Missouri River Water Quality Report 2017 for the Upper Missouri River, MT

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Executive Summary

In 2016, The Upper Missouri Watershed Alliance (hereafter referred to as UMOWA) began collecting water quality data at seven sites on the Upper Missouri River between Wolf Creek and Cascade. These sites were chosen to coincide with preexisting sites that were established for the sampling of macroinvertebrates by Montana Biological Survey in 2015. This was the second year that water quality samples were collected. Samples were collected in July and October of 2017. High water during the spring of 2017 prevented the collection of April samples.

The goals of the water sampling project are: 1) to establish baseline water quality data as it may affect benthic macroinvertebrate and plant communities and 2) collect baseline information about total suspended and dissolved solids and nutrients to allow for spatial and temporal comparisons of water quality in the Upper Missouri River. In 2016, samples were analyzed for recoverable metals. In 2017, this analysis was eliminated for financial reasons and because these materials were recovered at very low levels in 2016 suggesting that under current conditions, they pose no immediate threat to the Missouri River.

The water quality data collected in 2017 reinforced the seasonal and spatial trends observed in 2016 and allowed a year-to-year comparison between 2016 and 2017.

Overall, nutrient concentrations were higher in 2017 than 2016. The increase was most apparent during October. During October of 2017, five sites (LPPC US, Craig, Dearborn US, Dearborn DS, and Hardy Creek) exceeded the recommended screening value for inorganic nitrogen concentrations, the numeric nutrient standard for total nitrogen, and (with the addition of the Cascade site) the numeric nutrient standard for total phosphorus. In 2016, no sites during any season exceeded the numeric nutrient standards or screening values set by the Montana Department of Environmental Quality (hereafter referred to as MDEQ).

Therefore, during the fall period of 2017, nutrient levels within the Missouri River exceeded the recommended levels set by MDEQ. This is cause for concern. It is possible that high nutrient levels are the biggest threat that the Upper Missouri River is facing at present. It is critical that UMOWA continue to monitor water quality in 2018 to see if nutrient concentrations remain at threatening levels.

1.0 Introduction

The 2.84 mile reach of the Missouri River from Holter Dam to Little Prickly Pear Creek is listed as impaired by the Montana Department of Environmental Quality for aquatic life due to increased total nitrogen concentrations due to grazing in riparian zones, flow regime alterations from municipal point source discharges, increased total phosphorus concentrations due to natural sources, and sedimentation/siltation caused by on-site treatment systems (septic systems) and upstream impoundments (MDEQ 2016). The 20.93 mile reach of the Missouri River from Little Prickly Pear Creek to Sheep Creek is listed as impaired for aquatic life due to increased arsenic concentrations due to grazing in riparian zones, increased total nitrogen concentrations due to impacts from hydrostructure flow regulation/modification, and sedimentation/siltation caused by irrigated crop production and natural sources (MDEQ 2016).

In 2016, the Aquatic Resources Committee of UMOWA determined to fund the collection of water quality data on a periodic and consistent basis to monitor the health of the Upper Missouri River between Holter Dam and Cascade. Samples were collected concurrently with macroinvertebrate samples being collected by Montana Biological Survey (Stagliano, 2015) to determine if any correlation exists between water chemistry and aquatic insect community structure. The overall goals of the project were to 1) establish baseline water quality data as it may affect benthic macroinvertebrate and plant communities, and 2) collect baseline information about total suspended/dissolved solids and nutrient and metal concentrations to allow for spatial and temporal comparisons of water quality. In 2017, analysis of metal concentrations was eliminated from the project goals. The 2017 study focused on nutrient concentrations as well as total suspended/dissolved solids concentrations.

2.0 Methods

2.1 Sample Site Selection

Water quality samples were collected from seven sites between Wolf Creek and the town of Cascade. The sites coincided with the sites that have been sampled for macroinvertebrates by Montana Biological Survey for UMOWA since 2015. The sites were chosen to be spatially representative of the entire upper Missouri River. The sites capture the influence of the three major tributaries (Little Prickly Pear Creek, the Dearborn River, and Sheep Creek) upon water quality.

Station ID	Site Name	Latitude	Longitude
MO_LPPC_US	**MISSOURI RIVER U/S LITTLE PRICKLY PEAR**	**47.02281**	**-112.01527**
MO_LPPC_DS	**MISSOURI RIVER D/S LITTLE PRICKLY PEAR**	**47.02345**	**-112.01523**
MO_CRAIG	**MISSOURI RIVER U/S CRAIG**	**47.05415**	**-111.96701**
MO_DEAR_US	**MISSOURI RIVER U/S DEARBORN**	**47.12819**	**-111.91174**
MO_DEAR_DS	**MISSOURI RIVER D/S DEARBORN**	**47.12791**	**-111.9109**
MO_HARDY	**MISSOURI RIVER U/S OF SHEEP CREEK (HARDY BR.)**	**47.16781**	**-111.83366**
MO_CASCADE	**MISSOURI RIVER AT CASCADE FAS**	**47.28062**	**-111.69113**

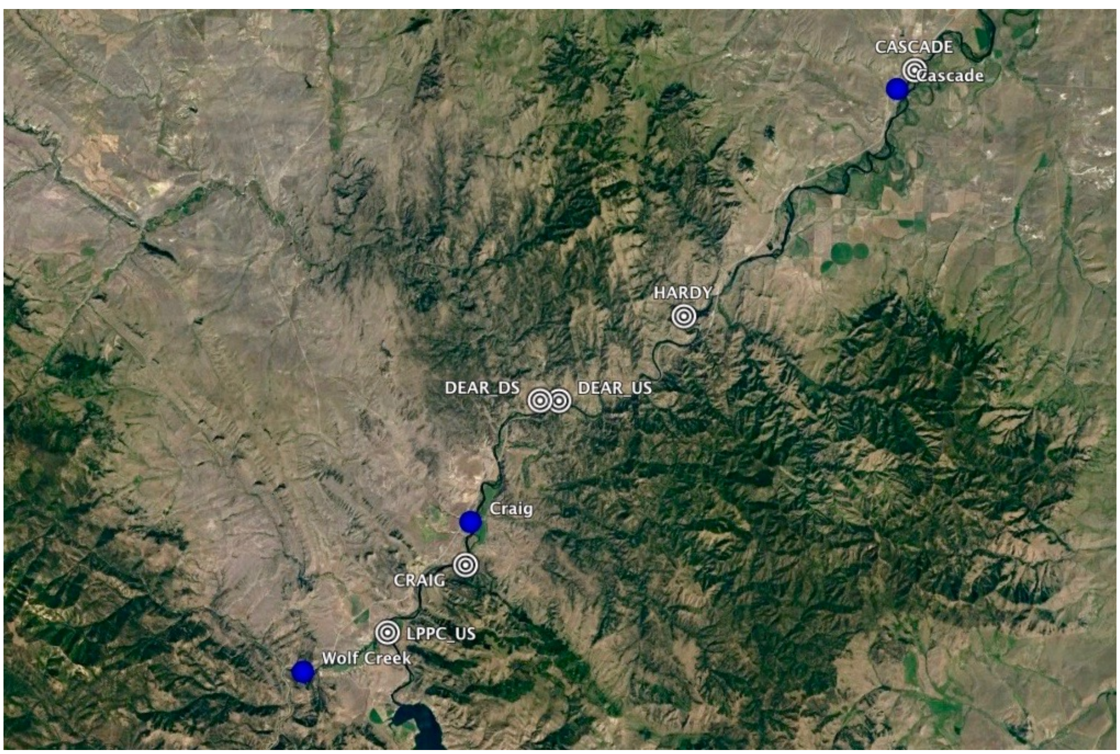


Figure 1 Sample sites are denoted by bull's-eyes.

2.2 Sample Timing

Samples were collected seasonally in order to examine temporal changes in water quality throughout the year. In 2017, samples were collected in July and October. High water during the spring prevented the collection of April samples.

Summer samples were collected July 13th. These samples captured base-flow water quality during the summer growing season. Fall samples were collected October 1st. These samples captured base-flow water quality following the summer growing season. The image below shows flows recorded at Holter Dam throughout 2017. The red arrows represent water quality sampling dates.

Figure 2 Red arrows represent sampling dates.

2.3 Water Sampling Methods

Water quality samples were collected in sterilized bottles provided by Energy Laboratories Inc. At the time of sample collection, each bottle and lid were triple-rinsed with ambient river water prior to collecting the final sample. Total nitrogen samples were collected in 250 mL HDPE bottles and kept on ice until analyzed. Total phosphorus and inorganic nitrogen (nitrate and nitrite) samples were collected in 250 mL HDPE bottles, preserved with sulfuric acid, and kept on ice until analyzed. Total suspended solids and total dissolved solids samples were collected in 1000 mL HDPE bottles and kept on ice until analyzed. All water samples were submitted to Energy Laboratories Inc. within 48 hours of collection.

2.4 Quality Assurance – Field Blanks and Duplicates

During each seasonal sampling, one field duplicate and one field blank set of samples were collected to ensure the quality of the sampling procedure and the accuracy of the lab analysis.

Field duplicates consist of an extra set of sample bottles filled with the same water from the same sampling site. Field duplicates were collected, handled, and stored in the same way as the routine samples for laboratory shipment. In theory, a duplicate sample should yield results identical to the other sample taken at the same site at the same time. Collecting and analyzing duplicate samples ensures that the sampling and analysis process is consistently accurate.

Field blanks consist of an extra set of sample bottles filled with deionized (DI) water and transported with the other samples in the field. Field blanks were prepared in the field at the same time as the routine samples and handled and analyzed in the same way as the routine samples. In theory, field blank samples should be clean of all contaminants. Collecting and analyzing field blank samples ensures that the sampling and analysis processes are free of contaminants.

2.5 Water Quality Analysis

Energy Laboratories Inc. in Helena, MT analyzed all water quality data. Energy Laboratories Inc. routinely processes samples for MDEQ and has been proven to produce data of very high accuracy and consistency.

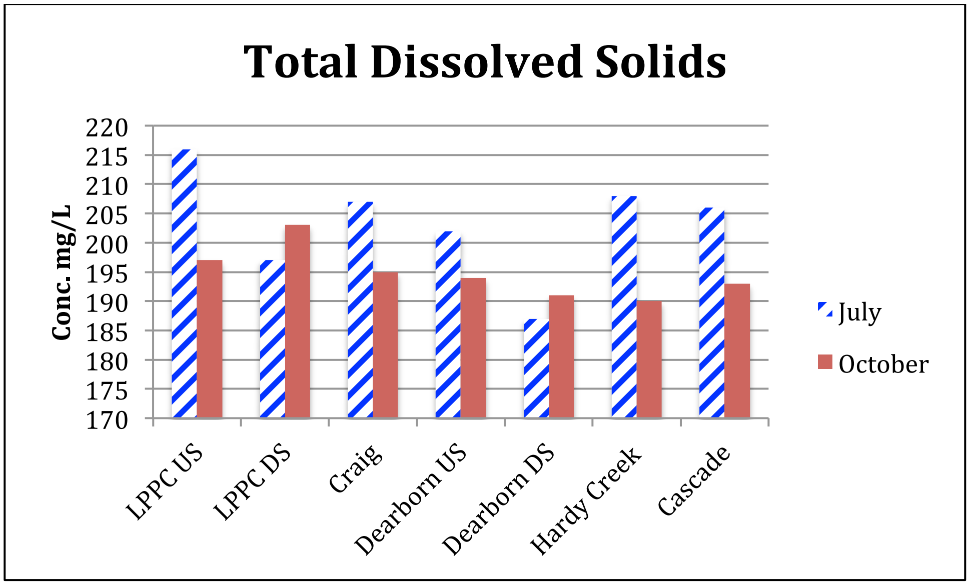
3.0 Results for 2017

Whenever possible, results were interpreted relative to established MDEQ numeric standards. MDEQ has established these numeric water quality criteria in effort to control excessive pollution in Montana's rivers, lakes, and streams. MDEQ Circular 12A (MDEQ, 2014) provided base numeric nutrient standards of 0.3 mg/L for total nitrogen concentrations and 0.03 mg/L for total phosphorus concentrations. The screening value of 0.1 mg/L for inorganic nitrogen concentrations was provided via personal communication with MDEQ staff. Where applicable, screening values and numeric nutrient standards are represented as dark horizontal lines on the graphs below. A numerical table of all 2016 and 2017 results can be found in Appendix A.

It should be noted that the field blank sample collected in October yielded an inorganic nitrogen concentration of 0.03 mg/L. This means that inorganic nitrogen values reported for October 2017 may be artificially high.

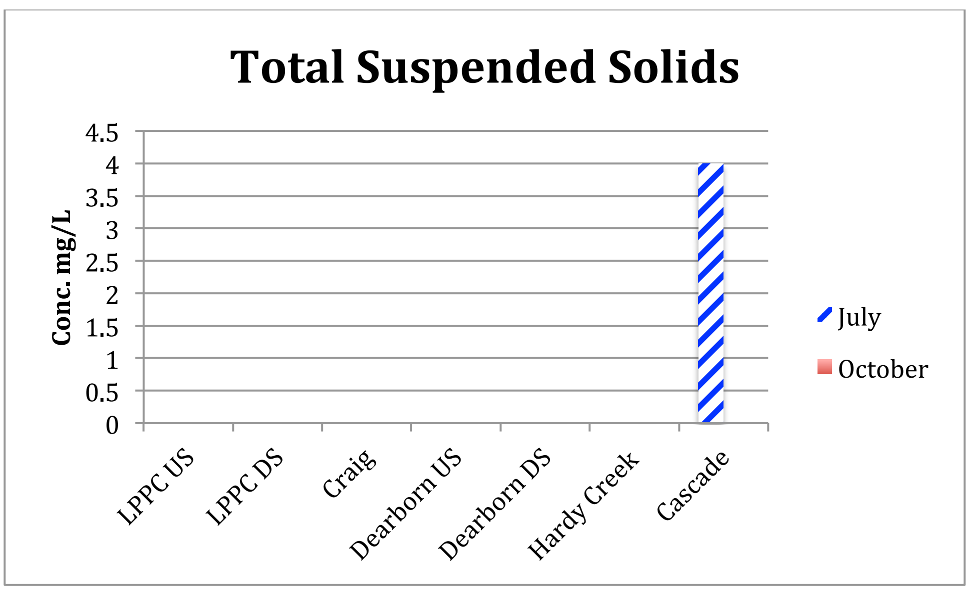
3.1 Total Dissolved Solids

Total Dissolved solids (TDS) concentrations ranged between 187 and 216 mg/L.



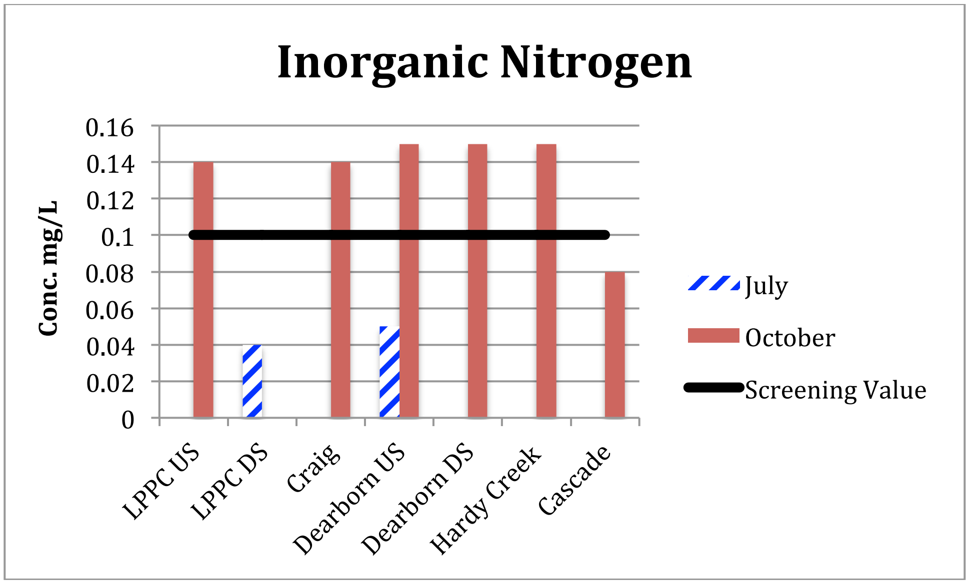
3.2 Total Suspended Solids

Total suspended solids (TSS) concentrations ranged between 0 and 4 mg/L.



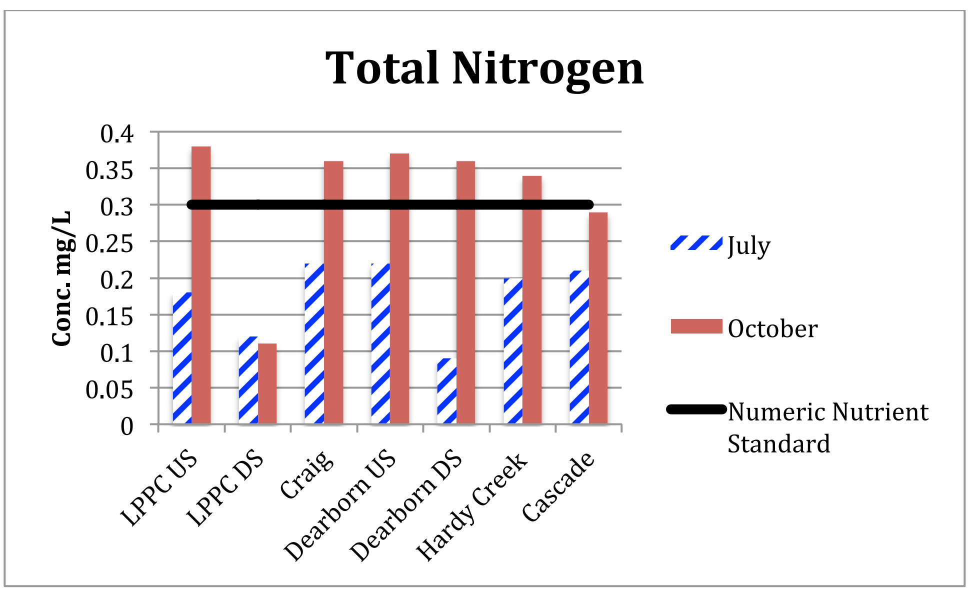
3.3 Inorganic Nitrogen

Inorganic nitrogen concentrations ranged between 0 and 0.15 mg/L.



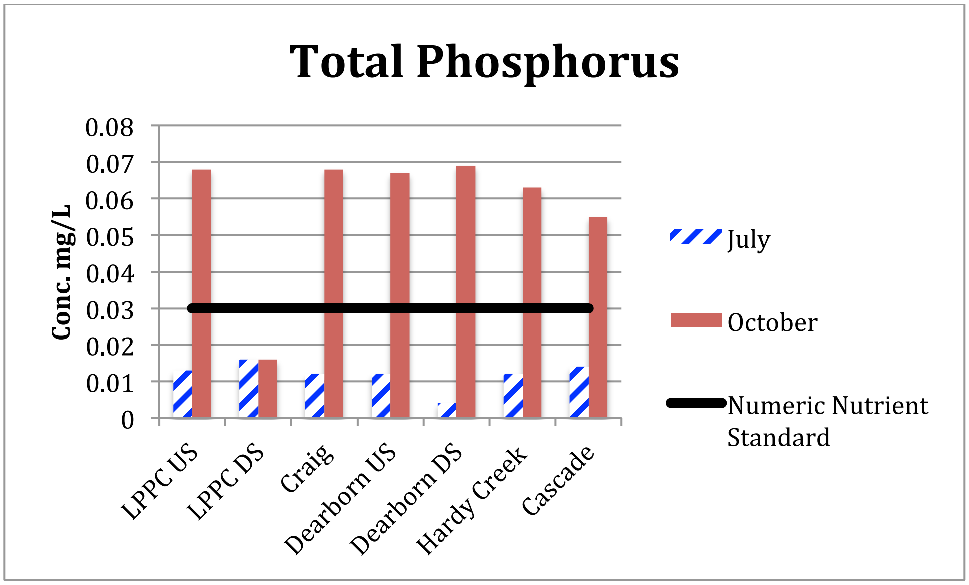
3.4 Total Nitrogen

Total nitrogen concentrations ranged between 0.09 and 0.38 mg/L.



3.5 Total Phosphorus

Total phosphorus concentrations ranged between 0.004 and 0.069 mg/L.



4.0 Discussion

4.1 Spatial Trends

When comparing upstream sites to downstream sites, no strong trends were observed for any of the measured substances with one notable exception. During October, the LPPC DS site yielded anomalously low nutrient concentrations. Concentrations of all three nutrients measured (inorganic nitrogen, total nitrogen, and total phosphorus) were much lower at this site than elsewhere during the same time period. This suggests that the discharge from Little Prickly Pear Creek is creating a localized reduction in nutrient levels downstream of its outlet during the fall period.

4.2 Seasonal Trends

Total dissolved solids (TDS) concentrations were higher in July than in October for five of the seven sites. The elevated concentration of TDS observed in July is likely caused by reduced discharge and more concentrated surface water following spring runoff. TDS values measured with a hand-held Oakton meter during June high-flows of 2017 ranged from 150-165 mg/L (Stagliano 2017). It is unclear to what extent natural and anthropogenic sources (runoff, fertilizers, and pesticides) are contributing to TDS concentrations.

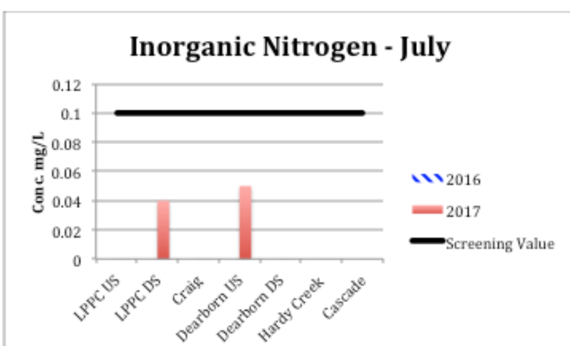
Overall, nutrient levels were greater in October than July. Inorganic nitrogen, total nitrogen, and total phosphorus concentrations increased between July and October for six of the seven sites (the one exception was the LPPC DS site as described in 4.1).

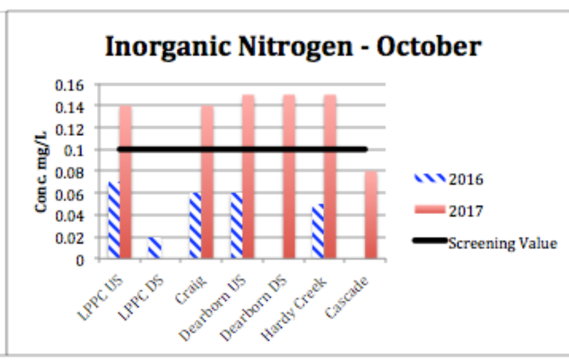
4.3 Yearly Trends

Total dissolved solids concentrations were not consistently collected in 2016 so a yearly comparison cannot be made.

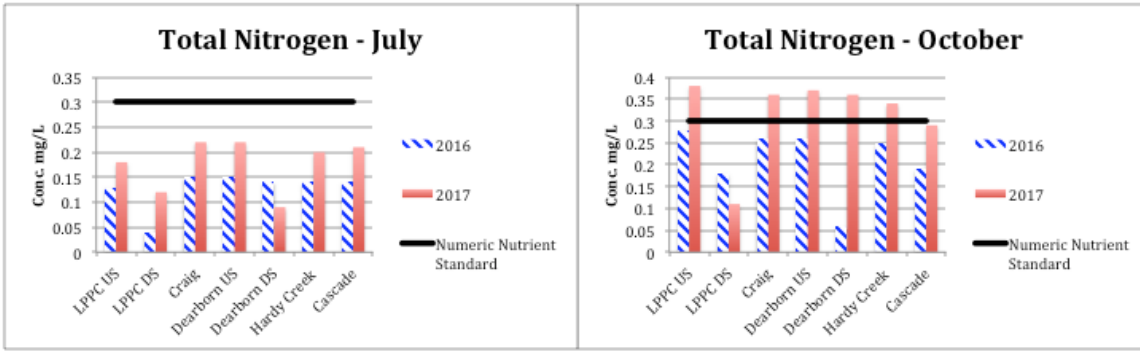
Total suspended solids concentrations were similar between 2016 and 2017. The concentration was zero at all sites in July and October except the Cascade site, which exhibited low concentrations during July of both years.

During the summer period, inorganic nitrogen concentrations were greater in 2017 than 2016 for two of the seven sites but all remained below the recommended screening value. During the fall period, inorganic nitrogen concentrations were greater in 2017 than 2016 for six of the seven sites, five of which exceeded MDEQ's screening value (LPPC US, Craig, Dearborn US, Dearborn DS, and Hardy Creek). As mentioned in section 3.0, it is possible that inorganic nitrogen concentrations reported for the October sampling period of 2017 are artificially high. The field blank collected for this sampling period yielded an inorganic nitrogen concentration of 0.03 mg/L. Even if the reported result magnitudes for October 2017 were decreased by this amount (0.03 mg/L) as a correction, the inorganic nitrogen concentrations at five of the eight sites would still exceed the screening value for this sampling period.

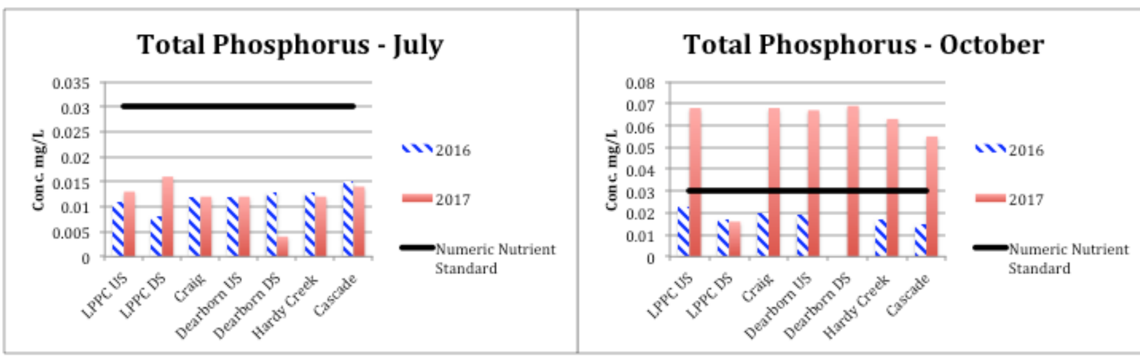




During the summer period, total nitrogen concentrations were greater in 2017 than 2016 for six of the seven sites but all remained below the numeric nutrient standard. During the fall period, total nitrogen concentrations were greater in 2017 than 2016 for six of the seven sites, five of which exceeded the numeric nutrient standard (LPPC US, Craig, Dearborn US, Dearborn DS, and Hardy Creek).



During the summer period, total phosphorus concentrations remained similar between 2016 and 2017 at most of the sites. All 2016 and 2017 total phosphorus concentrations recorded in July were below the numeric nutrient standard. During the fall period, total phosphorus concentrations were greater in 2017 than 2016 for six of the seven sites, six of which exceeded the numeric nutrient standard (LPPC US, Craig, Dearborn US, Dearborn DS, Hardy Creek, and Cascade).



5.0 Conclusion

This study has established a comprehensive baseline of the water quality of the upper Missouri River for two years, 2016 and 2017. This study has uncovered several spatial and temporal trends. The primary trend observed between 2016 and 2017 is an increase in inorganic nitrogen, total nitrogen, and total phosphorus concentrations during the fall period.

During October of 2017, five of seven sites exceeded the recommended screening value for inorganic nitrogen concentrations, five of seven sites exceeded the numeric nutrient standard for total nitrogen concentrations, and six of seven sites exceeded the numeric nutrient standard for total phosphorus concentrations. In the two years of this study, these are the first observed instances of nutrient concentrations exceeding the numeric nutrient standards and screening values set by MDEQ.

This means that during the fall period of 2017, nutrient levels within the Missouri River exceeded the recommended levels set by MDEQ. These elevated nutrient levels contribute to excessive growth of aquatic plants and algae. This is cause for concern. It is possible that high nutrient levels are the biggest threat that the Upper Missouri River is facing at present. It is critical that UMOWA continue to monitor water quality in 2018 to see if nutrient concentrations remain at threatening levels.

Appendix A: Yearly water quality data for 2016 and 2017

Sample Site	Year	Sample Time	TSS (mg/L)	TDS (mg/L)	Inorganic Nitrogen (mg/L)	Total Nitrogen (mg/L)	Total Phosphorus (mg/L)
LPPC US	2016	April	0	NA	0	0.24	0.014
LPPC DS	2016	April	14	NA	0.05	0.23	0.02
Craig	2016	April	4	NA	0	0.22	0.016
Dearborn US	2016	April	4	NA	0	0.22	0.018
Dearborn DS	2016	April	7	NA	0	0.09	0.01
Hardy Creek	2016	April	5	NA	0	0.23	0.021
Cascade	2016	April	8	NA	0	0.26	0.019
LPPC US	2016	July	0	NA	0	0.13	0.011
LPPC DS	2016	July	0	NA	0	0.04	0.008
Craig	2016	July	0	NA	0	0.15	0.012
Dearborn US	2016	July	0	NA	0	0.15	0.012
Dearborn DS	2016	July	0	NA	0	0.14	0.013
Hardy Creek	2016	July	0	NA	0	0.14	0.013
Cascade	2016	July	5	NA	0	0.14	0.015
LPPC US	2016	October	0	NA	0.07	0.28	0.023
LPPC DS	2016	October	0	NA	0.02	0.18	0.017
Craig	2016	October	0	NA	0.06	0.26	0.02
Dearborn US	2016	October	0	NA	0.06	0.26	0.019
Dearborn DS	2016	October	0	NA	0	0.06	0
Hardy Creek	2016	October	0	NA	0.05	0.25	0.017
Cascade	2016	October	0	NA	0	0.19	0.015
LPPC US	2017	April	NA	NA	NA	NA	NA
LPPC DS	2017	April	NA	NA	NA	NA	NA
Craig	2017	April	NA	NA	NA	NA	NA
Dearborn US	2017	April	NA	NA	NA	NA	NA
Dearborn DS	2017	April	NA	NA	NA	NA	NA
Hardy Creek	2017	April	NA	NA	NA	NA	NA
Cascade	2017	April	NA	NA	NA	NA	NA
LPPC US	2017	July	0	216	0	0.18	0.013
LPPC DS	2017	July	0	197	0.04	0.12	0.016
Craig	2017	July	0	207	0	0.22	0.012
Dearborn US	2017	July	0	202	0.05	0.22	0.012
Dearborn DS	2017	July	0	187	0	0.09	0.004
Hardy Creek	2017	July	0	208	0	0.2	0.012
Cascade	2017	July	4	206	0	0.21	0.014
LPPC US	2017	October	0	197	0.14	0.38	0.068
LPPC DS	2017	October	0	203	0	0.11	0.016
Craig	2017	October	0	195	0.14	0.36	0.068
Dearborn US	2017	October	0	194	0.15	0.37	0.067
Dearborn DS	2017	October	0	191	0.15	0.36	0.069
Hardy Creek	2017	October	0	190	0.15	0.34	0.063
Cascade	2017	October	0	193	0.08	0.29	0.055

References

Appendix A: Impaired Waters. (2016). Available at: http://deq.mt.gov/Portals/112/Water/wqpb/CWAIC/Reports/IRs/2016/App_A.pdf

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