Secondary Biomonitoring of Heavy Metal Pollutants in Ogden, Utah


Margarita Rivera, Dr. Heather Root

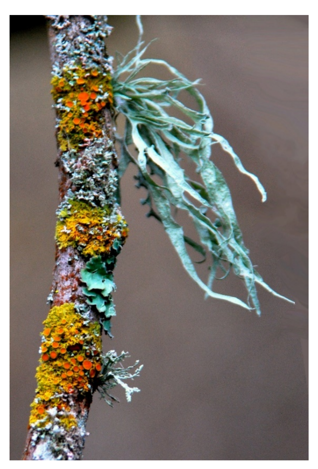
Weber State University Botany Department, Ogden, UT, USA

Introduction

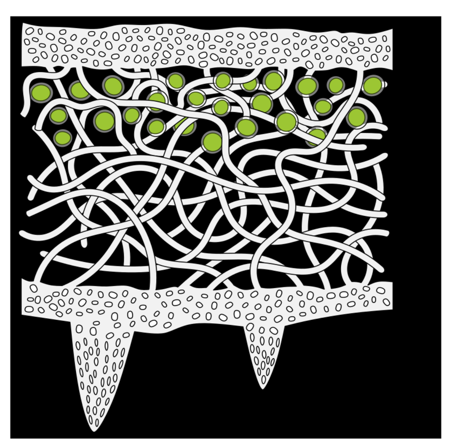
Lichens have been widely used to help determine the air quality in urban environments. During the summer of 2016, Weber State University's Botany Department conducted a biomonitoring of Ogden's air quality using lichen analysis across a grid in Ogden Utah. The results identified several locations with high concentrations of heavy metal pollutants such as arsenic, lead, cadmium, and chromium, which have known negative human health effects. Some of these locations that showed high levels of heavy metal pollutants were in neighborhoods or public recreational spaces. During the summer and fall of 2019, I conducted a secondary biomonitoring from the nine high concentration areas of the heavy metal pollutants. A new site was added to my research where there was little to no data of lichen samples from the previous study. A total of 58 lichen samples were collected from the ten sites. The expected result for this research is to examine the spatial distribution and potential sources of airborne heavy metals across Ogden. By combining the secondary biomonitoring result to the first biomonitoring data we can potentially narrow down the specific locations of where the pollutants and their respective sources.

Image by PIXABAY

What is a Lichen



This Photo by Unknown Author is licensed under CC BY-SA



Cross section of foliose lichen: The cortex is the outer layer of tightly woven fungus filaments (hyphae) with a photobiont layer has photosynthesizing green algae. Nefronus - Own work

This Photo by Unknown Author is licensed under CC BY-SA-NC

A lichen are a mutualistic symbiotic relationship between three organisms: fungi, algae and/or cyanobacteria. Unlike plants, lichens lack waxy cuticles and roots. They absorb their nutrients from the atmosphere, like a sponge absorbing water. With the high capacity of their cation exchange, they can hold positively charged ions, like pollutants such as heavy metals. Lichens can be found in many environmental conditions, and can grow on almost any surface. t is estimated that 6% of Earth's land surface is covered by lichens. (McCune, 2007)

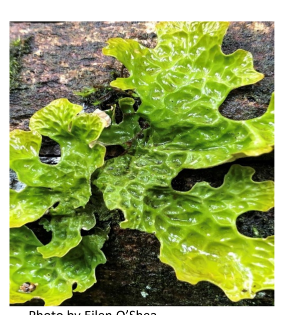


Photo by Eileen O'Shea

This Photo by Unknown Author is licensed under CC BY-SA

Photo by Eileen O'Shea

Study area and hypothesis

Photo take by Margarita Rivera site MR 2B from 2019 research. Close to the Ogden River on the West Side of railroad track.

Photo take by Dr. Root on Plot 11 from the 2016 research. Plot is located north of Madison Elementary in Ogden, UT.

Photo taken by Margarita Rivera of site MR 2E from the 2019 research. Close to The Kayak Park on the West side of Ogden, UT.

The ten sites where this study took place were located in Ogden Utah. It is in the Western region of the United States, just north of Salt Lake City. The ten sites were selected from a previous systematic sampling grid that was conducted during the summer of 2016 by Matthew Haithcock. The 2016 research, provided 61 sampling plots that overlaid across Ogden. The rang of the grid ran from 23rd street to 36th street (north to south), and from the Bonneville Shoreline trail (mountainside) to Fort Buenaventura (east to west). Out of the 61 sites, I chose the sites that contain highs levels of toxic metals that are dangerous to humans, for example arsenic, cadmium, chromium and lead.

Hypothesis: That there is a correlation between the secondary biomonitoring results to the first biomonitoring data.

Methods

Picture take by Margarita Rivera. Looking at X. montana through a dissecting microscope.

Picture taken by Dr. Root of tree with some lichen.

Xanthomendoza montana. This Photo was taken by I'm lichen your style .CONOR LAWLESS / FLICKR

Picture take by Dr. Root of a tree with more lichens.

Photo taken by Dr. Root of Matt during the 2016 research collecting lichens using titanium tweezers and putting them in a sterilized Kapak bag.

The lichen that was used regarding the 2016 and 2019 research projects was Xanthomenoza montana. This lichen is mostly found on bark, both hardwoods and conifers and in fairly open dry habitats. The lichens from both 2016 and 2019 were collected during the months of July-September. They were collected by wearing sterile gloves and using titanium tweezers sterilized with reagent 70% alcohol. The samples ranged from ranged from grams of raw collected material. If no suitable lichen was found at a grid point, we recorded that this point had insufficient lichen. Most samples were collected from on public property, such as parks. If a sample was located on private property, permission to collect was requested and a note was made that the collection was made on private property. Collections were made from trees at least 1.5 meters from the ground to minimize sample contamination due to animal disturbance, passing cars, and dust. After the lichen samples were collected, they were placed in sterile metalized polyester Kapak bags. The bag were then folded, sealed with lab tape, labeled with collection number, address, and date and stored at 4°C. At each collection site, collection number, GPS location, tree genus, site characteristics, tree DBH, tree location, and any collection notes were recorded on a data sheet.

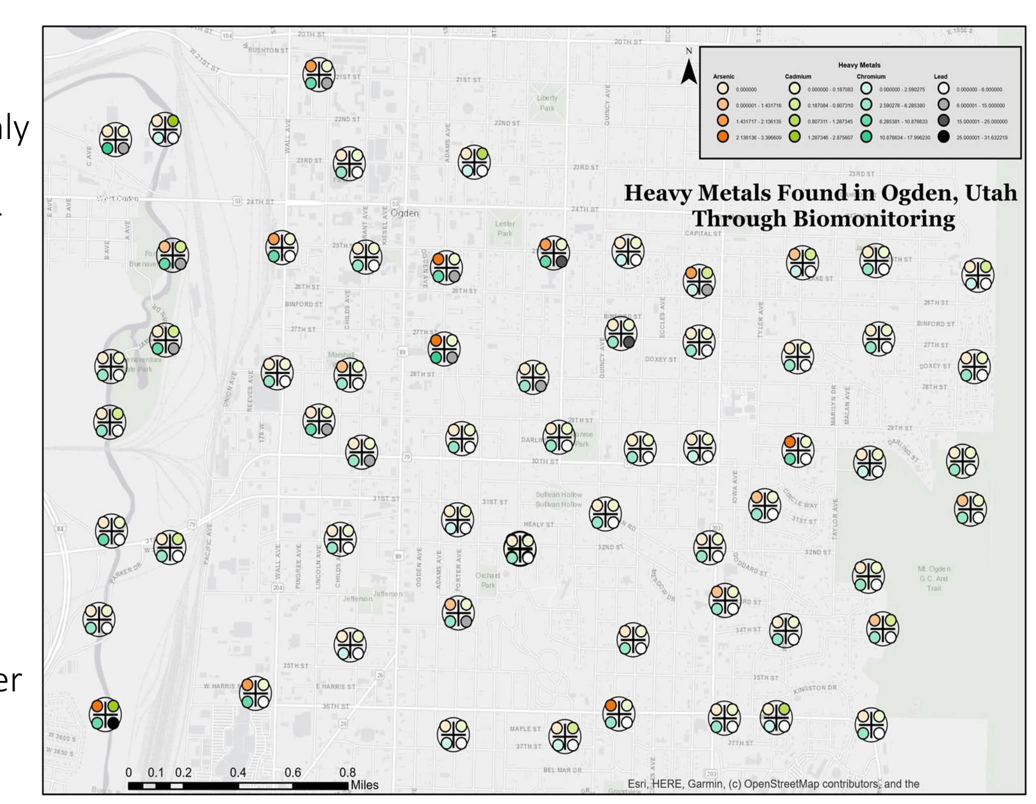
The sampling and cleaning methods took place in Weber State University Filed Methods labs in the Botany Department during September- December 2019. To minimizing exposure to contaminants, all equipment used was sterilized using reagent alcohol (70%). Each sample was transferred into a weigh boat and cleaned under a dissecting microscope. All cleaning work was completed wearing clean powder-free nitrile gloves. All bark, dirt, organisms, and other debris were removed using titanium forceps and clean lichen was placed into a second weigh boat until a minimum sample weight of 0.100g was acquired. Samples were weighted to the nearest 0.001g on an analytical balance. Clean samples were placed back into the original Kapak bag, cleaned of debris, sealed with tape, and labeled as before including cleaned weight and the date cleaned. Samples were returned to the fridge for storage at 4°C until all samples were ready to be shipped for analysis.

The lichen samples were later shipped to Randy Kolka and John Larson at the USDA Forest Service Northern Research Station. The samples analysis will not be available till further notice. To prepare the lichen samples, the lab grinded them into a fine powder for where they were latter digests and analyzed for 26 elements using inductively coupled plasma (ICP) optical emission spectrometry. Quality control measures consisted of independent check standards to monitor ICP calibration performance and reagent and method blanks. Reported concentrations are in mg/kg for all elements

Results and summary

Results: Samples are still being analyzed from the 2019 research by Randy Kolka and John Larson at the USDA Forest Service Northern Research Station in Grand Rapids, Main.

Summary: Lichen play an important role in our natural world. Not only do they give our natural world that extra pop of color and texture, they also play an important role as biominotors of our air quality. Air quality is a major concern for Utah. The Wasatch Mountains are a unique topography features that trap our emissions in high and low temperatures and trap particulate matter in our ozone layer. Particulate matter can increasing high levels of pollution that are being trapped by the phenomenon of inversion. These particulate matter could be dangerous to children, elderly people and people with respiratory problems. By comparing these two research I plant to bring awareness to this problem, by showing how important lichens play as biomonitors for our air quality. Lichens are symbiotic relationship between two or even three organism that came together to survive in a changing environment. They also provide us the aesthetical features of natures in many colors and texture but most importantly they can bring awareness of how our environment is changing.



Map created by Margarita Rivera with ArcGIS Map. The map show the different locations of the areas where high amounts of heavy metals were located through out Ogden, Utah during the summer of 2016 by Matthew Haithcock.

Acknowledgements & references

My mentor Dr. Heather Root who brought curiosity of the natural world into my life and always taking her time to teach me in her own special little way to help me understand, Dr. Suzanne Harley for pushing me and being so kind, Dr. Barbara Wachocki for always being honest and to always speak our mind, Sonya Welsh for always having her door open, WSU Botany Department, Dr. Ryan Frazier for helping me understand that maps are artistic outlet of scientific data , Dr. Michael Hernandez for being a great teacher and taking his time to make me understand ARCGIS, Geoscience Department, OUR depart for funding and USDA Forest Service Northern Research Station for keeping running my samples at an affordable price. My husband Michael Rivera for taking his time to enjoy the outdoors with me while doing field work and for his support throughout this project and second degree. To my botany nerds, who took the time to help me out along the way while having a good time.

Geiser, L., McCune, B. (2009). Macrolichens of the Pacific Northwest. Corvallis, OR: Oregon State University Press.

McCune, B.; Grenon, J.; Martin, E.; Mutch, L.S.; Martin, E.P. (March 2007). "Lichens in relation to management issues in the Sierra Nevada national parks". North American Fungi. 2: 1–39.