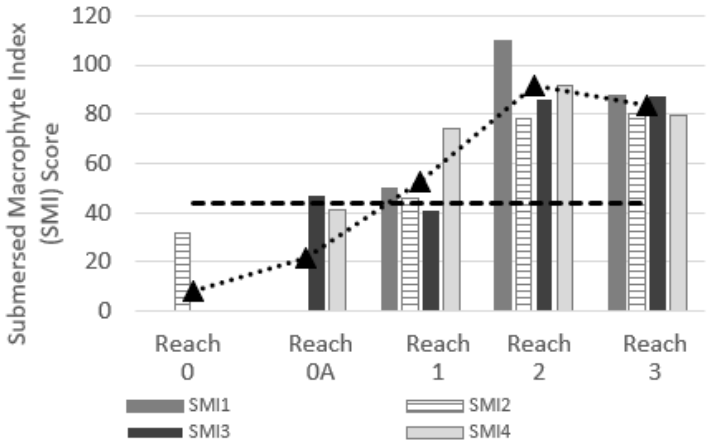


Figure 2.5: SMI Scores by Aggregate (Bars) and Reach Averages (Triangles) (Lund and Drake, 2016)
[Note: UMR Reach 0 was split into two reaches, Reach 0 and 0A]

The *Provisional Methodology* established a threshold SMI score of 44 but did not specify how to assign condition class based on those scores. One simple method to integrate scores into an assessment is to compare reach means to the threshold value. Mean SMI scores of Reaches 1, 2, and 3, are above the threshold and mean scores in Reach 0 well are below the threshold. An alternative way of comparing results to the threshold is to consider the percent of aggregates meeting the threshold and then determine class using the 50% and 75% demarcations in a manner similar to the dual assemblage (Table 2.6). In this case, both approaches described above yield the same result for condition class, but this will not necessarily be true in all cases.

Table 2.6: Reach Scores for Average SMI and Percentage of Aggregate
[Note: UMR Reach 0 was split into two reaches, 0 and 0A, for purposes of vegetation monitoring]

Reach	Reach Average SMI Score	Above or Below Assessment Threshold SMI Score of 44	% of Aggregate Scores Above Threshold of 44	Condition Class
0	7	**Below**	0%	**Poor**
0A	21	**Below**	25%	**Poor**
1	50	**Above**	75%	**Good**
2	84	**Above**	100%	**Good**
3	79	**Above**	100%	**Good**

Average SMI scores indicated a general improvement in SAV abundance moving downstream of Lake Pepin. SMI scores in Reach 0 (including both 0 and 0A segments) were below the SMI threshold score of 44. SAV was only found in three of eight aggregates within these segments. In this reach, the underlying physical and structural conditions, large-rock dominated substrates, confined channels, and high water velocity are not suitable for SAV establishment. Therefore, vegetation monitoring in Reach

0 may not provide an instructive CWA assessment tool and may not be useful to integrate these results into the overall assessment evaluation for aquatic life. Future efforts should consider removing Reach 0 from sampling. These issues were known prior to the Pilot, but it was agreed to proceed with monitoring in Reach 0, in part to determine the viability of future monitoring of vegetation in this reach.

It is possible that high water levels may have biased Pilot sampling in two ways. First, sampling may have been biased towards the shoreline since the methods for determining sampling sites rely on the location of the littoral zone (less than 2 m depth) at the time of sampling. Sampling conducted closer to shoreline may have contributed to higher frequency of SAV occurrence observed during the Pilot in four of five aggregates in comparison to UMRR sampling. Second, in the absence of direct scouring of vegetation, high water levels during 2016 Pilot sampling may have resulted in an increased maximum depth of SAV occurrence relative to what was observed during the original SMI study (Moore et al., 2011). This was supported by the fact that the observed depth of occurrence of SAV during this Pilot study met or exceeded the original SMI study's 95th percentile values in 9 of 14 aggregates. These potential biases should be considered when comparing reach scores over time (Lund and Drake, 2016).

The Upper Mississippi River Restoration program's (UMRR) Long Term Resource Monitoring (LTRM) data indicated that 2016 was a year of high abundance for all forms of aquatic vegetation despite the high flows and that direct scouring of rooted vegetation was not widespread. UMRR has monitored Pools 4 and 8 (portions of Reaches 1,2 and 3) since 1998. Further, there was rough comparability in the frequency of vegetation occurrence found in the Pilot and in UMRR sampling conducted in overlapping areas slightly earlier in the season in 2016 – i.e., both sampling efforts indicated high vegetation abundance (Lund and Drake, 2016).

Comparing SMI results in the both Pilot and LTRM data indicate that the 2016 Pilot scores were relatively high among the years sampled but within the ranges of the ten year period of LTRM data (Figure 2.6). Whether this reflects a trend of generally improving vegetation conditions or results in part from the biases described above should be kept in mind as Pilot results are considered.

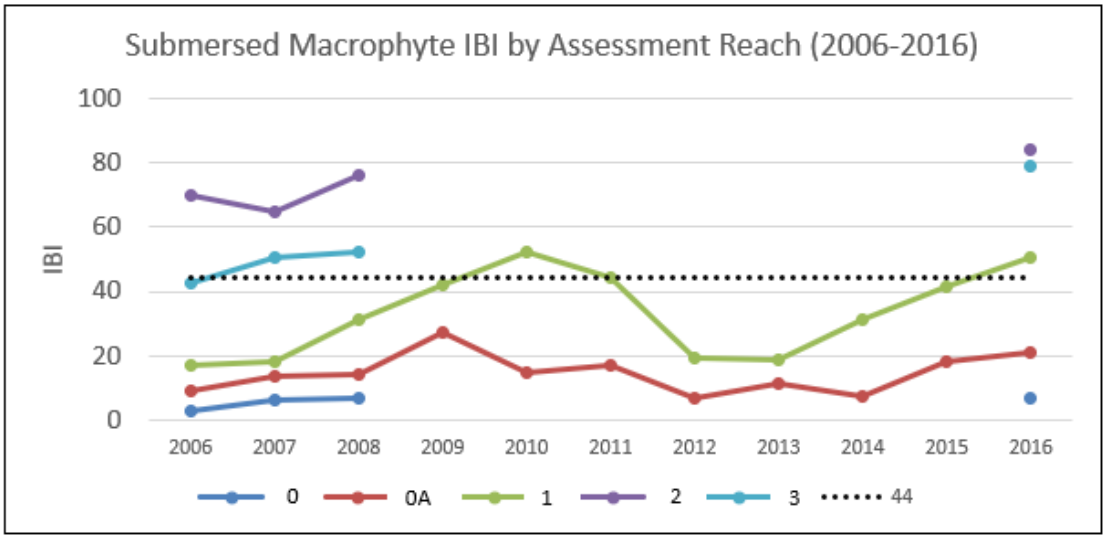


Figure 2.6: Submersed Macrophyte Index (SMI) scores (reach averages) over time in Pilot reaches (figure from E. Lund, MNDNR)

Potential modifications to SMI score calculation are being considered to address possible overestimation of maximum depth of vegetation. The Pilot project team also recommends fixed aggregate boundaries (i.e. sub-reaches) to calculate SMI scores and any potential future site selection. This is a change from the original published SMI method that delineates site aggregations based on the location of approximately 20 adjacent sites, an approach that resulted in varying numbers and location of aggregations from year to year.

Total Suspended Solids **—** Recent research has demonstrated important relationships between fish community condition and TSS levels in the UMR's reaches (Giblin, 2017). Conditions differ upstream of Lake Pepin (Reaches 0 and 1) and downstream of Lake Pepin (Reaches 2 and 3) because the lake acts as a settling basin for sediment. The *Provisional Methodology* recommends using the 32 mg/l TSS threshold level above Lake Pepin and 16mg/l TSS below Lake Pepin (Table 2.7). The 32 mg/l TSS threshold is also the site-specific standard used by Minnesota Pollution Control Agency (MPCA) for the "South Metro" Mississippi River (St. Paul to Red Wing, Minnesota). The *Provisional Methodology* integrates these thresholds and uses the "pooled median" from probabilistic and fixed site monitoring to make reach-level comparisons to thresholds.

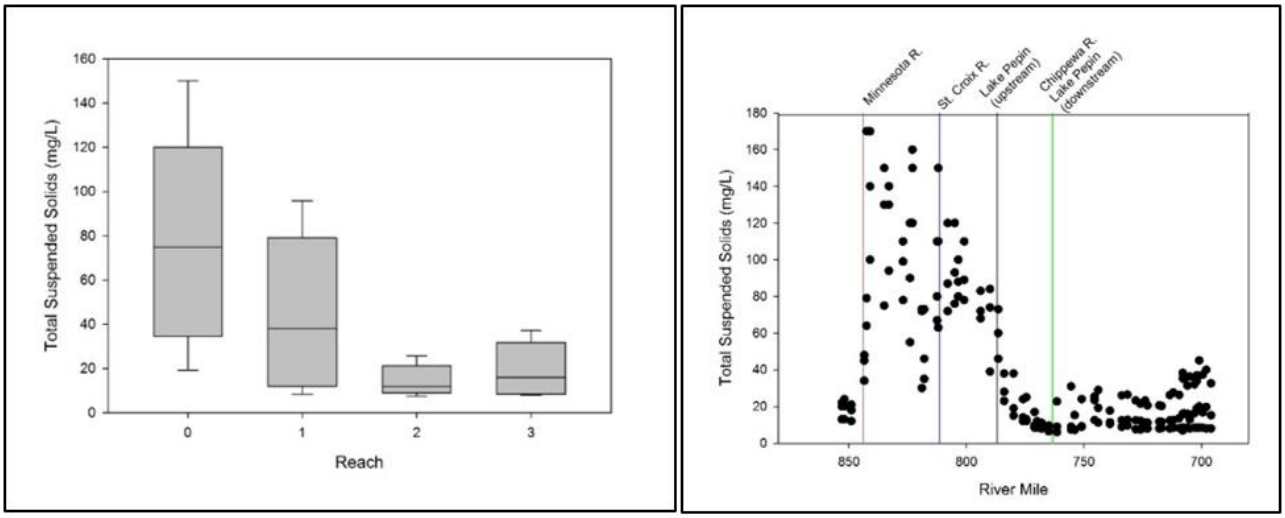
Table 2.7: Determining Aquatic Life Condition Class Using TSS UMR

Source of data	Segment of River	Condition Class		
		Good	**Fair**	**Poor**
Fixed Station Monitoring annual median (n=5) ***and*** monthly median from Probabilistic Monitoring sampling (July-September) in one year of the five-year assessment period (n=3). Value will be calculated as the median of the pooled fixed and probabilistic values (n=8).	Above Lake Pepin	Overall summer median ≤ 32 mg/l.	Overall summer median > 32 mg/l but ≤ 40 mg/l.	Overall summer median > 40 mg/l
	Below Lake Pepin (i.e., below confluence with Chippewa River) to L&D 13	Overall summer median ≤ 16 mg/l.	Overall summer median > 16 mg/l but ≤ 30 mg/l.	Overall summer median > 30 mg/l

TSS medians varied among reaches and months sampled (Table 2.8). Probabilistic TSS monitoring results for the longitudinal extent of the Pilot illustrate the impact of the Minnesota River on increasing TSS concentrations just downstream of river mile 844 (Figure 2.7). The St. Croix River and Lake Pepin (upstream of the Chippewa River) dilute and trap TSS. Downstream of Lake Pepin, TSS concentrations begin to gradually increase as additional, turbid tributaries empty into the UMR (Figure 2.8).

Table 2.8: Pooled Median TSS Values for the Pilot Reaches (results in mg/l)

Reach	Fixed Site Median	July Probabilistic Median	August Probabilistic Median	September Probabilistic Median	Pooled Median	Condition Class
0	48.5	76	79	72	74	**Poor**
1	33.5	39	26.5	55.5	36.3	**Fair**
2	15.5	9.6	20.2	11.2	13.4	**Good**
3	19.2	8.3	34.9	16.2	17.7	**Fair**



Figures 2.7 and 2.8: TSS Results from Probabilistic Monitoring (July-September 2016) by River Mile and Reach (S. Giblin, Wisconsin DNR). The box and whisker plot (left figure) displays the median (horizontal line within the box) and the 25th and 75th percentiles of the results (boundaries of the box).

All of the individual components as delineated in the *Provisional Methodology* were considered in determining the overall aquatic life use condition class for an individual reach. The dual assemblage evaluation was the primary component of the aquatic life use assessment, and the supplemental components (SAV, TSS) were also considered in making an overall determination. In some cases, there was not agreement among all the indicator groups. This was anticipated and is common among assessments that include multiple biological assemblages.

The Pilot project team considered all available information in deciding overall condition class (Table 2.9). The determinations are based on just one sampling season and should be considered more of a test outcome from the methodology than a definitive statement of condition.

Table 2.9: Summary of Aquatic Life Condition Indicators and Determination of Overall Condition

Reach	Overall Aquatic Life Use Condition	Dual Assemblage*	Vegetation**	TSS**
0	**Fair**	Percentage of sites meeting assessment thresholds = 88%	Twin Cities Reach *0*† Reach Score = 7 Below threshold (44)‡ Twin Cities *0A* Reach Reach Score = 21 Below threshold (44)	Pooled mean = 74 mg/L Above threshold (40)
		Provisional condition class = **Good**	Provisional condition class = **Poor**	Provisional condition class = **Poor**
1	**Good**	Percentage of sites meeting assessment threshold = 100%	Reach Score = 50 Above threshold (44)	Pooled mean = 36.25 mg/L Between threshold (32-40)
		Provisional condition class = **Good**	Provisional condition class = **Good**	Provisional condition class = **Fair**
2	**Good**	Percentage of sites meeting assessment thresholds = 88%	Reach Score = 84 Above threshold (44)	Pooled mean = 13.35 mg/L Below threshold (16)
		Provisional condition class = **Good**	Provisional condition class = **Good**	Provisional condition class = **Good**
3	**Good**	Percentage of sites meeting assessment thresholds = 82%	Reach Score = 79 Above threshold (44)	Pooled mean = 17.7 mg/L Between threshold (16-30)
		Provisional condition class = **Good**	Provisional condition class = **Good**	Provisional condition class = **Fair**

* The site based and reach assessment, per the provisional UMR CWA methodology, incorporates both fish and macroinvertebrate scores.

** The provisional UMR CWA assessment characterizes vegetation scores and TSS results as supplemental in the assessment. Note that thresholds are different above and below Lake Pepin.

† Vegetation monitoring split Reach 0 into "*0*" and "*0A*" reaches.

‡ Unlike other indicators, a good/fair/poor class based on % of miles (sites) above threshold has not been confirmed as the preferred approach for vegetation. Shown here is a recommendation based on two potential methods of determining status. See Section 2.4.1 for further discussion.

Recreation Use Condition

The goal of recreation use monitoring is to assess the relative water quality condition for primary contact recreation use e.g., swimming. This assessment is based on the results of monitoring for two indicators, bacteria (*E. coli*) as an indicator of potential presence of pathogens and chlorophyll-*a* as an indicator of algal abundance. These indicators affect the aesthetic appeal of contact recreation as well as the potential presence of cyanobacteria, which can present public health concerns if cyanotoxins are produced.

Per the *Provisional UMR CWA Assessment Methodology*, results of both fixed site and probabilistic site sampling are incorporated into the assessment (Table 3.1; UMRBA, 2016). The value of 35 ug/l chlorophyll-α is equivalent to MPCA's riverine eutrophication standard applicable to UMR pools. Lake Pepin has a separate site-specific standard of 28 ug/l.

Table 3.1: Methods for Assessing UMR CWA Reach-Level Recreation Use Condition Classes

Source of Data	Good	Fair	Poor
Fixed Station Monitoring during recreation season with monthly sampling over 5 years	Overall *E. coli* geometric mean ≤ 126 cfu/100 ml & < 10% of samples exceed STV* (410 cfu/100 ml) and the overall average chlorophyll-*a* level is less than 35 ug/l	Overall *E. coli* geometric mean ≤ 126 cfu/100 ml but significantly >10% of samples exceed STV (410 cfu/100 ml)** or the overall average chlorophyll-*a* level is between 35 and 60 ug/l	Overall *E. coli* geometric mean > 126 cfu/100 ml or the overall average chlorophyll-*a* level is 60 ug/l or greater
Probabilistic Station Monitoring during recreation season at 15 sites sampled 3 times in 1 of 5 years	On average over the three rounds of sampling/year, the percentage of probabilistic samples exceeding the STV (410 cfu/100 ml) is not significantly > 10% and the overall average of chlorophyll-*a* for all three rounds of probabilistic samples is less than 35 ug/l	On average over the three rounds of sampling in 1 of 5 years, significantly > 10% exceed the STV (410 cfu/100 ml), or the overall average level of chlorophyll-*a* of the probabilistic samples is 35 ug/l or greater for any of the three rounds of sampling	*Category not used with results of probabilistic monitoring.****
Overall Condition Class	***Fixed station E. coli geometric mean ≤ 126 cfu/100 ml & < 10% of samples exceed STV (410 cfu/100 ml), and average percentage of probabilistic samples exceeding the STV is not significantly > 10%, and the overall average level of chlorophyll-a is less than 35 ug/l***	***Fixed station E. coli geometric mean < 126 cfu/100 ml but significantly > 10% of samples exceed STV (410 cfu/100 ml) or average percentage of probabilistic samples exceeding the STV is significantly > 10% or the overall average chlorophyll-a level is between 35 and 60 ug/l***	***Fixed station E. coli geometric mean > 126 cfu/100 or the overall average chlorophyll-a level is 60 ug/l or greater***

*Statistical Threshold Value (STV) according to the USEPA "approximates the 90th percentile of the water quality distribution and is intended to be a value that should not be exceed by more than 10 percent of the samples taken (USEPA, 2012)
**From Appendix 2 of Provisional Methodology for Clean Water Act Assessment of the Upper Mississippi River- July 2015
*** From Table 9 of Provisional Methodology for Clean Water Act Assessment of the Upper Mississippi River – July 2015

The geometric mean of fixed station *E. coli* results for the recreation season (April-October) was calculated for each reach and compared to the threshold value of 126 colony forming units (cfu)/100 ml. The percentage of these samples exceeding the statistical threshold value (STV) 410 cfu/100 ml was analyzed from the three probabilistic sampling events. For all reaches, both fixed station and probabilistic monitoring results were below the geometric mean threshold and STV exceedance percentage. A few cases had more than 10 percent of values above the STV with none significantly greater than 10 percent

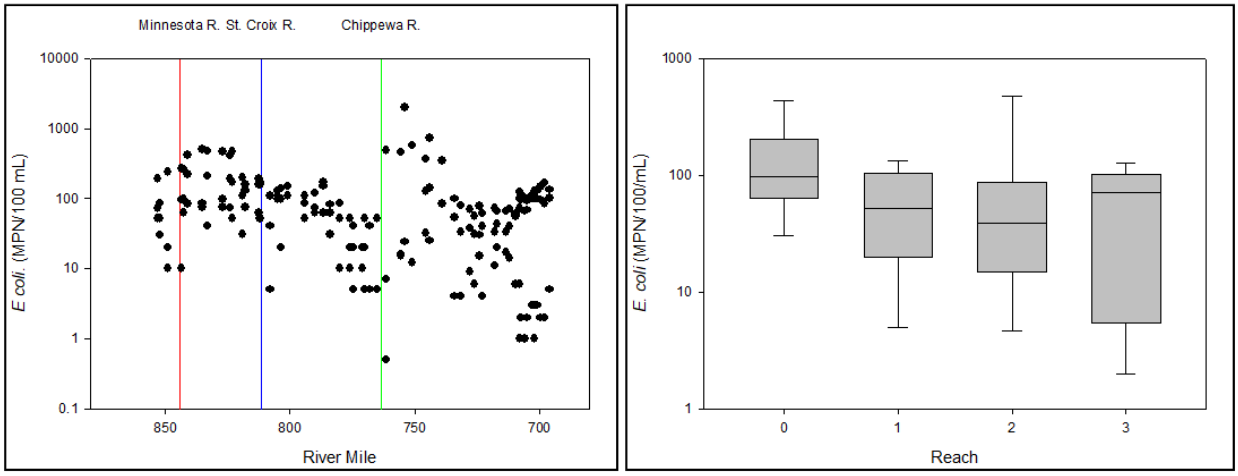
(Table 3.2.). *E. coli* results across the Pilot reaches were expressed as the most probable number (mpn) of cells (Figures 3.1 and 3.2). No distinct spatial trends were apparent in these results (Figures 3.1 and 3.2).

Table 3.2: Results of Recreation Use Condition Assessment

Reach	Overall Condition Class	Fixed Station Results	Probabilistic Results
0	**Good**	*E. coli* geometric mean = **54.14** % of samples exceeding STV = 0%	% of samples exceeding STV = 12%*
		Chl-*a* level average = **30.14 ug/l**	Chl-*a* level average = **16.25 ug/l**
		Provisional condition class = **Good**	Provisional condition class = **Good**
1	**Good**	*E. coli* geometric mean = **24.24** % of samples exceeding STV = 0%	% of samples exceeding STV = 0%
		Chl-*a* level average = **27.57 ug/l**	Chl-*a* level average = **13.93 ug/l**
		Provisional condition class = **Good**	Provisional condition class = **Good**
2	**Good**	*E. coli* geometric mean = **36.12** % of samples exceeding STV = 0%	% of samples exceeding STV = 12.7%*
		Chl-*a* level average = **18.71 ug/l**	Chl-*a* level average = **20.08 ug/l**
		Provisional condition class = **Good**	Provisional condition class = **Good**
3	**Good**	*E. coli* geometric mean = **40.25** % of samples exceeding STV = 14.28%**	% of samples exceeding STV = 0%
		Chl-*a* level average = **14.68 ug/l**	Chl-*a* level average = **20 ug/l**
		Provisional condition class = **Good**	Provisional condition class = **Good**

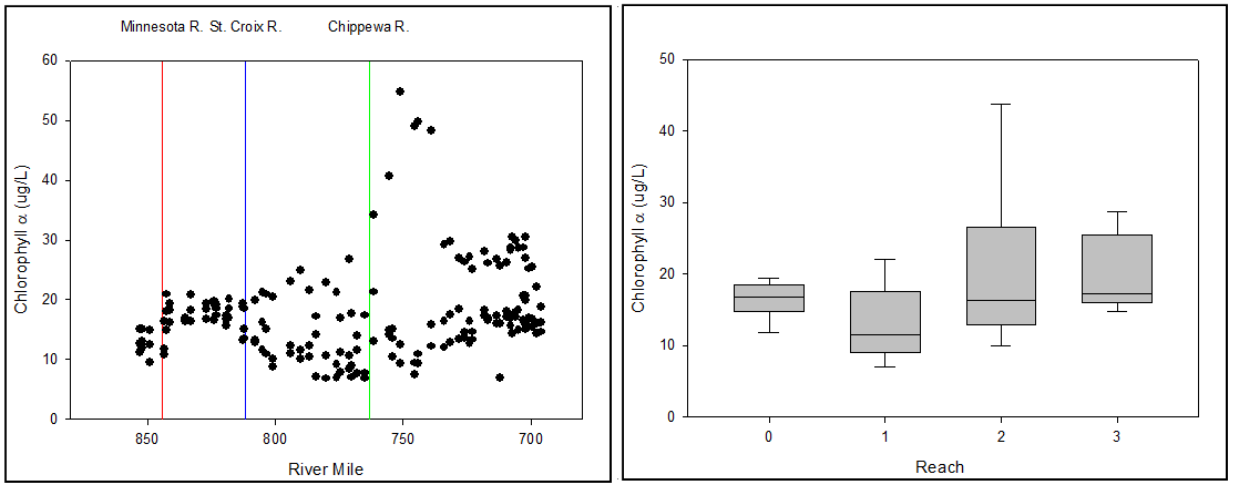
* Not significantly greater than 10%, see Appendix 2 of Provisional UMR CWA Assessment Methodology.

** Sample size is less than 10 (n=7). Not great enough to determine confidence level.



Figures 3.1 and 3.2: E. coli Results by River Mile and Reach (S. Giblin, Wisconsin DNR). The box and whisker plot (right figure) displays the median (horizontal line within the box) and the 25th and 75th percentiles of the results (boundaries of the box).

For each reach, the average chlorophyll-*a* results were calculated for both fixed station and probabilistic monitoring during the recreation season. All averages calculated fell below 35 ug/l, the highest threshold value for a reach to remain in the "good" condition class (Figures 3.3 and 3.4). Using the combined assessment of both *E. coli* and chlorophyll-*a*, the overall condition assessment for Reaches 0-3 was "good" (Table 3.2).



Figures 3.3 and 3.4: Chlorophyll-α Results by River Mile and Reach (S. Giblin, WIDNR). The box and whisker plot (right figure) displays the median (horizontal line within the box) and the 25th and 75th percentiles of the results (boundaries of the box).

Given the considerable spatial and temporal variability in levels of indicator bacteria in rivers and the timing of the assessment, the assessment of relative water quality condition in a UMR assessment reach is designed to be a long-term characterization and should not be interpreted as a recommendation on the short-term safety of the assessment reach for primary contact recreation. Furthermore, the recreation season in 2016 was affected by high discharge and this likely impacted *E. coli* concentrations and reduced the production of algae, resulting in low chlorophyll-α values.

Fish Consumption Use Condition

The UMR CWA Recommended Monitoring Plan includes fish tissue sampling to determine fish consumption advisories. An alternative assessment method, according to the *Provisional Methodology*, is to reference existing state-issued fish consumption advisories. The Pilot project team elected to drop fish tissue sampling to reduce cost, avoid a high number of fish takes, and eliminate unnecessary challenges with integrating the results into existing fish consumption advisories. Condition classes are based on the most restrictive advisory effective within a respective reach i.e., children under 15 and women who are or may become pregnant. A "good" value has an advisory allowing for one fish meal per week, "fair" has an advisory suggesting only one meal per month for any species, and "poor" has an advisory to not eat any fish species (Table 4.1). Existing fish consumption advisories were found on the Minnesota Department of Health and Wisconsin Department of Natural Resource websites.

Table 4.1: Fish Consumption Condition Classes Based on Fish Consumption Advisories

Reach	Condition Class	Most Restrictive Advisory in Place on Reach
0	**Fair**	MN – 1 meal/month *(multiple species in Pools 1 and 2 due to mercury, PCBs, and PFOS)* WI- Not applicable
1	**Fair**	MN – 1 meal/month *(multiple species in Pools 3 and 4 due to mercury, PCBs, and PFOS)* WI – 1 meal/month *(multiple species in Pools 3 and 4 due to mercury, PCBs, and PFOS)*
2	**Fair**	MN – 1 meal/month *(multiple species in Pools 4, 5, 5a and 6 due to mercury, PCBs, and PFOS)* WI – 1 meal/month *(multiple species in Pools 4, 5, 5a and 6 due to mercury, PCBs, and PFOS)*
3	**Fair**	MN – 1 meal/month *(multiple species in Pools 7 and 8 due to mercury and PCBs)* WI – 1 meal/month *(multiple species in Pools 7 and 8 due to mercury and PCBs)*

Summary of Condition Classes

Perhaps the most important takeaway from the Pilot is that the collaborative approach to UMR CWA monitoring and assessment can produce a shared characterization of condition across use types (Table 5.1). The outcomes presented here must be considered in light of the limited time frame of the Pilot and the atypical conditions (i.e., high flows) under which most of the data were collected. This Pilot was not intended as a replacement for 303(d)/305(b) assessments. However, states can choose to integrate the Pilot results into their CWA assessment process. Note that drinking water use consumption, typically considered one of the major use categories in CWA assessments, was not evaluated under the Pilot as there are no drinking water intakes in the study area.

Table 5.1: Summarized Condition Class Across All Uses

Reach	Recreation	Aquatic Life				Fish Consumption
	E. coli & Chlorophyll-a	Dual Assemblage (Fish & Macroinverts)	Vegetation	TSS	*Overall Aquatic Life*	Advisory-Based
0	Good	Good	Poor	Poor	Fair	Fair
1	Good	Good	Good	Fair	Good	Fair
2	Good	Good	Good	Good	Good	Fair
3	Good	Good	Good	Fair	Good	Fair

Next Steps for UMR CWA Condition Assessment

This *Water Quality Condition Assessment* provided the first test of the *UMR Provisional Methodology* and *UMR Recommended Monitoring Plan*. The UMRBA Water Quality Task Force and the MN-WI Pilot project team reviewed the outcomes of this condition assessment to formulate recommendations for any modifications to the assessment methodology and/or UMR CWA monitoring. Potential modifications are discussed in the companion report to this document, the *Pilot Project Evaluation Report*.

Acronyms Used

BCG – Biological Condition Gradient

EMAP-GRE – Environmental Monitoring and Assessment Program-Great Rivers Ecosystems

GRFIn – Great River Fish Index

LTRM – Long Term Resource Monitoring

MDH – Minnesota Department of Health

MPCA – Minnesota Pollution Control Agency

SAV – Submersed Aquatic Vegetation

SMI – Submersed Macrophyte Index

STV – Statistical Threshold Value

TSS – Total Suspended Solids

UMR CWA – Upper Mississippi River Clean Water Act

UMRBA – Upper Mississippi River Basin Association

UMRR – Upper Mississippi River Restoration Program

USACE – United States Army Corps of Engineers

USEPA – United States Environmental Protection Agency

USGS – United States Geological Survey

WI DNR – Wisconsin Department of Natural Resources

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