Infiltration Rates at Different Stages of Prairie Restoration

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Introduction

Infiltration rate (IR) is defined as the volume of fluid that passes through or into another substance per unit of time[1]. Infiltration rates in soils depend on many factors such as clast size, porosity, permeability, vegetation coverage, microtopography, precipitation intensity, and hillslope gradient and length[2].

Plants increase soil volume for infiltration via their roots[1]. Roots also help develop soil structure and increase aeration for micro-organisms which "serve as pathways for preferential flow"[1].

This project examines how native, restored prairie plants impact infiltration rates.

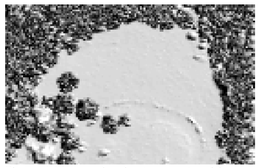

Figure. 1 Mormon handcart remnant prairie

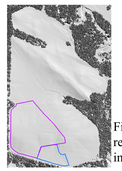

Figure 2. Ashton 1-acre restored and 6-acre impaired prairie.

Research Question and Hypothesis

Q: How do infiltration rates change with different stages of prairie restoration?

H_0: There is no difference in infiltration rates between the restored prairies and the impaired prairie.
H_A: There is a difference in infiltration rates between the restored prairies and the impaired prairie.

- Independent variable: Prairie restoration age (years)
- Dependent variable: Infiltration rate (cm/s)

Data and Methodology

Data:
1. Mormon Handcart Park remnant prairie is a native landscape to Johnson County, Iowa
2. Ashton 1-acre restored prairie is on its 2nd year of restoration with reseeded native prairie species
3. Ashton 6-acre impaired prairie has been sprayed with a pesticide, with no reseeding yet

- 14-15 infiltration measurements and soil samples collected per prairie
  - 43 total infiltration measurements and soil samples

Methods:
- Used ArcMap 10.7 to visualize prairie location slopes and generate random sample sites
- Identified 15 sites per prairie in toe slopes with slope gradients ≤ 2.5%
- Mini Disk Infiltrometer set to 2 cm suction rate, recorded every 30 seconds for 5 minutes per site[5]
  - Infiltration rates calculated via Decagon Devices Microsoft Excel spreadsheet provided in Mini Disk Infiltrometer manual[4]
- Oven dried soil at 105°C for 24 hours then ground up via mortar and pestle and sieved for clast size using US standard sieves No. 18, 35, 60, 120, and 230
- Calculated analysis of variance (ANOVA) stats in Excel for infiltration and sieve data

Results

ANOVA of Infiltration (cm/s)	
F-test =	2.532E+00
p-value =	0.092173

Figure 3. ANOVA F-test and p-value calculated based on individual and global infiltration rates measured per prairie.

Figure 5. Mini Disk Tension Infiltrometer placed on bare earth with measurements recorded every 30 seconds for 5 minutes.

ANOVA of Sediment Clast Sizes	
F-test =	11.94
p-value =	0.000086

Figure 7. ANOVA F-test and p-value based on soil sample sieving. Clast size determination based on classification chart[3].

Figure 7. Soil sample post oven and mortar and pestle.

	Remnant	Restored	Impaired
Mean IR (cm/s)	1.01E-04	1.14E-05	4.09E-05

Figure 4. Mean infiltration rates averaged from 14-15 measurements collected per prairie.

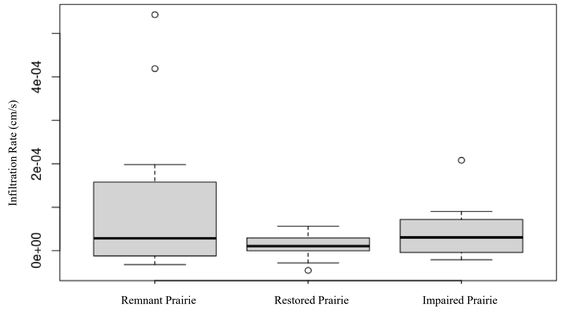

Figure 6. Boxplot displaying infiltration rates per prairie. Black line represents median infiltration rate. A total of 4 outliers were observed.

With a p-value of 0.092, we fail to reject the null hypothesis.

	Remnant	Restored	Impaired
Mean % silt or finer clasts	23.572961	51.44785	35.93541

Figure 8. ANOVA F-test and p-value calculated based on

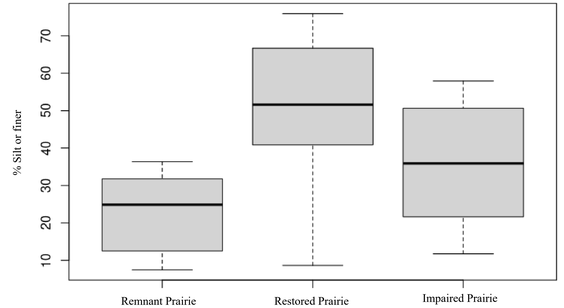

Figure 9. Boxplot displaying percentage of silt-sized or finer clasts sizes. Black line represents median percentage of silt-sized or finer clasts sizes.

With a p-value of 8.6E-5, we have strong enough evidence to support that there is a difference in sediment clast size between the restored and impaired prairies.

Discussion

While we fail to reject the null hypothesis that there is no difference in IRs between stages of prairie restoration, it is interesting to find a significant difference in sediment clast sizes between prairie locations.

Some potential impacts on IRs in this study are differences in sediment clast sizes, weather conditions, slight variations in slope per sample site, and soil carbon content.

Due to time constraints, we were unable to conduct soil carbon analysis and would highly recommend doing so in future projects. Infiltration was collected during a 5-day drought which may have potentially impacted IR measurements as some soils with clay content have been positively correlated with high initial IRs in dry conditions[1]. Slight variations in slope ranged from 0.0% - 2.5% which may have. If conducting a similar experiment, increasing sample sizes to at least 30 infiltration measurements and soil samples would be ideal for statistical analysis.

A total of two infiltration measurements and soil samples were unable to be collected and analyzed due to field complications. A double-ring infiltrometer was originally planned for infiltration measurements, however, the Mini Disk Infiltrometer was more efficient due to time constraints

Figure 10. One of 45 sediment runoff traps constructed and set-up on remnant, restored, and impaired prairie.

Future Collection:
An additional goal of this project was to quantify differences in sediment runoff per prairie. Due to time constraints, no data were able to be collected within this project's timeframe. A total of 45 sediment runoff traps were constructed and placed at each infiltration site and are set to be collected at the end of summer.

References

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