Biodiversity of Plants in Highly Polluted Areas

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Abstract

The research topic of our Urban Barcode Project proposal is to understand the biodiversity of plants by identifying and observing changes in the native and non-native plant samples taken during the summer, fall, and winter season. We want to keep working on last year's research, therefore we will be using data and the same methods from last year's proposal.

We will complete this project by going to the Riverside park near the Henry Hudson Parkway and collecting a sampling of different species. We will extract 20-30 leaf samples from 3 distances from the highway: 5 meters, 10 meters, and 20 meters. We are going to be focusing on what type of plant species we are able to find and compare them to how the number of species is affected by the seasons of the year. We will analyze if there is a change in invasive species vs. non-invasive species based off of each season.

Introduction

New York city is known for its high diversity. New York City is one of the most populated metropolis in the world with over 8.6 million people. Not only is the Big Apple known for its highly diverse community with people from all around the world, but the city is also abundant in the diverse groups of species of trees and plants. According to the most recent *TreesCount!* street tree census conducted in 2015 by the New York City Department of Parks and Recreation, census data collectors identified 132 different species of trees citywide. The top 3 common species citywide were London Planetree (13.3%), Honeylocust (9.9%), and Callery Pear (9.0%), respectively. In the borough of Manhattan, the top 3 common species were Honeylocust (21.1%), Callery Pear (11.7%), and Ginkgo (9.4%) in that respective order.

Since New York City is a populous and a concentrated urban place, it correlates to the concentrated pollution the city is impacted by. There are various forms of pollution that have been affecting New York City's environment since the Industrial Boom came into place. From air pollution arising out of emissions of carbon dioxide and exhaust emissions, from cars to soil contamination/pollution caused by industrial activity and improper disposal of waste. New York City has been becoming more polluted over the years, not only affecting people living in the city but also the natural ecosystem that lives in this area.

An example of this would be the growth of invasive species in different places in the area being able to exploit the resources that trees/plants that native species need, which allows the invasive species to thrive and take over the new environment. In the 1995 and 2005 *TreesCount!* census, London Planetree was the most prevalent species and was also the most common in 2015, with Honeylocust and Callery pear in second and third most abundant species in that respective order. The most significant change in prevalent species since the 1995 and 2005 census and the most recent census was the drop of Norway Maple citywide from 14% in 2005 to 5.2% in 2015. The percentage drop in this species is due to the fact that it is a non-native species that is invading the ecosystems, which makes them invasive. Invasive species like Norway Maple to take hold in a new environment. Invasive species are defined as organisms that are non-native of the selected ecosystem that can cause harm to the environment, the economy and/or to human health. Invasive species industrialization effects in the atmosphere and how these affect plants in general, these bioindicators can help identify how polluted an area is. This is what we are going to be focusing on our object.

Materials & Methods

Materials:

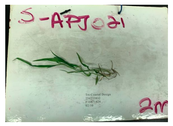
- Samples (collected)
- Ziplock bags
- Gloves
- Centrifuge Tubes/ storage tubes
- Meter Stick (4)
- Phone (to identify the location of the samples)

The rest of the materials are provided by the Harlem DNA lab when the samples are ready for barcoding.

Collection Method:

We will be collecting our sample of leaves from Riverside Park, on 83rd street and Henry Hudson Parkway. We will be extracting the leaves from trees from different distances from the parkway. We will first collect 20-30 different leaves samples. If unable to collect the samples adjacent to the parkway we will travel a short distance that is still near the parkway and record that distance and add the 5 ft, 15 ft and 20 ft from that distance we started at. The distances traveled will be 5 ft, 15 ft and 90 ft from the parkway.

At each distance, we will locate trees and bushes. We will gather leaves from them by using a 1-by-1 meter square to get samples from specific places and minimize our selection. Each distance will have a radius of 5 -10 ft per area since the trees will not be in a straight line.



Storage:

After we extract the leaves from the trees, we will place them in individual zip-lock bags, labeled with the distance the samples were taken from along with the season. Samples will then be stored in freezers at Frank McCourt High School until taken to the Harlem DNA Lab for processing.

DNA Barcoding:

Once the leaves are collected and placed in the centrifuge tubes, we will then take them to the Harlem DNA Open Lab. We will then follow the rbcl Isolation technique to identify the species/gene of the leaves. We will then compare the sequences obtained using DNA subway according to the DNA Barcoding Protocol We are doing this to determine what species thrive in certain distances from a place that is considered " polluted' due to what is located near it. In this case, we chose the Henry Hudson Parkway because it cars produce gas that pollutes the air and since it's a parkway it is busy which means that the area would be exposed to exhaust.

Results

The most common species among all seasons was *helleborus*; while the plant Helleborus Orientalis was found within 5 meters or 20 meters of the highway during the Summer and Fall of 2019, 5 different plants of the family was found in the Winter 2018. This seems to be the most common plant in the park. In the same way the plant Hosta Ventricosa was found 5 times within 5 meters and 20 meters of the highway in both the Summer and Fall of 2019.

Tables & Figures

Fall 2019		
Appeared Species	Times it appears	Meters from highway
Ilex Laevigata	2	Within 5 meters
Hosta Ventricosa	3	Within 5 meters, 20 meters
Helleborus Orientalis	2	Within 1 meter
Liriope Spicata	1	10 meters
Epipremnum Aureum	1	10 meters
Euphorbia Esula	1	10 meters
Celtis Biondii	1	5 meters
Chorispora Tenella	1	5 meters
Unknown	-	-

Winter 2019		
Appeared Species	Times it appears	Meters from highway
Aquilegia Vulgaris	1	5 meters
Helleborus Croaticus	1	20 meters
Helleborus Foetidus	3	20 meters
helleborus orientalis	4	1 meters, 5 meters and 20 meters
Helleborus thibetanus	5	5 meters and 15 meters
Helleborus viridis	1	20 meters
Hydrangea chinensis	1	5 meters
Isopyrum Biternatum	1	20 meters
No comparison availability	2	5 meters and 20 meters
No info/No Sequence	5	5 meters, 15 meters and 20 meters
Skimmia reevesiana	1	15 meters
Zanthoxylum avicennae	1	2 meters

Summer 2019		
Appeared Species	Times it appears	Meters from highway
Chorispora Tenella	1	20 meters
Celtis Biondii	1	20 meters
Tupistra Ochracea	1	20 meters
Hosta Ventricosa	2	5 meters, 20 meters
Quercus Robur	2	2 meters, 5 meters
Galinsoga Quadriradiata	2	2 meters
Helleborus Orientalis	3	2 meters, 5 meters
Muhlenbergia hakonensis	1	2 meters
Acalypha Indica	1	5 meters

Discussion

At the end, it was found that as the species were farther away from the highway, there were more types of plant species found. It was also found that the Winter 2018 had more different types of species with around 10 distinct ones than the Summer and Fall of 2019 which both had 9 different species, some of which were the same. This was surprising because the Winter tends to dry out plants, while in the Summer more plants grow. This might have been because 27 samples were collected in the Winter, only 13 in the Fall and 14 in the Summer. This might have caused more different types of plants to be randomly chosen so more species would be counted for.

Due to this successful result, in order to further investigate the connection between pollution and biodiversity, it would be nice to also collect samples during the Spring in the same way as it was collected for this project. Since more plans tend to grow in the Spring, investigating the same relationship during this season would deepen our conclusion regarding the effect pollution has on biodiversity of plants in an urban setting.

References

Barron, James. "New York City's Population Hits a Record 8.6 Million." *The New York Times*, The New York Times, 22 Mar. 2018, www.nytimes.com/2018/03/22/nyregion/new-york-city-population.html.

"Bioindicators: the Natural Indicator of Environmental Pollution." *Taylor & Francis Online*, 22 Apr. 2016, www.tandfonline.com/doi/full/10.1080/21553769.2016.1162753.

Cold Springs Harbor DNA Learning Center (2014). Using DNA Barcodes to Identify and Classify Living Things. Retrieved from http://www.dnabarcoding101.org/files/using-dna-barcodes.pdf

International Environmental Technology. "What Is Soil Contamination? And Why Does It Happen?" *What Are Negative Emissions? Envirotech Online*, 26 Nov. 2014, www.envirotech-online.com/news/health-and-safety/10/breaking-news/what-is-soil-contamination-and-why-does-it-happen/32581.

"NYC Street Tree Census - 2015 Report." *NYC Street Tree Census - 2015 Report*, media.nycgovparks.org/images/web/TreesCount/Index.html

Pham, D. (2015, April 14). This Map Lets You Explore NYC's 592,130 Street Trees by Species and Trunk Thickness. Retrieved November 9, 2018, from https://www.6sqft.com/amazing-maps-explore-the-citys-592130-street-trees-by-species/http://media.nycgovparks.org/images/web/TreesCount/Index.html

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