The Effect of Grazing Intensity on Soil Bulk Density

Chad L. Engels, Graduate Student, NDSU Department of Civil Engineering

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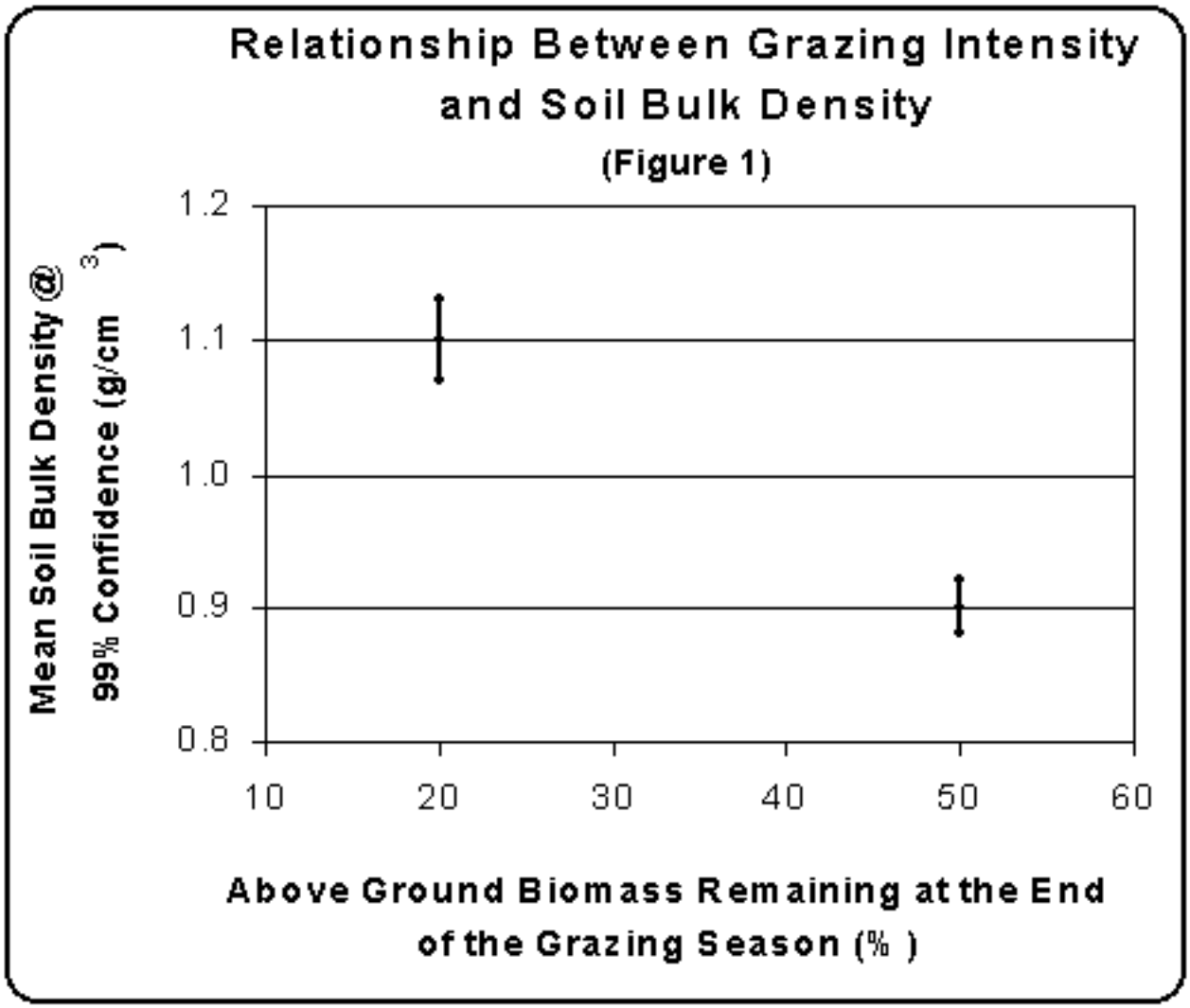
The effect of grazing on rangeland hydrology is of particular importance to the rangeland manager and producer. The need to utilize available water resources in the form of rainfall is of growing interest because of the desire to reduce the frequency and severity of drought. Several studies have shown that overgrazing leads to increases in runoff and soil erosion. These processes, which work against water conservation, are the result of physical changes that take place in the soil and vegetation. One specific physical change that may occur in a soil is compaction.

Soil compaction has important hydrologic implications in terms of its contribution to reduced plant growth, reduced infiltration rates, and increased runoff potentials (Gifford et al., 1977). Compaction, which is simply the increase of a soil's bulk density, is the result of trampling and root thinning. Lull (1959) calculated the static ground pressures exerted by mature cattle to be in the order of 24 pounds per square inch at standstill. Pressures will be four times that amount as the animal moves and the weight is transferred between hoofs. Thus, it is logical that as stocking increases, the effects of additional trampling will be seen, and are measurable. Bulk density is also a function of the root mass that occupies the soil column. Since above ground foliage is proportional to the root mass, increased grazing will also increase bulk densities. However, the ability of livestock to alter soil bulk densities is not solely a function of stocking density.

Pre-existing soil texture and moisture conditions are also important variables to consider when investigating the relationship between soil compaction and grazing intensity. Soil physics dictates that wet soils will compact more readily than dry soils. That is to say, less force is required to compact a wet soil than to compact the same soil to the same density when dry. Given that geographic climatic conditions differ, the ease of soil compaction due to wetness, on average, will be regionally dependent. Soil texture is also important in determining the potential for soil compaction. Anybody who has ever been to a public beach will notice that even though the ground is heavily traveled the coarse textured sand remains loose and unconsolidated. Van Haveren (1983) found that coarse-textured soil bulk densities were not affected by grazing intensity. However, bulk density was found to increase with grazing intensity on fine textured soils. This indicates that there must be a greater awareness for the effects of overgrazing on soils with a significant clay fraction.

An investigation of soil bulk densities as influenced by grazing intensity was conducted during the summer of 1999 at the Central Grasslands Research Extension Center. The study site consists of three replications of extremely grazed pastures and three replications of moderately grazed pastures. In this

study, extreme grazing is defined as that stocking rate which leaves 20% (505 lbs/acre) of an average year's above ground biomass remaining at the end of the grazing season. Moderate grazing leaves 50% (1,652 lbs/acre). The pastures are stocked in mid to late May and have been continuously grazed into autumn for the past ten years. Bulk density samples were collected at the soil surface (3 inches in depth) from silty range sites with loam to clay loam texturing. The results of the study are shown in the Figure 1. The average bulk density from the moderately grazed pastures is 0.9 g/cm^3. The average bulk density from the extremely grazed pastures is 1.1 g/cm^3. The averages have a 99% confidence interval of 0.02 g/cm^3 and 0.03 g/cm^3 for the moderate and extreme grazing respectively. This means that we can say with 99% confidence that the average bulk density on moderately grazed pastures is between 0.88 and 0.92 g/cm^3 and the average bulk density on extremely grazed pastures is between 1.07 and 1.13 g/cm^3. The bulk density data corresponds to a soil porosity of 64.7 and 60.3 percent on moderate and extreme grazing treatments respectively. The data shows that the intensity of grazing does indeed affect the bulk density and porosity of Missouri Coteau soils. The data also provides possible explanations why infiltration rates may change with intensity of grazing.



Chad Engels
Department of Civil Engineering
North Dakota State University
1410 14th Ave. North
Fargo, ND 58105
E-mail: engels@badlands.nodak.edu
