LICHENS OF PHILADELPHIA

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Introduction:

Lichens are sensitive to pollution, making them excellent indicators of air quality. Systems of using lichen community structure for air quality monitoring are in widespread use throughout the world (reviewed by Conti and Cecchetti, 2001 and Nimis et al., 2002), including the northeast (Will-Wolf et al., 2015) and mid-Atlantic regions of the United States (Will-Wolf et al., 2014).

Urban areas generally have very poor air quality, and correspondingly low species diversity and cover (Gries, 1999). The absence of lichens from densely populated urban centers in the northeastern U.S. has been well characterized since the pioneering work of Brodo in New York City (1968). However, there is evidence that lichens are responding positively to recent improvements in urban air quality in the northeast (Howe and Lendemer 2010).

We sought to characterize the cover and diversity of epiphytic lichens on trees in the Philadelphia-Camden urban matrix, and to relate those patterns in lichen communities to patterns in human population communities in the area.

Goals:

Some of the questions we hope to answer with this Lichens of Philadelphia research project are simple biological questions and others are more complex socio-spatial questions. The data analysis we have conducted to date has addressed questions 1 and 2.

(1) How does lichen diversity and cover change with distance from the center of an urban area?

(2) Are there tree habitat types that lead to richer lichen communities in cities?

(3) Are there thresholds of human population density below which there are obvious increases in lichen cover and diversity?

(4) At constant human population density, are there differences in lichen cover with different socioeconomic conditions (household income)?

(5) Do lichens respond most strongly to land use on a local (100m) scale, or on the landscape scale (1000m)?

Methods:

We created a lichen survey array around Philadelphia, PA, as pictured (Figure 1), with 8 transects, each 45° apart around Philadelphia, each consisting of a monitoring point every 2 miles for 14 miles from downtown Philadelphia (City Hall). These transects include sites with many different land use types, economic conditions and proximity to industrial operations, major roads and wetlands.

At each monitoring point, we selected the 4 closest trees of different species that were at least 17cm dbh. We included only hardwood trees in the analysis, as chemical composition and ephiphyte communities on conifers are distinct. We also excluded London plane tree and river birch since these trees slough off bark, providing poor habitat for epiphytes. Monitoring points that included no nearby trees (example: on Delaware River) were moved to the closest suitable habitat.

On each tree, we collected data on the lichen species present and percent cover in 4 plots that are each x 10cm wide x 25cm high on the N, E, S, and W sides of the tree, 1.37m from the ground. We recorded the tree species and tree diameter at breast height, as those factors were correlated with lichen diversity in the study of urban lichens of Cincinnati by Washburn and Culley (2006).

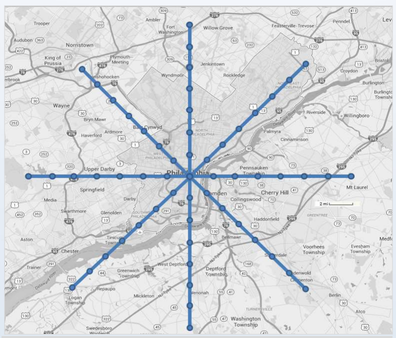
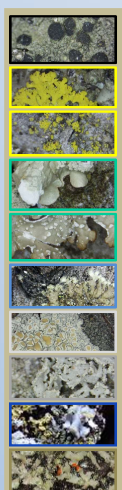


Figure 1: Philadelphia-Camden transect locations with survey points indicated as circles.

Figure 4. Habitat types

Results and Discussion:

We found many lichens common to urban areas of the northeastern United States, many of which (indicated by*) were found by Allen and Howe (2016) on Freshkills Park in Staten Island, NY.



Amandinea polyspora (Willey) E. Lay & P. May

Candelaria concolor (Dicks.) Arnold*

Candelariella efflorescens R. C. Harris & W. R. Buck

Flavoparmelia caperata (L.) Hale*

Punctelia caesiana Lendemer & Hodkinson

Hyperphyscia adglutinata (Flörke) H. Mayr.& Poelt

Lecanora strobilina (Sprengel) Kieffer*

Physcia millegrana (Degel.)*

Physciella chloantha (Ach.) Essl.*

Phaeophyscia rubropulchra (Degel) Essl.*

Known nitrophilic lichens, *Candelaria concolor* (Dicks.) Arnold, and *Physcia millegrana* (Degel.) represented most of the cover in the downtown area (Fig. 3), but were present throughout the surveyed area, especially on trees in parks, on roadsides, or near streets (Fig.2).

Large foliose lichens including *Flavoparmelia caperata* were absent from central Philadelphia, and were found intermittently at increasing frequencies farther from the city but was found intermittently on trees at least 6 miles away (Fig3).

Figure 2: Average epiphyte cover on trees by habitat

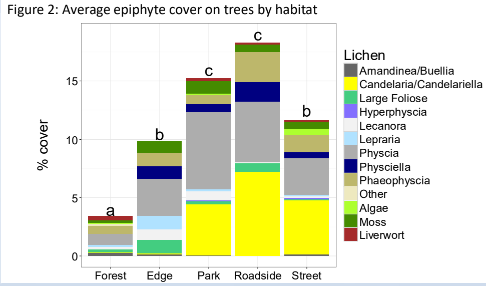
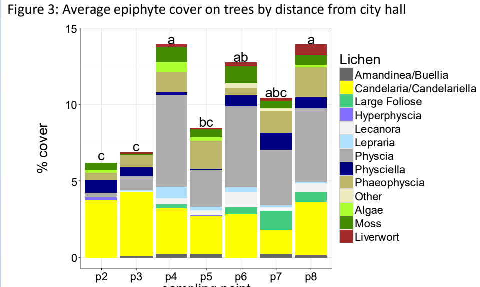


Figure 3: Average epiphyte cover on trees by distance from city hall



Results and Discussion:

We found that lichen cover was significantly related to light availability. Sites in heavy shade (forest) had the least lichen cover, whereas sites where more sunlight hit the bark had higher cover. There was no significant difference in lichen diversity or richness between habitat types.

We found lichen cover 14 miles from the city center was significantly different from lichen cover at the urban center (Fig. 3), though lichen richness and diversity were not affected.

The southernmost transect had significantly higher lichen cover and diversity than the NE transect. This makes sense since the population density does decrease linearly with distance. The next step is to compare the lichen community variables directly with population densities.

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Literature Cited:

Allen, J.L. and N.M. Howe, 2016. Landfill Lichens: A checklist for Freshkills Park, Staten Island, NY *Opuscula Philolechenum* 15:82-91.

Brodo, I. M. 1968. The Lichens of Long Island, New York: A Vegetational and Floristic Analysis. *New York State Mus. & Sci. Service Bulletin* 410: 1-330. Albany, New York.

Conti, M.E., and G. Cecchetti. 2001. Biological monitoring: lichens as bioindicators of air pollution assessment - a review. *Environmental Pollution* 114: 471-492.

Gries, C. 1999. Lichens as indicators of air pollution. In: Nash III, T.H. (Ed.), Lichen Biology. Cambridge University Press, Cambridge, pp. 240–254.

Howe, N.M., and J. C. Lendemer, 2010. The recovery of a simplified lichen community at the Palmerton Zinc Smelter after 34 years. In: A Lichenological Legacy – Festschrift Thomas H. Nash III. S.T. Bates, F. Bungartz, R. Lücking, M.A. Herrera-Campos & A. Zambrano (eds.). *Bibliotheca Lichenologica* 106: 120–136.

Nimis, P. L., C. Scheidegger and P. Wolseley (eds.) 2002. Monitoring with lichens–monitoring lichens. NATO Science Series. Kluwer Academic Publishers, The Hague, Netherlands.

Washburn, S. J. and T. M. Culley. 2006. Epiphytic Macrolichens of the Greater Cincinnati Metropolitan Area — Part II : Distribution , Diversity and Urban Ecology. *The Bryologist* 109 (4): 516–26.

Will-Wolf, S., M. P. Nelsen, M. T. Trest, K. Rolih, A. Reis, and S. Jovan. 2014. Lichen community indices for response to climate and air quality in the Mid-atlantic states, U.S.A. Internal USDA FIA report, October 2014.

Will-Wolf, S., S. Jovan, P. Neitlich, J.E. Peck, and R. Rosentreter. 2015. Lichen-based indices to quantify responses to climate and air pollution across northeastern U.S.A. *The Bryologist*, 118(1):59-82.