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# Measurement of Heavy Metals and Enzyme Activities in the Wetlands of the Moreau River

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ABSTRACT

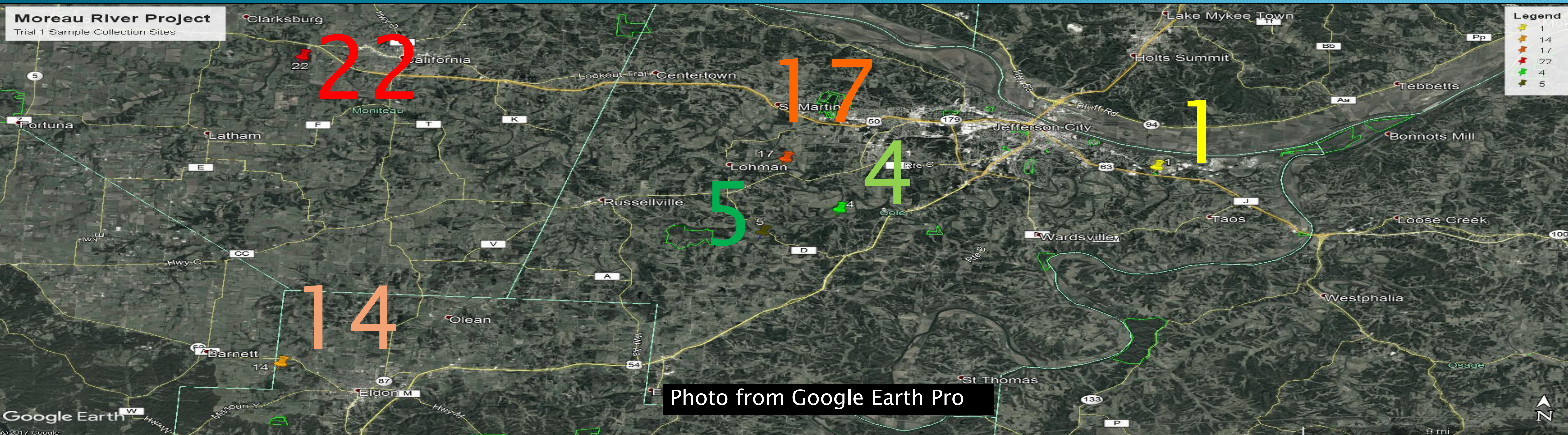
Research has indicated that the use of animal manure as fertilizer is a significant point source of pollution to the environment. Heavy metals can be found in and from items such as cigarettes, construction sites, mining areas, and some over-the-counter medications. The use of these items can cause serious health effects on humans and the environment. Through surface runoff, the heavy metals are transported to the wetlands causing pollution. The sensitivity of enzymes to the environmental pollution, the ease of assay, and their role in soil biological functions makes them useful tool as indicator of soil quality. The objectives of this study are: 1) To measure the activities of  $\beta$ -glucosidase, arylsulfatase, acid phosphatase, and  $\beta$ -glucosaminadase in the soil of Moreau River wetlands; 2) To measure the concentration of heavy metals in soil samples taken from Moreau River wetlands. The results indicated no concern about heavy metal content in water as it was below standard levels. The enzyme activities showed seasonal trends and were correlated with organic matter content of the soil of the sampling locations.

INTRODUCTION

- The Moreau River watershed is approximately 584 square miles located primarily in Cole, Miller, and Moniteau County, Missouri. (Weriech)
- Farmers that use manure as fertilizers which may be contributing to non-point source pollution through run off.
- With population on the rise, there could be more residential and industrial zoning along the Moreau River and North and South Moreau Creeks.
- The present study investigated the soil health by measuring the soil enzymes activity, which are known to play a critical role in mineralization of C, N, P and S in the soil.
- Soil enzymes are a group of enzymes present in the soil that play an important role in soil ecology, physical and chemical properties, fertility and soil health.
- The objectives of this study was to measure the activities of arylsulfatase,  $\beta$ -glucosaminadase,  $\beta$ -glucosidase, acid phosphatase, and heavy metals (As, Cd, Cr, Pb) in the soil of Moreau River wetlands and to measure the concentration of heavy metals in water (As, Cd, Cr, Pb) samples taken from Moreau River.

MATERIALS AND METHODS.

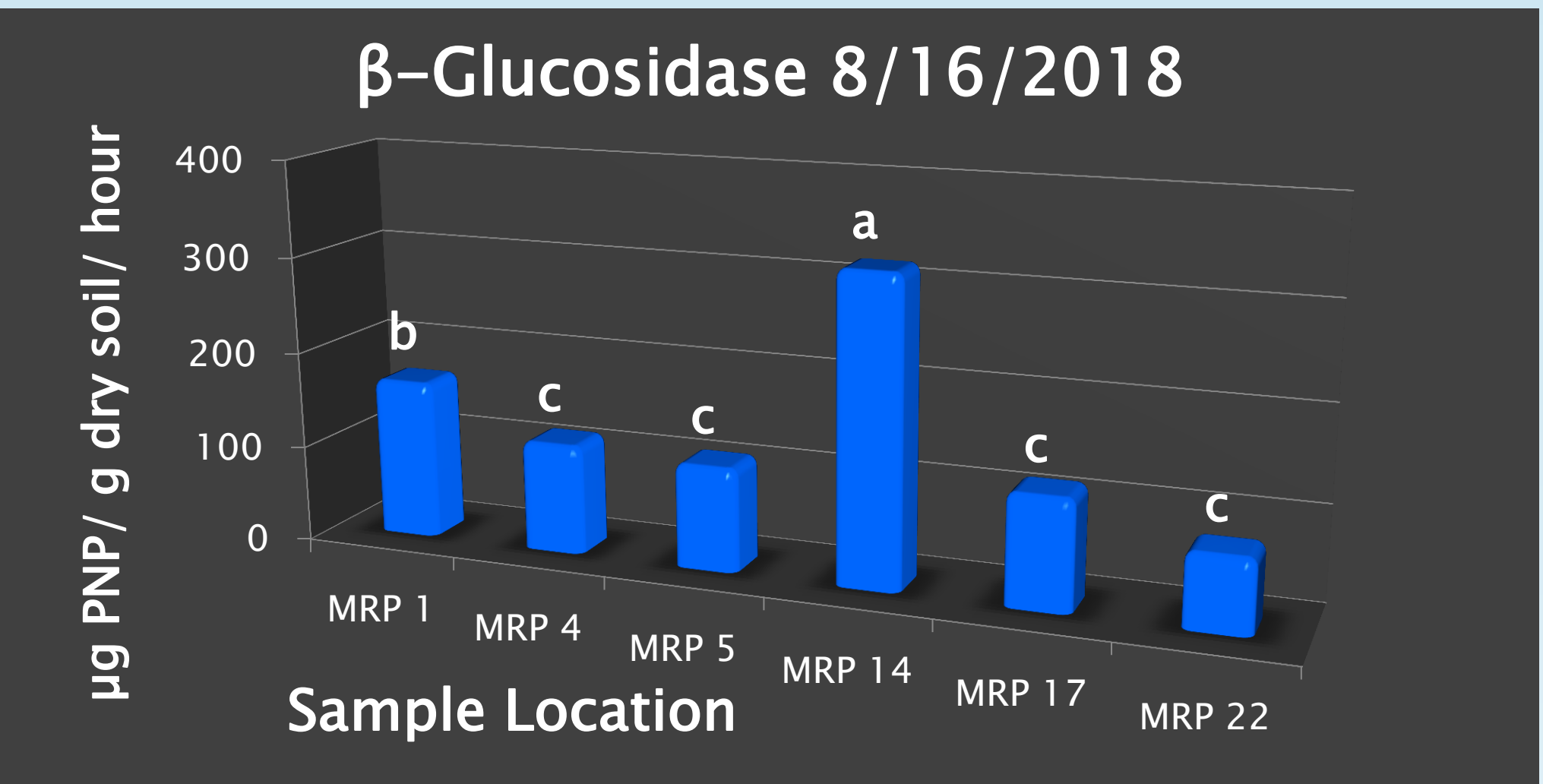
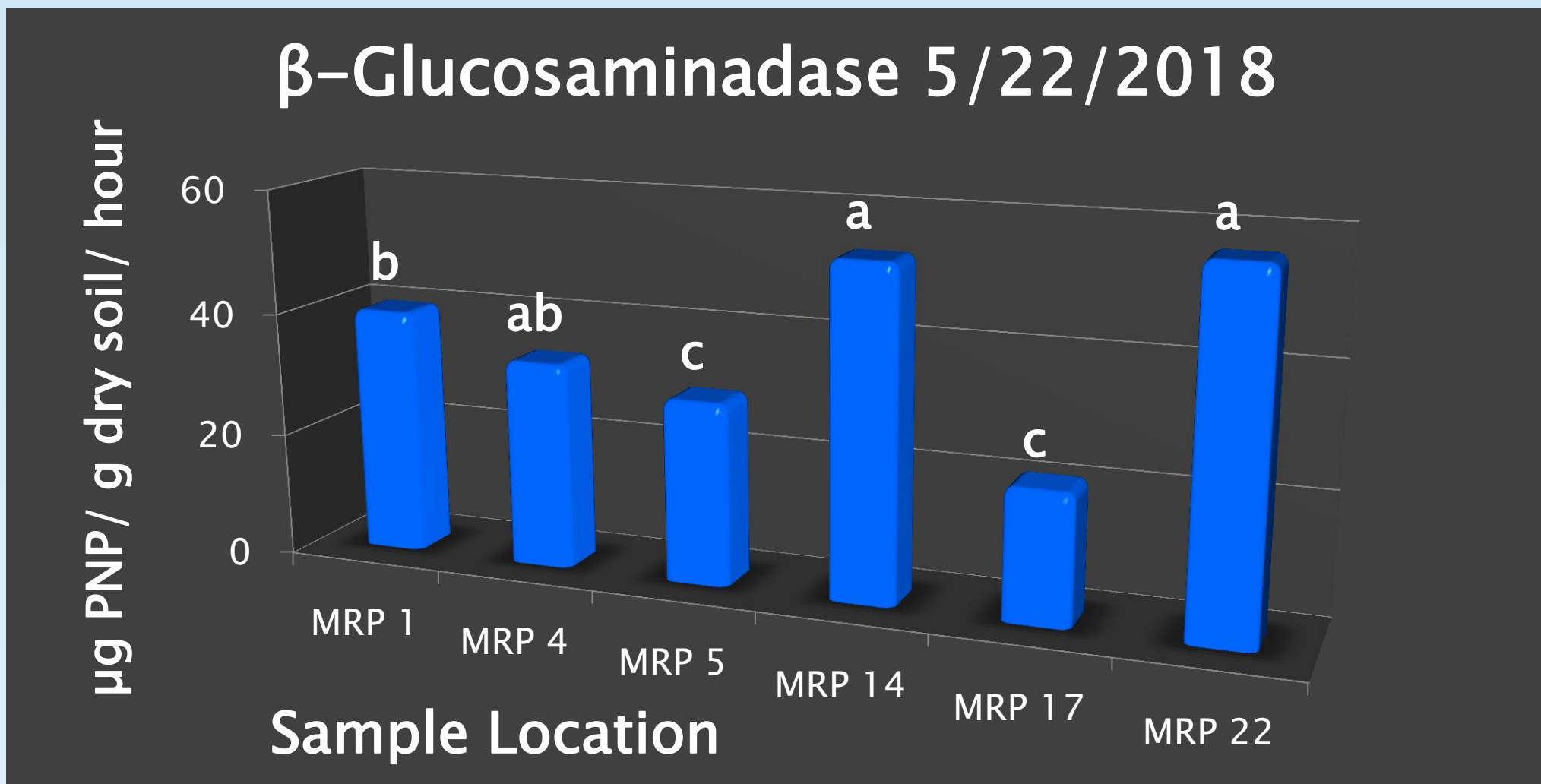
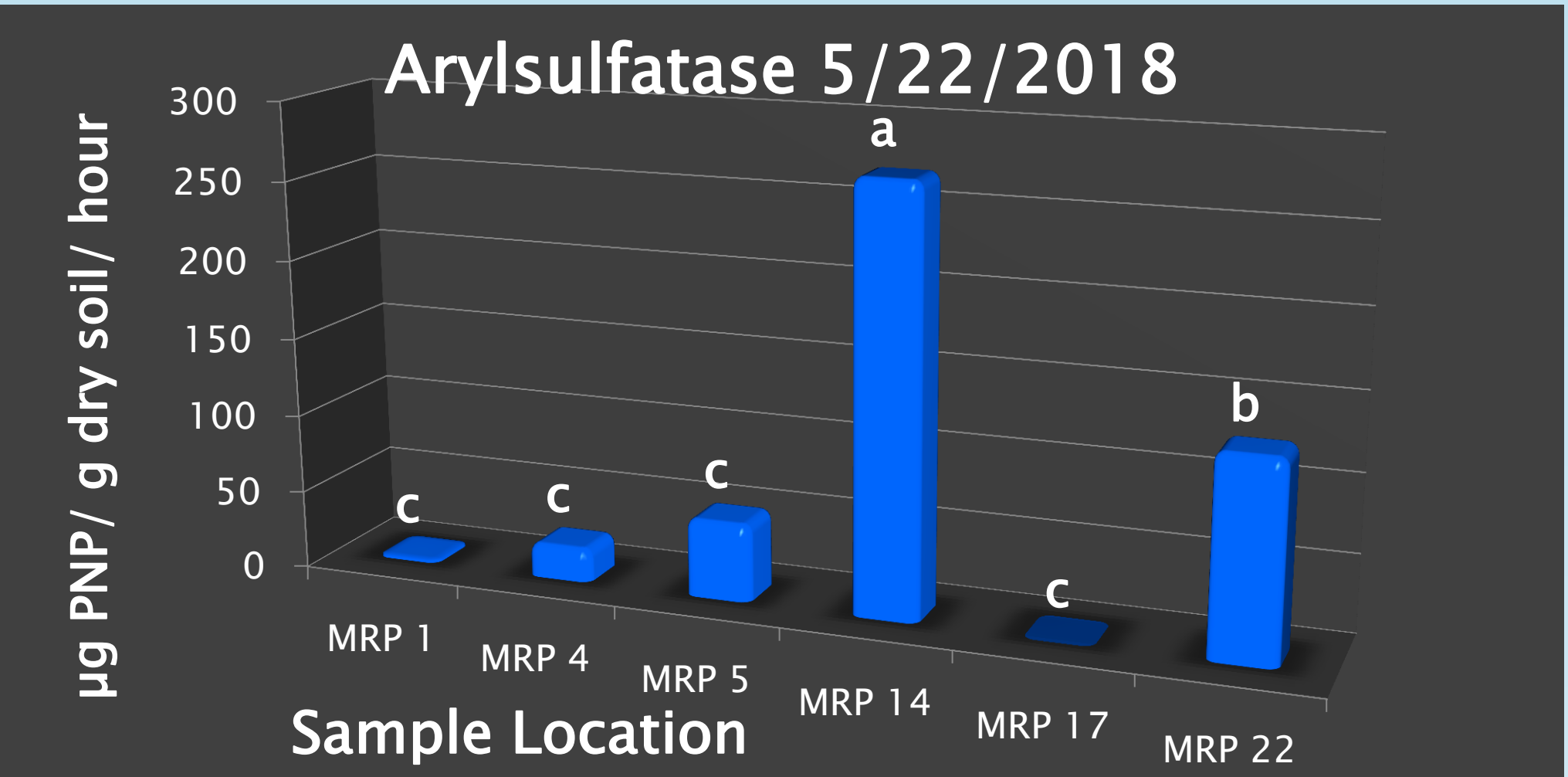
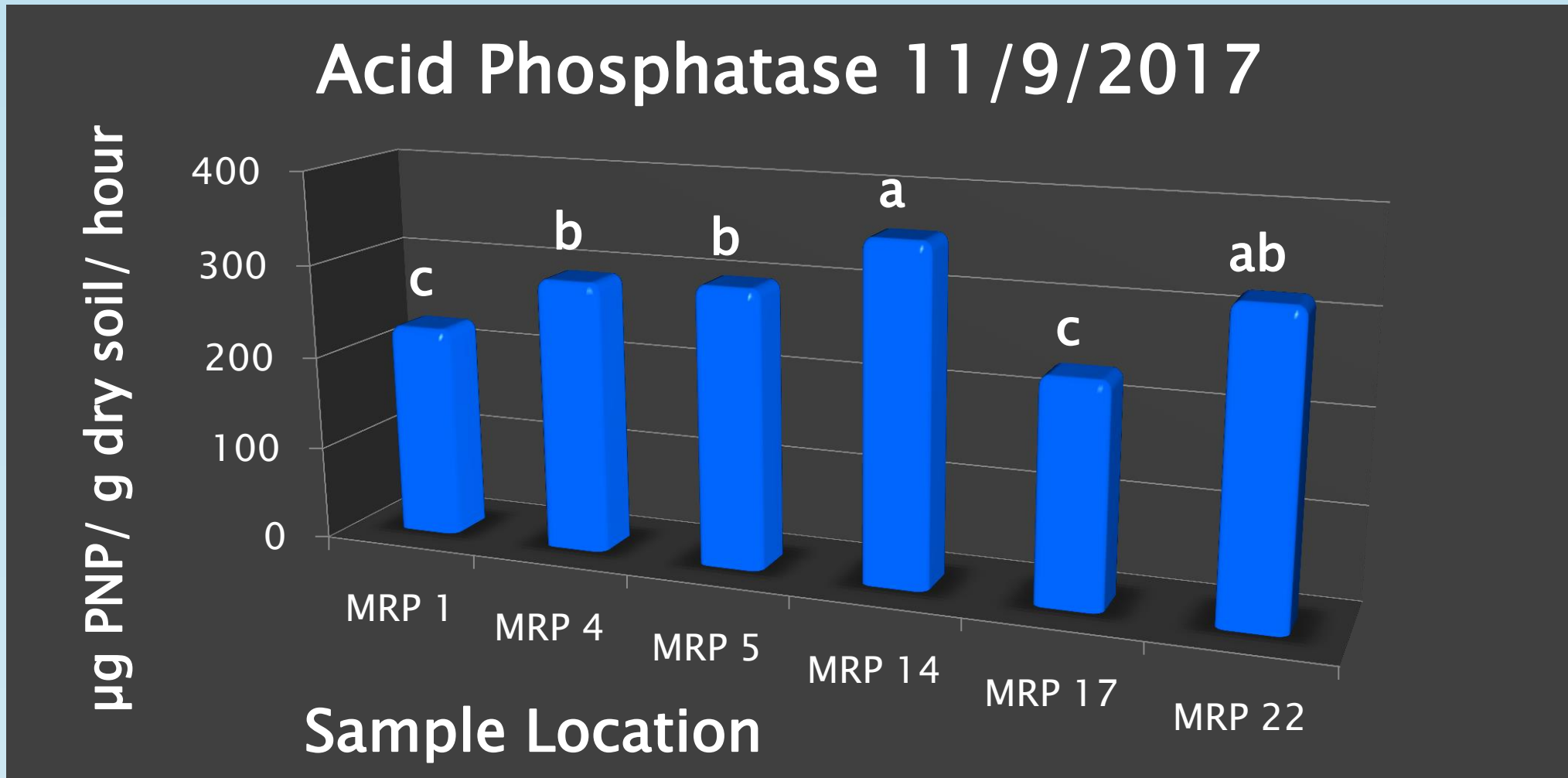
- Sample Locations:** The samples were taken from accessible points near the mouths and heads of the Moreau River and the North and South Moreau Creeks. Site #1–Hwy 50 Moreau River Access (Cole), Site #4–Loesch Rd (Cole), Site #5–Vaughn Ford Rd (Cole), Site #14–Miller Ln (Miller), Site #17–Meadows Ford Rd (Cole), and Site #22–Kiely Ford Rd (Moniteau).
- Sample Dates:** The samples were collected on three different dates November 10, 2017 (Testing 1), May 22, 2018 (Testing 2), and August 16, 2018 (Testing 3).
- Soil properties:** At all of the sites, the soil was more than 50% sand, between 40% and 10% silt, and less than 10% clay. The soil has a pH that ranges from 6.71 to 6.91 and an organic matter content ranging from a 4.43% to a 5.69%.
- Enzyme Activity:** The enzymes selected were acid phosphatase,  $\beta$ -glucosidase,  $\beta$ -glucosaminidase and arylsulfatase. The activities of acid phosphatase,  $\beta$ -glucosidase and arylsulfatase was carried out as described in Tabatabai (1994). The activity of  $\beta$ -glucosaminidase was determined by the method of Parham and Deng (2000). All substrates were obtained from Sigma Aldrich.
- IC/ICP:** Ion analysis of the soil and water was performed on a Thermo Scientific™ Dionex™ ICS-5000 + with suppressed conductivity. Soil digestion was performed on a Milestone™ Ultrawave SRC. Trace metal analysis of soil and water was performed on a Agilent™ 5110 ICP-OES.
- Statistical Analysis:** Statistical analysis was carried out using randomized block design. Analysis of Variance was performed using Statistix 8 program at  $P < 0.05$ . The Tukey Multiple Comparison test was used to compare the difference in treatment means.



RESULTS (HEAVY METALS)

Soils				Water			
Site # and Test	As ppm	Cd ppm	Cr ppm	Site # and Test	As ppm	Cd ppm	Pb ppm
MRP 1_T1	N/D	0.33	47.0	MRP 1_T2	N/D	0.001	0
MRP 4_T1	3.85	0.33	32.8	MRP 4_T2	N/D	0	0
MRP 5_T1	7.53	0.65	31.1	MRP 5_T2	N/D	0.001	N/D
MRP 14_T1	10.9	0.00	29.5	MRP 14_T2	0.008	0	0
MRP 17_T1	N/D	0.34	28.8	MRP 17_T2	0.01	0.001	0.01
MRP 22_T1	N/D	0.34	36.6	MRP 22_T2	0.002	0	0
MRP 1_T2	1.01	0.00	42.8	MRP 1_T3	0.008	0	0
MRP 4_T2	7.61	0.00	36.4	MRP 4_T3	N/D	0.001	0.01
MRP 5_T2	7.65	0.66	32.4	MRP 5_T3	0.006	0	0
MRP 14_T2	8.44	0.00	26.4	MRP 14_T3	0.002	0	0.02
MRP 17_T2	2.99	0.66	32.8	MRP 17_T3	0.012	0.001	0.01
MRP 22_T2	3.98	0.00	34.9	MRP 22_T3	0.005	0	0.01
Allowed conceration				Allowed Limits			
	75	85	3000	Drinking Water Supply	0.05	0.005	0.015
				Irrigation	0.1	-	-
				Livestock and Wildlife Protection	0.1	-	0.05
				Groundwater	0.05	0.005	-

RESULTS (SOIL ENZYMES)



DISCUSSION

- Overall the analysis of samples taken at the reported times showed that results for the water heavy metal content was below the standards in “10 CSR 20–7” and soil results were below the standards set out by the USDA NRCS.
- The soil enzyme assay results show that location MRP 14 has the highest enzyme activity for all three sampling dates. This is attributed to higher organic matter content in soil at location MRP 14.
- Enzyme activities can be used as indicators of changes in soil heath (Dinesh et al., 2012).
- The physiochemical characteristics of the soil such as pH, ionic composition, texture and hydrostatic pressure can influence the chemical form, mobility, bioavailability and toxicity of pollutants. (Schlich et. al., 2015).

CONCLUSION

- We tested for additional heavy metals in the samples of soil and water, but only showed the ones that we received the highest results here, still they are below the standards, with little concern because this water is not a drinking water supply.
- The enzyme activity levels from all of the samples that were collected showed similar trend throughout all of the locations. Activities correlated with organic matter content of soil.
- From these test results, there is no harm to be caused to plants and/or animals that utilize the Moreau River wetlands.
- As the area around the Moreau wetlands develops into residential and industrial zones, there will need to be more required tests to monitor the health of the soil and water.

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