

## Graduate Research Plan Statement

### **Motivation**

Chicago has a history characterized by social divide and income disparity. This unique history has caused the city to be demographically fragmented. Knowing this, it is probable that the urban landscape, including trees, is also disproportionate across the city. Current research looking at the relationship between trees and socioeconomic factors is customarily limited to only looking at percent canopy cover. **Existing literature looking at tree biodiversity is notably sparse.** Biodiversity is important in an urban setting because it provides a protective barrier from natural disaster and increased adaptability and resilience to environmental change. Trees, specifically, provide fundamental ecosystem services to a city, including climate regulation, greenhouse gas sequestration, pollution filtration, and reduced heat island effects.<sup>1</sup> A natural extension of my graduate work exploring tree biodiversity is understanding why tree biodiversity increases in areas with low per capita income, and decreases in areas with high per capita income, a key finding from my study. Additionally, drawing from my extensive literature research, **typically (if at all) urban vegetation studies will only look at biodiversity at one point in time, and then compare it with the biodiversity seen many years later. However, this approach does not reveal emerging patterns that have could have impacted biodiversity over time.**

### **Research Plan**

For my M.S., I have been interested in the following: (1) What direction is the correlation between income and tree biodiversity? (2) What role does current land use and historical legacy play in the tree biodiversity that is seen today? (3) What methodologies do researchers typically rely on, and what variables do they use, when studying the relationship between urban forestry and socioeconomic factors? Is there room for improvement? I plan to build onto my graduate work in a PhD program in Ecology. Some of the questions I am interested in answering are the following: (1) To what extent is the soil surrounding a tree influencing the tree biodiversity seen across Chicago, Illinois? *Hypothesis: More affluent areas have lower tree biodiversity because of soil damage caused by land management practices.* (2) Can land–use changes and management strategies, and the specific biological effect(s) they are causing over time, be revealed to help tree biodiversity **conservation efforts**? *Hypothesis: Yes, stable isotopes can be used as a tool in providing information about the origin and nature of biological and land changes over time.*

### **Methods and Resources**

Because of my prior work, I have the Shannon Diversity Index calculated for each Chicago census tract and community area, which I used to determine if an area has high or low tree biodiversity. The Morton Arboretum, an international leader in tree research, provided me with their 2020 detailed tree report which included more information than what was publicly available. The data that I was given was then statistically analyzed in R to identify the direction of correlations using geographically weighted regression (GMS). Ordinary least squares (OLS) is a commonly used method in urban forestry studies, however, it does not take into account non-stationary variables such as the environment and demographics. GMS is an extension of OLS, whereby the independent and dependent variables are allowed to vary depending on the location. For my proposed PhD work, the isotopic composition of soil that surround trees in pre-established quadrants, used in the 2020 tree report published by Morton Arboretum, will be analyzed in our lab at the University of Illinois at Chicago each year for

3 years. Permits to perform this on-the-ground-work have already been approved by the city of Chicago. Stable isotopes are useful in this research because they will track nutrient cycling, the sources and movement of water, the origin and presence of pollutants and/or contaminants, microbial activity, and the kind of land-use changes and practices that have taken place. **Soil composition can influence which tree species can thrive, and therefore affect tree biodiversity.** Stable isotopes simultaneously can reveal the pace and extent of change by taking samples for 3 consecutive years. The environmental variables, represented as isotopic signatures, and how they are changing over time, will be analyzed using ANOVA. My PI, Miquel Gonzalez-Meler, manages the stable isotope laboratory at the University of Illinois at Chicago and I have unlimited access to this facility, including a newly released mass spectrometer. Further, more isotopic instrumentation is readily available in a nearby department. I have an extensive network of scientists and experts available for help and/or resources when I need it, as I have been an active part of CROCUS, a 5 year U.S. Department of Energy funded project managed by Argonne National Laboratory. CROCUS will provide the resources that I need going into the field to collect samples and properly processing these samples in the lab. The NSF GRFP would advantageously supplement what is given to UIC from CROCUS funding, and allow me to funnel my full attention and enthusiasm toward the project.

### **Intellectual Merit**

**No research prior to my proposed graduate study has looked at tree or plant biodiversity and its possible relationship to socioeconomic variables in Chicago. Additionally, studies to understand tree biodiversity, in general, remain in short supply.** My research is imperative because while there is a broad understanding and agreement that the environment is undergoing rapid change, **it is crucial to also know exactly how fast and how, mechanically speaking, environmental change is occurring.** Stable isotopes are a powerful tool that can allow us to, in a sense, go back in time to reveal how what we are observing got to be in the state that it is in. My research **will build on what we know about tree biodiversity via publications and a reservoir of accessible, novel data. This proposed work can encourage comparable future research and/or research in other disciplines.**

### **Broader Impacts**

**Tree biodiversity is essential in an urban ecosystem.** In a recent study, it was found that greater tree biodiversity is associated with higher carbon and nitrogen accumulation.<sup>2</sup> Tree biodiversity provides urban dwellers better air quality, temperature regulation, stormwater management, and reduced stress. My proposed graduate research will **help with tree biodiversity conservation efforts, and provide the data needed to advance environmental justice** by revealing any existing environmental inequalities. This research is important for Chicago, a diverse city fraught with inequalities, **but this proposed work's importance extends beyond a single city border.**

### **Literature References**

1. Asanok, L., Kamyo, T., Norsaeangsi, M., Yotapakdee, T. & Navakam, S. Assessment of the Diversity of Large Tree Species in Rapidly Urbanizing Areas along the Chao Phraya River Rim, Central Thailand. *Sustainability* 13, 10342 (2021).
2. Chen, X. *et al.* Tree diversity increases decadal forest soil carbon and nitrogen accrual. *Nature* 618, 94–101 (2023).