Disturbance Effects of Human and Animal Compaction of Soil on Microbiota and Water Content

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Question: How do the soil and habituated organisms react to differing trampling levels?

Hypothesis: Human and animal trampling will result in greater surface water content, lower water infiltration, and a lesser amount of soil dwelling arthropods in high impact areas compared to low impact areas.

Introduction:

Finland is known for its temperate climate and midnight sun that attracts tourists during the summer months. With the increase in tourism, we can expect an alteration to the vegetation and soil biota of the land due to increased foot traffic. Another contributor to foot traffic on the soil are the large concentrations of reindeer herds that graze the land in northern parts of Finland. Consequences of human and animal compaction of the soil can include reduction in flow of water, decreased vegetation and microbiota properties that are essential for the maintenance of organisms in the ecosystem. Impaired water retention in the soil can lead to soil rotting, drought, and erosion. Another indicator of the effect of human and animal trampling on the soil is the abundance and diversity of arthropods in the soil. Arthropods serve as a useful bioindicator of the well-being of an ecosystem. The combined effect of trampling from humans and animals on the plant and soil community in Kilpisjärvi is examined in this experiment. Additionally, we look at the impact of trampling on the water retention abilities of the soil from various sample sites in the area during June 2019. We hypothesize that an increase in trampling will lead to decreased vegetation, decreased abundance of arthropods, and decreased water retaining abilities.

Methods:

Measurement of Water Retention

Three representative samples were taken from four different sample sites. The three individual samples were taken from a spot that was exposed to high trampling, medium trampling, and low trampling: on a trail, near a trail, and off the trail. The top layer of vegetation was removed from the sample and the soil was procured from the layer underneath. The soil was collected in labeled boxes and transferred to a lab where the initial weight was obtained. The 18 samples were added to glass bowls to be heated at 105 ^{o}C for three days. After the soil dried the final weight was obtained and the difference between the weight of the samples were indicative of the water content, expressed as % g water/ g dry soil

Soil Biology of Kilpisjärvi

To observe the soil-dwelling arthropods, separate samples were taken to a depth of 5-10 cm at each sampling site with differing trampling levels. Each sample was added to a modified Tullgren funnel that held the soil within a metal can resting on a mesh screen over top a plastic funnel. The apparatus was attached to a small container of ethanol. An incandescent light bulb was attached to the funnel to heat the soil and force the arthropods to exit through the funnel opening and land into the bottle of ethanol. The organisms collected in the bottle of ethanol were viewed through a microscope where abundance was observed.

Measurement of Water Infiltration

A modified infiltrometer was constructed in the field. The high and medium trampling samples were submerged in 30 mL of water and timed to observe the amount of water that was absorbed per unit of time. The low samples were submerged in 50 mL of water.

Results:

Water Content in the Soil Samples

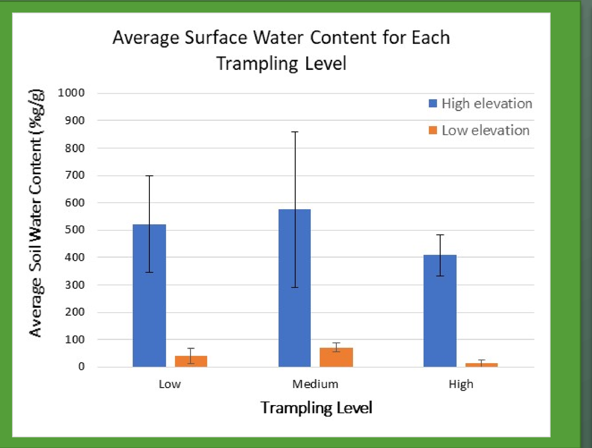
All trampling levels at higher elevations were high in soil water content without much difference among them (Graph 1). Some of the highest moisture levels were found in the low and medium trampling areas. Water content was much lower at the low elevation transect, where foot traffic is greater, particularly at the high trampling site.

Observation of Arthropod Diversity and Abundance

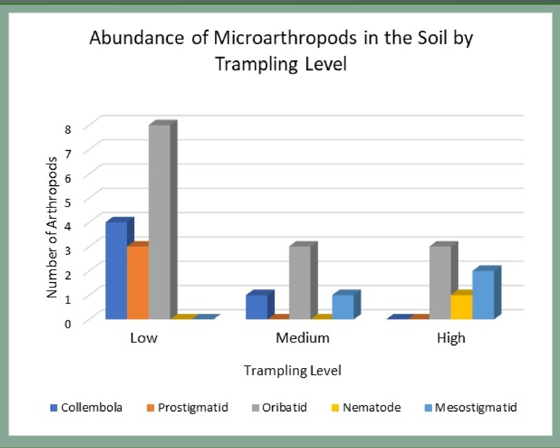
In both trials conducted, the low impact samples contained the most arthropods and greatest diversity compared to the high and medium impact areas' samples. The low sampling area contained 2 collembola in the first trial and 2 Collembola, 3 Prostigmatid- and 8 Oribatid mites. The medium trampling level soil samples contained no arthropods in the first trial and 1 Collembolan, 3 Oribatid, and 1 Mesostigmatid mite. The high sampling area samples contained a single nematode while the second sample contained 2 Mesostigmatid – and 3 Oribatid mites (Graph 2).

Water Infiltration of Each Soil Sample

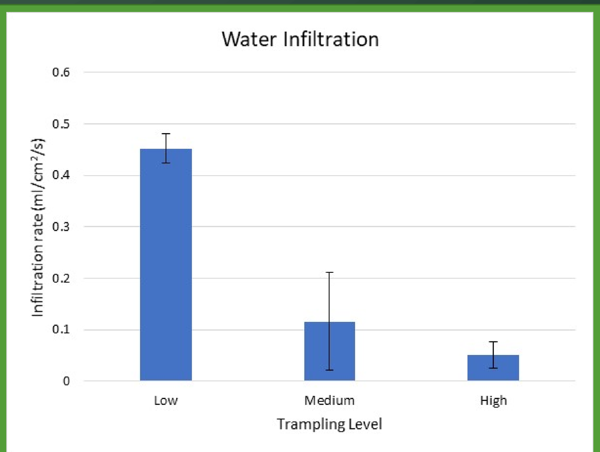
In each replicate, water was able to infiltrate the low trampling impact samples in a shorter amount of time compared to the high and medium trampling areas. In two instances, the medium trampling area sites took longer to be infiltrated by the water compared to the high trampling area sites (Graph 3).



Graph 1. The graph is organized by trampling level: L, low; M, medium; H, high. Bars represent the average of three samples, with SE error bars.



Graph 2. The graph displays the amount of microarthropods found in each trampling area. The totals of the three trials have been combined for each kind of arthropod.



Graph 3. Water infiltration is displayed by trampling level. Each unit is a function of volume (mL H_2O) divided by the area of a cylinder (πr^2) divided by time (seconds).

Discussion:

The soil samples from the areas of higher human and animal trampling had roughly equivalent water content compared to samples from areas of low trampling impact. Additionally, the samples taken from lower elevations, where trampling was greater, contained less water than samples taken from higher elevations. However, they often appear more saturated, possibly due to the much lower rate of water infiltration. Water remains pooled on the surface to become mud, rather than moving into the soil. This result gives an indication that human and animal trampling on a trail can lead to the over saturation of surface soil. Increased water content in the soil can lead to erosive conditions which explains why there is always a lack of vegetation on trails. Additionally, water was able to infiltrate the samples from low trampling impact faster than samples of high trampling impact. This result could have consequences that affect the ability of plants to grow in an area that is experiencing a high volume of foot traffic such as during the summer tourist season. The same low trampling areas showed a greater amount of diversity and abundance of soil dwelling arthropods compared to areas of high and medium trampling impact. The difference between trampling level intensities reflect the maintaining abilities of the arthropods in the nutrient composition in the soil and plant diversity.

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