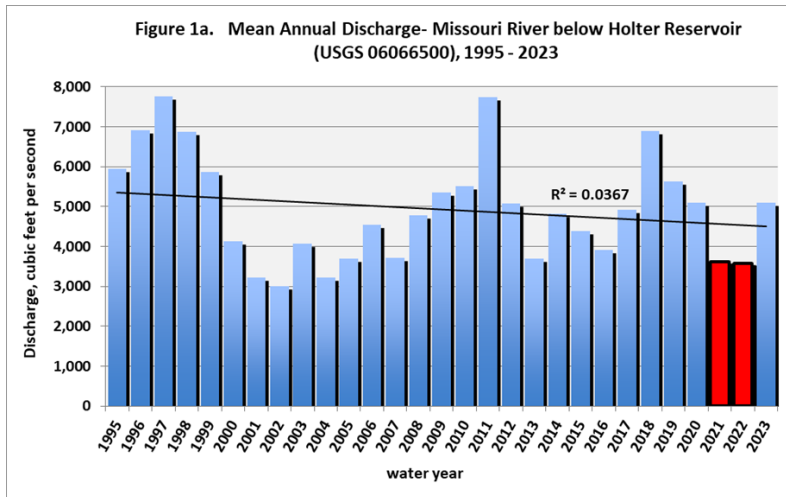


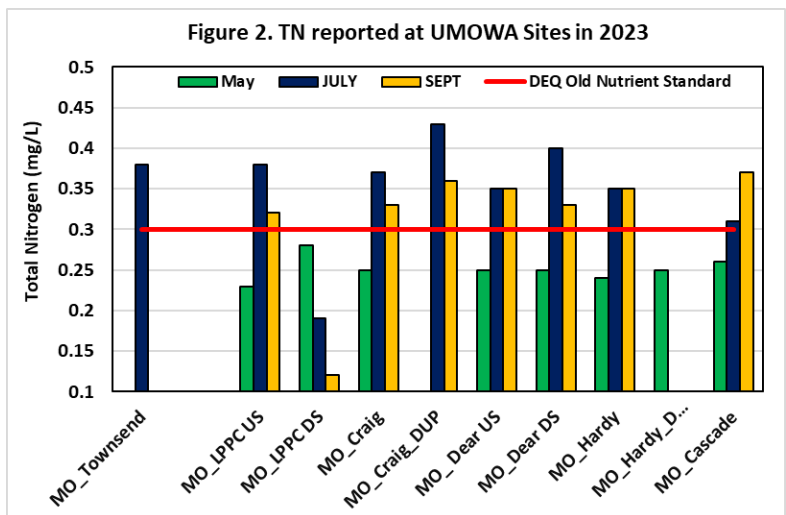
Tracking the Water Quality Pulse of the Upper Missouri River in 2023

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It doesn't take a scientist to know that there was a lot more 'water in the river' (streamflow) in 2023 compared to the last 2 years of low-flows (**Figure 1a, red bars on graph**); especially in June, when the Missouri River below Holter reached a peak streamflow of 15,300 cfs. Although we did not break any records and still have a slight declining trend when it comes to mean annual discharge over the last 29-years (**black line on graph**), water levels sure were nice compared to 2021 and 2022; two of the lowest discharges reported since 2013. Remember 2013, things in Montana sure seemed a little slower, less crazy, and a whole lot less crowded.



This past year, as we have since 2016, UMOWA collected water chemistry (WQ) samples in Spring, Summer and Fall at 7 sites from Wolf Creek to Cascade and, since 2021, at the Missouri River at Townsend. In 2023, nutrient levels, particularly total nitrogen (TN) in the summer and fall, have increased and exceeded the old DEQ nutrient standard downstream of Holter Dam compared 2021 and 2022 (**Figure 2, above red line**). The Missouri River upstream of Canyon Ferry has reported consistently high TN and oftentimes total phosphorus (TP) levels. Little Prickly Pear Creek may contribute some added TN in the spring but dilutes (decreases) TN levels in the adjacent Missouri River in the Summer and Fall (**Figure 2, MO_LPPC US vs. MO_LPPC DS**). The Dearborn River may be contributing some added TN in the summer



but provides a slight dilution of TN in the adjacent Missouri River in the Fall (**Figure 2, MO_DEAR US vs. MO_DEAR DS**).

Lower mean discharge and no large flushing flows in 2021 and 2022 did not provide the lower Missouri River below Canyon Ferry with a large nutrient pulse that occurred from 2017 to 2020 and again in 2023. Due to UMOWA's water quality

collections, especially in the tributaries that are contributing excess nutrients upstream of Townsend (Deep, Dry, Greyson and others), we have a pretty good explanation for why this is the case. During low flow years, nutrients, both TN and TP have more time to be utilized by plants and algae within the reservoir and do not appear to be high downstream of Holter Dam. Whereas, during high discharge years, nutrients are not utilized quickly enough as they flow through the reservoirs and wind up exceeding the nutrient thresholds below Holter Reservoir as we had in summer and fall of 2023.

On the flip side, a large flushing flow often clears out sediment and silt from cobbles which favors mayfly and caddisfly colonization and abundance. And from the looks of the Fall 2023 macroinvertebrate data, 2024 could be a banner year for BWO, Tricos and Tan Caddisflies in some of the stretches of the Missouri from Holter Dam to downstream of Wolf Creek bridge, and around the Dearborn River downstream to Hardy Bridge.