Lichen Diversity at the Westshore Campus: Impact of Highway Proximity

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Introduction

Northeast Ohio is home to a healthy population of lichens-symbionts between a fungus and a photosynthetic algae (Figure 1).

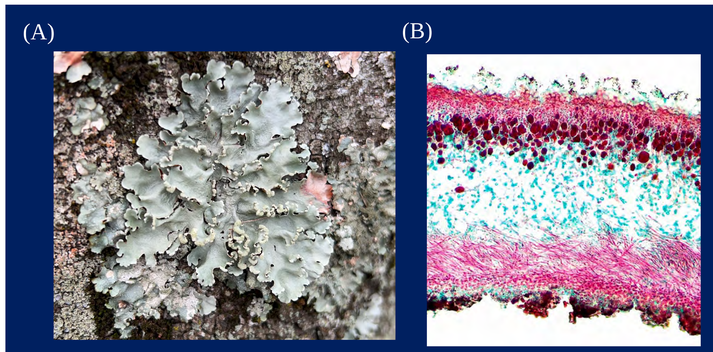

Figure 1. (A) Greenshield Lichen (Flavoparmelia caperata) common to Ohio. (B) Microscopic image with algal cells stained red and fungal hyphae in blue.

Lichens are exceptionally sensitive to hostile elements in the environment (Yang J., et. al) especially noxious elements common in air pollution like nitrogen dioxide (NO_2) and sulfur dioxide (SO^2) which arise from the burning of fossil fuels. As such, lichens are pollution bioindicators. Monitoring and reducing environmental pollution is a key issue for sustainable environment (United Nations General Assembly 1987). The Westshore Campus is located adjacent to a major highway and as such, air quality may be poor in certain parts of the campus. Lichen diversity on the trees around the campus could help indicate which parts of the campus are ideal for outdoor activities.

Hypothesis

Lichens are pollution bioindicators and their diversity and density can help inform local air quality.

In this experiment, the lichen density and diversity were measured on trees in two locations– one farther and one near to I-90 - to measure the impact of proximity to noxious environmental gasses on lichens. Two predictions were made:

1. Lichens will be less diverse on trees near the highway.
2. Lichens will be less dense on trees near the highway.

Materials & Methods

Tree Selection

Tree pairs with similar circumference were chosen for measurement of lichen density and diversity (n = 8). Each pair differed in their proximity to the highway with one close to I-90 and one far from I-90 (see figure 1). The cardinal direction in which the lichen was measured as well as the tree circumference were matched for paired trees.

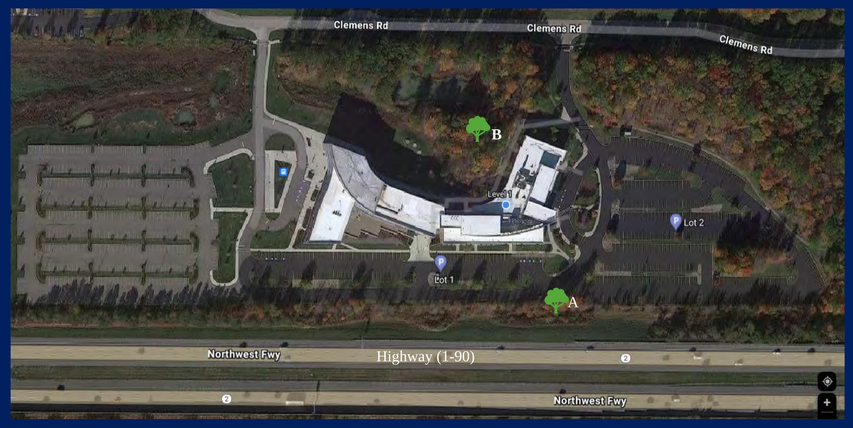

Figure 2. Google Map view of the Westshore Campus illustrating location of tree selection. A. Near Highway. B. Far from Highway (outdoor classroom location).

Lichen Measurement

Each tree was inspected for 3 types of lichens (Figure 2); crustose, foliose, and fruticose as well as moss or bare bark using a density grid (Figure 3). The grid was laid on the tree and the presence of lichen, moss, or bare bark inside circles was tallied. A paired T-test was used to determine the impact of highway proximity on lichen density ($p < 0.05$ was set as significant).

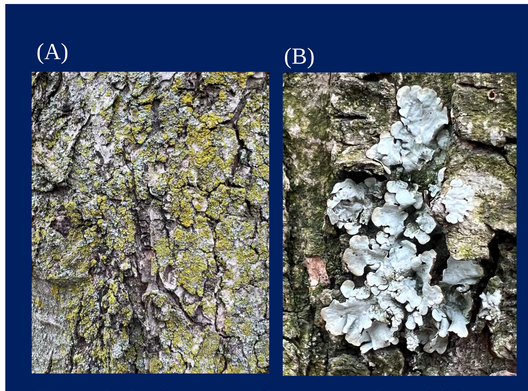

Figure 3. Study trees with crustose (A) and foliose (B) lichens.

Figure 4: Lichen density grid

Results

Trees further from the highway had a higher density and diversity of lichens, suggesting better air quality

The trees far from the highway had an average lichen tally of 41.8+/- 13.3, while the trees near the highway had significantly lower lichen density (9.0 +/- 16.0). t (4) = 16.2, $p = 0.0002$ (Figure 5).

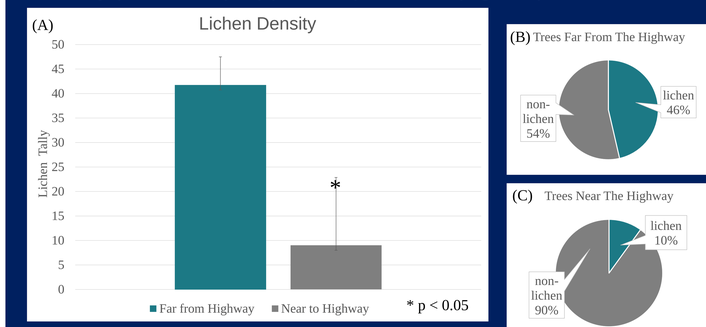

Figure 5. (A) Bars represent mean lichen tallies on trees near or far from the highway with the error bars representing the standard error of the mean. Trees far from the highway were nearly 50% covered with lichens (B), while trees near the highway were only 10% covered (C).

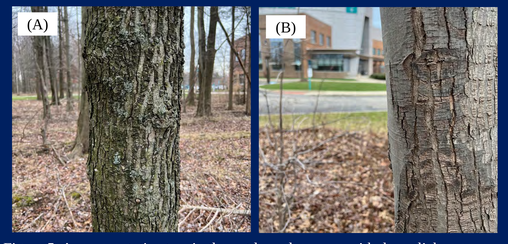

Figure 5. A representative tree in the outdoor classroom with dense lichen cover (A) compared to a tree near the highway (B).

The difference in lichen density in trees near the highway compared to in the outdoor learning lab behind campus is easy to see in these two representative photographs.

Discussion

The data confirmed the hypothesis that lichens are bioindicators of pollution. The lichen tree coverage in the outdoor learning lab was robust compared to the coverage on trees beside the highway. The study regions are close in proximity (250m), but the trees in the outdoor learning lab are shielded from the highway by the building. The exhaust fumes from the highway was apparent to the individuals conducting the study; there was a strong odor in the region. Long-term exposure to major roadway pollution, defined as spending substantial time within 200m of highways has been shown to elevate risk for asthma and other cardiorespiratory health issues (Brugge, et. al, 2007). Because Westshore Campus is adjacent to a highway, it would be appropriate for sustainability plans to include a focus on air quality both indoors and during outdoor activities. This study can help by alerting the campus community on the utility of lichen density on campus trees on air quality. Future directions for this research will be to use sensors to detect air quality and particulates related to traffic pollution.

References

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