Trail Impact Monitoring in Forest Park

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Portland State UNIVERSITY

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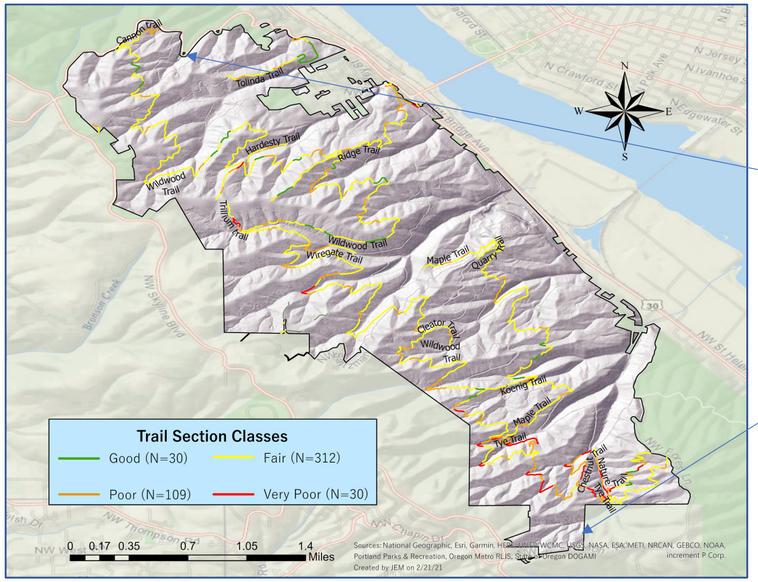
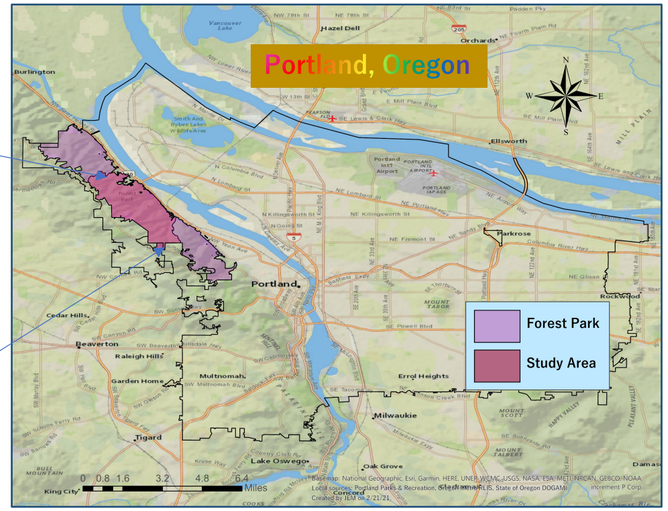
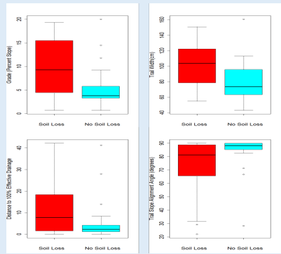




Finding 1: Sections displaying soil loss are steeper, closer aligned to the slope "fall line," wider and further from effective drainage.



Sections	Total	Width (cm) (mean, median)		Percent Grade (mean, median)		Distance (m) (mean, median)		TSA (degrees) (mean, median)	
No Soil Loss	21	81.7	73.7	5.7	3.8	5.9	2.3	83.5	88.3
Soil Loss	19	100.9	103.7	9.8	9.3	11.5	7.8	71.5	81.3
Total	40	90.8	83.0	7.6	4.8	8.6	2.6	77.8	87.2

Trail Class	Mean Grade (%)	Median Grade (%)	Mean TSA (degrees)	Median TSA (degrees)	Mean Width (cm)	Median Width (cm)
Good	3.4	3.5	89.4	90	97.5	99.7
Fair	6.3	4.6	81.9	88.3	80.6	71.2
Poor	10.8	11.7	71.1	77.3	90.4	93.8
Very Poor	10.2	10.1	68.8	84.8	94.8	83
All	7.6	4.8	77.8	87.2	90.8	83

Finding 2: Trail grade is an exceptionally strong indicator of soil loss in Forest Park. Furthermore, trail grade can be effectively predicted using GIS.

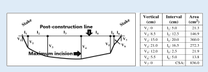
- Maximum incision and CSA soil loss values were highly correlated (Spearman's RHO = 0.98). Their multiple regression outputs were also nearly identical.
- Multiple regression models indicated multicollinearity among grade, TSA, and drainage distance for both soil loss metrics. Grade was the strongest predictor.
- Future researchers may consider using GIS grade exclusively.
- Tedious CSA measurements are only necessary if trying to quantify total soil loss.

Maximum Incision Multiple Regression Summary

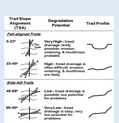
Statistic	All Variables	Field Grade + Width	GIS Grade
p-value	0.04	<0.001	<0.001
Adjusted r^2	0.32	0.35	0.26

Methods Overview

- **Sampling:** Soil loss indicators were measured at three randomly selected transects within 40 ~250' sections stratified by class. Each of the four condition classes were represented by 10 randomly selected sections.
- **Response Indicators:**
  - **Cross-Sectional Area (CSA):** The two-dimensional profile between original construction and existing tread at a given transect
  - **Maximum Incision:** Deepest Point between original construction and current tread levels.
- **Predictor Indicators:**
  - **Distance to 100% effective drainage:** The nearest point above transect where 100% of flowing water exits the trail, such as a water bar or outsloped tread.
  - **Trail Slope Alignment (TSA):** Bearing of the trail in relation to bearing of landform bisected.
  - **Grade:** Percent slope between transect and a point on the trail 10 feet upslope, using survey rods and clinometers.



Variable Interval CSA overview, Olive & Marion 2009



From Marion & Wimpey 2017

TSA of ~1-5 degrees. Very steep!

Grade tools

Project Summary

Portland Oregon's Forest Park is a beautiful natural area with habitat connectivity and biodiversity rarely found in urban forests. Greater Portland residents enjoy the 5,200-acre park in large numbers to run, hike, ride, and socialize. Although much of the trail system is well built, fire lanes and other unsustainable trails promote erosion and other avoidable impacts to the ecosystem. Even properly aligned trails come at a cost to ecosystem health through initial construction and subsequent wildlife disturbances. This inherent conflict between recreation and preservation led to the field of recreation ecology and frameworks for compromise based on indicator-informed management objectives.

In 2020 we conducted a recreation ecology study to measure soil loss and its causes on trails in Forest Park. While trails may adversely affect natural areas in a variety of ways, soil loss appears to be associated with many other impacts including vegetation trampling, hydrologic system alterations, and user safety issues, leading recreation ecologists to assert soil loss as a key indicator for trail sustainability. Our research modified past methods with inclusion of a stratified study design based on recent trail condition class data gathered by Portland Parks & Recreation staff.

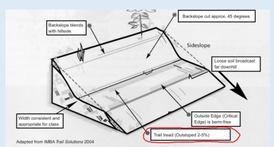
We narrowed our study area to pedestrian-only trails in Forest Park's Central Management Unit (CMU) with 10 ~250' trail sections randomly selected from each of four present condition classes. Results reflected professional trail management best management practices, with exponentially more soil loss on trails >10% grade and a stronger-than-normal explanation of soil loss by trail grade and width. We also demonstrated that the new trail condition class data alone might be highly accurate in prioritizing future trail improvements, especially when our GIS-derived grade data is included.

Finding 3: The recent trail condition classification system reflects soil loss and sustainable trail layout.

Class	Number of sections in each grade category (GIS Grade)				Percent Sustainably Laid Out Sections	Soil Loss Sections (n)	CSA Soil Loss	Maximum Incision
	0-5%	6-10%	11-20%	>20%				
Good	8	2	0	0	100%	2	685	4
Fair	7	2	0	1	90%	2	551	5
Poor	2	2	4	2	40%	8	7706	14
Very Poor	4	2	2	2	60%	7	5335	10

Recommendations

- Expand and replicate studies. Include GIS-derived and trail user variables.
- Use this work to justify trail relocations where grade is steep and soil loss is present.
- Focus efforts on sections with soil loss that are <10% grade, as many may have a "quick fix."
- Continue applying BMPs to trail maintenance in general, as this study neatly defends them.



Ideal profile for hillside trails

Stonework to prevent erosion

Grade reversals for proper drainage

References

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See Also

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