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A look at Lichen Elemental Concentrations and Lichen Diversity from Edge to Interior in Canco Woods

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ABSTRACT

Many species of lichen have the ability to acquire nutrients from the atmosphere and to accumulate aerosolized particulates and atmospheric pollutants into their tissues. Studies have found that lichen exhibit species-specific tolerances for pollutants and can have large ranges, making them excellent tools for long-term monitoring of air quality *in-situ*. In this research, we present preliminary findings for elemental concentrations and lichen diversity between edge and interior sections of a small urban woodlot located in Portland, Maine.

Comparisons of species richness and diversity of lichen growing on mature red maple (*Acer rubrum*) showed little difference between edge and interior sites. However, elemental analysis of common green shield lichen (*Flavoparmelia caperata*) collected from mature Red Oak (*Quercus rubra*) revealed differences in strontium and calcium levels between edge and interior samples. Although these results are preliminary in nature, this data will help lay the foundation for future research using lichen species to assess long-term habitat health and environmental changes.

BACKGROUND

Previous studies on lichen have found :
•Sulfur dioxide from car emissions has the greatest impact on presence and recovery of species (Loppi et al., 2004).
•Lichens were reported to be sensitive to both SO_x and NO_x and their diversity decreased around urban areas (Giordani, 2007).
•Lichens near roads tend to have higher concentrations of lead, cadmium, and zinc (Jie Liu et al., 2016).
•Examination of shield lichen using X-ray fluorescence spectrometry reported higher levels of lead and copper in urban areas (Gunathilaka et al., 2011).

The majority of studies focus on lichen diversity or elemental composition in lichen, but there are very few studies examining whether there are significant differences in elemental concentrations and lichen diversity from forest edge to interior.

In this study we tested the hypothesis that elemental concentrations would significantly differ in lichen collected from edge and interior trees in an urban forest setting.
Similarly, we hypothesized that lichen diversity would be greater on interior trees vs. edge trees in an urban forest setting.

METHOD

- *Field Collection Elemental Analysis*. *Flavoparmelia caperata* samples were collected from *Quercus rubra* in Canco Woods, a 12.75 acre forest located in Portland, Maine at 0, 8, 16, 32, 64 and 128 meters from the forest edge following methods described by Hilmo and Holien (2002).
- 14 samples were collected using metal tweezers and stored in plastic bags at -18ºC for 24 hours. Samples were then dried in a drying oven at 75ºC for 24 hours.
- Lichen were ground to a powder using a coffee grinder and mortar and pestle.
- Samples were then placed in plastic XRF cups (23 mm I.D.) covered with Mylar film.
- Elemental composition was determined using an x-ray fluorescence (XRF) spectrometer (XL3t Thermo Fisher, Waltham).

- *Field Collection Diversity*. All lichen species between 3 and 6 feet were identified on every 3rd *Acer rubrum* at 0, 8, 16, 32, 64 and 128 meters from the forest edge.
- A total of five trees were sampled at each depth gradient for replication.
- Lichen species were determined using *Lichens of the North Woods* by Joe Walewski.
- Lichen species diversity was determined using ANOVA and Shannon Diversity Index (*H'*).

RESULTS

Elemental Concentrations

Detectable levels were found for the heavy metals lead, iron, copper, zinc, calcium and strontium.
•Average levels for lead were 115.94 ppm at the 0-8 meter gradient, 84.05 ppm at the 16-32 meter gradient, and 117.58 at the 64-128 meter gradient (see Fig. 1).
•Average iron levels were 5147.69 ppm at the 0-8 meter gradient, 3418.88 at the 16-32 meter gradient, and 3349.01 at the 64-128 meter gradient (see Fig. 2).
•Strontium was the only heavy metal to have a statistically significant difference from edge to interior, reported average levels of 84.61 ppm at the 0-8 meter gradient, 85.53 ppm at the 16-32 meter gradient, and 50.99 ppm at the 64-128 meter gradient (see Fig. 3). The p-value for strontium was 0.016.
•Calcium also reported a statistically significant difference from edge to interior, with average levels of 135827.3 ppm at the 0-8 meter gradient, 126430. 89 ppm at the 16-32 meter gradient, and 81525.49 ppm at the 64-128 meter gradient (See Fig. 4). The p-value for calcium was 0.033

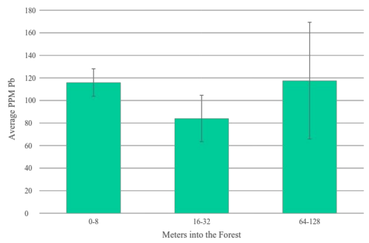

Figure 1. Average lead levels in lichen samples per gradient measured in PPM

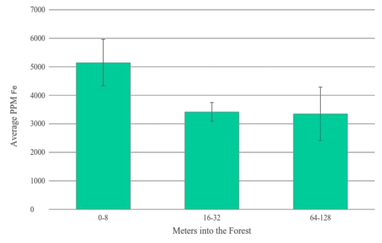

Figure 2. Average iron levels in lichen samples per gradient measured in PPM

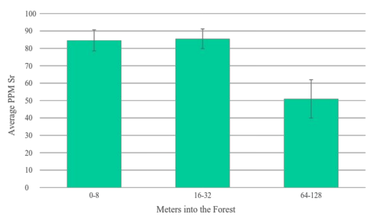

Figure 3. Average strontium levels in lichen samples per gradient measured in PPM

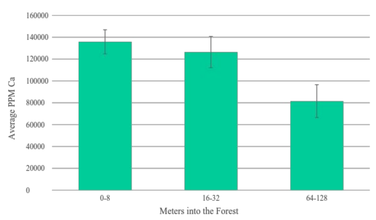

Figure 4. Average calcium levels in lichen samples per gradient measured in PPM

Lichen Diversity

Results obtained from the Shannon Diversity Index (*H'*) for Fluffy Dust, Common Green Shield, and Rough Speckled Shield (see Fig. 5) found no significant difference of diversity between the three species from edge to interior.
•S.D.I for interior was H= 0.87
•S.D.I for edge was H= 0.90

ANOVA analysis for number of lichen species per tree found a statistically significant difference in number of lichen species present from edge vs interior (see Table 1). The p-value for species richness was 0.001

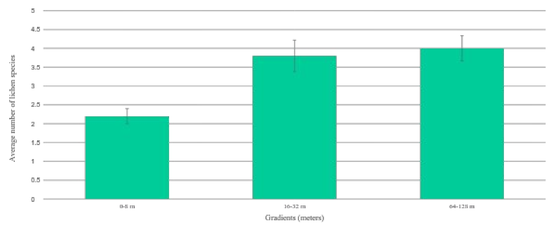

Figure 5. Average number of lichen species per gradient

P-Value= 0.001

Figure 5. Common species of lichen found in Canco Woods. The species pictured from left to right; *Lepraria lobificans* (Fluffy Dust), *Flavoparmelia caperata* (Common Green Shield), *Punctelia rudecta* (Rough Speckled Shield).

CONCLUSION

Elemental Concentrations
•Based on results from the ANOVA test, we reject our hypothesis that there is a significant difference in elemental composition in lichen from edge vs interior trees.
•Results reported for strontium and calcium show a significant difference in concentration and might be a topic of interest in future studies.
•While there was no significant difference in the concentrations of lead, copper, and zinc, the levels found in the lichen were reported as enhanced from background levels (Nieboer & Richardson, 1981).
•Future studies examining elemental concentrations of lichen could use a more sensitive instrument that measures ppb for greater accuracy.

Lichen Diversity
•Results from the ANOVA test for statistical significance on lichen species diversity from edge to interior allows us to accept our hypothesis that species diversity is greater on the interior than the edge.
•Common Green Shield was more present on forest edge than interior, while Fluffy Dust was more present towards the interior.
•Similar to results from Giordani (2007), our results indicated a decrease of lichen diversity towards the road edge.

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