

The Impact of Camping on Soil Properties in the Strawberry Lake Campground in the Turtle Mountains

Strawberry Lake

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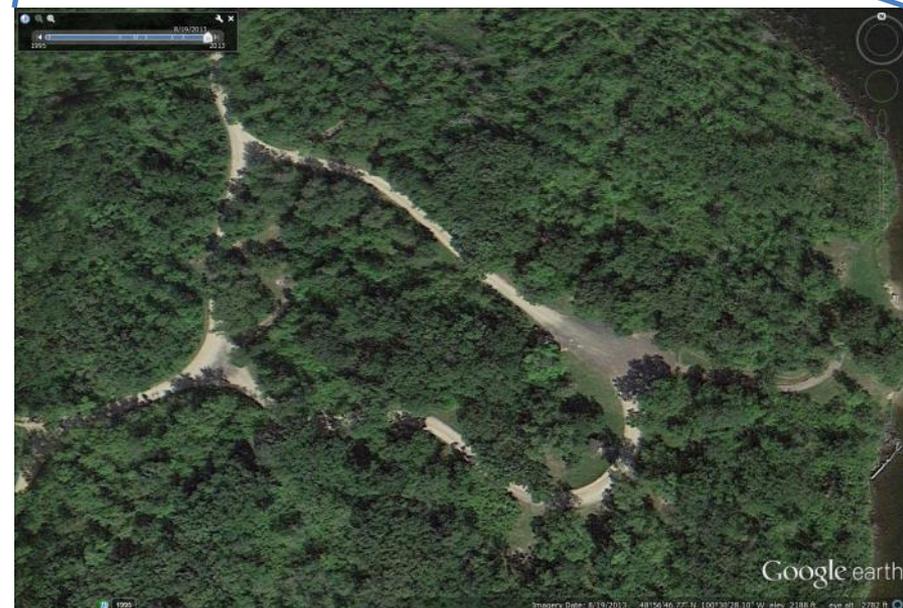
Background

- Previous studies have demonstrated that recreational activities, including camping, can have a negative impact on soils, influencing their ability to provide ecosystem services
- Negative impacts may include compaction, increased penetration resistance, loss of vegetative cover, reduced organic matter content, and heavy metal contamination



Background

- The campground at Strawberry Lake, in the Turtle Mountains of North Dakota, is a low-use campground
 - No more than 3 of the 13 campsites were utilized when checked 4 times in 2011-2013
- Wanted to investigate if the use level was having negative impacts on the soils



Materials and Methods

- 3 campsites were randomly selected from the 13 at the campground
- Soil samples were taken at the surface and at 30 cm depth
- Samples were collected:
 - At the edge of the fire pits
 - Half-way between the fire pits and campsite edges
 - At the campsite edge
 - About 3 m into the woods outside the campsite



Materials and Methods

- Tests/analyses run:
 - Bulk density
 - Penetration resistance
 - Soil organic matter
 - Zn, Mn, and Cu concentrations
- Mean values for each test were statistically compared for significant differences using paired t-tests



Results

- Bulk density:

Table 1. Bulk density comparisons in each of the campsite zones. Values with the same letter beside them do not have statistically significant differences at the 95% confidence interval.

Campsite Zone	Surface		30 cm	
	Mean BD (g cm ⁻³)	Std. Dev. (g cm ⁻³)	Mean BD (g cm ⁻³)	Std. Dev. (g cm ⁻³)
Edge of Fire Ring	1.36 ^a	0.171	1.55 ^d	0.069
Midpoint	1.21 ^{ab}	0.108	1.48 ^e	0.096
Perimeter of Campsite	1.14 ^{bc}	0.105	1.48 ^e	0.45
Woods (control)	1.18 ^c	0.068	1.46 ^e	0.072

Results

- Penetration resistance:

Table 2. Soil penetration resistance comparisons in each of the campsite zones. Values with the same letter beside them do not have statistically significant differences at the 95% confidence interval.

Campsite Zone	Surface		30 cm	
	Mean Resistance (kg cm ⁻²)	Std. Dev. (kg cm ⁻²)	Mean Resistance (kg cm ⁻²)	Std. Dev. (kg cm ⁻²)
Edge of Fire Ring	3.87 ^a	0.56	3.37 ^{ab}	1.30
Midpoint	3.63 ^{ab}	0.96	2.46 ^b	1.52
Perimeter of Campsite	3.19 ^{ab}	0.68	2.53 ^b	1.16
Woods (control)	2.96 ^b	0.59	2.94 ^b	0.80

Results

- Soil organic matter:

Table 3. Soil organic matter (SOM) contents in each of the campsite zones. Values with the same letter beside them do not have statistically significant differences at the 90% confidence interval.

Campsite Zone	Surface		30 cm	
	Mean SOM (g cm ⁻³)	Std. Dev. (g cm ⁻³)	Mean SOM (g cm ⁻³)	Std. Dev. (g cm ⁻³)
Edge of Fire Ring	0.109 ^a	0.035	0.074 ^b	0.079
Midpoint	0.135	0.024	0.043 ^b	0.017
Perimeter of Campsite	0.118 ^a	0.045	0.041 ^b	0.011
Woods (control)	0.113 ^a	0.038	0.038 ^b	0.014

Results

- Metal content:

Table 4. Soil metal contents in each of the campsite zones.

Campsite Zone	Surface						30 cm					
	Zn		Mn		Cu		Zn		Mn		Cu	
	Mean (g kg ⁻¹)	Std. Dev. (g kg ⁻¹)	Mean (g kg ⁻¹)	Std. Dev. (g kg ⁻¹)	Mean (g kg ⁻¹)	Std. Dev. (g kg ⁻¹)	Mean (g kg ⁻¹)	Std. Dev. (g kg ⁻¹)	Mean (g kg ⁻¹)	Std. Dev. (g kg ⁻¹)	Mean (g kg ⁻¹)	Std. Dev. (g kg ⁻¹)
Edge of Fire Ring	0.0044	0.0022	0.0149	0.0248	0.0006	0.0001	0.0011	0.0002	0.0068	0.0029	0.0004	0.00002
Midpoint	0.0072	0.0021	0.0067	0.0014	0.0017	0.0027	0.0012	0.0003	0.0068	0.0008	0.0011	0.008
Perimeter of Campsite	0.0048	0.0021	0.0085	0.0013	0.0006	0.0002	0.0014	0.0004	0.0077	0.0031	0.0005	0.0002
Woods (control)	0.0031	0.0017	0.0077	0.0028	0.0006	0.0001	0.0012	0.0005	0.0074	0.0028	0.0005	0.0001

Discussion

- Bulk Density:
 - Bulk density is significantly higher in areas of high traffic as compared to the controls, at both the surface and 30 cm depths
 - Bulk density at the edge of the campsites is not significantly different from the controls
 - None of the bulk density values were high enough to be root-limiting

Discussion

- Penetration resistance:
 - Values in the highest impact area (edge of fire ring) are higher than the controls, no other differences found
- Soil organic matter:
 - No significant effects on soil organic matter content were found

Discussion

- Metal content:
 - EPA limit for Zn is 23 g kg^{-1} , maximum value at Strawberry Lake was 0.0072 g kg^{-1}
 - EPA limit for Cu is 3.1 g kg^{-1} , maximum value at Strawberry Lake was $0.00172 \text{ g kg}^{-1}$
 - There are no EPA limits for Mn, but values were significantly lower than natural values reported nearby in Manitoba
- Metal contamination is not a problem at the Strawberry Lake campground

Conclusions

- The low impact camping taking place at the Strawberry Lake campground is not leading to significant negative impacts on the soil
- This is consistent with on-site observations:
 - Soils are dark colored with OM and have good structure
 - With the exception of the fire pits, vegetation in the campsites is fairly lush



Acknowledgement

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Questions???