5-12-2024

Black Walnut Tree Health Distribution in an Urban Landscape

Gabriel Smith
Syracuse University

Abstract

Food access and climate change are two of the greatest challenges facing an increasingly urbanized society. Within cities, trees play a critical role for people and the planet, providing solutions to food insecurity and closing the metabolic rift. Trees provide food for human and non-human communities, shelter for biodiversity, and microclimate regulation. In this context, the health of trees is paramount because of the connection between species health and the capacity to provide services. Eastern black walnut (BW) trees (*Juglans nigra*) are an important and underutilized native nut tree in the Northeastern US. The kernel has the highest protein content of northeastern nut species, its wood is one of the most economically valuable, there are a number of non-timber products that can be created using various parts of the tree, and BW appears to be resilient to climate impacts in the northeast. BW contributes to provisioning services in the urban environment by producing nuts, and contributes to regulating services, such as runoff management in riparian zones and air filtration. BW is perceived, however, in multiple competing ways by actors like city management and public groups representing different attitudes towards BW present in the city. While the city can assess for risk and establish health rankings of individual trees, there is a limit to the health interventions they can provide caused by the neighborhood attitudes towards these trees, city resources, and the current state of forestry research and practice which they follow. At the intersection of urban food provisioning, urban ecological management, and justice movements, agroecology is poised to provide a framework for achieving the goals of city management and to expand the conversation to include food sovereignty. Fundamentally the question becomes one of health; the health of the urban environment, its interconnectedness with the health of all its inhabitants (human and more-than), and how to manage for increased health of both. This work seeks to begin answering these

questions by examining the interrelatedness of Black Walnut tree health and socioeconomic wellbeing in Syracuse, NY. By systematically assessing BW tree health; comparing tree distribution to socioeconomic distribution; connecting tree health to equity; we reveal a story about the Syracuse urban canopy as a tool to mitigating food insecurity and climate change through the lens of equity and social justice.

Black Walnut Tree Health Distribution in an Urban Landscape

By Gabriel Smith

B.A., Lake Forest College 2011

Thesis submitted in partial fulfillment of the requirements for the degree of Master of Science in Food Studies

Syracuse University

May 2024

"Jeweled trees abound in flowers and fruit where living beings enjoy themselves at ease."

-The Lotus Sutra (Watson, 1993)

Acknowledgments

I would like to thank the faculty and staff of the Department of Nutrition and Food Studies, as well as all the staff of FALK college for providing me with an enjoyable environment to produce this work and complete my master's degree. Thank you to my advisor, Dr. Esteli Jimenez-Soto, and my committee members for all their patience and assistance. A special thanks to my cohort, my friends, what an unbelievable stroke of luck that we all were here at the same time and spent so many hours together as friends first and foremost. This comradery was what allowed me to endure the troughs of graduate school. Many thanks to my family for their trust in my decisions, leaving a career to go back to school, and for supporting me materially, financially, in the years beforehand. A constant thanks to a friend and mentor, Jason Joyce, who unknowingly started me on a path of development that I couldn't figure out how to start on my own. Thanks for taking a chance on me, for trusting me, putting up with me, and for pushing me to take the next step.

I want to thank and dedicate this thesis to my mentor in life, Daisaku Ikeda. Your example as an ordinary individual with a passion to accomplish something extraordinary for the sake of the happiness of others is a constant source of inspiration and growth. Without your actions I would not be here today, I would not have found the single constant that weaves through this beautiful life, and I would not have pushed through my own doubt and delusion to follow my mission to create value in my own unique way. "When one comes to realize and see that each thing—the cherry, the plum, the peach, the damson—in its own entity, without

undergoing any change, possesses the eternally endowed three bodies, then this is what is meant by the word ryō.” (Watson, 2003)

Table of Contents

Abbreviations

ISA ……………… International Society of Arboriculture

NYNGA…………. New York Nut Growers Association

NYTCA………….. New York Tree Crop Alliance

TRAQ…………… Tree Risk Assessment Qualification

UFMP…………… Urban Forest Master Plan

USDA…………… United States Department of Agriculture

UTC……………… Urban Tree Canopy

Introduction

The last 15 years have seen two major global food shortages (Wezel et al., 2020), revealing the fragility and inequalities in our globalized, commodity-driven food system, as well as its vulnerability to the impacts of climate change (Tornaghi, 2014; Wezel et al, 2020; Albrecht, Weik, 2020). Along with this is the increasingly urbanized human population. 50% of the world's population already live in cities, with an expected 1% annual urbanization rate further testing the tenuous stability of the food system.

Multiple approaches and frameworks have emerged to ameliorate the food crisis and strengthening the food system’s resilience in response to climate change in urban landscapes (Tornaghi and Dehaene, 2020). One of these frameworks is Urban agroecology, which incorporates a food justice and human health lens into urban planning, and a strong focus on urban food forests. Agroecology—which recognizes the centrality of biodiversity, the co-creation of knowledge, and justice for food system transformation—provides a framework upon which to study, design, and manage urban spaces that are both socially and environmentally just. Agroecology is grounded in community-based actions that value slow positive feedback loops (Tornaghi & Dehaene, 2020) such as soil care and valuation in land use policies, encouraging and empowering those that are experiencing the adverse effects of urbanization, within and at the peripheries of urban centers. Agroecology responds to a longer timeline, facilitating natural ecological cycles and planning on generational succession of both plant and people. An urban agroecology, as a science, practice, and movement, lends these principles to the complex challenges facing urban citizens. Urban agroecological systems promote biodiversity, which is associated with ecosystem functions and services of great value for human and ecological communities in urban landscapes.

Urban agroecology highlights the importance of forests and street trees within urban landscapes (Egerer & Cohen, 2020). Trees, especially street trees, fill a crucial space in city design and provide important ecosystem services to neighborhoods (Mansfield et al., 2005). For instance, trees filter the air and prevent road pollution from spreading into neighborhoods; trees increase community wellbeing and promote greater mental health outcomes; trees and greenspaces increase community engagement; trees can provide nutrition for people; trees increase biodiversity of urban settings, buffer the heat island effect, and play a role in reducing criminal activity (Shepley et al., 2019; Romanova & Lovell, 2021; Kuo & Sullivan, 2001; Lovell et al., 2023; Müller et al., 2018).

Urban forests are key repositories of biodiversity globally, being capable of holding much higher levels of biodiversity than previously thought, and studies are showing that management with an understanding of socioeconomics can preserve native biodiversity while incorporating new species (Alvey, 2006). Recent research has demonstrated that while species richness is agreed to generally decline towards urban centers, termed the "urban-rural gradient", that this is not an innate characteristic of urbanization, and that managing for biodiversity in urban cores could decrease the need for conserving remnant land elsewhere (Alvey, 2006; Yang et al., 2017).

Importantly, urban forests are critical for food system resilience and have gained increased attention in recent years as an asset for regional and state governments (USDA, 2023; NRCS, 2023). All forms of food production in the urban and peri-urban environment, including food produced by street trees, are beginning to be championed and explored by diverse groups including neighborhood and food system organizations, corporate and government entities, agroecological movements, as well as legal, and sometimes illegal, foragers (Allen et al, 2021). For example, GIS research mapped Boston's urban center to show the availability of land for urban agriculture; with full utilization of currently unused plantable urban space, farmers could provide fresh produce for all its inhabitants (Saha & Eckelman, 2017).

Other research supports the many benefits that trees provide in the form of ecosystem services as well as improvements in community health and individual well-being (Jones et al., 2013). The nutritional value of forageable tree species in urban areas is an important variable to include in city management, as they can potentially help meet the food needs of citizens in areas of food apartheid (Bunge et al, 2019). Recently this has grown to consider solving urban environmental problems like the air pollution and the heat island effect (Wang et al., 2021; Wolf et al., 2020). Additionally, a comprehensive study by Albrecht & Wiek(2021) shows that food forests, the most visible of urban forest phenomena, consistently offer educational, community, and food provisioning services.

Despite the importance of urban forests for ecosystem service provisioning in urban landscapes, street trees are increasingly disappearing across the nation along with their canopy cover at an annual rate of 175,000 acres since 1970, valued at $96 million in lost ecosystem services (Nowak & Greenfield, 2018; Syracuse City Arborist, pers. Comm.). Multiple factors have contributed to their gradual disappearance, including natural disasters (Forzieri et al., 2022), increased urbanization (Yang et al., 2017), spread of invasive species, pests, and diseases that threaten the health of urban trees (Forzieri et al., 2022; Jones et al., 2014; Wiggins et al., 2014), a lack of government funds and staffing to replace and maintain healthy trees (Nowak & Greenfield, 2018) and a general prioritization of urban development over planned development that incorporates ecological design (Mansfield et al., 2005; Nowak & Greenfield, 2018). In addition, the distribution of trees in cities is not always equitable. Studies demonstrate that tree biodiversity in neighborhoods is often positively correlated with age, income, and race, however, parks do not demonstrate the same trend (Foster et al., 2024; Volin et al., 2020).

While current goals of state and federal programs include equity as a priority, forestry protocols and management could greatly benefit from the inclusion of agroecological principles, such as participatory decision making and human health outcomes at the individual and community level. For this reason, city management could support increasing and enhancing canopy cover and tree access in cities, as well as alleviating inequity, as city-managed property and trees will act as key environments for the provisioning of ecosystem services (Alvey, 2006).

These pressures are pushing municipalities to enact measures for the protection and expansion of their urban canopy internationally and across the US. At the international and national levels, the UN and the USDA both have started to pay more attention towards forestry, agroforestry and urban forestry as key links in preserving biodiversity, buffering climate impact, supplying nutritional benefits, and providing ecological services. The combination of having a concentrated population in urban centers, along with the fact that the urban tree canopy is close to one quarter of the US's total canopy (Jones et al., 2013), clearly emphasize the potential impact of urban forestry on population health.

Syracuse and the Eastern black walnut

The Syracuse Urban Forest Master Plan (UFMP) is exemplary of how the initiative of local municipalities is acting to protect and enhance the urban canopy. The Syracuse UFMP document was created from multiple years of public outreach and community engagement around an initial *State of the Forest* report conducted in 2016 by the Davey Resource Group for the city. It outlines the needs, challenges, and goals for the city's canopy, as the forestry department seeks to increase equitable canopy coverage and the percentage of native species in the canopy composition. The report emphasizes that tree loss is outpacing tree planting, mostly due to a lack of labor and funding, reiterating the national trends (*Urban and Community Forestry Program*, 2016; Jones et al., 2013; Syracuse UFMP, 2021).

In response to the labor and funding shortages facing municipalities in their effort to expand the urban canopy, the USDA has rapidly expanded its funding for community forestry projects. Recently the Inflation Reduction Act allocated over one billion dollars to forestry grant funding; the US forest service and the Urban Community Forestry Program have requested social justice aligned projects and speak to the need for biodiversity, canopy justice, nutrition, food forests for green infrastructure, and work force training.

One finding that arose from urban agroecological approaches was that nut trees can be potentially more useful for phytoremediation in urban settings because of their capacity to uptake heavy metals into their woody material, yet offer safe, uncontaminated nutrition due to the kernel being protected from the ground via the shell (Romanova & Lovell, 2021; von Hoffen & Säumel, 2014). This allows their use in areas that are not suitable for other forms of urban agriculture and as useful borders for urban gardens. In fact, the nut cropping trees of the northeast have been connected with human settlements in north America for millennia.

Northeast black walnut is culturally and ecologically important. More research is needed that focuses on assessing BW health and distribution in urban settings and its relevance for social equity. Socio-economics can be integrated into the analysis of the urban canopy to attempt to produce novel findings of human and tree health interactions.

Black walnut (BW) (*Juglans nigra*), a native tree of the northeast, is of potentially great significance for the city of Syracuse. Its geographic distribution extends into the northeast following sites of indigenous stewardship (Bosco, 2022). Activists and nonprofits promoting alternative foodways such as foraging and community gleaning programs find BW to be a valuable species (Syracuse Urban Food Forest Project, pers. Comm.). Its nutrient profile is denser in vitamins and minerals than English walnuts, and overall, it has excellent vitamin and mineral composition (Antora et al., 2022). BW is disease resistant and is expected to tolerate climate impacts well (SUFMP, 2021), which is particularly important because climate change predictions suggest that Syracuse may transition from zone 5 to zone 6 or 7 over the next 50-100 years (https://crt-climate-explorer.nemac.org/; https://cpo.noaa.gov/). BW provides essential root stock for commercial walnuts, and a growing community of nut producers in the Northeast use this species as a prominent marketed flavorful nut (NYNGA[1], NYTCA[2], Comm. Pers.).

In addition to acting as a climate change-resistant food source, BW is one of the most valuable timber species in the world (Jose & Holzmueller; 2008 Mortier et al., 2020) such that it has often been extracted illegally from public lands by forest “bandits” or culled from private property by individuals posing as official city foresters (Syracuse City Arborist, Pers. comm.) and is listed as one of the more monetarily valuable species by the Syracuse State of the Forest Report (DRG, 2016) due to its provisioning and regulating services.

Considering the complex and unpredictable outcomes of climate change, it is critical to carry out a thorough and systematic study of BW tree health in urban environments. Black walnut is projected to see its suitable growing zone increase due to climate change (*Juglans nigra L*, USDA.gov, n.d). Yet, we can expect similar shifts in suitable climatic ranges for pests and diseases, as well as their hosts and vectors (Singh et al., 2023), potentially threatening BW health. For instance, eastern BW is at risk of thousand cankers disease (TCD), resulting from the pathogen *Geosmithia morbida;* the primary vector of this pathogen is the Walnut Twig Beetle (Chahal et al., 2019). In the last decade TCD has been slowly increasing its range east and north due to climate change and anthropogenic influences (Williams & Ginzel, 2021; Wiggins, 2014). Preserving functional biodiversity within the biome is an important action to take in response to novel stressors; another action is to use more transdisciplinary approaches when “monitoring, managing and mitigating” different risks (Singh et al., 2023). Raum et al. (2023) note that urban trees experience greater variability and more extreme incidences of stressors and are already threatened the most by drought, heat, and insect pests. Social outreach and interface with urban forest management and policy will be important for municipalities in their development of new management strategies (Singh et al., 2023; Raum et al., 2023).

Theoretical Framework: Urban Agroecology

This research aims to understand the link between BW health and social indicators of wellbeing in Syracuse, NY. Urban agroecology/political ecology is a helpful framework to understand these contentious relationships. In this section, I expand on the theoretical and practical relationship between tree health and socioeconomic factors and why it is important when considering urban natural resources.

Agroecology is a science, a practice, and a movement. Although practiced for millennia by Indigenous peoples, agroecology became increasingly recognized as a scientific field as the application of ecological principles for the design and management of agroecosystems (Gliessman, Altieri, etc.). In 2007, in response to the already seen failures of neo-liberal agronomics, a gathering of allies for food sovereignty was convened in Mali. The resulting Nyeleni declaration, report, and synthesis put forward a “collective understanding of Food

Sovereignty" with 6 themes combining human and more-than-human values (ICS, 2007). Agroecology is named as an ecological production approach within these documents that creates value in the form of nutrition and greater environmental health, while also being a form of community and cultural empowerment (ICS, 2007).

Agroecology continued to be given greater attention as a powerful framework for the transformation of our food system– particularly after the global food shortage that resulted in 2009's global economic crisis– by food sovereignty movements, such as La Via Campesina (Wezel and Soldat, 2009). Wezel and Soldat explain the temporal and spatial shift that is occurring as Agroecology is used in different ways, "[authors] go beyond this by leaving the concrete spatial scale and entering the full dimension of the food system. This dimension includes local, regional, national, and global geographic scales… it is necessary to simultaneously consider and analyze natural, social, human, physical and financial capital dimensions to shape concepts for agricultural sustainability, the core topic of agroecology." (Wezel, Soldat, 2009, pg. 12) The most recent overview of agroecology by Wezel et al. (year) is decisive in poising agroecology as an answer to the failure of industrial modern agriculture and global commodity market, the "global food system" (Wezel et al, 2020). Aspects of the science of agroecology and practice have been incorporated into United States agriculture, mostly in the form of agroforestry, though currently this is less than 1% of total farming (Patel-Weynand et al., 2017).

Agroforestry shares principles of agroecology, taking a systems approach to understanding a productive landscape that has trees integrated with other cropping and livestock systems. The USDA is providing more funding and training opportunities to the public and to state and local level management in agroforestry, urban agroforestry, and community forestry:

“Through the U&CF [urban and community forestry] Program, communities receive technical and financial assistance to establish and protect community trees and forests to improve air quality, water quality, human health, and wildlife habitat. This landscape-scale approach often requires planning and integrating agroforestry systems into the green infrastructure of larger landscapes that include a matrix of urban, rural, agricultural, and forest lands” (USDA, Agroforestry Strategic Framework, 2019).

Agroforestry as defined and implemented by federal and state actors, however, is limited by the reliance on top-down financial structures, hierarchy of decision making and power, and the legal restrictions, real or perceived, that can inhibit activities like foraging and the creation of urban productive green spaces (Brandner & Schunko, 2022; McLain et al., 2017). It faces challenges listed above like climate change and the cultural perceptions of species, that will influence management. This could be an opportunity to integrate the social dimension, human health, into agroforestry management.

Plant pathologists already see the need for including plant disease in the One Health model that is used as a framework to understand zoonotic diseases and human interaction (Singh et al., 2023). Human health and plant health are linked; One Health could utilize a transdisciplinary and intergovernmental approach to studying plant disease, ensuring nutrition and functional ecosystems for regional community livelihoods and individual health (Singh et al., 2023). The incredible impact that plant disease has on several markers of human health will be further exacerbated by climate change.

Using urban agroecology in conjunction with agroforestry, understanding cultural and economic influences on urban canopy, and how the multiple *Healths* of human and more-than-human are interconnected will aid in the effort of mitigating and adapting to climate change. This way it could be possible to align actions for human health with actions for ecological health, in all the multiple ways that they are understood by the community. It is a critical task, then, to clearly communicate how we perceive and measure health.

In their literature review, Bezner Kerr et al. (2022) describe agroecology's social theory as organized within the themes of social well-being, livelihoods, meaningful work, and gender and social equity. These aspects that contribute to human health are being improved due to increases in nutrition and participation in meaningful cultural practices; improvements in equity and income are documented however there is a lack of work with these topics (Bezner Kerr et al., 2022) How does this change or transform when studied in the context of urban agroecology?

Using these definitions of health to start, we have themes to give context to what we observe and measure when looking at the socio-demographics of urban canopy health. We have themes for plant health when we join ecological health markers found in agroecology. Biodiversity, soil health, animal health, and synergy are all principles of agroecology that guide measuring of ecological health. Agroforestry already increases biodiversity (Santos et al., 2022), and I have described the efforts of city forestry departments to increase canopy and canopy equity. Social values included in Agroforestry theory and practice, as they are in agroecology, could provide a more robust framework for achieving these forestry goals.

The Importance of Black Walnut Trees and their Management in the City of Syracuse, NY.

In the city of Syracuse, historically redlined neighborhoods with majority black populations of city residents continue to struggle with urban renewal campaigns and the legacies of generations of neglect from the government (Mulcahy, 2023). Many citizens in these neighborhoods have significantly less access to food, education, jobs, common public services, and protections from exploitative housing management (Mulcahy, 2023; Bunge et al. 2019). The

Syracuse *State of the Forest Report* (2016), prepared by the Davey Resource group, and the *Syracuse Urban Forest Master Plan* (2021) marked these same neighborhoods (Appendix 1) as being the priority for Urban Tree Canopy (UTC) projects. The Syracuse Urban Forest Master Plan (SUFMP) aims to increase the percentage of UTC across all of Syracuse to 30% (current average is 24%). The city's priorities are those spaces that are below average canopy and disadvantaged according to census criteria. In this context, the city of Syracuse is focusing on vacant lot land management and is on track to plant 1,200 trees each year, two thirds of these in disadvantaged neighborhoods (Syracuse City Arborist, pers. Comm.). 36% of all the standing trees that compose the urban tree canopy are considered invasive species, which can have a less beneficial impact on ecosystem services compared to similar native species (Charles & Dukes, 2007; Pejchar & Mooney, 2009). Thus, the Forest Master Plan seeks to increase canopy coverage and lower the presence of non-native species while keeping canopy coverage of any single species at around 10% of the total urban canopy. The plan seeks to have a healthy range of tree age in the canopy and to do so in a way that is socially just (SUFMP, 2021). Clearly the Syracuse city foresters, as well as their colleagues across the US, have a dynamic and critical task before them.

Cultural responses to native plants and invasive species are critical to understand in order to promote healthier and more biodiverse urban landscapes (Doody et al., 2014; Ernwein & Matthey, 2019; Jones et al., 2014). While Syracuse city arborists have raised awareness and public interest in enhancing the urban forest for all, the department has become increasingly reactionary in its management due to budget constraints. To explain further, the calls to the department largely dictate work that is done, especially removals. The Syracuse city arborist, who leads decision making for the department, acknowledges that most calls about black walnuts construe them as “nuisance species” (Syracuse City Arborist, comms. Pers.). City residents may perceive them as such due to the dropping nuts, leaf litter, or tendency to drop branches and twigs.

Urban Forestry management assessments in other large municipalities show that most tree work is done in consolidated areas, responding to calls, rather than dispersed to the areas and trees in greatest need as mapped by the forestry department’s management plan (Davey Resource Group, City of Tallahassee, 2018). This can create a pattern where neighborhoods with more means to attend to their urban canopy will most actively call upon the department to remove trees and change what species are planted diminishing the crews time to respond to trees that are already marked as needing maintenance.

Given that street trees and managed green spaces increase surrounding property values (Mansfield et al., 2005) the cultural performance of official city management coupled with neighborhood residents' actions on private property can contribute to canopy injustice, while selecting for a species composition that citizens are inequitably affected by. Attitudes such as these towards “nuisance species” may be inadvertently decreasing functional diversity and ecosystem services, including food provisioning for city residents, as well as hindering progress in transforming urban green spaces into productive areas. Furthermore, the species planted or removed will have a lasting impact on the health of the people in those areas. The critical nature of these decisions makes clear and effective management plans incredibly valuable. It is also critical to understand how trees are assessed within these plans and agree on an understanding of health. For instance, we could discuss black walnut and its services to human health via nutrition, cultural meaning, nutrient cycling, water management, air filtration, and cognitive health. This could guide outreach and education efforts during community engagement, so that citizens are empowered and included in the management of their natural resources.

Urban and community forestry as a practice does include significant amounts of community engagement. Forest master plans are an example of the outcome of co-creating objectives. While it is useful to have, there are still many areas of tension where cultural perceptions and official management practices conflict.

Urban Political Ecology seeks to understand how urban landscapes are shaped by environmental and social processes (Christophers, 2018), and provides a critical perspective to reveal what might be shaping the "health" of urban trees. The City of Syracuse has several different institutions and communities that act to shape the ecology and topology around them. People are influenced by the culture of the community they live in; institutions, acting as agents, act according to a culture of capitalist frameworks concerned with asset and risk allocation. As Christophers (2018) states, institutions work to allocate risk and create differential experiences of risk. This "reordering of space," as Jones (2014) explains, is a result of one type of risk becoming real and manifest, warranting action to change the physical experience of the citizens that engage with that space. In the case of trees, a city has far more structural power in determining the narrative around natural resources and their management than the populus. Ernwein (2019, 2021) tracks social hierarchy and its reinforcement in green initiatives, as cities use public events to normalize one way of engaging with a space, and in the way the city workforce is altered by engaging with a more ecological form of management. The work force doing the green work in urban settings is often reflective of capitalist hierarchies of decision making (Ernwein, 2014, 2021). Within city parks especially, the labor that keeps these spaces clean and tidy is an amalgamation of public and private forces; unpaid workers, either volunteers or forced community service; welfare workers; public work trainees; nonprofit staff; often these individuals will never benefit from the increased property values and ecosystem services their paid and unpaid work results in (Krinsky & Simonet, 2017). The health of these human laborers becomes further entangled with the health of trees when government practice begins to incorporate vegetal labor in the form of carbon credits or ecosystem services.

While it is possible for citizens to act and inform how their urban space is governed, it requires being aware of the ways in which risk is defined and managed (Jones et al, 2014). Outreach by city officials can change the way relationships are performed by private citizens for the benefit of the environment, raising awareness of the importance of biodiversity, or of a particular native species (Doody et al, 2013). Narratives like "greening", however, can also be used as explanation for the lack of management and budget cuts to natural resource departments; one type of *risk* becomes greater than any other type of *risk*.

Current conversations of urban agroecology will benefit from the work done on social hierarchies in "greening" efforts and government communication, as agroecology the movement, science, and practice are soil first and anti-hierarchical (Tornaghi, 2014; Tornaghi & Dehaene, 2020). Using urban political ecology, particularly urban political *agro*ecology, as a foundation, one task of my work is to construct and or aid in the construction of a health assessment methodology that does include aspects of social justice and canopy equity. Using urban agroecology aids in pushing the conversation out of the realm of management and more into the realm of commons. This is achieved by utilizing the participatory, co-creative, justice centered framework of the parent science, agroecology (Toledo, 2022).

As cities and governments begin to discuss regional resiliency with more fervor, it is important to see who benefits and what "sustainable" project is green lighted for development. It is important to acknowledge that urban renewal historically has failed, and that many residents still are unable to enjoy the ecosystem services that governments have come to commodify. Agroecology's transformative power is in building alternatives as well as dismantling and subverting existing structures (Tornaghi & Dehaene, 2020). It considers the system. Any model, any development, any growth that does not start here is not sustainable and will ultimately fall short in addressing the inequities that exist. Incorporating broader health markers, ones that include both human and ecological communities, in urban tree health assessments could lead to a better assessment model that captures the interdependent nature of urban ecologies with historical urban development and inequities, thus responding more accurately to changes in management and community investment.

Research Objectives

Addressing the questions posed below will bring insight into the distribution and factors influencing tree health in different areas, and the relationship between tree presence and socio-economic factors. By analyzing these factors, I hope to gain a better understanding of the complex dynamics between tree health, urban development, and management practices. It is expected that healthy trees should not be as present in disadvantaged neighborhoods as they are in neighborhoods experiencing more advantages.

The overarching goal of this study is to gain a comprehensive understanding of the health status and spatial distribution of BW in the urban landscape, and its relationship to socioeconomic, demographic factors, and environmental factors in the city of Syracuse, NY. Using an agroecological lens, I analyzed the physical variables of the trees and their immediate environment in relation to census block group data, bringing social justice and food access issues into the conversation of urban forest management. The use of agroecological principles will keep the relationship between social wellbeing and species health at the forefront of the discussion and help identify gaps in current tree health assessment methodology.

Specifically, I asked:

1. What is the current health status of *Juglans nigra* within the city boundary of Syracuse, NY?
2. What is the relationship between tree health, as measured by the city, environmental data, and the socioeconomic data?

METHODS

Site Description

Syracuse, NY is located on the 43rd parallel, about 16 miles south of Lake Ontario. It has a hot-summer humid continental climate and an annual rain fall of 38.47 inches. Syracuse experiences abundant snow fall due to the lake effect and contribution from nor'easters. It is in the temperate forest and eastern wood plain ecoregion (Ecoregion III, EPA, 2023) and has many of the hardwood species for which the northeast is famous. Introduced non-native species account for 36% of the urban forest; European buckthorn alone is 21% of the total (SUFMP, 2021). The city is hilly, with flat sections associated with creeks and the lakefront. The city has 26 recognized neighborhoods, with varying levels of canopy coverage and species composition. The city's population is about 46% white alone, and 30% black or African American alone (data.census.gov, P2, 2020). There is a 9% unemployment rate and a median income of $40k; when separated by race there is a nearly $20k difference between white and black or African American median incomes, $48K and $31K respectively (US census bureau, ACS 2021). MIT's Living Wage Calculator (2023) estimates the annual costs of one adult with zero children in the Syracuse metro area are over $32 thousand.

Data Collection: Tree Health and Census Block Data

Q1

To understand the spatial distribution of health of BW in the urban landscape of Syracuse, NY, I used tree assessment data for the 273-city managed black walnut from the Davey Resource Group (DRG) tree keeper website for Syracuse (syracuseny.treekeepersoftware.com), exported to excel, and uploaded into ArcGIS Pro. All data cells were edited to match input specifications for GIS; all numerical census data was kept.

Q2

I conducted field observations to evaluate the health status of trees using assessment variables from two methodologies: Alkimim Reis et al. (2020), and Soto Pinto et al. (2017), because of their strong agroecological focus. This means that observations be conductible without institutionalized expert knowledge or expensive equipment and the ability for the methodology to be adopted to other systems. An urban agroecological tree health assessment model then is open access, and responsive to community participation in deciding what factors or outcomes are desired. One of these works is Urban and one is Agroecological, providing my field methodology with the needed robustness to speak to any gaps in city methodology and to move towards discussion of equity and nutrition. They are both based in participatory approaches, one for increased agroforestry production (Pinto et al., 2017) and one for enhancing urban canopy by assessing infrastructure challenges like tree interference with sidewalks and powerlines (Reis et al., 2020).

For field observations I randomly selected 61 total trees. 47 trees within the 273 total population of managed BW in the city of Syracuse were selected using the ‘Random Selection’ tool in ArcGIS Pro. This selection did not include any walnuts marked by the city as in “poor” condition (N=14), and it was decided to include all "poor" trees in the total for representation giving the final N=61.

For each of these trees, I conducted field observations to assess health, recording 16 biophysical and ecological variables related to tree health (Table 1). I complemented these tree health variables with additional visual indicators of tree health and environmental factors based on existing literature of black walnut and conversations with a grower and six tree specialists/professionals in relevant fields. These variables are: 1) *Ability to access*- defined as: was I able to access the tree and where it would drop nuts with ease and no legal, physical, or cultural challenges?; 2) Diameter at standard height (DSH) collected using the standard US forestry height of 4.5ft; 3) Canopy density % collected using a densiometer, averaging 4 measurements at each cardinal direction of the tree trunk; 4) Crown Health (bad 1-5 good); 5) Crown Thinning; 6) Branch Dieback %; 7) Shoot Dieback; 8) Chlorosis %; 9) Leaf Necrosis %; the fourth variable through ninth are included as typical forestry professional measurements, all are visual assessments.

Trunk and root damage, # of exposed roots, and stand regeneration (number of basal shoots) are included via visual observation and counting. Damage is a variable included in the city forester's assessment as trunk damage and root exposure are often vectors for disease; basal shoots can be related to root damage, these shoots can be a visual indicator of tree stress and response to poor health (Shannon Lynch, Comms. Pers.) These trees were each visited once with visits occurring over the months of October, November, and December 2022.

I collected data on local environmental factors, such as 1) Species richness and 2) tree abundance in a 15-meter radius; 3)fruiting is included as a binary es/no visual observation; 4) percent groundcover paved, percent ground cover natural, and percent ground cover lawn are visual observations recorded within 15 meters, to examine how certain local urban features and the composition of ground cover relate to or may explain tree health, species richness/abundance and their relationship to socioeconomic variables.

To evaluate if there are patterns among tree health and socioeconomic factors, census data for each tract of Syracuse was extracted from the American Community Survey 5-Year Estimates (2017-2021). Census data was downloaded as an Excel sheet from Social Explorer (socialexplorer.com), which allows for geographic specification down to the tract level. This Excel sheet was imported into ArcGIS Pro and transformed into a standalone table to use in the creation of joined shapefiles. The census data table, the Davey tree data table, and the individual tree selection data table exist as point files geolocated using census map shapefiles, and parcel data for the city of Syracuse. The spatial join tool was used, joining the census data and the census shapefile using the GEOID as the join field. Another spatial join was performed using the joined census shapefile and the point file of black walnut trees. Embedding all the locationally correlated ACS data into each individual tree point resulted in a shapefile where each tree could be selected and show its surrounding census data. Each census block being selected showed the BW tree data they contained. The table containing the total population of BW was exported from ArcGIS Pro into Excel, and the randomly selected observed trees table was exported as a separate Excel table.

Data Analysis

Q1.

Hot spot analysis was run in ArcGIS Pro to identify significant clusters. Further spatial analysis measures the pattern of distribution relative to environmental features like soil type and proximity of watershed features. Descriptive statistics were gathered using Excel and ArcGIS Pro.

Q2.

To discern relationships between tree health and socioeconomic factors I constructed Pearson correlation models using SPSS (Arkkelin, 2014). The coding changed language such as 'severe' and 'good', describing multiple variables, to number rankings (Table 2).

Several different matrices were created by running multivariate analysis in SPSS. The health variable 'condition' is the singular health variable (table 3.a) in the first socio-economic analysis which used only the census data. Eleven data columns (table 3.c) from the ACS table were selected based on that variable's relevance to environmental justice and urban disparities, based on existing literature (Nyelele & Kroll, 2020).

Results

1. **Current health status and distribution of *Juglans nigra* within the city of Syracuse, NY.**

The City of Syracuse has a total of 277 BW trees (syracuseny.treekeepersoftware.com). Of these 1.09% are dead, 5.43% are in poor condition, 58.7% are in fair condition, 34.06% in good condition, and 0.72% are in excellent condition.

Based on visual observations of point layer files in GIS, the spread of BW appears to follow the course of the Onondaga Creek zone, placing a majority of the BW population in the south and southwest (Appendix 1).

The Arc Pro GIS hotspot spatial analysis tool identified 3 significant clusters (Appendix 2) in the Court-Woodlawn area, Elmwood area, and the Tipp Hill area (ESRI, 2023). 167 of the individuals occur on the west side of the Interstate 81.

Arc Pro Hot Spot analysis and cluster analysis does not indicate any significant pattern for the distribution of Diameter at Standard Height (DSH); the mode for DSH is <4 inches, and the average is 13 inches. The soil types are silt loams of varying slope; all are well drained. There is a significant absence of trees in the presence of the soil classification ‘urban soils’ which is a large area, including the entire downtown of Syracuse and the final segment of the Onondaga Creek as it connects with the lake. The average recorded species richness within 15 meters of observed trees is 4.13, with a range of 0-15. The average tree abundance within 15 meters of observed trees is 7.62. Averages for percent ground cover natural, lawn, and paved are 27%, 37%, and 36% respectively.

2. Relationship between Tree Health and Socioeconomic Factors

There are significant correlations among the various environmental variables. Species richness and total number of trees are both strongly positively correlated, r (degrees of freedom)= .539, .595 respectively, with percent ground cover vegetation ($p<0.001$). The data shows a significant positive correlation between percent ground cover vegetation and ‘median value’, r(df)= .351 (Figure 1). The measurement of how many trees are in a 15m radius around the observed tree increases with increases in the percentage of natural ground cover, the median home value, and the percentage of the population that is non-Hispanic/white alone (Figure 2,3,4). Species richness is also strongly positively correlated with number of trees, r = .404 ($P \leq .001$).

The average of “median value of homes” of the census blocks linked to the studied BW is $101,147 US dollars.

According to the ACS 5-year estimates (2017-2021), the neighborhoods where significant clusters of BW occurred have low-income, low formal education, low food access, predominantly rental housing, and a majority black/non-Hispanic populations.

Discussion

1. **Current health status and distribution of *Juglans nigra* within the city of Syracuse, NY.**

This research examined the health status and spatial distribution of BW in the urban landscape, and its relationship to socioeconomic and demographic factors in the city of Syracuse, NY. Spatial analysis indicated that The Elmwood neighborhood has the highest count of BW, n=36, followed by Court-Woodlawn and Tipp Hill which both have n=24. These all demonstrate statistically significant clusters through GIS analysis. Uniquely, Court-Woodlawn's cluster can be explained to an unmanaged lot and inaccessible steeply sloped property margins where many BW have created a stand. In the other cases, it is the presence of parks, such as Elmwood Park, that create the conditions for these trees to present themselves in clusters; Lawn cover is a variable that behaved oddly, and upon reflection of the site visits, it was determined that trees in parks, with lawn, could be affecting this variable. Even here though, it is frequently the unmanaged borders between private property line and park that offers the space for BW. The presence of BW in unmanaged spaces could be reflecting the story of removal that is occurring due to the perception of BW as a “nuisance.”

2. Relationship between Tree Health and Socioeconomic Factors: Promoting Social and Ecological Equity in Syracuse, NY

Weaving field observations of tree health and the existing assessment methodologies, and socioeconomic composition of the city of Syracuse, I hope to show the tension of cultural norms and the impact they have on urban community well-being and the forest itself. Furthermore, I hope to show the ease with which certain agroecological principles can be incorporated into urban forestry to help promote social justice and equity.

The strong positive correlation that species richness has with number of trees and percent natural ground cover could be an indication of social values and wellbeing are lack thereof influencing ecology. Median home value has a strong positive correlation with percent ground cover natural. This could indicate a pattern of environmental correlation with census data tied to higher income, higher educated, higher percentage white neighborhoods, as these demographics are significantly correlated in census data.

It is not possible nor is it my aim to attempt to clarify if cultural values towards BW changes based on wealth; further there is no correlation in my data to even begin. Wealthier neighborhoods may not be the ones to have an abundance of natural ground cover; many of the sites visited that had high percentages of natural ground cover were in the border of parks, vacant lots, or unclaimed street land in more industrially developed segments of Syracuse. This is supported by work done on the ability of ruderal and urban landscapes to hold a large amount of biodiversity (Müller et al., 2018; Sardeshpande & Shackleton, 2020; von Hoffen & Säumel, 2014; Yang et al., 2017).

The social ecology of lawns has been studied and most data support the finding of more lawns and higher fertilizer use in wealthy neighborhoods (Fraser et al., 2013; Larson et al., 2008). These works show that institutional power and existing cultural hierarchies have greater influence over yard management than personal values. This naturally extends to parks as well, which have an expected look and way of use.

The census tracts with the highest presence of poor health trees had majority white populations, with lower educational achievement; under 12% of the population over 25 years have bachelor's degrees. Average annual income is $38k and $48k in two tracts next to each other. The higher earning tract is majority renter occupied, at 53%, and the lower earning tract is 91% owner occupied. In the majority owner occupied tract there is 25% lot vacancy, one of the highest among the tracts included, which could offer refuge for black walnut. This research however, didn't result in any significant correlation for poor health trees, nor any indication of clustering.

Other work has shown how communities and culture can shape biodiversity and the health of urban systems. This may be through conscious community efforts by a niche group that is open to engagement with city management and peer-to-peer education (McLain et al., 2017). Often age and experience with agricultural systems can be a hindrance to seeing systems in new ways, lowering the implementation of beneficial practices or creating negative perceptions of potential agricultural use in urban spaces (Borremans et al., 2016). There is a space for education by professionals to inform communities and alter perceptions of woody species, thus altering the management of them; this allows for new cultural practices to emerge, both in private land and public space (Doody et al., 2014).

Building on research that indicates agroecologically managed urban gardens, as nodes of green infrastructure, contribute to greater plant biodiversity, which encourage higher animal and pollinator diversity, and contribute to greater ecosystem services, Philpott et al. (2020), stress the importance of better understanding the drivers of species composition and diversity. The research introduces several new findings regarding species richness in urban gardens. Country of origin and gender most strongly correlate with increased biodiversity in garden plots, and time spent in the garden has a positive correlation with overall species richness. Within urban gardens, species composition is strongly determined by the individual gardener's management. In what ways might this extend to citywide management and trees? Further, these findings support claims made by other political ecologists, that management of green spaces and the use of *risk* as a narrative tool complicate urban greening efforts and perpetuate historical inequities of access and development (Christophers, 2018; Jones et al., 2014).

The literatures of political ecology, urban agroecology, and governmentality have examined *risk* as a tool for reinforcing power dynamics, encouraging xenophobia for humans and more-than-human *aliens*, altering the physical landscape, and increasing urban development (Christophers, 2018; Collins, 2008; Ernwein & Fall, 2015; Zimmerer & Bassett, 2012). However, in urban agroecology, risk and the impact it has on daily city crew decision making is not entirely elucidated.

Clarifying how *risk i*s defined is useful for engaging with social justice and will aid in the creation of methodology that is sensitive to equity. While research exists indicating the positive outcomes of the presence of trees, there is still a need to measure how management of those trees is impacting social justice issues just as there is need to measure how agroecological approaches are impacting social justice issues (Bezner Kerr et al., 2022).

As the city of Syracuse moves forward with its Urban Forest Master Plan (FMP), collecting information about managed trees that does have a relationship with the census data of the communities these trees are in becomes increasingly important. Agroecology offers a framework for understanding these new data points because it pushes for a systemic approach. These agroecological observations would provide a richer picture of the state of the urban environment by nesting statistical data points into a lived space. It would allow for other forms of knowledge and experience. It could create space for intricate and detailed forms of systems management and provide a space for community engagement with the multiplicity of species and their performances over their lifespans. The need to bring in productive systems such as food forests into urban spaces means that city foresters will need a more nuanced way of assessing health and greater ability to engage with communities.

Jones et al., speak to the conflict between the emerging refrains in urban natural resource management of "trees-*as*-risk versus trees-*at*-risk." (Jones et al. 2014. 211) Basing their research within the multi-year conflict over the removal of city street fig trees in Newcastle, Australia, known as the Laman Street Fig (LSF), the authors reveal that risk, and the assessment of risk can be a strategy of power and expert opinions can be brought forth on both sides.

Work from Jones and Ernwien show that "greening" can be appropriating, exploitative, and perpetuating of existing hierarchies (Ernwein, 2014; Jones et al., 2014). Essentially, absorbing the plant and more-than-human into the capitalist neoliberal agenda of government management allows the urban center to respond to cultural criticisms and new research in health without having to actually change existing structures or undue past oppressions and damages (Ernwein, 2020, 2021). Jones in particular, with the addition of Doody et al., and the idea of performance, readily reveals that risk is understood in different ways by different actors, and that the senescence of woody and vegetative life forms can be seen as an excuse by city authorities to implement desired development strategies.

The phenomena of a species as a nuisance, which is the primary call received by the Syracuse arborist regarding black walnut, is a cultural development, one that is strengthened or countered through various performances, by people, groups, and the plant species themselves. As Doody's research points out, depending on the space, a native woody seedling will be interpreted in different ways, and often it is in the interstitial space, or ruderal space of the urban, where opportunities for seedlings exist.

There is an opportunity here for rich community building and the alleviation of many social injustices experienced by disadvantaged communities. It will need more than just the planting of hardy generalist species trees in urban landscapes. There could be a move toward participation of communities in active management and use of their environment. The intersections of cultural performance, the ability to exercise ownership over the "natural" space around oneself, the history of development and the plans for future development, are ripe spaces to investigate how plant species may influence our urban places. "Their treatment is always dependent on context and, consequently, the realities of seedlings performed in a garden is always momentary, unpredictable, improvisatory and *multiple*." (Doody et al., 2014)

For Urban Forestry Management

As mentioned before, Urban and Community Forestry within USDA is leading by example with efforts that meld social values and ecological goals, bringing distinct fields of knowledge and practice that converge within the conversation of health. While the current health assessment of the city is valuable, it does not take note of incredibly useful information that is completely interrelated with the individual tree being assessed. Further, this missed data is vitally important to the mission of the forestry department and is essential to further understanding patterns of canopy injustice and inequity. It would be an impactful move to incorporate one or two of the most significant field variables from this study into the existing health assessment that is run by the forestry department. Taking a quick note of species richness and number of trees of a certain DSH threshold would gradually create a robust data set. This could be collected over several years by forestry staff during various procedures, and the data could then be integrated into GIS by a summer intern, or a community mapping group. The city would then have a map, not only of the individual trees they manage, but also a map of species richness and diversity across the urban landscape. This would bring much of the daily tasks of municipal forestry into alignment with the greater vision of the Urban Forest Master Plan and with social equity issues.

Limitations, Recommendations and Suggestions for Future Research

There is much to discuss about the variables I selected for analysis, however much of the selection was due to a lack of data for multiple criteria. This includes all of the categories for canopy and branch health as well as suckering. Leaf drop happened quickly as field visits started, meaning it was not possible to ascertain these categories like leaf necrosis, crown health and branch die-back. Branch dieback (large branches dying back to the trunk), shoot dieback (basal and epicormic shoots dying back to trunk), chlorosis and necrosis are all variables related to visuals symptoms of stress and or injury. The vast majority of trees did not display visual symptoms on the branches. I took note of this in the results by including the cities own remarks about damage on a few trees, and the dominant recommended management of pruning. Species diversity was not measured and will be an important variable to collect in future work; species richness is a fast measurement to take and could be incorporated into a standard operating procedure for city forester’s tree visits. Crown class is a typical forestry measurement that can provide useful growth type information but was also seen as not relevant in the final analysis.

The statistical work displayed intriguing correlations, particularly the significant correlations between the field observation variables and ACS census data. More work needs to be done to tease out how exactly biodiversity as measured by species richness is correlated with socio-economic data. It is tempting to see how natural cover increases with higher incomes, and how species richness increases with natural cover, and make assumptions. However, at this time, there is too much noise to verifiably say that median home value and species richness are correlated in any way.

Qualitative research will be extremely useful in conjunction with more detailed field observations and robust data sets. Knowing how other non-profit groups view trees, what species they are planting, and how easy it is to source various bare-root trees, will all impact urban resource management strategy. Further, the fact that no strong correlations could be detected between socioeconomic data and species richness, number of trees, or health indicate that the sampling of only city managed trees is too limited. The issue of parks and open spaces needs to be addressed, and the usefulness of ruderal landscapes, especially as the latter are increasingly seen as relevant and important in conversations of urban equity, conservation, and foraging. Observational field work is an approach that could offer many findings to this research. During my tree site visits I was often the only person out, and although my visits were brief, generally 10-20 minutes, it was remarkable to consistently observe this sparsity of presence. Spending more time with a few trees or spending concentrated time out during kernel harvesting season would be incredibly useful in understanding the cultural and communal aspects of the spaces around these trees, the spaces that these trees help create. Engaging with, tagging along with, and interviewing city foresters will also be a rich direction to pursue to understand how community forestry might be incorporated.

Conclusion

The pressures of climate change impacts, land use change, habitat loss, urban expansion, and development are all resulting in urban forest loss, while many municipalities across the US lack urban forestry programs to enact the practices to sustain urban forest efforts (Albrecht & Wiek, 2021; Jones et al., 2013).

Through this work I attempt to identify patterns existing in the social and ecological data about canopy injustice and urban ecological inequities while focusing on a single tree species, the black walnut. This research has sought to add quantitative data analysis of tree health and risk assessment to this conversation. Based in the city of Syracuse, a city that is implementing a well-constructed and justice-oriented Master Forest Plan, the analysis reveals that the expected managers of this urban canopy will be left with tools that bring them into this tension of trees-as-risk and trees-at-risk. It would be more equitable to give these foresters agency to engage with the community before work is conducted. This would mean leaning away from the trend of privatizing management and relying on capitalist models to provide labor. It would mean leaning into participatory management where equitably paid city employees can provide outreach and education to communities. These communities in turn can create goals for the Urban Forest Master Plan that are aligned with their needs and desires. This is just a glimpse of what could be gained by seeking a deeper understanding of the social-ecological relationships that exist in our urban spaces. Indeed, the relationships that have in many ways crafted our urban landscape.

TABLES and FIGURES

Table 1. **Field Observation Variables including variable type (Discrete, binary, continuous) and collection method (visual, measuring tape, densiometer)**

VARIABLE	VARIABLE TYPE	COLLECTION METHOD
Ability to Access	Discrete (yes or no)	Visual
Diameter at Standard Height	Continuous (inches)	Measuring tape
Canopy Density	Continuous (%)	densiometer
Branch Dieback	Continuous (%)	visual
Shoot Dieback	Continuous (%)	visual
Chlorosis	Continuous (%)	visual
Necrosis	Continuous (%)	visual
# of Community Species in 10m Radius	Discrete (#)	Visual count with measure tape
# of Trees in 10m Radius	Discrete (#)	Visual count
Presence of fruit	Discrete (yes or no)	Visual
Ground Cover – Paved (In radius)	Continuous (%)	Visual
Ground Cover – Grass (In radius)	Continuous (%)	Visual
Ground Cover – Natural (In radius)	Continuous (%)	Visual
Trunk and Root damage	Binary (yes or no)	Visual
# of exposed roots	Discrete	Visual
Number of basal shoots	Discrete	Visual

Table 2. The number values given to the corresponding word rankings used in analysis.

Assigned values for variables
DRG condition rank code: poor = 1, fair=2, good=3, excellent=4
Probability of failure code: low=1, moderate=2, high=3, extra high=4
TRAQ consequence of failure code: negligible=1, minor=2, significant=3, severe=4
TRAQ-Failure likelihood code: improbable=1, possible=2, probable=3
TRAQ- Likelihood of Failure Impacting Target code: unlikely=1, somewhat likely=2, likely=3
TRAQ-Risk Rating code: low=1, moderate=2, high=3, severe=4
TRAQ- Target Impact Likelihood code: very low=1, low=2, medium=3, high=4
N/A = 0

Tables 3.a,b,c

Variable used in statistical analysis

a. **Assessment Methodologies**
DRG Condition rank
Risk Rating
TRAQ-Consequence of Failure
TRAQ-Failure Likelihood
TRAQ-Likelihood Failure Impacting Target

TRAQ-Risk Rating
TRAQ-Target Impact Likelihood

b. **Field Observations**
Species richness
number of trees in 15m radius
Percent groundcover paved
percent ground cover natural
percent ground cover lawn
DSH

c. **ACS Census Data**
Percent Total Population_ Not Hispanic or Latino_ White Alone
Percent Total Population_ Not Hispanic or Latino_ Black or African American Alone
Percent Civilian Population 16 to 19 Years_ Not High School Graduate_ Not Enrolled _Dropped Out

Median Household Income In 2020 Inflation Adjusted Dollars
percent Occupied Housing Units_ Owner Occupied
percent Occupied Housing Units_ Renter Occupied
Percent Housing Units_ Vacant
Percent Vacant Housing Units_ Other Vacant
Median Value
Median Gross Rent
Percent Families_ Income Below Poverty Level

Table 4. The correlation among different risk method outcomes. Includes all Tree Risk Assessment Qualification (TRAQ) outcomes. This analysis was ultimately not useful in the conversation of health, perception, and value.

		DRG Condition rank	Risk Rating	TRAQ-Consequence of Failure	TRAQ-Failure Likelihood	TRAQ-Likelihood Failure Impacting Target	TRAQ-Risk Rating	TRAQ-Target Impact Likelihood
Davey Resource	Pearson Correlation	1	-.379**	0.206	.302*	0.255	0.232	.284*

Group Condition rank	Sig. (2-tailed)		0.003	0.117	0.020	0.051	0.077	0.029
	N	59	59	59	59	59	59	59
TRAQ-Risk Rating	Pearson Correlation	0.232	-0.194	.861**	.879**	.976**	1	.935**
	Sig. (2-tailed)	0.077	0.142	P<0.001	P<0.001	P<0.001		P<0.001
	N	59	59	59	59	59	59	59

Figure 1.

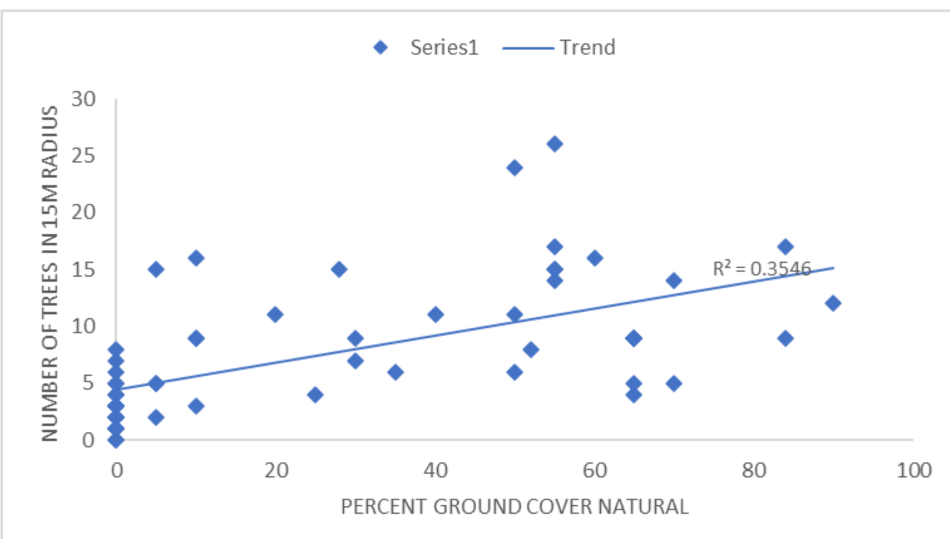


Figure 2.

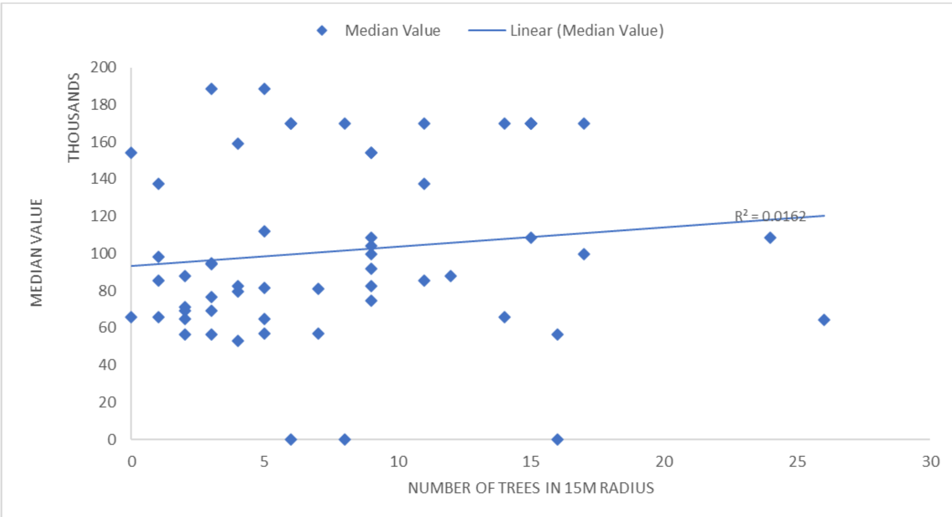


Figure 3.

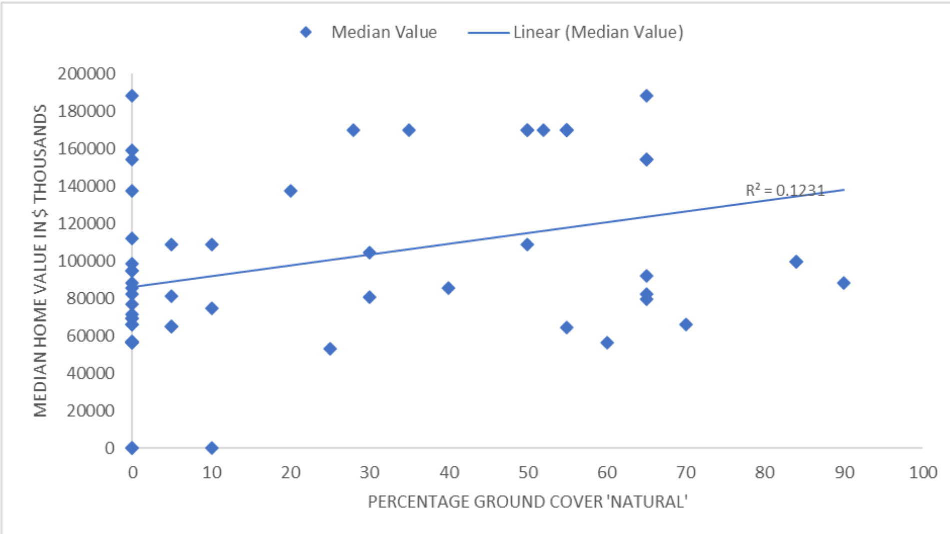
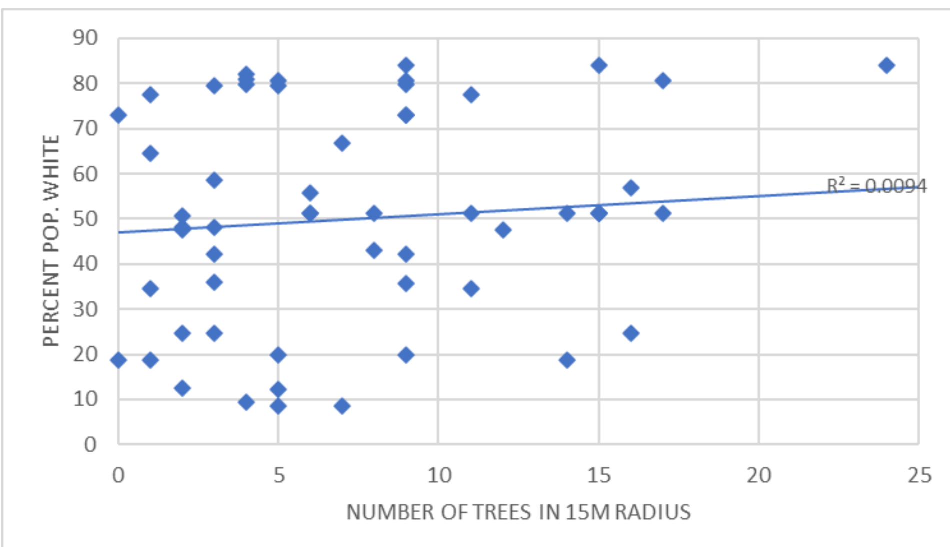
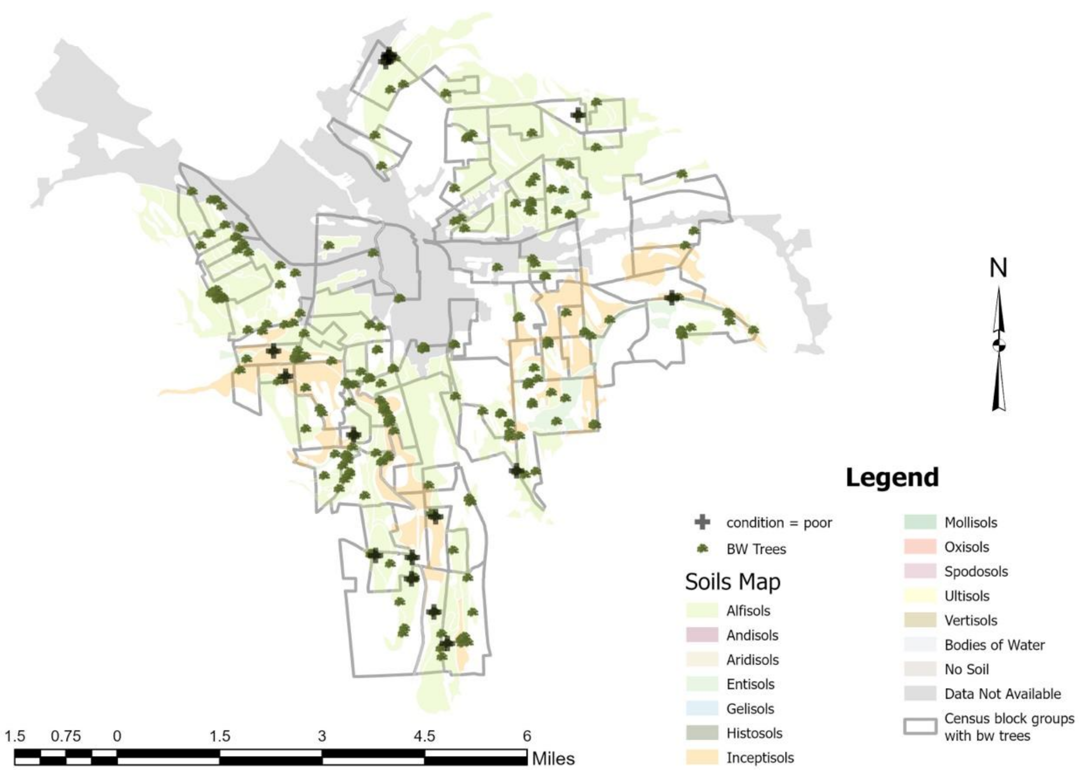


Figure 4. Points represent individual BW trees. The Y-axis, percentage population white of the census block, and the X-axis, Tree Abundance, show an increasing trend.

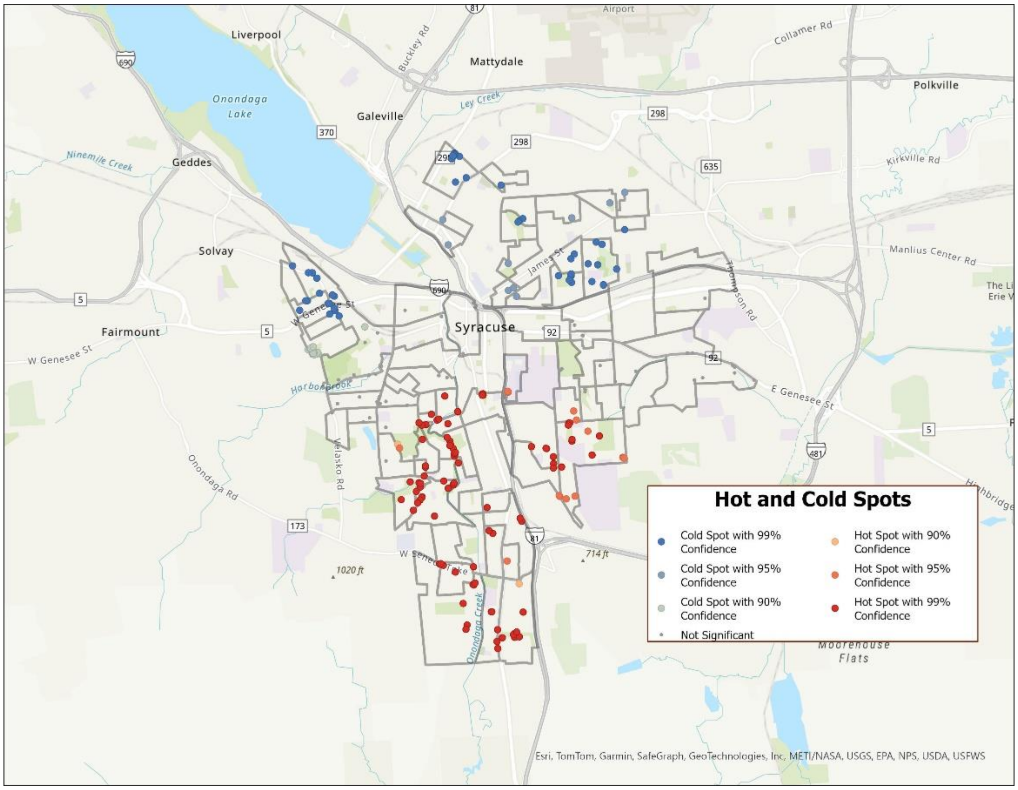


APPENDIX

1. **Distribution of black walnut in Syracuse, NY. With soil map.**



2. **Hot Spot analysis**



Hot spots have an *n* higher than the average and cold spots have an *n* lower than the average.

References

2013 Urban Forest Management Plan. (2021, April 20). City of Tampa. https://www.tampa.gov/document/2013-urban-forest-management-plan-68531

Albrecht, S., & Wiek, A. (2021). Food forests: Their services and sustainability. *Journal of Agriculture, Food Systems, and Community Development*, *10*(3), Article 3. https://doi.org/10.5304/jafscd.2021.103.014

Allen, J. A., , & Mason, A. C. (2021). Urban food forests in the American Southwest. *Urban Agriculture & Regional Food Systems*, *6*(1). http://dx.doi.org/10.1002/uar2.20018

Alvey, A. A. (2006). Promoting and preserving biodiversity in the urban forest. *Urban Forestry & Urban Greening*, *5*(4), 195–201. https://doi.org/10.1016/j.ufug.2006.09.003

Andreu, M. G. (n.d.). *Citation for This Report:*

Bendfeldt, E., McGonagle, M., & Niewolny, K. (2021). Rethinking farmer knowledge from soil to plate through narrative inquiry: An agroecological food systems perspective. *Journal of Agriculture, Food Systems, and Community Development*, *11*(1), Article 1. https://doi.org/10.5304/jafscd.2021.111.012

Borremans, L., Reubens, B., Van Gils, B., Baeyens, D., Vandevelde, C., & Wauters, E. (2016). A sociopsychological analysis of agroforestry adoption in Flanders: Understanding the discrepancy between conceptual opportunities and actual implementation. *Agroecology and Sustainable Food Systems*, *40*(9), 1008–1036. https://doi.org/10.1080/21683565.2016.1204643

Brown, S. E., Miller, D. C., Ordonez, P. J., & Baylis, K. (2018). Evidence for the impacts of agroforestry on agricultural productivity, ecosystem services, and human well-being in high-income countries: A systematic map protocol. *Environmental Evidence*, *7*(1), 24. https://doi.org/10.1186/s13750-018-0136-0

Bunge, A., Diemont, S. A. W., Bunge, J. A., & Harris, S. (2019). Urban foraging for food security and sovereignty: Quantifying edible forest yield in Syracuse, New York using four common fruit- and nut-producing street tree species. *Journal of Urban Ecology*, *5*(1), juy028. https://doi.org/10.1093/jue/juy028

Christophers, B. (2018). Risk capital: Urban political ecology and entanglements of financial and environmental risk in Washington, D.C. *Environment and Planning E: Nature and Space*, *1*(1–2), 144–164. https://doi.org/10.1177/2514848618770369

Collins, T. W. (2008). The political ecology of hazard vulnerability: Marginalization, facilitation and the production of differential risk to urban wildfires in Arizona's White Mountains. *Journal of Political Ecology*, *15*(1), Article 1. https://doi.org/10.2458/v15i1.21686

Daniels, T., & Berthier, M. (n.d.). *MARKETING & COMMUNICATIONS DEPARTMENT, Tel: 305.673.7575*.

Doody, B. J., Perkins, H. C., Sullivan, J. J., Meurk, C. D., & Stewart, G. H. (2014). Performing weeds: Gardening, plant agencies and urban plant conservation. *Geoforum*, *56*, 124–136. https://doi.org/10.1016/j.geoforum.2014.07.001

Egerer, M., & Cohen, H. (2020). *Urban Agroecology: Interdisciplinary Research and Future Directions*. CRC Press.

Environment and Crime in the Inner City: Does Vegetation Reduce Crime? - Frances E. Kuo, William C. Sullivan, 2001. (n.d.). Retrieved July 2, 2023, from https://journals.sagepub.com/doi/abs/10.1177/0013916501333002?casa_token=B5QBxTMsgu4AAAAA:FV-rSjoOmCEQfYuqS6qvBYM4sywe8zu3fmza53Ue-IFNNfbA26yDwJ1XThPToFuQQ2KCVEjWYDc

Ernwein, M. (2014). Framing urban gardening and agriculture: On space, scale and the public. *Geoforum*, *56*, 77–86. https://doi.org/10.1016/j.geoforum.2014.06.016

Ernwein, M. (2020). *From undead commodities to lively labourers: (Re)valuing vegetal life, reclaiming the power to design-with plants*. JOVIS Verlag. https://ora.ox.ac.uk/objects/uuid:912d2403-0990-4783-a641-59b6046f3725

Ernwein, M. (2021). Bringing Urban Parks to Life: The More-Than-Human Politics of Urban Ecological Work. *Annals of the American Association of Geographers*, *111*(2), 559–576. https://doi.org/10.1080/24694452.2020.1773230

Ernwein, M., & Fall, J. J. (2015). Communicating invasion: Understanding social anxieties around mobile species. *Geografiska Annaler: Series B, Human Geography*, *97*(2), 155–167. https://doi.org/10.1111/geob.12071

Ernwein, M., & Matthey, L. (2019). Events in the affective city: Affect, attention and alignment in two ordinary urban events. *Environment and Planning A: Economy and Space*, *51*(2), 283–301. https://doi.org/10.1177/0308518X18757509

Feeley, K. J., Bravo-Avila, C., Fadrique, B., Perez, T. M., & Zuleta, D. (2020). Climate-driven changes in the composition of New World plant communities. *Nature Climate Change*, *10*(10), 965–970. https://doi.org/10.1038/s41558-020-0873-2

Forzieri, G., Dakos, V., McDowell, N. G., Ramdane, A., & Cescatti, A. (2022). Emerging signals of declining forest resilience under climate change. *Nature*, *608*(7923), Article 7923. https://doi.org/10.1038/s41586-022-04959-9

Foster, A., Dunham, I. M., & Bukowska, A. (2024). An environmental justice analysis of urban tree canopy distribution and change. Journal of Urban Affairs, 46(3), 493–508. https://doi.org/10.1080/07352166.2022.2083514

Gliessman, S. (2017). Special issue: Food planning and urban agriculture. *Agroecology and Sustainable Food Systems*, *41*(8), 885–886. https://doi.org/10.1080/21683565.2017.1343524

Gray, P. (2020, November). *Tree Risk Assessment Review—Bark Summer 2020.pdf*. Arboriculture Australia. https://www.validtreerisk.com/resources/Documents/Media/Tree%20Risk%20Assessment%20Review%20-%20Bark%20Summer%202020.pdf

Hammelman, C., Shoffner, E., Cruzat, M., & Lee, S. (2022). Assembling agroecological socio-natures: A political ecology analysis of urban and peri-urban agriculture in Rosario, Argentina. *Agriculture and Human Values*, *39*(1), 371–383. https://doi.org/10.1007/s10460-021-10253-7

Hurley, P. T., & Emery, M. R. (2018). Locating provisioning ecosystem services in urban forests: Forageable woody species in New York City, USA. *Landscape and Urban Planning*, *170*, 266–275. https://doi.org/10.1016/j.landurbplan.2017.09.025

Inostroza, L. (2014). Open Spaces and Urban Ecosystem Services. Cooling Effect towards Urban Planning in South American Cities. *TeMA - Journal of Land Use, Mobility and Environment*. https://doi.org/10.6092/1970-9870/2541

International Society of Arboriculture. (n.d.). Retrieved July 2, 2023, from https://wwv.isa-arbor.com/store/product/324/cid/117/

Jones, R. E., Davis, K. L., & Bradford, J. (2013). The Value of Trees: Factors Influencing Homeowner Support for Protecting Local Urban Trees. *Environment and Behavior*, *45*(5), 650–676. https://doi.org/10.1177/0013916512439409

Jones, R. M., Instone, L., & Mee, K. J. (2014). Making risk real: Urban trees and the ontological politics of risk. *Geoforum*, *56*, 211–225. https://doi.org/10.1016/j.geoforum.2014.07.009

Juglans ntdra L. (n.d.). Retrieved April 6, 2022, from https://www.srs.fs.usda.gov/pubs/misc/ag_654/volume_2/juglans/nigra.htm

Konijnendijk, C., Devkota, D., Mansourian, S., & Wildburger, C. (n.d.). *FORESTS AND TREES FOR HUMAN HEALTH: PATHWAYS, IMPACTS, CHALLENGES AND RESPONSE OPTIONS*.

Kuo, F. E., & Sullivan, W. C. (2001). Environment and Crime in the Inner City: Does Vegetation Reduce Crime? *Environment and Behavior*, *33*(3), 343–367. https://doi.org/10.1177/0013916501333002

Lovell, S. T., Krishnaswamy, K., Lin, C.-H., Meier, N., Revord, R. S., & Thomas, A. L. (2023). Nuts and berries from agroforestry systems in temperate regions can form the foundation for a healthier human diet and improved outcomes from diet-related diseases. *Agroforestry Systems*. https://doi.org/10.1007/s10457-023-00858-8

Mansfield, C., Pattanayak, S. K., McDow, W., McDonald, R., & Halpin, P. (2005). Shades of Green: Measuring the value of urban forests in the housing market. *Journal of Forest Economics*, *11*(3), 177–199. https://doi.org/10.1016/j.jfe.2005.08.002

McDonogh, G., & Checker, M. (2015). *Sustainability in the Global City*. Cambridge University Press.

McLain, R. J., Poe, M. R., Urgenson, L. S., Blahna, D. J., & Buttolph, L. P. (2017). Urban non-timber forest products stewardship practices among foragers in Seattle, washington (USA). *Urban Forestry & Urban Greening*, *28*, 36–42. https://doi.org/10.1016/j.ufug.2017.10.005

Müller, A., Bøcher, P. K., Fischer, C., & Svenning, J.-C. (2018). 'Wild' in the city context: Do relative wild areas offer opportunities for urban biodiversity? *Landscape and Urban Planning*, *170*, 256–265. https://doi.org/10.1016/j.landurbplan.2017.09.027

Nowak, D. J., & Greenfield, E. J. (2018). Declining urban and community tree cover in the United States. *Urban Forestry &amp\mathsemicolon Urban Greening*, *32*, 32–55. https://doi.org/10.1016/j.ufug.2018.03.006

Patel-Weynand, T., Bentrup, G., & Schoeneberger, M. M. (2017). *Agroforestry: Enhancing Resiliency in U.S. Agricultural Landscapes Under Changing Conditions* (WO-GTR-96; p. WO-GTR-96). U.S. Department of Agriculture, Forest Service. https://doi.org/10.2737/WO-GTR-96

Pattanayak, S., Mansfield, C., McDow, W., Mcdonald, R., & Halpin, P. (2005). Shades of Green: Measuring the value of urban forests in the housing market. *Journal of Forest Economics*, *11*, 177–199. https://doi.org/10.1016/j.jfe.2005.08.002

Philpott, S., Egerer, M., Bichier, P., Cohen, H., Cohen, R., Liere, H., Jha, S., & Lin, B. (2020). Gardener demographics, experience, and motivations drive differences in plant species richness and composition in urban gardens. *Ecology and Society*, *25*(4). https://doi.org/10.5751/ES-11666-250408

Pinto, L. S., Martínez, M. A., Zurimendi, P. M., & Jiménez-Ferrer, G. (2017). Tree Quality in Agroforestry Systems Managed by Small-Scale Mayan Farmers in Chiapas, Mexico. *Small-Scale Forestry*, *16*(1), 103–118. https://doi.org/10.1007/s11842-016-9345-y

Poverty in U.S. cities with more than 50,000 people. (n.d.). Retrieved July 7, 2023, from https://datawrapper.dwcdn.net/XAsno/2/

Romanova, O., & Lovell, S. (2021). Food safety considerations of urban agroforestry systems grown in contaminated environments. *Urban Agriculture & Regional Food Systems*, *6*(1), e20008. https://doi.org/10.1002/uar2.20008

Saha, M., & Eckelman, M. J. (2017). Growing fresh fruits and vegetables in an urban landscape: A geospatial assessment of ground level and rooftop urban agriculture potential in Boston, USA. *Landscape and Urban Planning*, *165*, 130–141. https://doi.org/10.1016/j.landurbplan.2017.04.015

Santos, M., Cajaiba, R. L., Bastos, R., Gonzalez, D., Petrescu Bakış, A.-L., Ferreira, D., Leote, P., Barreto da Silva, W., Cabral, J. A., Gonçalves, B., & Mosquera-Losada, M. R. (2022). Why Do Agroforestry Systems Enhance Biodiversity? Evidence From Habitat Amount Hypothesis Predictions. *Frontiers in Ecology and Evolution*, *9*. https://www.frontiersin.org/articles/10.3389/fevo.2021.630151

Sardeshpande, M., & Shackleton, C. (2020). Urban foraging: Land management policy, perspectives, and potential. *PLOS ONE*, *15*(4), e0230693. https://doi.org/10.1371/journal.pone.0230693

Shepley, M., Sachs, N., Sadatsafavi, H., Fournier, C., & Peditto, K. (2019). The Impact of Green Space on Violent Crime in Urban Environments: An Evidence Synthesis. *International Journal of Environmental Research and Public Health*, *16*(24), 5119. https://doi.org/10.3390/ijerph16245119

The Map: Segregated Syracuse - See first documented association of race and redlining. (2021, February 23). WSTM. https://cnycentral.com/news/the-map-segregated-syracuse/the-map-segregated-syracuse-see-first-documented-association-of-race-and-redlining

Toledo, V. M. (2022). Agroecology and spirituality: Reflections about an unrecognized link. *Agroecology and Sustainable Food Systems*, *46*(4), 626–641. https://doi.org/10.1080/21683565.2022.2027842

Tornaghi, C. (2014). Critical geography of urban agriculture. *Progress in Human Geography*, *38*(4), 551–567. https://doi.org/10.1177/0309132513512542

Tornaghi, C., & Dehaene, M. (2020). The prefigurative power of urban political agroecology: Rethinking the urbanisms of agroecological transitions for food system transformation. *Agroecology and Sustainable Food Systems*, *44*(5), 594–610. https://doi.org/10.1080/21683565.2019.1680593

Vaz, E., De Noronha, T., & Nijkamp, P. (2014). Exploratory Landscape Metrics for Agricultural Sustainability. *Agroecology and Sustainable Food Systems*, *38*(1), 92–108. https://doi.org/10.1080/21683565.2013.825829

Volin, E., Ellis, A., Hirabayashi, S., Maco, S., Nowak, D. J., Parent, J., & Fahey, R. T. (2020). Assessing macro-scale patterns in urban tree canopy and inequality. Urban Forestry & Urban Greening, 55, 126818. https://doi.org/10.1016/j.ufug.2020.126818

von Hoffen, L. P., & Säumel, I. (2014). Orchards for edible cities: Cadmium and lead content in nuts, berries, pome and stone fruits harvested within the inner city neighbourhoods in Berlin, Germany. *Ecotoxicology and Environmental Safety*, *101*, 233–239. https://doi.org/10.1016/j.ecoenv.2013.11.023

Wang, X., Dallimer, M., Scott, C. E., Shi, W., & Gao, J. (2021). Tree species richness and diversity predicts the magnitude of urban heat island mitigation effects of greenspaces. Science of The Total Environment, 770, 145211. https://doi.org/10.1016/j.scitotenv.2021.145211

Watson, Burton. *The Lotus Sutra*. Tr. New York: Columbia University Press, 1993.

Watson, Burton. *Record of the Orally Transmitted Teachings*, Soka Gakkai, 2003.

Wezel, A., Herren, B. G., Kerr, R. B., Barrios, E., Gonçalves, A. L. R., & Sinclair, F. (2020). Agroecological principles and elements and their implications for transitioning to sustainable food systems. A review. *Agronomy for Sustainable Development*, *40*(6), 40. https://doi.org/10.1007/s13593-020-00646-z

Wezel, A., & Soldat, V. (2009). A quantitative and qualitative historical analysis of the scientific discipline agroecology. *International Journal of Agricultural Sustainability*, *7*, 3–18. https://doi.org/10.3763/ijas.2009.0400

Wiggins, G. J., Grant, J. F., Lambdin, P. L., Merten, P., Nix, K. A., Hadziabdic, D., & Windham, M. T. (2014). Discovery of Walnut Twig Beetle, Pityophthorus juglandis, Associated with Forested Black Walnut, Juglans nigra, in the Eastern U.S. *Forests*, *5*(6), Article 6. https://doi.org/10.3390/f5061185

Williams, G. M., & Ginzel, M. D. (2021). Competitive Advantage of Geosmithia morbida in Low-Moisture Wood May Explain Historical Outbreaks of Thousand Cankers Disease and Predict the Future Fate of Juglans nigra Within Its Native Range. *Frontiers in Forests and Global Change*, *4*. https://www.frontiersin.org/articles/10.3389/ffgc.2021.725066

Wolf, K. L., Lam, S. T., McKeen, J. K., Richardson, G. R. A., van den Bosch, M., & Bardekjian, A. C. (2020). Urban Trees and Human Health: A Scoping Review. International Journal of Environmental Research and Public Health, 17(12), Article 12. https://doi.org/10.3390/ijerph17124371

Yang, J., Yan, P., He, R., & Song, X. (2017). Exploring land-use legacy effects on taxonomic and functional diversity of woody plants in a rapidly urbanizing landscape. *Landscape and Urban Planning*, *162*, 92–103. https://doi.org/10.1016/j.landurbplan.2017.02.003

Zimmerer, K. S., & Bassett, T. J. (2012). *Political Ecology: An Integrative Approach to Geography and Environment-Development Studies*. Guilford Press.

VITA

Gabriel Smith

2011 B.A in Philosophy, Lake Forest College

2023 Syracuse University, Falk College Food Studies, Community and Comensality Award

2023 Agroforestry Educator, Cornell Cooperative Extension

2024 M.S in Food Studies, Syracuse University

Field of Study

Agroforestry