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ENVS 114A: Soil Science

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Erosion, Soils, and Adaptations: Plant Life in Bryce Canyon National Park

Introduction:

Soil plays a fundamental role in shaping ecosystems and supporting plant life. In areas with distinct geological features, such as Bryce Canyon National Park, soil-forming processes are unique and can have profound effects on plant growth and adaptation. Understanding the specific soils of this region can provide insight into how plants thrive in such extreme environments, therefore, this study will examine the relationship between the soil types at Bryce Canyon and the adaptability of plants, seeking to answer: How do the soil-forming processes at Bryce Canyon affect plant growth and adaptation? This question is important because it could reveal insights into the resilience of plants in harsh, semi-arid conditions, potentially informing conservation efforts and land management practices at the park (Carr et al., 2022; Hildebrand, 2012).

Site overview:

Bryce Canyon National Park is known for its dramatic topography including high mesas, cliffs, and deep canyons, resulting in a complex and varied distribution of soils. Two key soil types found within the park include Brycan very fine sandy loam and Paunsaugunt gravelly loam. Brycan very fine sandy loam is typically found on gentle slopes and has a fine texture that allows for moderate water retention, which is beneficial for supporting vegetation. On the other hand, Paunsaugunt gravelly loam, found at higher elevations and steeper slopes, is coarser and well-drained, leading to rapid water runoff and limited plant growth due to soil dryness (Web Soil Survey, 2024). According to the Web Soil Survey (2024), the soils at Bryce Canyon are primarily composed of Entisols and Aridisols. These soils are formed from sandstone and limestone parent materials, and their characteristics are heavily influenced by the region's semiarid climate. Factors such as slope, elevation, and vegetation cover play a major role in shaping the soils, which vary from deep, loamy soils in lowland areas to shallow, rocky soils on the higher, exposed ridges. These differences in soil texture, depth, and water retention capacity create microhabitats that determine which plant species can thrive in each area (Graybosch & Buchanan, 1983).

Woods et al. (2001) further describe the regional soil types and their implications for plant growth. They identify the presence of fine sandy loam and very fine sandy loam textures, particularly in eolian deposits derived from sandstone, which form the foundation for the park's soils. The combination of Quaternary colluvium, alluvium, and eolian materials shapes these soils, with variations in moisture availability directly affecting the vegetation found at each elevation and topographic position.

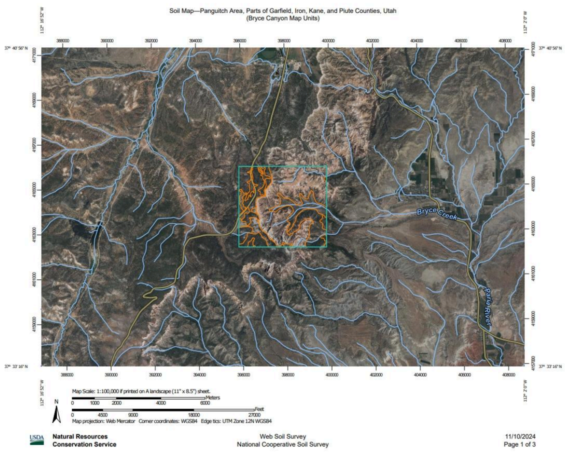
Methods:

To explore the relationship between soil-forming processes and plant adaptation at Bryce Canyon, I utilized data from the Web Soil Survey (WSS) and peer-reviewed literature. I first identified relevant soil properties, including texture, organic matter content, and water retention capacity, for various soil types found at the site. To complement this, I reviewed studies on plant ecology in Bryce Canyon (Graybosch & Buchanan, 1983; Hildebrand, 2012) and analyzed data from a recent vegetation health monitoring study (Carr et al., 2022). These sources were selected due to their relevance in examining the impact of soil characteristics on plant growth in the park and were primarily found through Google Scholar.

Results/Data

The analysis of soil data from WSS revealed several key soil properties that influence plant growth. Figure 1 presents a map of the soil distribution in Bryce Canyon, highlighting the prevalence of Brycan very fine sandy loam and Paunsaugunt gravelly loam.

Figure 1: Soil Map of Bryce Canyon National Park (Web Soil Survey, 2024). Screenshot of Area of Interest (AOI).



Soil Map—Panguitch Area, Parts of Garfield, Iron, Kane, and Piute Counties, Utah Bryce Canyon Map Units

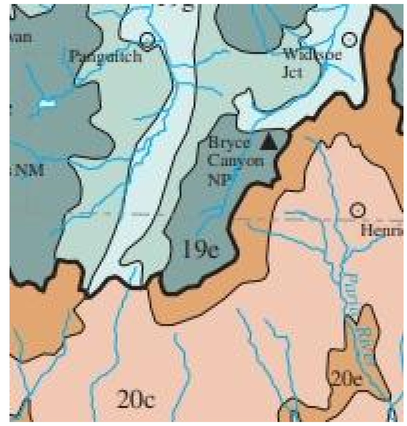
Map Unit Legend

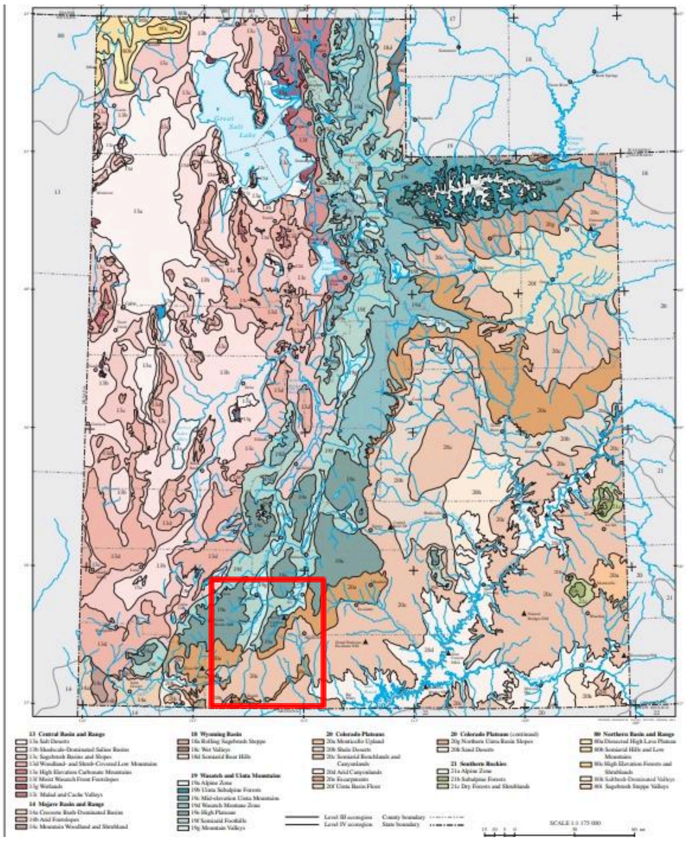
Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
8	Badland-Cannonville-Rock outcrop complex, 30 to 50 percent slopes	180.3	5.1%
9	Badland-Rock outcrop-Paunsaugunt complex, 2 to 20 percent slopes	4.8	0.1%
25	Brycan very fine sandy loam, 1 to 6 percent slopes	34.3	1.0%
26	Brycan very fine sandy loam, 6 to 15 percent slopes	0.4	0.0%
36	Clapper cobbly loam, 30 to 60 percent slopes	31.0	0.9%
96	Neto fine sandy loam, 1 to 5 percent slopes	29.3	0.8%
105	Pahreah-Sheege complex, 1 to 20 percent slopes	121.8	3.4%
107	Pahreah-Swapps complex, 25 to 65 percent slopes	98.1	2.8%
110	Paunsaugunt gravelly loam, 2 to 15 percent slopes	489.6	13.8%
115	Podo-Wiggler complex, 10 to 50 percent slopes	4.2	0.1%
122	Rock outcrop	1,747.7	49.3%
124	Rubble land	368.2	10.4%
147	Tridell gravelly loam, moist, 4 to 25 percent slopes	11.0	0.3%
150	Ustic Torrifluvents, occasionally flooded, 2 to 8 percent slopes	317.8	9.0%
152	Venture very cobbly silt loam, 4 to 25 percent slopes	106.5	3.0%
Totals for Area of Interest		**3,545.2**	**100.0%**

Additionally, a comparison of plant communities across different soil types showed a clear relationship between soil texture and plant growth. In the lowland areas where Brycan soils are prevalent, vegetation health, particularly in grass and herbaceous species, was found to be better (Carr et al., 2022). In contrast, the steeper, more exposed areas with Paunsaugunt gravelly loam support only sparse vegetation, which is adapted to dry conditions and shallow soils. These plants, such as Utah juniper and pinyon pine, have deep root systems that allow them to access water stored deeper in the soil (Graybosch & Buchanan, 1983; Stein, 1988).

Woods et al. (2001) highlight that areas with eolian-derived soils, such as those in the lowlands of Bryce Canyon, have a higher moisture retention capacity due to their fine sandy loam texture. This allows for a broader variety of plant species to thrive in these regions. The combination of adequate moisture retention and nutrient cycling creates an environment more conducive to plant growth, supporting species diversity. Conversely, the more arid regions, where soil moisture is limited, foster plant communities adapted to drought conditions, with specialized root systems and slower growth rates.

Figure 2: Ecoregions of Utah (Woods et al., 2001). Screenshot of Bryce Canyon Region and Corresponding Map Key and Description.





19. Wasatch and Uinta Mountains

20. Colorado Plateaus

The climate data from Carr et al. (2022) indicate a gradual decline in snowfall over the years, which impacts the moisture content of the soils, particularly in the higher elevations of the park. The decrease in snowfall, combined with reduced evapotranspiration has led to a shift in vegetation patterns, favoring species that can adapt to drier conditions (Hildebrand, 2012). These shifts suggest that soil properties, influenced by both natural and anthropogenic factors, are critical for understanding plant responses to climate change in the region.

Discussion

The soils of Bryce Canyon are shaped by complex interactions of climate, topography, and parent material, all of which affect plant adaptation. The slower-draining soils in lowland areas (e.g., Brycan soils) provide more stable moisture conditions, supporting a variety of plants, including grasses, forbs, and shrubs. In contrast, the coarser soils in upland areas (e.g., Paunsaugunt gravelly loam) promote plant species that are adapted to drier conditions, such as pinyon pine and Utah juniper, which have specialized root systems for accessing deep soil moisture.

Woods et al. (2001) further emphasize that areas with exposed bedrock, such as canyon walls and structural benches, often have shallow, rocky soils that are less conducive to plant growth. These regions are dominated by species that can withstand harsh conditions, such as low nutrient availability and high evaporation rates.

The study also suggests that soil-forming processes, including erosion, weathering, and deposition, play a fundamental role in determining which plant species can survive in different parts of the park. For example, soils formed from limestone parent material tend to be more alkaline and less fertile, limiting plant growth. Meanwhile, soils formed from sandstone or shale may be more suitable for supporting diverse vegetation due to their more neutral pH and better moisture retention (Marine, 1963).

Conclusion

This study confirms that soil-forming processes significantly impact plant growth and adaptation in Bryce Canyon National Park. The soils, which range from fine sandy loams to gravelly, rocky types, create distinct microhabitats that favor different plant species. The decrease in snowfall, coupled with climate change trends, further exacerbates the challenges faced by plant species in the park, especially in areas with less moisture-retentive soils. Moving forward, a more comprehensive study could involve collecting soil moisture data in real-time across various soil types to better understand seasonal variations and their impact on vegetation health. Additionally, examining the role of soil microbes and their interaction with plant roots could provide deeper insights into the resilience of plant species to changing soil conditions.

References

Graybosch, Robert A. and Buchanan, Hayle (1983) "Vegetative types and endemic plants of the Bryce Canyon Breaks," Great Basin Naturalist: Vol. 43 : No. 4 , Article 19. Available at: https://scholarsarchive.byu.edu/gbn/vol43/iss4/19

Carr, A., Stark, A., Grinstead, A., & Frost, M. (2022). *Bryce Canyon Water Resources: Monitoring Vegetation Health and Water Availability in Bryce Canyon National Park for Drought Stress Mitigation Planning*. NASA DEVELOP National Program Maryland-Goddard.

Hildebrand, T. (2012). *Correlation Between Wetland Vegetative and Microbial Community Diversity of Bryce Canyon National Park's Southern Regions–Phase I*. Colorado Plateau Cooperative Ecosystems Studies Unit; Agreement No. H1200-09-0005.

Marine, I., 1963, Ground-water resources of the Bryce Canyon National Park area, Utah, with a section on the drilling of a test well: Hydrology of the Public Domain (Water Supply Paper 1475), p. 441-477.

Stein, S. J. (1988). FIRE HISTORY OF THE PAUNSAUGUNT PLATEAU IN SOUTHERN UTAH. *The Great Basin Naturalist*, *48*(1), 58–63. http://www.jstor.org/stable/41712409

Web Soil Survey (WSS). (n.d.). Web Soil Survey - Home

Woods, A.J., Lammers, D.A., Bryce, S.A., Omernik, J.M., Denton, R.L., Domeier, M., and Comstock, J.A. (2001). Ecoregions of Utah (color poster with map, descriptive text, summary tables, and photographs): Reston, Virginia, U.S. Geological Survey (map scale 1:1,175,000).