



GREEN FUND

Sustainability Through Student Innovation

2025 Student Research Grant Application

Abstract

Northern Arizona University (NAU) is committed to achieving carbon neutrality by 2030, a goal that necessitates not only the reduction of emissions but also an accurate accounting of carbon sequestration on campus. This project aims to create a comprehensive, campus-wide tree inventory to quantify above-ground biomass and estimate carbon sequestration using TreeKeeper software. As trees are the primary means of carbon capture in urban environments, this data is essential for NAU's Climate Action Plan. The inventory will include critical metrics such as tree height, diameter at breast height (DBH), and condition, following U.S. Forest Service protocols. To date, over 5,200 trees have been surveyed with this project, with an inventory (all trees north of I-40) expected to cover 6,000–7,000 trees, potentially more. This will not only quantify carbon sequestration and above ground biomass but also assess additional ecosystem services such as stormwater retention, air quality benefits, and energy savings from shade. The results will inform sustainable planning, including strategic tree planting to address urban heat island effects, enhance biodiversity, and improve campus resiliency to climate change. The broader impacts on the NAU campus community include educational opportunities across disciplines, integration into operational planning and construction guidelines, and support for wellness initiatives. Data will be available via a web-based map and maintained by the NAU Office of Sustainability and GIS office. This project serves as a model for other institutions and demonstrates NAU's leadership in using natural climate solutions to meet institutional sustainability goals.

Detailed Project Proposal

Climate action is vital across all sectors of society, therefore, NAU has incorporated carbon reduction plans into its campus policies. The most significant action being the commitment to carbon neutrality by 2030 (Northern Arizona University, 2021). In order to do this, NAU would need to quantify its emissions but also its rate of carbon sequestration (Cox, 2012). Further, all campus trees, which are the main way significant carbon is sequestered in urban settings (Nowak & Crane, 2001), would need to be surveyed and calculated for above ground biomass and carbon sequestration. NAU would be one of the first universities in the United States to quantify its above-ground biomass on a campus-wide scale. To achieve these goals, NAU's Office of Sustainability in collaboration with the School of Earth and

Sustainability needs to conduct a comprehensive campus tree index collecting data such as height and DBH but also condition for future management of each tree. The measuring of all campus trees, calculating carbon sequestration rates via TreeKeeper Software, and recording tree condition would contribute to NAU's ability to reach carbon neutrality and mitigate current carbon emissions campuswide while also assigning ecosystem services and consequently a market value to each tree.

Nicholas Holen, an NAU Forestry master's student, completed a data collection of North campus trees in 2014 and 2018 (Holen, 2019), therefore, a reevaluation of this tree inventory is required to properly provide up-to-date carbon capture rates. Additionally, Holen's data was not collected for the whole campus or by the same team nor time-frame. This collected data will be provided to NAU's Office of Sustainability to aid in achieving the Carbon Neutrality Plan by calculating on-campus tree sequestration and applying these findings to future campus projects, whether it be the implementation of building structures or the conversion of green spaces.

For this inventory, we have snaked from North Campus to South to ensure all trees are recorded in the TreeKeeper Software. Variables collected for the inventory include height, diameter at breast height (DBH), condition, pests, conflict with infrastructure, and maintenance needs. Height was measured in feet through the use of rangefinders, starting from the lowest visible bark above ground to the tallest point of the tree. When trees were on a slope, height was taken from the uphill side. If the base was blocked, we used the lowest visible point and added the blocked portion to the total. When the top could not be seen, we estimated using nearby buildings or other trees. DBH was measured at 4.5 ft above ground with the diameter side of a logger's tape, recorded to the nearest tenth of an inch. On slopes, DBH was taken from the uphill side. For trees with more than six trunks, we measured the six largest or up to 8 if that was the total number of trunks. Forked trees had each trunk measured. If dense canopy made breast height inaccessible, measurements were taken at the lowest reachable point or estimated by comparing nearby trees of the same species and recorded in the notes section of the Treekeeper Software. The previous methods were done to match protocols established by the US Forest Service tree surveying methods (i-Tree, 2021). The field data was collected on an iPad into the TreeKeeper Software.

This project addresses the first four of the five Arizona Forest Action Plan 2020 goals. Specifically, it will lead to planning for a more climate-resilient campus environment. It also will be a tool for student and administrator education about the benefits of our trees, and the potential future benefits of purposeful planting of new trees with energy efficiency, urban heat island-related, and species diversity goals (i.e., better climate resiliency and an increased, resilient canopy) in mind. This project will provide many resources to the NAU community as well as work to disseminate the findings. We will provide web based access to inventory maps and a final report for the campus community; train campus Landscaping & Outdoor Services staff on the inventory systems and how to update the information; share results with faculty in Forestry, Environmental Sciences, Construction Management and Civil Engineering for classroom uses and to enhance education around the value of urban forests to climate adaptations and mitigation; share tree inventory and maps with NAU Employee Assistance and Wellness for potential integration into campus tree walk therapy sessions;

integrate results into the campus Landscape Master Plan update for project planning purposes and updates to tree species palettes; integrate with campus Tree Care Plan including updates to goals; integrate into Planning Design & Construction Technical Standards and Design Guidelines, in particular for tree valuation for damage and removals, tree preservation within Historic Preservation Zone, and site planning for construction projects; integrate results into Climate Action Plan carbon accounting for sources and campus sinks; identify strategic spaces for new tree planting to enhance climate resiliency, biodiversity, carbon sequestration, and stormwater mitigation. Once the project is completed we will disseminate maps and a final report to operations departments as well as the Society of American Foresters and Environmental Science student organizations for their use.

References

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Contact Information

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Project Advisor Name: Erik Nielsen

Project Advisor Department: NAU Office of Sustainability

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Position: Chief Sustainability Officer and Professor of Environmental Science and Policy

Project Name: Comprehensive inventory of trees and ecosystem service valuation on the Northern Arizona University Flagstaff Campus

Date of Application Submission: 8/20/25

Questionnaire

Please select the focus of your research project, then address the following questions.

☐ Other: **Urban forestry, climate adaptation/mitigation**

1. How will your research promote the purpose of the Green Fund and further sustainability on NAU's campus?

This project will support NAU's climate neutrality goals and further campus sustainability by providing a comprehensive inventory of 5,000-6,000 trees as well as investigating their prospective ecosystem services. Currently, we have measured over 4,232 trees and are almost done with all of campus north of E Pine Knoll Dr. Results will quantify carbon sequestration, stormwater retention, air quality benefits, and energy saving through shade. Apart from the inventory serving as an educational tool for future staff and students, the findings will inform tree planting for heat island reduction, climate adaptation, and improved biodiversity. The results of the inventory will be a spatially-explicit, tree inventory software-based data set that will be housed in NAU's GIS office, and available for use by the Office of Sustainability, Facilities Services, and academic departments.

The project will be institutionally grounded in NAU's strategic goal of reaching carbon neutrality, the Comprehensive Smart Sustainable Master Plan, and the

Landscape Master Plan. For the financial sustainability of the project, the Office of Sustainability has committed to maintaining the tree inventory software subscription for future years, to support ongoing inventory access and spatial visualization tools.

Long term goals include:

- 1. Enhancing the care and establishment of trees as part of construction and renovation projects to decrease the urban heat island and HVAC load on our buildings.*
- 2. annual updates of the tree inventory with involvement from Forestry faculty and students.*
- 3. Use of the project database as the tool for campus tree care, risk assessment, and damage monitoring.*
- 4. Development of a virtual campus tree tour to enhance community engagement around climate mitigation and adaptation, and the role of natural climate solutions.*
- 5. Increased participation of Arbor Day observance activities on campus such as tree planting by campus and other community members at strategic locations.*
- 6. Establishment of tree valuation for maintaining, preserving and replacing campus trees.*

- 2.** Will your research require the utilization of any spaces or infrastructure on campus? If so, identify the specific locations and/or infrastructure, how much of the space you require, and what each space will be used for. Please refer to the [Space Committee Approval Process](#) document to know if your research will require approval through the space committee.

Yes, the research will be conducted across the entire NAU Flagstaff Campus, as the project involves mapping and assessing all trees on university property. There are a few locations which we have not been able to access, including construction areas around SkyView and the Skydome (which we plan to return to), dorm courtyards, the fenced area behind Knoles Parking Garage, private yard on east side of Calderon, and the Renewable Energy Test Area.

- 3.** Will other departments on campus be needed to assist in this project (i.e. Facility Services, Campus Transit)? If so, identify department partnerships.

This project is a collaborative effort between NAU units:

- 1. NAU Office of Sustainability:** *The information obtained via this tree inventory and canopy analysis will be directly useful for applications such as tracking progress on NAU's Climate Action Plan, for setting future goals related to climate mitigation and adaptation, and for seeking additional funding. This office will provide guidance as needed, especially on what is most important to them for the ecosystem services analysis.*

2. **NAU Facility Services:** This unit, specifically the Landscaping & Outdoor Services Department, is responsible for tree care on campus. The tree inventory, in particular, will be an important tool to use for planning, maintenance, and improving the aesthetics and safety of campus. In addition, Planning Design & Construction will be a primary user of the inventory and will provide guidance on the tree valuation analysis.
 3. **NAU School of Forestry:** A faculty member or graduate student will lead the inventory and tree canopy analysis. The graduate student or faculty supervisor conducts QAQC on the student crew data collection. The results of the inventory and canopy analysis will be directly useful for classes such as Urban Forestry.
4. How will you monitor the impact of your research after completion? What do you plan to do with the results of your research?

Impact will be monitored by completing and maintaining the full campus tree inventory and canopy analysis in Treekeeper, which allows updates over time. The Office of Sustainability will measure progress toward canopy cover, species diversity, and carbon neutrality goals. NAU can then use the data to guide tree planting, maintenance, and construction planning. Results will be shared through a web-based tree map, integration into the Landscape Master Plan and Climate Action Plan, and use in coursework and student projects.

Project Budget

1. Does this project have any other sources of funding, and/or have you applied for other sources of funding? If so, list all additional sources of funding, both confirmed and potential, outside of the funds being requested from the Green Fund.

Community Challenge Grant - funding all used up for the last 12 weeks of the project

Line Item Budget:

Item	Item Justification	Quantity	Price per Unit
Project Tree Tech 1	Finish Tree Inventory	200	\$16.25/hour
Project Tree Tech 2	Finish Tree Inventory	200	\$16.25/hour
Project Tree Tech 3	Finish Tree Inventory	200	\$16.25/hour
ERE/Benefits 8.06% x \$9,750	Safety of Employees	3	\$785.85
5%	Contingency	N/A	\$487.50

Total Funding Requested: \$11,023.35



Project Timeline

Expected Timeline:

Action	Parties Involved	Completion Month & Year
Tree Data Collection ~ Start as soon as funding received	3 NAU employees	October, 2025
Data Correction, Quality Control, and Editing	1 NAU employee	October, 2025

Expected Project Completion Date: October 31, 2025

Commitment to Present Research

Please read and sign the statement below, acknowledging your commitment to present the findings of your research.

If selected as a recipient of the Green Fund Student Research Grant, regardless of the outcome of my research project, I Sophie Radder commit to presenting the status of the research as described in this application in the form of an oral presentation to the Green Fund Committee or a poster exhibit presentation at the Undergraduate or Graduate Research Symposium, no more than 1 year after receiving notification of funding.

The oral presentation to the Green Fund Committee will consist of an approximately 10 minute long PowerPoint that includes the following aspects of your project:

- Original goal and purpose of research
- Conflicts or changes to the original purpose
- Results/Conclusion
- All relevant graphical displays of data

Student Signature:

Sophie Radder