How Does Dead Matter and Leaf Litter Affect Soil Moisture and Plant Growth?

Cailyn Chen[1], Nwanneka Odikagbue[2], Sudipto Halder[3]

Natural Areas Conservancy

[1] Benjamin N. Cardozo High School [2] Thomas A. Edison CTE High School [3] Thomas A. Edison CTE High School

Introduction

When decomposed, leaf litter serves as a source of energy and nutrients in forest and terrestrial ecosystems, accounting for approximately 70% of dead organic matter (Zhao et al., 2022). An experiment by Lopez Iglesias et al. showcased that litter from the Ailanthus altissima and Ficus carica species significantly boosts plant growth (2014), which led us to believe that the presence of leaf litter in an area allows for higher soil moisture, and eventual plant growth. For our study, we compared the percentage of leaf litter to soil moisture and the amount of growth in the herbaceous layer to analyze any present patterns in Forest Park , Queens. For our data sampling, we looked at a frequented area (site 1) and an isolated area (site 2). By studying the impact of leaf litter on vegetation and soil moisture, we can further understand what conditions are ideal for plant growth within our urban natural areas. To further understand the impact of leaf litter on plant growth, we examined 2D cover percentage data, the organic components found on the surface level of our subplots, the understory tally of the herbaceous population, and moisture influxes. Following preceding studies and initial observations made upon our two subplots, we hypothesize that more dead plant matter and foliage in an area would result in a higher soil moisture range and plant growth.

Recording the 2D cover data of our subplot.

Materials

Plot Protocol
- Chaining pin
- Transect tape
- Compass
- 8 pin flags
- Sharpie

Subplot Protocol
- Quadrat (1 x 1 m)
- iNaturalist
- DBH Tape
- Ruler
- Camera

Soil Moisture Protocol
- Luster Leaf Digital Moisture Meter

Methodology

Plot Protocol
1. A chaining pin was inserted into the ground at the plot center.
2. Transect tape and a compass was used to measure 5m lines from the centerpoint towards each cardinal direction.
3. A pin flag was placed along each line at the 2.5m and 5m marks in each cardinal direction.
4. Each pin flag at 5m was labeled with its respective cardinal direction (N, E, S, W).

(Natural Areas Conservancy, 2025)

Subplot Protocol
1. A quadrat was set up by putting its bottom left corner at each 2.5m ordinal point (NW, NE, SW, SE) to determine each subplot placement.
2. For each quadrat, data was recorded:
   a. An approximate percentage of each feature of the 2D cover percentage was recorded (leaf litter, vegetation cover, live wood, and bare soil)
   b. Live vegetation was identified and counted using iNaturalist. If it was unidentifiable, it was recorded as unknown. Woody seedlings and sprouts were considered understory if they had a DBH <2 cm.
   c. A ruler was held vertically onto the soil at 2.5m and 5m until there was resistance to measure the leaf litter depth.
   d. Subplot photos were taken and saved for reference.

(Natural Areas Conservancy, 2025)

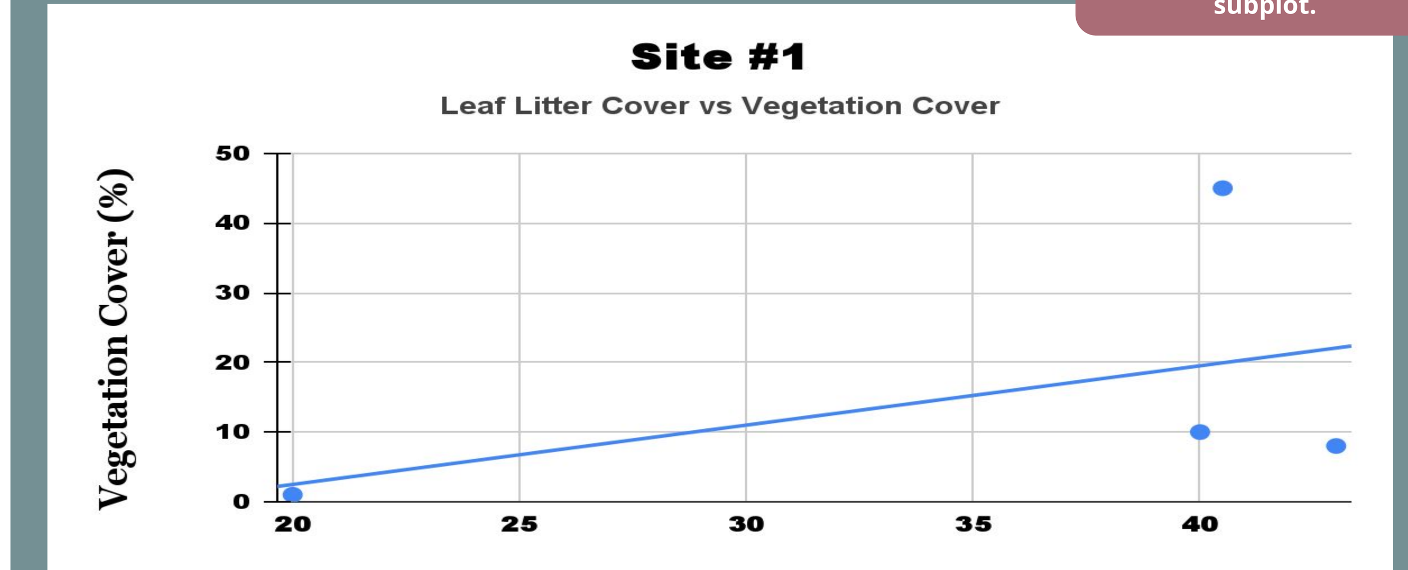
Soil Moisture Protocol:
1. Four arbitrary spots in the boundaries of each quadrat plot (NW, SW, NE, SE) were selected for soil moisture measurement.
2. For each measurement, the Luster Leaf Digital Moisture Meter probe was inserted vertically, approximately 2/3rds of the way into the soil to measure soil moisture.
   a. The meter readings were written down when the reading on the display of the meter was constant for about 4 - 6 seconds. The meter readings range from 0 to 10 with 0 being dry and 10 being extremely moist/wet.
3. The four measurements of each subplot were averaged to determine the final moisture reading.

Unknown Sprout

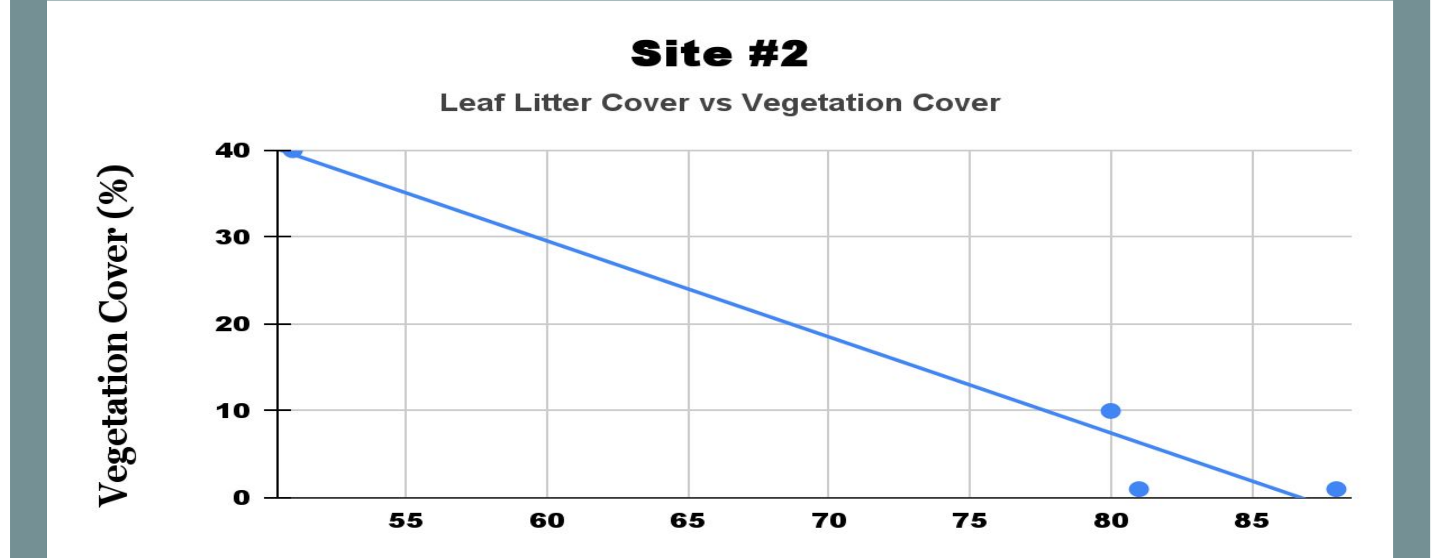
Luster Leaf Moisture Meter measurement in Site 2

Solomon's Plume

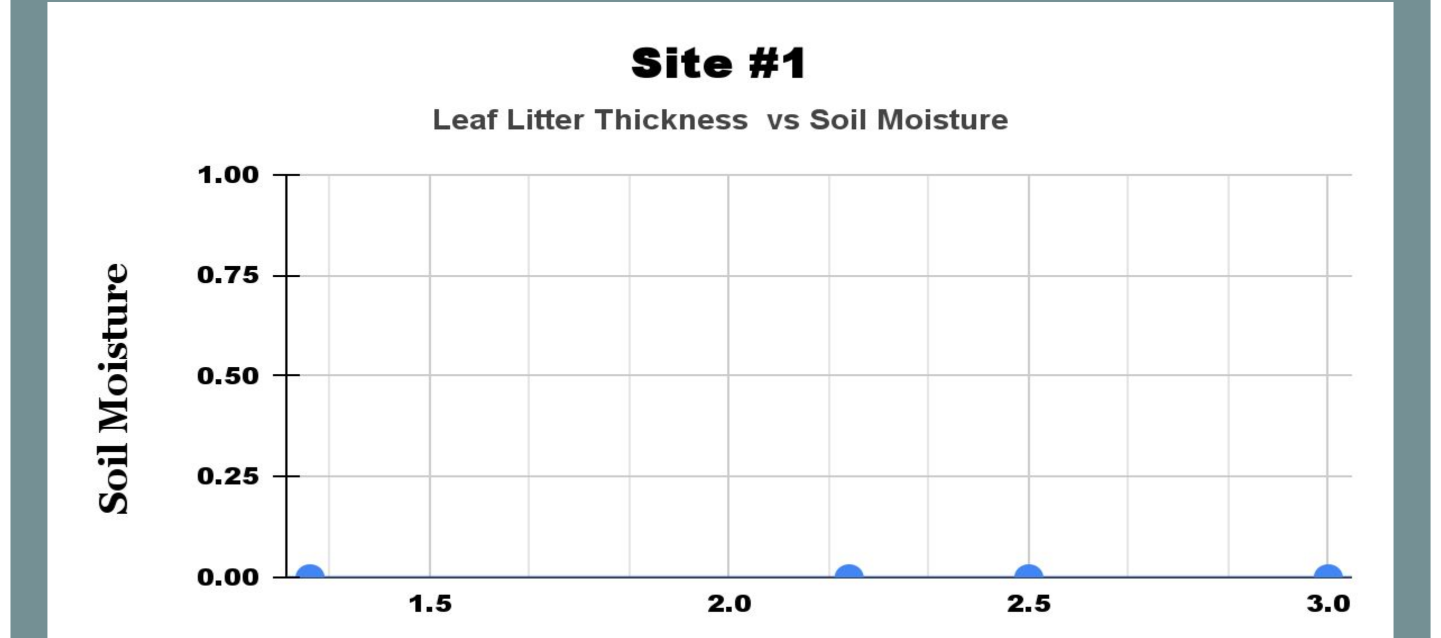
Each point records one subplot.



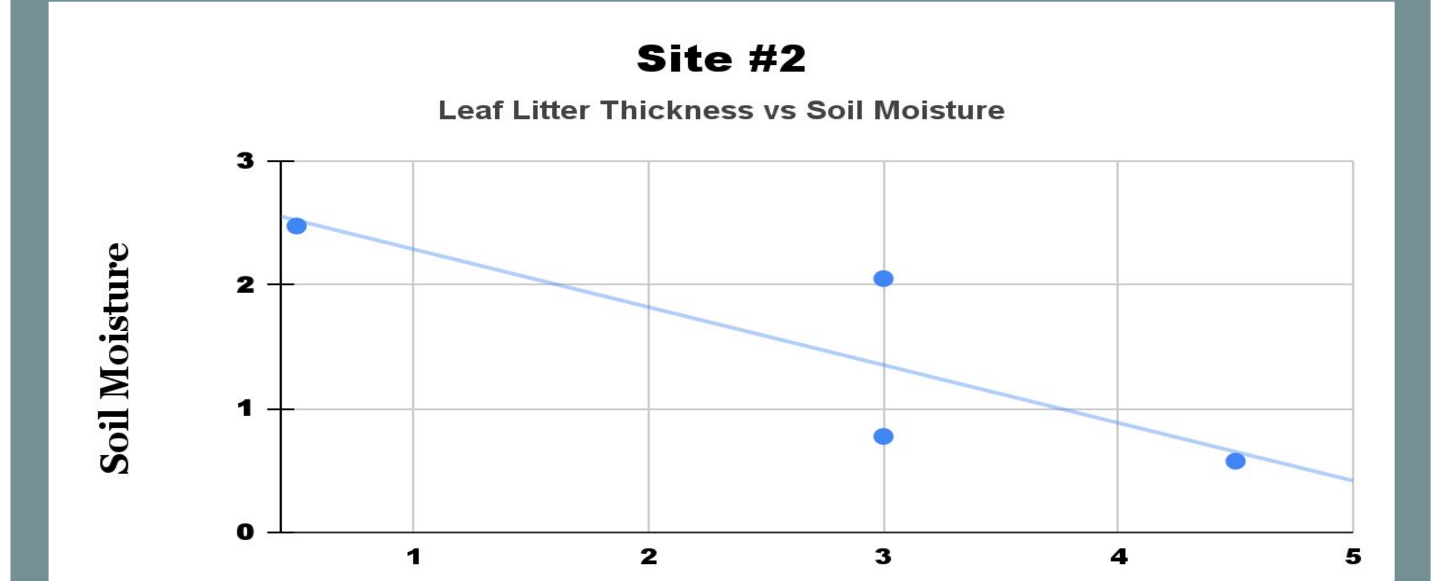
(Figure 1) Directly proportional relationship between Leaf Litter Cover (%) and Vegetation Cover (%)



(Figure 2) Inversely proportional relationship between Leaf Litter Cover (%) and Vegetation Cover (%)



(Figure 3) No relationship between Leaf Litter Thickness (cm) and Soil Moisture. All measurements are 0.



(Figure 4) Inversely proportional relationship between Leaf Litter thickness (cm) and Soil Moisture

Conclusion

Our hypothesis that leaf litter is directly proportional to soil moisture and plant growth was not supported. We thought that more leaf litter would hold onto more moisture and contain more nutrients to be poured upon the soil, promoting plant growth. Instead, we found that there is likely an ideal percentage of leaf litter that would allow for a higher percentage of vegetation cover in the two sites measured in Forest Park, Queens. In Figure 1, the minimum/maximum range of leaf litter is 20% to 45%, with a general trend that suggests that vegetation cover increases as the leaf litter in the area increases. Contrary to this trend, in Figure 2, the understory vegetation cover decreased as leaf litter increased with a range of leaf litter from 50% to 90%. Although these graphs show opposite relationships between the two factors, the maximum range for plant growth is seen when leaf litter covers around 45-50% of an area. Putting figure 1 and 2 together, there is a midpoint that showcases high amounts of vegetation when about 45% of leaf litter was present. We can thus conclude that the ideal leaf litter cover for the best plant growth is 45–50%.

Regarding moisture, our readings seemed unclear and were impacted by site conditions and features. For Site 1, noted in Figure 3, our average moisture level of each ordinal subplot was 0. Figure 4, showcased that soil with high amounts of leaf litter had less moisture. This does not support our hypothesis, and we believe that our limitations do not give us an evident result. There are many factors and differences between the two sites that we cannot account for. Two major distinctions between Site 1 and Site 2 are that Site 2 has a flatter landscape and a canopy with higher crown vigor. Any runoff from rain would slide down the steep slope of Site 1, leaving less water for leaf litter to trap, therefore keeping the soil dry and brittle. The closed canopy of Site 2 would result in more shade, causing less evaporation to happen, keeping the soil moist. Also, there appears to be more leaf litter in Site 2, working in our favor to be able to examine the effects.

Putting the two variables in our hypothesis to the test, we found information that we would have thought otherwise. Whether gardening or in a natural area, leaf litter is a great addition to the soil. By researching the effect of dead matter and leaf litter on plant growth, we can know the ideal change in leaf litter to make our understory as productive as can be. This can therefore promote the health of our forests and provide great biodiverse habitats for native wildlife.

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References

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