OPTIMIZED HORSE TRAIL DESIGN FOR ILLINOIS SOIL

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Abstract.—One of the fastest growing forms of outdoor recreation is equestrian trail riding. In a study examining long-term trends of use on Forest Service lands, equestrian-based recreation was identified as one of the top five activities experiencing growth. As the numbers of horse riders rise, the economic impact of equestrian recreation can be expected to increase across the country. However, equestrian use has been identified with several negative impacts on trail systems including soil compaction, increased trail width and depth, and reduced surface litter. Evidence shows that the problems associated with recreation impact are likely the result of poor planning and location rather than the type of use alone. Due to the role of landscape characteristics such as wet soils and steep slopes in influencing common trail issues (i.e., muddy sections and eroded treads), landscape considerations during the planning process should be able to prevent most impacts before they happen. Furthermore, observational evidence shows that factors such as trail position, trail slope alignment angle (TSA), grade, water drainage, and type of use are significant determinants in how a trail erodes. If a trail is properly designed, much of the degradation associated with heavy impact might be prevented.

The goal of our research project was to empirically test for the effects of trail design, proximal landscape attributes, and routing characteristics on equestrian trail soil transport and erosion using an experimental trial built on the University Farms south of Carbondale, IL. Although several recent observational studies identified factors driving erosion in pedestrian trails, they lacked fully controlled designs. In this study, we seek to overcome this basic limitation in our understanding. Researchers and practitioners will be able to use the results of this study to design and maintain trails at lower cost, improved safety, and higher ecological resilience. The trail's close proximity to Southern Illinois University's Horse Center allowed for easy access by participants and gave the study a closely controlled group of users. Because of the erosive nature of the area's soil, the study's results are applicable to a wide range of soil types.

To prevent ambiguous causes of erosion associated with existing trail usage from influencing the study, the study trail was designed de novo in ArcGIS. Raster maps of the study area were added to represent elevation, water bodies, aspect, and structures for analysis. A view shed analysis was also performed on a nearby gun range for extra safety when designing the trail route. Once designed, the mile-long trail was divided into 5- m segments for monitoring. Based on established research, five primary design factors identified with influencing erosion were tracked for each segment: trail slope alignment angle, landform position, percent canopy cover, substrate modification, and benching. In addition, each trail segment's average slope, sinuosity, and azimuth were recorded as independent variables, and horse use was tracked over the course of the study.

Each segment was then monitored for increased erosion, muddiness, rugosity, and soil compaction. Measurements were taken on the first weekend of the month and immediately after rain events where total liquid precipitation exceeded 1.0 inch in

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24 hours. Because water has been identified as a primary factor in erosion along trail surfaces, monitoring the trail after rain events was critical. Monitoring the trail's condition after extensive rain was also important for maintenance during the experiment, because any downed trees or other obstructions had to be cleared quickly to prevent unwanted or unsafe behaviors by riders. For instance, a downed tree blocking part of the trail would cause bypassing, thus widening the trail and influencing the results of the study.

Data collection is ongoing, but early analyses indicate useful correlation of soil conductivity (as measured by human-portable electromagnetic field induction instruments) to primary trail design factors previously linked to active erosion (e.g., trail-slope alignment, landform position). Work is ongoing to use multivariate analysis of variance, or MANOVA, to compare the independent groups to the dependent variables so that we can determine if there are any differences in variance between each independent factor and more than one of the dependent variables. We predict that segments optimizing values for the design variables will erode at lower rates than other segments. Based on the current research, we also predict that trail segment slope, TSA, and landform position (as a proxy for drainage) will be the most influential factors in determining how each segment erodes.
