Examining the Effects of Urbanization on Soil Characteristics in Portland, Oregon's Forest Park

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Background Information

•Forests are beneficial to people in urban environments because they reduce heating and cooling costs, improve air quality, reduce flooding, increase real estate values, reduce noise levels, and improve psychological and physical health
•The impact of urbanization on soil is not well understood
•Urban forests often have abnormally high soil temperature, low quality leaf litter, accelerated O horizon carbon cycling, and deposition of nitrogen into forests that are typically N limited
•Studies have shown urban forests to have high tree mortality rates and a lack of tree recruitment, including in Forest Park
•Lichen surveys performed in 2013 suggest high nitrogen deposition may be related to the high tree mortality rates

Goals of the Study

•Contribute to Dr. Broshot's urban forest ecology work by examining soil characteristics in Forest Park and at control sites
•Examine potential causes of lack of recruitment in urban forests

Hypotheses

•The nitrogen content would be greater in urban forest soils samples than at the control sites
•The soil carbon content would be greater in rural forest soil samples than at the control sites
•The C/N ratio would be greater in the rural forest control sites
•The O horizon would be deeper in the urban forest than at the control sites

Methods

- In 2014, soil samples from the A Horizon were collected from 24 long-term research sites and 8 conifer recruitment sites in Forest Park, and at 3 control sites in the Clackamas River basin
- Depth of the O horizon was measured at each site; pH was measured in the A horizon
- Collected soil samples were processed and sent to the OSU Analytical Laboratory, where they were analyzed for percent carbon, percent nitrogen, and C/N ratio

Acknowledgements

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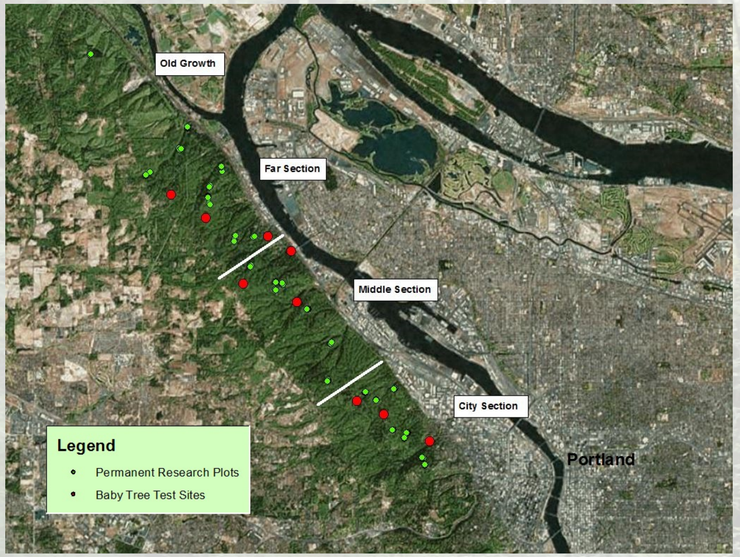

Figure 1. Map showing the locations of the permanent research plots and the baby tree test sites in Forest Park and the Old Growth (Ancient Forest Preserve).

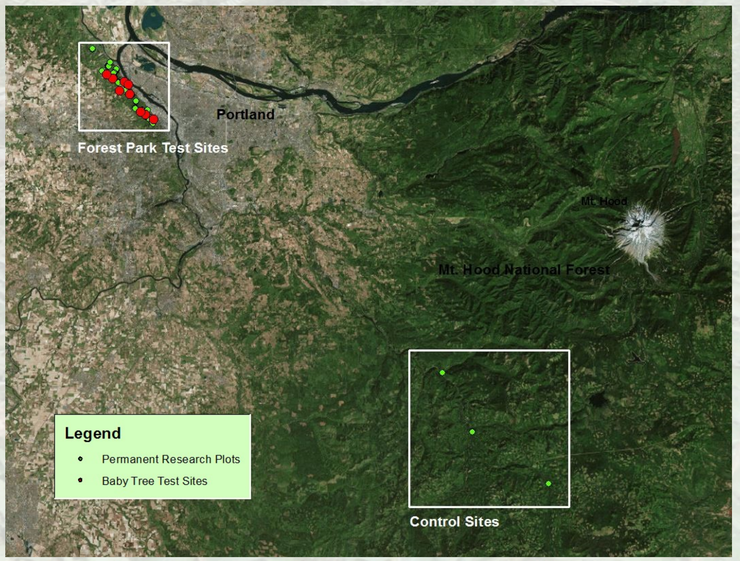

Figure 2. Map showing the location of the control sites in the Mount Hood National Forest relative to Forest Park.

Results

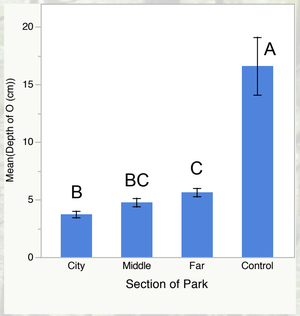

Figure 3. Mean depth of the O horizon versus location ($p<0.0001$).

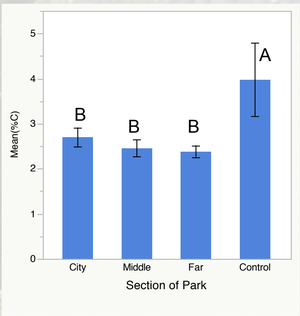

Figure 4. Mean percent C content in soil versus location ($p=0.067$).

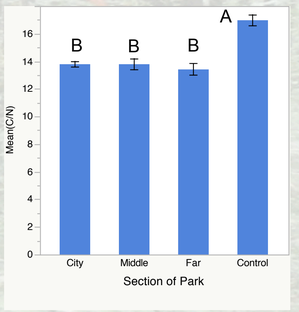

Figure 5. Mean C/N ratio versus location ($p=0.0003$).

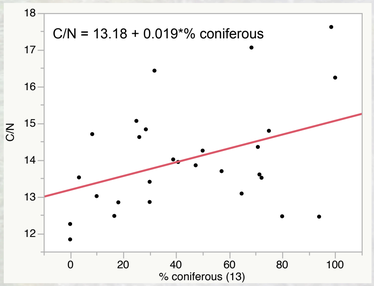

Figure 6. Regression of % coniferous trees versus C/N ratio ($p=0.0378$; $r^2 = 0.15$

Conclusions

•Depth of O is often greater in urban forests (opposite of what we found) because urban soils tend to have fewer soil organisms due to the deposition of heavy metals
•Urban leaf litter tends to decay more slowly due to repressed soil organisms and damage from ozone. This results in more carbon in rural soils (what we found)
•Higher C/N ratio in the rural soil may still be bad news, as all sites had a value < 25:1, the ratio at which soils are considered nitrogen saturated and begin leaching nitrate
•When negatively charged nitrate leaches from soil, it takes positively charged calcium, magnesium, and potassium with it, causing the soil to become increasingly infertile and more acidic
•Low tree recruitment may be related to the repression of soil organisms (e.g., mycorrhizae), deposition of heavy metals, or loss of soil fertility