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Promoting Workforce Diversity Through an Educational Project Focused on Climate-Smart Urban Forestry: A Conceptual Framework

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Promoting Workforce Diversity Through an Educational Project Focused on Climate-Smart Urban Forestry: A Conceptual Framework

There is limited ethnic and gender diversity of students in natural resources and forestry disciplines in the United States which can constrain the ability to develop a diverse workforce. The disconnect of students in urban areas from nature-based experiences is referred to as “nature-deficit disorder” which is likely contributing to the low enrollment in forestry. This paper provides the conceptual framework to promote the education of a graduate student, undergraduate students, and high school students in climate-smart forestry practices in urban forests. In addition to the students, the project team also includes two forestry faculty members, with one faculty member having expertise in urban forestry and another faculty member specialized in climate-smart forestry practices. Specific objectives include: a) Conduct graduate programs to attract highly promising individuals to research or teaching careers in the food and agricultural sciences; b) Conduct undergraduate research, teaching, and scholarship programs to promote undergraduate enrollment and meet national needs in the development of natural resource and forestry scientists and professionals; and c) Increase the number and diversity of students who will pursue and complete a postsecondary degree in the natural resources and forestry. Key activities are organized into three main educational tracks. Track #1: The graduate student will assist with leading the summer camp and conducting field and laboratory research related to climate-smart urban forestry. Track #2: The undergraduate students will serve as ambassadors and provide a bridge point between the high school students and the project team; furthermore, the undergraduate students will assist the graduate student with their field research and collect data for their independent study project. Track #3: The high school students will be exposed to advanced methods of climate-smart urban forestry and be made aware of career opportunities in natural resources and forestry. These types of education activities will help with combatting ‘nature-deficit disorder’, and also serve as an investment towards the long-term, future recruitment of students in natural resources field in general, and forestry in particular. The educational initiative has anticipated broad impacts by contributing to a diverse and climate-literate workforce that possesses the tools to safeguard forests from climate change.

Keywords

climate resilience, faculty mentoring, outdoor education, peer mentoring, summer camp, underrepresented minority

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1. INTRODUCTION

In the digital social media era, adolescents in urban areas typically have limited experiences and connections with nature and the environment which has been termed "nature- deficit disorder" (Frey and Parent 2019; Cudworth and Lumber 2021). Frey and Parent (2019) feel this is one of the factors that has contributed to the decline of enrollment of students in natural resource fields such as forestry. Furthermore, there is growing concern that of the students going into different academic fields, there is limited gender and ethnic diversity in natural resource disciplines such as forestry (Sample et al. 2015) compared to peer disciplines such as biology which typically have higher diversity. There is limited ethnic and gender diversity of students in the forestry program at West Virginia University (WVU) which constrains the ability to develop a diverse workforce in West Virginia and the Mid-Atlantic region. Prioritizing ethnic and gender diversity in natural resource fields such as forestry is important so that the composition of the work force in these programs is aligned with demographic metrics in society as a whole (Sharik 2015a). Ensuring diversity within the ranks of faculty mentors also helps with fostering future recruitment of a diverse student pool (Atkins et al. 2020; Sharik 2015b). Improving workforce diversity is also a priority area of the US Department of Agriculture (USDA) which has a branch dedicated to forestry issues via the US Forest Service (USFS).

The importance of experiential learning in forestry has been examined especially in the context of outdoor education (Bragg and Tappe 2015). The importance of outdoor learning has been especially acknowledged as a potential antidote against nature-deficit disorder in the United Kingdom where there has been widespread popularity of their forestry schools tailored primarily to elementary and middle school students (Cudworth and Lumber 2021; Garden 2022; Harris 2023). In Australia, Keith et al. (2021) showed that were was a so-called adolescent dip in connection with the environment and that girls were more likely to volunteer for conservation efforts. Unfortunately, there has been comparatively less examination of the importance of outdoor education in applied natural resource programs in the United States (e.g., Frey and Parent 2019). Frey and Parent (2019) stressed the synergistic effects of outdoor experiences provided in a summer camp context which led to improvements in academic motivation and development of leadership skills as well as the capacity to collaborate effectively in groups. Frey and Parent (2019) speculated that the lack of opportunities to connect with the natural world is potentially connected to declining college enrollment in natural resource disciplines. Urban forests play a central role in bridging the gap that exists between the digital sphere of urban life versus nature in more wilderness areas (van den Bosch 2017).

Sharik et al. (2015b) have outlined the declining trend in undergraduate enrollment in undergraduate forestry programs in the United States. Compared to other disciplines, forestry unfortunately has a low proportion of women and visible minorities. For instance, as of 2012, enrollment levels of women in forestry were only 18% compared to 57% of the full undergraduate population. Furthermore, minority enrollment in 2012 was only 12% in forestry programs compared to 40% across all undergraduate programs. Issues with diversity in natural resource programs in general, and forestry in particular, need to be addressed so that the composition of the work force in these programs need to be reflective of demographic metrics in society as a whole (Sharik et al. 2015a). It has been suggested that recruitment of minorities in natural resources and forestry programs will be promoted if there are visible role models in the

form of minority faculty members (Sharik et al. 2015b). Furthermore, a shared identity between mentor and mentee was considered important for underrepresented minorities and female students (Atkins et al. 2020). Analysis of web pages at academic institutions offering natural resources and forestry programs has shown limited diversity of minorities and women in the faculty and staff pages, and in the rare instances they are present they are shown primarily in passive roles (Bal and Sharik 2019b). An example of a passive role would be a picture of a minority or woman on the campus of a university, compared to an active image of one measuring a tree in a forest. Web content analysis showed better diversity representation in the main landing pages of professional society web pages, but the diversity representation drops within the sub-links for the secondary web pages which included an "About" web page and a "Membership" page (Bal and Sharik 2019a). This process of self-reflection, also referred to as reflexivity (Pienkowski 2022), applied to diversity related issues in the discipline of forestry will help safeguard the production of a diverse workforce in the future.

The instrumental climatic record has indicated that global average surface temperatures have increased by 0.78^{o}C for the 2003-2012 period relative to 1850-1900 period (IPCC 2013). The 20th century warming trend has been induced by increases in greenhouse gases, most notably CO_2 released primarily as a result of anthropogenic activities (fossil fuel use and land use changes such as tropical deforestation). Projections of future climate change based on general circulation models and different emission scenarios of greenhouse gases indicate a further warming within the range of 0.3^{o}C –4.8^{o}C by the end of the 21st century (2081-2100) relative to 1986-2005 (IPCC 2013). While little change is expected in annual average precipitation, higher temperatures are expected to lead to increased rates of evapotranspiration in plants. Future climate change (i.e., global warming and increased summer dryness) is expected to generally reduce forest productivity and increase rates of tree mortality (Allen et al. 2010). Climate change's potential impact on forest resources poses a huge challenge for sustainable management (Millar et al. 2007). To address these climate challenges, it is important to develop climate-smart technologies and management approaches (Shephard et al. 2022), especially in urban areas (Swanson et al. 2016). Furthermore, improving workforce diversity can assist with climate adaptation and provide a voice for marginalized populations including indigenous communities that have a fountain of traditional ecological knowledge (e.g., Hosen et al. 2020).

In the urban forest, climate change will impact species growth, physiological processes and resiliency to pest and pathogens, leading to a decrease in ecosystem services. Additionally, as storms become more frequent and intense (IPCC 2013) tree failure is expected to lead to increased property damage and personal injury (Dahle et al. 2014, Dahle et al. 2017) and a further canopy reduction. Urban forest managers need additional knowledge on tree selection and growth and so they can develop management tools to maintain ecosystem services provided by urban canopy cover. Recommended strategies for urban forest adaptation include: sustain or restore fundamental ecological functions, reducing the impact of biological stressors, and facilitate adjustments of species composition in order to select trees species that match current and future conditions (Swanston et al. 2016). Adaptation policies are a work in progress. For instance, in an analysis of 20 Canadian cities, only 15% of them had alignment of urban forestry policies with climate change policies (Cheng et al. 2021).

The main objective of this paper is to provide an overview of the conceptual framework for a project that promotes the education of a Master's graduate student, multiple undergraduate students, and numerous high school students in climate-smart forestry practices in urban forests. This project was selected for funding by the United States Department of Agriculture (USDA), National Institute of Food and Agriculture (NIFA), via the Higher Education Challenge Grants Program. The US Department of Agriculture (USDA) is a broad governmental agency within which the US Forest Service is situated in. The USDA funds projects in both agriculture and forestry. Our project deals with urban forestry, not the other branches of the USDA. Specific objectives of this educational initiative include:

1) Conduct graduate programs to attract highly promising individuals to research or teaching careers in the food and agricultural sciences;
2) Conduct undergraduate research, teaching, and scholarship programs to promote undergraduate enrollment and meet national and international needs for training food and agricultural sciences scientists and professionals; and
3) Increase the number and diversity of students who will pursue and complete a postsecondary degree in the food and agricultural sciences.

Additionally, we believe that this educational initiative can serve as a national model toward helping to decrease the incidence of nature-deficit disorder of urban youth while increasing awareness of careers in natural resource management and urban forestry.

2. PROPOSED APPROACH

The proposed project will be carried out under three educational tracks centered around each group of students where Track #1 will focus on graduate student research and educational activities; Track #2 will focus on undergraduate student educational experiences and research activities; and Track #3 will focus on the educational activities of high school students. These tracks are described in further detail below. An overview of the core project components are also provided in Table 1. The interconnectedness of this project will be through the lens of graduate student training. The graduate student will participate in research, help educate both undergraduates and high school students, and will both gain and also provide an experiential learning experience.

2.1. Track #1

The educational opportunities for the graduate student will be to carry out scientific research that seeks to contrast climate sensitivity of trees in different urban site locations. The two project Co-Directors will mentor the graduate student in carrying out this research. The graduate research will also address different aspects of the District of Columbia (DC) Forest Action Plan that are in alignment with the USDA Science and Research Strategy priorities. To help expand resiliency across the DC area using urban forestry, the project will address the urban heat island effect by measuring how the urban heat index is impacting trees by comparing street trees to trees in Rock Creek Park. Furthermore, to help examine the impact of climate change, the project will model future growth and use iTree Eco to show how changes in growth might impact ecosystem services. Specifically, pollution, carbon sequestration and storage, oxygen production, avoided runoff and thus flooding potential, building energy saving, and avoided carbon emissions.

Table 1: Logic model describing core elements of the educational project.

Situation & Assumptions	Inputs	Activities	Outputs	Outcomes	External Factors
• There is limited ethnic and gender diversity of students in natural resources and forestry disciplines which can constrain the ability to develop a diverse work force. • The disconnect of students in urban areas from nature-based experiences is referred to as "nature-deficit disorder" which is likely contributing to low enrollment in forestry. • Getting students interested in urban forestry can serve as the bridge-point towards deeper connections with nature and wildland areas.	•Expert faculty with the capacity to mentor different student groups. •Interested students with a focus on a graduate student and undergraduate student experiences and ancillary participation of high school students. •Committed project partners including the DC Department of Transportation (DDOT). •Multiple urban and rural forestry demonstration sites in or near the Washington DC area. •Advanced methods of climate-smart forestry.	•The graduate student will assist with leading the summer camp and conducting field and laboratory research related to climate-smart urban forestry. •The undergraduate students will serve as ambassadors and provide a bridge point between the high school students and the project team. They will assist the graduate student with their field research and also collect data for their independent study project. •The high school students will be exposed to advanced methods of climate smart urban forestry and be made aware of career opportunities in natural resources and forestry. •The PD and Co-PD will provide mentoring of all students.	• 1 thesis dissertation developed by Master's graduate student • 3 scientific peer-reviewed manuscripts • 2 independent study reports developed by undergraduate student ambassadors • 1 outreach pamphlet summarizing main project findings • 3 presentations at project director's meeting • 1 presentation at conference made by Master's student • 27 participants reached including 1 Master's graduate student; 6 undergraduate students including 2 student ambassadors and 4 students receiving recruitment scholarships; and 20 high school students.	•Knowledge: Improved understanding of climate-smart urban forestry. •Actions: Deepen collaboration with forestry stakeholders and partners and knowledge transfer of climate-smart urban forestry. •Conditions: Increased workforce diversity in terms of both gender and ethnicity. Deeper connections of students with nature and improved recruitment in forestry.	•Intersection of ethnic and gender diversity with socioeconomic backgrounds of high school students may limit the capacity to afford post-secondary education despite being offered recruitment scholarship. •State or judicial restrictions around recruiting undergraduate students based on race and ethnicity.

To promote management for a more resilient forest, the graduate student will investigate what species are more likely to be climate resilient in Washington DC. This will include field inventories to collect increment core samples from street trees, urban trees, and rural trees. In addition, climatic sensitivity will also be assessed using automatic point dendrometers that will be used to monitor stem-growth fluctuations at an hourly time-step and relate it to changes in microclimatic and regional climatic data sources (Hirsch et al. 2023). The key microclimatic variables that will be monitored include temperature, relative humidity, and solar radiation. Climate data (temperature and precipitation) will be obtained from the meteorological stations nearest to the study areas from the U.S. National Climate Data Center (NCDC). Relationships between annual radial growth and forest stand dynamics and past climate records will be assessed using correlation and multiple linear regression techniques (Chhin et al. 2008). Different scenarios of future climate change based on different emission scenarios of greenhouse gases will be obtained from the NCDC. Dendroclimatic models developed from past growth will be used as the basis to project growth in the different forest types into the 21st century under different climate change scenarios (e.g., Chhin et al. 2008). This research by the graduate student will result in a thesis and research manuscripts.

2.2. Track #2

An undergraduate student selected for each summer internship and will serve multiple roles in the project. First, the undergraduate student will assist the graduate student with the field data collection during the summer. Second, the undergraduate student will be enrolled in a summer independent study course and will conduct a mini-sized project alongside the graduate student. The undergraduate student will be expected to carry out a small-scale analysis phase followed by the preparation of a report. Third, the undergraduate student will serve as a critical bridge-point between the high school students involved in Track #3 activities (described below) and the rest of the research team. We thus expect the undergraduate students will not only assist with building rapport but will also serve as role models in the potential next future career step for some of these high school students.

2.3. Track #3

This project will provide immersive outdoor-based learning opportunities for junior and senior high school students from the Washington, DC area in a week-long summer camp led by a Master's student and an undergraduate student with additional oversight and mentoring provided by the two Project Co-Directors. We will target our student recruitment on youth from Washington DC's Ward 6, 7 & 8 which have a large proportion of their areas that fall within disadvantage communities as designated by the Climate and Economic Justice Screening Tool (CEJEST 2023). The summer camp will introduce the high school students to the field of urban forestry, forest measurement and climate risk. The high school students (10 each year) will engage with WVU faculty, a graduate student and undergraduate student as they spend time in the field and classroom throughout the week. Activities will include how to measure trees diameter and height, estimate health and vitality, and quantify ecosystem service of the urban forests. The student will measure both street trees and park trees and then compare the two classes to learn how grown and benefits vary between urban forest tract as well as open grown trees. The summer camp will emphasize hands-on, experiential learning. High school students will learn how to use environmental data-loggers to monitor tree growth and micro-climate to

develop literacy in climate-smart forestry practices. The students will learn how to use the i-Tree suite of tools to quantify ecosystem services provided by the local trees. Local urban forestry practitioners will also be invited to share and demonstrate their climate adaptation practices in urban areas as well as providing an overview of career opportunities in urban forestry. High school students will have the opportunity to visit urban forests in the metro DC area. Undergraduate students will serve as student ambassadors and assist with delivery of the summer camp program which will help develop their leadership skills. The main assessment indicators for this project will be based primarily on the diversity of the high school students that are recruited as well as an assessment survey both before and after the summer camp. This will help demonstrate the extent to which urban forestry and climate change themes were grasped as a result of the summer camp. To help address the barrier of the cost of higher education, the project plans to offer undergraduate entrance scholarships to two high school students each year for a total of 4 students during the full project duration.

3. ANTICIPATED BROADER IMPACTS

The broader impacts of this proposed project are manifold. These types of education activities provided through this grant will help not only with combatting nature-deficit disorder, but it will also serve as an investment towards the long-term, future recruitment of students in natural resources fields, in particular forestry and urban forestry. Indeed, many of our current students come from rural areas and they do not realize the career opportunities available in urbanized areas (Dahle et al. 2020). The graduate student and the undergraduate students will develop leadership skills while preparing and delivering the summer camp. The high school students will be introduced to the natural world in their local urbanized area. In addition, the high school students will learn about climate-smart forestry practices and be introduced to urban forestry career opportunities. It is our intention to provide additional updates as this project progresses towards completion.

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