Spring 2021

Mentoring Through Moss: Measuring Air Pollution with High School Youth in the Duwamish Valley

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Nichole Vargas | Honors Senior Project | June 13th, 2021
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Introduction

What if the small, fluffy green organism that grows on trees can give us a snapshot into the quality of the air that we're breathing? Well, moss can do just that. Starting in May of 2021, multiple community members, organizations, academics, and high school students came together to collect, prepare, and analyze moss samples from neighborhood trees around the Duwamish Valley. I was fortunate enough to participate in the Duwamish Valley Moss and Air Quality Study, a partnership between community and science. I was a team leader and mentor to the high school students, who were taught about the science behind the study and the problems tied to poor air quality. Through the hands-on lessons, the students were empowered to care about the air their community was breathing and to act. In turn, I was taught a powerful lesson in the power of community, and what can be accomplished when science is used as a tool to improve human health.

There are three air monitors in South Seattle that record data on the ambient air pollutants. The three of them, however, are over a mile away from the South Park and Georgetown neighborhoods. The air monitors have been recording a decrease in air pollutions in recent decades. This proudly touted fact by Seattle politicians is not consistent with the reality of living in the Duwamish Valley. These neighborhoods experience the highest rates of asthma and other respiratory issues in Seattle. Surrounded by the industrial core of Seattle, a walk around the South Park and Georgetown neighborhoods is filled with airplanes flying overhead, trucks tumbling down residential streets, and redirected traffic over the South Park bridge due to the West Seattle bridge closure. This is the reality that the Duwamish Valley community faces. Along with the industrial noise and sights, there is also culture, vibrancy, and a strong sense of community in these neighborhoods. In a neighborhood center a couple blocks away from the Duwamish River Superfund site, you will find grassroots community organizing happening, one of which is called the Duwamish River Cleanup Coalition.

The Duwamish Valley, now a heavily industrialized land, was once a thriving estuary ecosystem where the Duwamish people lived and hunted. The current day neighborhoods of South Park and Georgetown sit in the Duwamish Valley and is home to almost 6,000 people and many businesses (Brown, 2021). There is a high population of people of color in these neighborhoods, so the poor air quality faced by these communities is an issue of environmental injustice. Environmental justice is a movement and discipline that advocates for the equitable distribution of environmental benefits, like clean air and green space, and environmental burdens, like pollution and car traffic (Greenpeace, n.d.). It has been heavily documented by researchers that people of color and low-income people are disproportionately affected by environmental burdens. The story of South Park and Georgetown unfortunately follows this pattern.

Project Background

Heavy metals such as arsenic and chromium are naturally occurring in our environment. However, chronic low-level exposure to heavy metals can be dangerous to humans, especially when inhaled. When heavy metals are broken down to tiny particles and combined with liquid droplets, they are considered particulate matter. At the size of 10 micrometers or smaller, the particulate matter can enter your body and cause problems. At a size 2.5 micrometers or smaller- smaller than a strand of human hair- are even more dangerous (EPA, n.d.-a). Particulate matter is emitted directly from construction sites and indirectly through chemical processes from power plants, industries, and cars (EPA, n.d.-a). Heavy metal particulate matter exposure is linked to health problems such as heart and lung disease, irregular heartbeat, heart attacks, asthma, and increased respiratory symptoms like couching and difficulty breathing (EPA, n.d.-b).

Moss is a bioindicator that is easy and inexpensive to collect. Moss grows on trees and absorbs its nutrients from the air. It also absorbs any heavy metals that may be in the air. The specific species of moss that we are collecting in this study is the *Orthotrichum lyellii.* This species doesn't live longer than a few years, so it is useful as a snapshot into what the air quality is like most recently. In collection, we made sure to only grab moss above waist height, to avoid moss contaminated with urine, road splashes, or other fluids. By analyzing moss collected at nose height in trees around where people live, we are able to get a close estimate into the number of heavy metals getting into people's lungs. The Duwamish Valley moss study measures the concentration of over 21 metals, with the 6 toxic 'priority' metals being arsenic, cadmium, chromium, cobalt, lead, and nickel. The study was conducted in 60 locations on a 250×250-meter sampling grid. By using a grid method, localized concentrations are able to be unearthed, at a level smaller than the air monitors allow. The goal of the study is to measure heavy metal air pollution in the Duwamish Valley, identify localized concentrations, and potentially identify sources. The data will then be used to support the advocacy work to change air pollution policy in the Duwamish Valley. The ultimate goal of this study and of the grassroots community organizing around this issue is to improve the air quality and health outcomes in the Duwamish Valley, for the people of the Duwamish Valley.

The study was first conducted by many of the same contributors in 2019 and are similar, and therefore comparable, to two other studies that occurred in Portland in 2016 and in Seattle parks in 2018. Three conclusions were drawn from the results of the 2019 study. The first conclusion was that trained youth can collect reliable scientific samples. Along with the samples collected and prepped by the youth, experts from the Army Corps of Engineers also collected samples to compare with the quality of the youth's samples. The youth's samples were essentially the same as the expert's samples. This shows that community members like high school students can reliably participate in scientific data collection. The second conclusion was that metal concentrations were highest near industrial areas and near the Duwamish River, while lowest in residential areas. This

shows that the sources of the metals are most likely from the industries, which run along the Duwamish River. Thirdly, the 2019 results found that metal were generally twice as high as in the Portland study, with the greatest differences being for arsenic and chromium.

The comparison between the Portland, Seattle parks and Duwamish Valley data sets reveals a contrast in air quality in the areas, and an even greater contrast in the policy reaction. Moss collected from residential streets in Portland showed an average in chromium concentration of 4.6 mg/kg, while moss collected from parks all over Seattle showed an average of 3.9 mg/kg. In comparison, the average concentration of chromium in moss in Georgetown and South Park was 11.1 mg/kg – more than double the average in Portland and nearly triple the average found in Seattle parks. As a result of the Portland study, new air monitors were installed and the Cleaner Air Oregon law was enacted, focusing on improving air quality and health outcomes in Portland. A proportionate policy response did not occur in the Duwamish Valley, although the results of the moss study there showed worse heavy metal air pollution than in Portland.

Project Responsibilities

I was responsible for leading a team of four high school youth in the collection phase of the project. As part of the internship position, I also mentored these high school youth. As a first-generation university student of color, I could serve as a role model for these youth, who may not have someone in their lives who could show them that college is possible for people like them. The mentoring aspect of the position was the most enjoyable part of the

experience. I got to know the students, joked around, and told stories, and responded when they asked me about my high school and college experience.

As a team leader, I was given the same training I would later give to the students. I learned about the prior studies, the results, and the importance of moss. Along with teaching the kids everything I had learned about moss and the studies, I also taught the youth about the scientific method and geography. Each student has a task at every tree to be sampled. I taught them that they had to be diligent with every step in order to ensure the validity of the results. It is easy to cut corners when the steps become repetitive after so many trees; messy handwriting is enough to cause problems further down the road in the process.

One small but important job that I was tasked with was picking up the printed journal pages from the University print and copy center. The students kept a binder with scans of handy documents like moss identification, the moss collection steps, and a reflection page to be filled out at the end of every day. Reflection was an emphasized part of every day's lesson plan. As the students reflected on what they saw that day, how they felt about it, and what they could do about it. I also reflected through the Notes app on my cell phone. I recorded what we did that day, any problems we ran into, and my general thoughts about the day. I also recorded what I observed from the students about how they felt about the project and the remarks they told me.

Daily Activities and Reflections

We met with the students on Tuesday evenings and Saturday mornings for about 2 to 3 hours, starting on May 29th. On the very first day of the study, the students were asked why they were participating in the study. Many responded that they were there because it gave them something to do on Saturdays. Other common responses were that they wanted to be outside, they wanted to learn about the environment, and that they wanted to do something new. These responses gave me insight into where the students were at the beginning of this journey. Many didn't have much knowledge in air pollution, moss, or geography. But they were willing to learn and eager to be outside. This informed my approach in my team leadership. I didn't assume the students knew all the specific terminology, and instead was ready to explain everything as we were doing it. This helped them to understand the importance of the project.

The first day was orientation. We split into our teams, and "Team Everything" was formed. The team I lead consists of four teenage girls, ranging from 13 to 17 years old. We came up with the name, because when I asked what food they liked, they responded with, "Everything." One of the team members is a skilled artist and drew a dragon on our giant sticky note which we had written down our team guidelines on, thus becoming our mascot. On the second day, we taught the youth about moss and the study methodology. This was done through a PowerPoint and lecture, so the students weren't as engaged on this day. On the third day, we practiced the process to prepare the moss samples to be sent out to the lab, starting with thoroughly sanitizing everything. The seated activity snipping moss provided a perfect venue to chat and get to know the girls more. They asked me if I partied in my college years, and how the heck I even got through high school. This conversation reminded me what it was like to be a teenage girl. As a high school girl, it was difficult to get through each day with the stress of school, family, and relationships. Getting though high school itself was a giant feat, so thinking about college seemed like a far off, impossible goal. Instead of urging them to attend college, I stepped back and told them about my tips on tackling procrastination and burn out, which I struggle with as well. The girls seemed receptive to my advice.

Then, we began moss collection. The girls took to it quickly, volunteering themselves for the hands-on job of collecting moss, even through thorny bushes and high branches. They were not afraid to get dirty. Some problems we faced in moss collection were finding viable trees and accessing the moss. Some locations only had young trees, or trees without the correct species of moss, or the mossy trees were out of reach or on private property. This did not discourage the girls, who were willing to jump and tread through thorny bushes for the moss. The girls took pride in their work, celebrating how many samples we were able to collect each day despite the difficulties. I was proud of them too.

Conclusion

This study is still ongoing, so I am not able to discuss the results of the 2021 moss samples. However, since there have not been any policy actions taken to reduce air pollutants in the area as a result of the 2019 study, it can be assumed that this year's results will be similar to those found in 2019. From this experience, I put into practice many lessons from my coursework, and I learned new lessons as well. For example, I learned about the messiness and flexibility needed in community-driven research. There are multiple individuals and organizations working together towards a common goal, all with different skills, expertise, and availability, all of which needs to be organized. I also learned of the impact that mentoring can have on high school students. When I was in high school, I had no one close to me that I was able to look at as a role model. With the support of my parents and my guidance counselor, I was able to make it to university. Being able to envision what's possible- to see someone that looks like you succeeding in higher education- is invaluable to students. I hope to provide to these students what I wasn't able to have.

Lastly, I have learned about the power of community. In higher education, it is easy to get caught up in academia culture and stay in a closed bubble. Interacting with community members and working with students has opened my eyes to the power that community

has. Community members from all walks of life are able to organize, learn, and demand change. Science should be used as a tool to aid community members in their advocacy, and not as a gatekeeping tool as academia often is. An aspect of environmental justice is procedural justice- or the inclusion of everyone in the decision-making process (Maiese and Burgess, 2020). Involving the community directly in research regarding their own neighborhood is a matter of justice. The people of the Duwamish Valley deserve to be in control of the air they breathe, and deserve clean air and clean lungs. This moss study is a step in reaching the justice they deserve.

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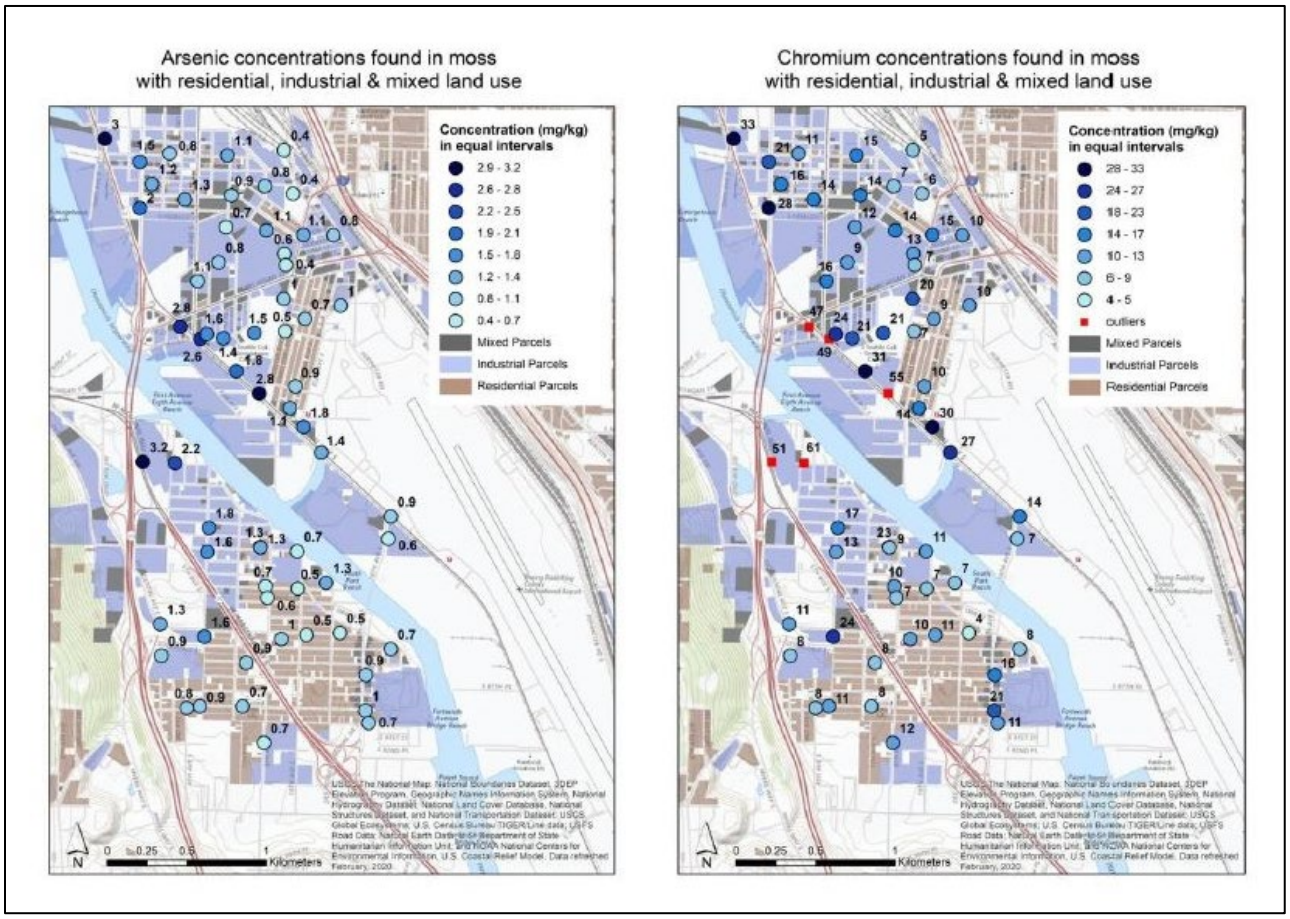
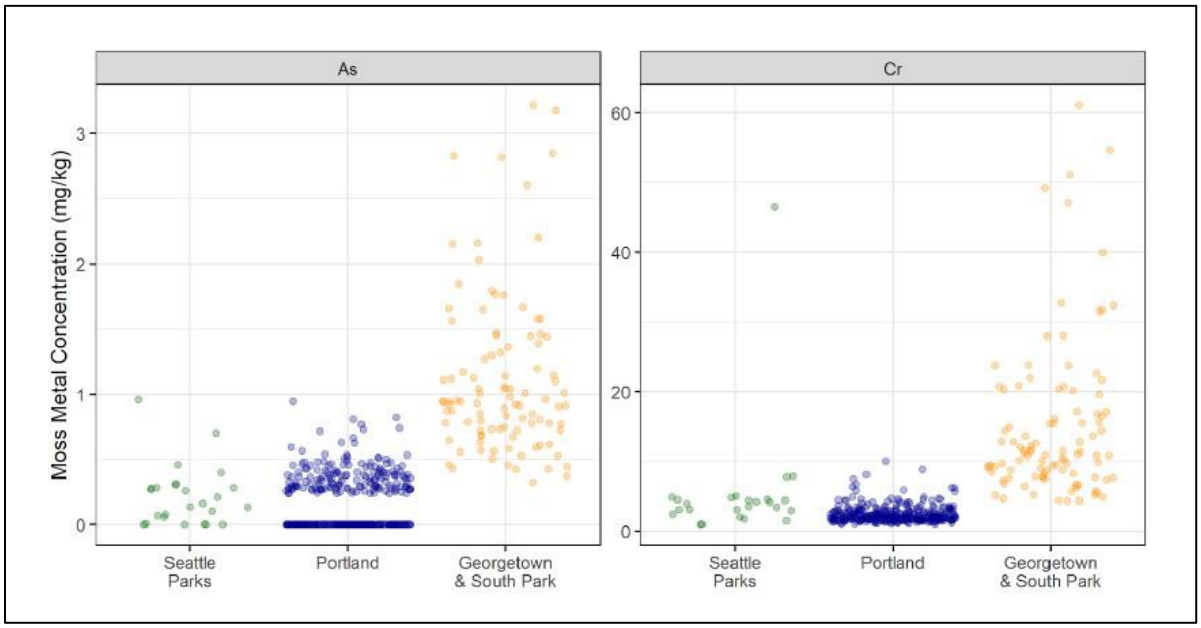
Appendices

Appendix 1. Map of Duwamish Valley Moss and Air Quality Study 2019-2020 Results



Appendix 2. Duwamish Valley Moss and Air Quality Study 2019-2020 Results Compared to Portland and Seattle Parks Data



Acknowledgements

Thank you to Professor Abel, Tammi Laninga, the Social Justice and Equity Committee, and the people of the Duwamish Valley. This internship is guided by Professor Troy Abel of the Environmental Studies department at the Huxley College of the Environment at the Peninsulas, and funded by the Social Justice and Equity Fund at Western Washington University.

For more information on the ongoing study, please visit the Duwamish Valley Cleanup Coalition website.