*Please submit this completed application, the supplemental budget spreadsheet, and any relevant supporting documentation by the deadline indicated in your Step 1 notification letter to* *Sustainability-Committee@Illinois.edu**.The Working Group Chairs will be in contact with you regarding any questions about the application. If you have any questions about the application process, please contact the SSC at* *Sustainability-Committee@Illinois.edu**.*

# General Information

**Project Name:** Student-led census of the Trelease Woods Forest Dynamics Plot

**Total Amount Requested from SSC:** Total Project Cost

**Project Topic Area(s):** [ ] Energy [x] Education [ ] Food & Waste

 [x] Land [ ] Water [ ] Transportation

# Contact Information

### Project Lead

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### Facilities Management Contact *(If Applicable)*

Contact Name: Name of Applicant or Project Lead

Email Address: Preferred Email Address

**Primary Project Team**

|  |  |  |
| --- | --- | --- |
| **Name** | **Department** | **Email** |
| James Dalling | Dept. Plant Biology | dalling@illinois.edu |
| Jennifer Fraterrigo | Dept. Natural Resources | jmf@illinois.edu |
| James Ellis | University Natural Areas | jellis@illinois.edu |
| Name | Department/Organization | Email Address |

# Project Description

**Please provide a brief background of the project, the goals, and the desired outcomes:**

Understanding how climate change, atmospheric nitrogen deposition, and invasive plant species will impact the future tree species composition and carbon sequestration potential of Midwestern forests will require the establishment of long-term forest dynamics plots. These plots are large enough to capture ecologically-relevant sample sizes of individuals of dominant tree species, and by means of periodic censuses, track rates of growth, mortality and recruitment of plant populations. In addition, by estimating both soil and vegetation carbon stocks, they provide predictions for long-term carbon sequestration trends essential to calibrate earth-system models.

Over the past 30 years a global network of forest monitoring sites has been established by strategic partnerships between the Smithsonian Institution and universities and forestry departments. This ‘Forest-Geo’ network currently monitors 6 million trees, and 10,000 tree species in 63 plots and 23 countries (<http://www.forestgeo.si.edu)>. Plots in the network are censused every five years using a detailed shared protocol generating data on forest productivity and dynamics that is directly comparable across sites. In recent years plots have been established across the Midwest in association with our peer institutions in Missouri, Indiana, Wisconsin and Michigan.

The goal of this project is to establish Trelease Woods, a 24 ha old growth deciduous forest, and a university-managed natural area, as the next site in the Forest-Geo network.

Unlike other forest plots currently in the Forest-Geo network, Trelease wood has an extraordinary history of study, allowing us to reconstruct the past as well as present composition, structure and carbon storage. The woods, which once were part of a much larger prairie forest grove, were purchased in two sections in 1917 and 1918. The first census of the tree community was carried out in 1922, with subsequent surveys in 1928, 1931-44, 1964, 1976, 1986, 1995, and 2004. This is the longest survey period for any Midwestern forest, and one of the most thoroughly surveyed forests in the world. During this period, Trelease has gone through dramatic transitions in its composition – including a long-term decline in oak abundance, a complete die-off of 1200 elm trees associated with Dutch Elm disease in 1955, and an associated increase in sugar maple abundance. A survey by undergraduates in the IB372 class in Fall 2017 showed that Trelease is now going through another major transition, as nearly all of the 700 ash trees in Trelease are infected by emerald ash borers and will die in the next 12-24 months.

We propose to complete a first census of Trelease woods using the standard Forest-Geo protocol in 2018-19, allowing Trelease to enter the plot network. In the census, all trees with a diameter >1 cm are mapped, tagged and identified, with the commitment that the plot will be re-censused every five years. Once completed, Trelease data will contribute to analyses of global forest productivity and carbon storage data. More importantly however, Trelease will become only the second student-led forest dynamics plot, following a model established in 2007 at UC Santa Cruz. At the Santa Cruz plot, over 100 undergraduate students have been involved in plot-base studies through undergraduate courses, senior theses, and internships. We anticipate that similar numbers of students will be involved either in the Trelease census itself, or in the use of the forest plot dataset, by participating in field projects designed using the data for the core Integrative Biology major course, IB203, Integrative Biology Honors Ecology class, IB372, the core NRES major course, NRES 219 - Principles of Ecosystem Management, and NRES 419 - Environment and Plant Ecosystems.

Key desired outcomes of the project are:

1. Complete a full census of Trelease Woods expanding knowledge of current forest composition and carbon storage, and contributing to a larger dataset on midwestern deciduous forests via ForestGeo
2. Provide experiential learning opportunities for a large number of undergraduate students from both ACES and LAS in forest ecology/field biology by participating in or leading forest census crews.
3. Provide a core data base on the location, species identity and size of trees in the Trelease Woods that can be used as source data by at least four undergraduate classes to design and develop group or student-led lab exercises.
4. Provide data that can be used to reconstruct changes in forest carbon storage at Trelease Woods over the last century (1922-2019).

**How will the project improve the sustainability of the Illinois campus and how will the project go above and beyond campus standards?**

Although Trelease Woods constitutes a small fraction of the campus footprint, it is disproportionately important for determining the carbon sequestration value of university plantings and soils because of its high tree density. Determining the carbon sequestration value of existing university plantings is an important component of understanding the sustainability of the UI campus and a stated objective of the Illinois Climate Action Plan (iCAP; Objective #5 in the area of Agriculture, Land Use, Food, and Sequestration). A full census of Trelease Woods would thus advance progress toward meeting the campus goal of carbon neutrality. The census could also inform future plantings on the main campus by indicating which tree species sequester the most carbon given local environmental conditions. Finally, protocols and transfer functions developed through the project could be used to quantify carbon storage in trees and soils on other university properties and on the main campus.

Any relevant opportunities for student involvement in your project

We anticipate that ~30 students will be involved in the initial census (see question “How this project will involve or impact students”). Additional students will be recruited to assist with soil sampling and processing at a later date, and in the development of individual research projects that make use of the census data. Students involved in the census will develop transferable skills in tree identification and mensuration, and data entry, management and analysis.

**Where will the project be located? Will special permissions be required to enact the project on this site? If so, please explain and submit any relevant letters of support with the application.**

The project will be located at Trelease Woods, 5 miles east of Urbana and approximately 10 minutes drive from campus. Trelease Woods are part of the University’s network of natural areas. Research and teaching activities within the natural areas is regulated by the Committee on Natural Areas (CNA) within the Office of the Vice-Chancellor for Research. Activities proposed here have been approved by the CNA (see attached letter).

Although the site is close to campus there is no public transport that can be used to access Trelease. We propose to rent a university vehicle for the duration of the census. For safety, the vehicle will remain at the site at all times while census workers are in the forest.

**Other than the project team, who will have a stake in the project? Please list other individuals, groups, or departments affiliated directly or indirectly by the project. This includes any entity providing funding (immediate, future, ongoing, matching, in-kind, etc.) and any entities that will be benefitting from this project. Please attach letters of commitment or support at the end of the application.**

Primary beneficiaries of this project will be undergraduate students in ACES – Department of Natural Resources, and LAS – School of Integrative Biology. Students participating in the forest census will be drawn primarily from these units, although we will advertise widely on campus, and may attract students from other majors (e.g., School of Earth, Sustainability and Environment concentration in Earth’s Biosphere and Ecology). We aim to establish a diverse mix of students (major, family background, race and ethnicity) among the census crews. This is particularly important because it is widely reported that under-represented minority (URM) students have a low rate of engagement in environmental sciences, and are therefore under-represented in environmental organizations (e.g. Taylor (2014) The state of diversity in environmental organizations https://orgs.law.harvard.edu/els/files/2014/02/FullReport\_Green2.0\_FINALReducedSize.pdf)

Under the Forest Geo model, funding for the first forest census is raised locally (in this case from the SSC) as an indication of the local PIs investment in the project. However, plot PIs entering the Forest Geo network make a commitment to repeat surveys every five years, generating valuable data on forest growth and turnover (mortality and recruitment). Typically, the longer plots remain in the network, the more valuable their data become. After the first census is completed (and Trelease has joined the network) we will therefore be able to request Smithsonian funding (for example, the Tyson plot in Missouri recently received $15K towards its recensus). As this project also has a substantial benefit to undergraduates through experiential learning, and as repeat censuses of Trelease will allow us to measure changes in forest carbon sequestration, we may also return to the SSC for support of a second census in 2023. Note: major costs are associated with the first census, which involves a one-time purchase of tree tags, and laser mapping of trees. The second census typically takes half as long as the initial census, and should therefore take about 3 months to complete.

Once we have completed the plot census in Spring 2019 we will have an exciting new data resource that undergraduate students can use to either carry out their own analyses (for example, as undergraduate research credit in the Dalling or Fraterrigo labs), or as part of a formal class activity or field lab. To make the most of these data we will apply to two funding sources on campus to develop teaching materials from the Trelease plot census. We will request support from the Office of Undergraduate Research (OUR) and from the Provost’s Initiative for Teaching Advancement (PITA) – application dates for both these funding sources are anticipated for March 2019. We will use these funds to:

1. Support the development of lesson and lab exercise plans around the census data. These lesson plans will be field tested using our undergraduate census workers, and then integrated into the curriculum of our classes that already do group field projects in Trelease woods. Adding census based field activities to the IB ecology classes IB203 and IB372 alone would engage ~200 sophomore and junior students with the Trelease census data each year. One example of a potential class project that could combine field work and use of the census data would be to measure tree heights in the field, use tree diameter data from the census and collate wood density data from published resources to generate an estimate of individual tree carbon storage. Students could then explore how the current ash tree dieback is impacting forest carbon storage at Trelease and potentially other sites.

2. Use the extensive field dataset that we will assemble as a vehicle to introduce undergraduate students to statistical analysis and data visualization using the R programming language. While the R language has been broadly adopted by biologists, and is a core skill that graduate students are expected to master, few opportunities have been developed for undergraduate students in SIB and ACES to gain experience using the program. The size of the dataset we will develop, containing information on >30,000 trees, necessitates that we develop powerful, yet accessible data management protocols that our students can use. Accordingly, we will develop a manual for exploring the Trelease census dataset using R, with examples of how to manipulate and extract data, apply statistical tests, and use plotting functions. In our application to the OUR we will also propose developing a shiny app – which is an interactive web-based app that students can use to access the plot data without the requisite R skills (for examples see https://shiny.rstudio.com/gallery/).

**Please indicate how this project will involve or impact students. What role will students play in the project?**

The plot census will be supervised by Profs. Dalling and Fraterrigo. We will hire a graduate student from the Dalling lab, with several years of experience in establishing Forest-Geo style plots in Panama, to train groups of students to carry out the census. Our census is broadly modeled on the Forest Ecology Research Plot established by Prof. Greg Gilbert at UC Santa Cruz. PI Dalling has worked for >25 years in Forest Geo plots, and consulted extensively with Prof. Gilbert in the development of this proposal. Prof. Gilbert has offered to share protocols developed at UC Santa Cruz for student training, in-field data entry, and data quality verification. An indication of the number of student interns/researchers involved in the UC Santa Cruz plot is available at <https://ferp.ucsc.edu/internships/>. We anticipate that a group of ~30 undergrad students, primarily majors in ACES and IB, will be involved in the census. In addition to collecting field data, students will be trained in plant identification in a workshop held at the beginning of the project, and will be given instruction by the PIs and grad student coordinator in using the programming language R, and existing R packages for analysis of Forest-Geo data (this can be done on days when weather prevents data collection). Students will therefore have the opportunity to contribute to either the analysis of the Trelease plot data, or to the development of independent research projects (e.g., under rubric IB 490) that combine census data with additional independent field work.

Although other suitable old growth forests (e.g., Brownfields Woods) are in the university’s natural areas network, and would be appropriate to establish a plot, we have selected Trelease because it is already a key site for undergraduate education in ecology. Last Fall, a total of 289 undergrad students from four classes: IB 203, IB 372, NRES 219 and NRES 419 spent up to three weeks collecting and analyzing data in Trelease woods. The plot dataset will provide an exciting new resource for these courses. Students will be able to explore and analyze plot datasets in the lab, while students and course instructors will be able to use plot data to develop hypotheses and lab exercises for class projects in the field.

Finally, we strongly believe in the importance of experiential learning. While students interested in cell or molecular biology have many opportunities to gain lab experience to help refine interests and define career goals, openings for students interested in ecology and environmental science are much more limited. This project will give a large number of students a chance to get a sense of what a career, or post-graduate work, in field biology involves. Social science research has shown that early exposure to environmental field research such as the work proposed here, is particularly valuable in determining student’s career pathways (Flowers et al. 2016). This is consistent with our own experience mentoring undergraduate students, where experience in research can transform both career goals and the post-graduate opportunities available to students.

Flowers SK et al. (2016) **Early Environmental Field Research Career Exploration: An Analysis of Impacts on Precollege Apprentices. CBE Life Sci Educ December 1, 2016 15:ar67. DOI: 10.1187/cbe.15-11-0230**

# Financial Information

*In addition to the below questions, please submit the supplemental budget spreadsheet available on the Student Sustainability Committee website. Submission of both documents by the submission deadline is required for consideration of your project.*

**Have you applied for funding from SSC before? If so, for what project?**

No. However I was a named collaborator on the 2012 proposal for the Woody Perrenial Polyculture experiment

**If this project is implemented, will there be any ongoing funding required? What is the strategy for supporting the project in order to cover replacement, operation, or renewal costs?

Please note that SSC provides funding on a case by case basis annually and should not be considered as an ongoing source of funding.**

Costs associated with setting up Trelease Woods as a Forest Geo plot are mostly associated with the first census. This includes laser mapping of tree locations, permanently marking trees with numbered aluminium tags and nails, and painting point of measurement locations on trees. After the census is completed, no additional upkeep costs are accrued until the next census takes place. Under the ForestGeo protocol, censuses take place every five years. However the cost of subsequent censuses is greatly reduced; trees have already been mapped and tagged. Subsequent censuses can therefore be completed in 3-4 months. We may return to SSC for much more limited funding for the next census in 2023, or we may be able to obtain funds for the census directly from the Smithsonian Forest Geo once the plot has been established.

**Please include any other sources of funding that have been obtained or applied for. Please attach any relevant letters of support as needed in a separate document.**

Please see attached letter of support from Dr. Stuart Davies, Director of Forest Geo.

As noted above, we intend to apply to the Office of Undergraduate Research and the Provost’s Initiative for Teaching Advancement in Spring 2019 to support development of curriculum that uses the census data we will have collected.

# Environmental, Economic, and Awareness Impacts

*In addition to the below questions, please indicate specific measurable impacts as applicable on the supplemental budget spreadsheet.*

**Which aspects of sustainability does your project address, and how? Does the project fit within any of the iCAP goals? If so, how does the project go beyond the university status quo standards and policies.**

This project addresses iCAP Objective #5 in the area of Agriculture, Land Use, Food, and Sequestration: Determining the carbon sequestration value of existing university plantings. While the focus of iCAP is to inventory trees and other plantings on the main campus, the university also manages a network of natural areas that sustain carbon-rich old-growth forest. These provide a benchmark of soil and biomass carbon storage of natural vegetation in the C-U area for comparison with new plantings, and will provide information on the carbon storage potential of native species introduced into campus planting initiatives. We have also been in discussion with Dr. Brent Lewis, who is beginning the tree census of the campus core, to ensure that data collected at Trelease and on campus are comparable, allowing future comparisons of growth and carbon storage in natural and managed/urban forests.

**How will the environmental impacts of your project be measured in the near and long term? What specific monitoring and evaluation processes will you be using to track outcomes and progress?**

The proposed census provides the core dataset that is needed to determine biomass carbon storage in Trelease woods. The first project milestone will therefore be the completion of mapping, measuring and identifying all woody trees in the plot. The second milestone will be the completion of a Trelease woods soil carbon map, following the Forest Geo protocol. These maps have already been generated for Tyson Woods in Missouri and Lilly Dickey woods following a sampling design developed by PI Dalling. The third milestone will be the creation of a whole ecosystem carbon budget for Trelease based on integrating the census data, soils data and additional measurements/literature data on wood density, crown volume and tree allometry. The ecosystem carbon budget will provide the baseline potential for carbon sequestration in mature forest for comparison with carbon sequestration achieved with campus plantings. The fourth milestone will be the integration of past partial censuses of Trelease from 1922 – 2004 with the current full census to determine how carbon sequestration at Trelease has changed over the last century, and is likely to change in the future.

Beyond these milestones there are several potential impacts of the census that can be measured over the long-term:

(1) Contribution of Trelease to our understanding of regional and global carbon budgets. Once the census is completed the plot data will become available for Forest Geo network wide analysis and collaboration. A measurable environmental impact will be the extent that the Trelease data are used in, and contribute to, science and policy papers that address climate change effects and mitigation measures associated with managing or enhancing forest cover.

(2) Contribution of census activities to the training of the next generation of environmental scientists. Work on the Trelease census will provide a diverse pool of students with experience and transferable skills which are likely to impact their career choices and career success. We will consult with CITL and Illini Success on developing surveys of students engaged in the census before and after working on the plot to determine how the experience has influenced attitudes towards, and preparedness for careers in ecology and environmental science. Similar to the Santa Cruz plot, we will also maintain a database of census participants to permit long-term engagement with these alumni.

(3) Adoption of management for iCAP objectives from Trelease data. Data from the census, and future re-censuses of the Trelease Woods will provide data on native species with traits that can maximize carbon sequestration. An additional impact will be the extent to which Trelease Woods census data informs planting designs and species choice for restoration and carbon sequestration on campus. We will therefore make Trelease data available to campus leaders and faculty involved in iCAP activities, in particular the iSEE Agriculture, Land Use, Food and Sequestration SWATeam.

**What is the plan for publicizing the project on campus? In addition to SSC, where will information about this project be reported?**

Opportunities for undergraduate involvement in the project, either as research credit, or as paid crew leaders, will be broadly advertised on campus starting at the end of Spring semester (e.g., fliers, announcement in undergrad classes, and in the IB student newsletter spotlight). In addition, we will promote the Trelease Woods site, and the role of the SSC in funding the census, on the Forest Geo website (forestgeo.si.edu), which provides a webpage for each forest plot. Finally, we will create a website for the Trelease Woods plot, linked to the University Committee for Natural Areas and School of Integrative Biology websites, which will provide access to the plot dataset, species descriptions and maps, historical inventory data from the site, and will recognize student participants in the project, and student research resulting from the census.

**What are your specific, measurable outreach goals? How will these be measured?**

1. Recruitment of a large and diverse pool of undergraduates to work on the census and conduct independent research using the Trelease plot data. Goal: recruitment of 30 grad students from >3 majors and at least 2 colleges. Inclusion of under-represented minority students.

2. Incorporation of Trelease census data and carbon sequestration-related activities into core ecology classes in the NRES and SIB major. Goal: 2-3 lesson plans developed for lab activities involving NRES and SIB students.

3. High profile-peer reviewed papers published using the Trelease census data. Goal: 3 papers published in the next 5 years involving Illinois undergraduate and graduate students that use Trelease data to address research questions related to carbon sequestration.

**Do you have any additional comments or relevant information to aid in evaluation of this application?**

Please provide any additional information here.