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ADMIN: Reason(s) Not Eligible

John Z. Duling Grant Application

Please note: This application may only be submitted July 1 - October 1.

If you have any questions, please email bduke@treefund.org or call 630-369-8300 x200.

Applicant

Principal Investigator

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Relevant citations authored	1. BERLAND A, Lange DA, in revision. Google Street View shows promise for virtual street tree surveys. Urban Forestry & Urban Greening. 2. BERLAND A, Shiflett SA, Shuster WD, Garmestani AS, Herrmann DL, Goddard HC, Hopton ME, in revision. The role of trees in urban stormwater management. Landscape and Urban Planning. 3. BERLAND A, Herrmann DL, Hopton, ME. 2016. National assessment of Tree City USA participation according to geography and socioeconomic characteristics. Arboriculture & Urban Forestry 42: 120-130. 4. BERLAND A, Hopton ME. 2016. Asian longhorned beetle complicates the relationship between taxonomic diversity and pest vulnerability in street tree assemblages. Arboricultural Journal 38: 28-40. 5. Green OO, Garmestani AS, Albro S, Ban NC, BERLAND A, Burkman CE, Gardiner MM, Gunderson L, Hopton ME, Schoon ML, Shuster WD. 2016. Adaptive governance to promote ecosystem services in urban green spaces. Urban Ecosystems 19: 77-93. 6. BERLAND A, Schwarz K, Herrmann DL, Hopton ME. 2015. How environmental justice patterns are shaped by place: terrain and tree canopy in Cincinnati, Ohio, USA. Cities and the Environment (CATE) 8(1): Article 1. 7. BERLAND A, Elliott GP. 2014. Unexpected connections between residential urban forest diversity and vulnerability to two invasive beetles. Landscape Ecology 29: 141-152. 8. BERLAND A, Hopton ME. 2014. Comparing street tree assemblages and associated stormwater benefits among communities in metropolitan Cincinnati, Ohio, USA. Urban Forestry & Urban Greening 13: 734-741. 9. BERLAND A, Manson SM. 2013. Patterns in residential urban forest structure along a synthetic urbanization gradient. Annals of the Association of American Geographers 103: 749-763. 10. BERLAND A. 2012. Long-term urbanization effects on tree canopy cover along an urban–rural gradient. Urban Ecosystems 15: 721-738.
Has this investigator previously received funding from the TREE Fund?	No
If yes, was the funding for this project?	No
Previous TREE Fund awards	

Co-Principal Investigator (if applicable)

Prefix	Dr.
First name	Jess
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Degrees	Ph.D., Environmental Science, Indiana University, 2014 M.S., Environmental Science, Indiana University, 2012 Master of Public Affairs, Indiana University, 2012 B.A., Biology & Environmental Studies, Lawrence University, 2009
Relevant citations authored	1. Watkins SL, Mincey SK, VOGT J, Sweeney SS. 2016. Is planting equitable? An examination of the spatial distribution of nonprofit urban street tree planting programs by canopy cover, income, race, and ethnicity. Environment and Behavior. In press. DOI: 10.1177/0013916516636423. 2. Widney SE, Fischer BC, VOGT J. 2016. Tree mortality undercuts ability of tree-planting programs to provide benefits: Results of a three-city study. Forests 7(3): 65. 3. VOGT JM, Fischer BC, Hauer RJ. 2016. Urban forestry and arboriculture as interdisciplinary environmental science: Importance and incorporation of other disciplines. Journal of Environmental Studies and Sciences 6:371-386. 4. VOGT J, Watkins SL, Widney S, Fischer BC. 2015. Comparing trees across cities and over time: The need to standardize at-planting data. Arborist News 24(6): 27-31. 5. VOGT JM, Hauer RJ, Fischer BC. 2015. The costs of maintaining and not maintaining the urban forest: A review of the urban forestry and arboriculture literature. Arboriculture & Urban Forestry 41: 293-323. 6. VOGT JM, Watkins SL, Mincey SK, Patterson M, Fischer BC. 2015. Explaining planted-tree survival and growth in urban neighborhoods: A study of recently-planted trees in Indianapolis. Landscape & Urban Planning 136: 130-143. 7. VOGT JM, Epstein G, Mincey SK, Fischer BC, McCord P. 2015. Putting the “E” in SES: Unpacking the ecology in the social-ecological systems framework. Ecology & Society 20: 55. 8. VOGT JM, Fischer BC. 2014. A protocol for citizen science

monitoring of urban trees. Cities and the Environment 7(2): Article 4.
9. Mincey SK, VOGT JM. 2014. Watering strategy, collective action, and neighborhood-planted trees: An Indianapolis case study. Arboriculture & Urban Forestry 40: 84-95.

Has this investigator previously received funding from the TREE Fund?	No
If yes, was the funding for this project?	
Previous TREE Fund awards	

Students/Interns (if applicable)

Student/Intern 1

Name	To be identified
Department or major	Environmental Science
Status	Undergraduate student

Student/Intern 2

Name	To be identified
Department or major	Environmental Science
Status	Undergraduate student

Student/Intern 3

Name	
Department or major	
Status	

Project

Project title	Evaluating virtual street tree surveys as a tool for municipal forest management
Research area	Urban forestry
Project summary	Street tree inventories are critical to municipal forest management, but many communities cannot afford to conduct field-based inventories. It is possible to characterize street trees by manually interpreting images in Google Street View, which offers a free and user-friendly platform for accessing ground-level photographs taken along roads throughout the USA. We previously conducted a proof-of-concept study demonstrating that a 'virtual survey' in Street View

can produce reasonably accurate data about street tree variables relevant to municipal management such as tree abundance, genus, and size class. However, that virtual survey was conducted by a single analyst with expertise in urban forest inventories, so we do not know how well this approach can be carried out by less experienced municipal staff or citizen scientists.

This project will build upon existing research to improve our understanding of the possibilities and limitations of conducting virtual street tree surveys in Google Street View. We will enlist analysts ranging from experts to novices to conduct virtual surveys to record basic tree attributes, and their performance will be evaluated against field data from the same set of streets. We are primarily interested in determining (1) what overall level of data quality can be generated using a virtual survey approach as compared to field surveys; and (2) how data quality varies according to the analyst's level of expertise, and whether citizen scientists can generate reliable data for management purposes. Our results will provide guidance for communities considering implementing this innovative approach for generating street tree inventory data.

Statement of problem

In recent decades, researchers and practitioners have prioritized the quantification of urban forest structure, function, and value. A better understanding of urban forest resources improves our ability to manage urban trees and justify expenditures on tree planting and care. Much of this work has focused on street trees, which are on the front lines of management and stewardship (Fischer & Steed, 2008). Street trees have numerous benefits including reduced energy use and stormwater runoff (McPherson et al., 2005), increased property values (Donovan & Butry, 2010), enhanced civic engagement (Fisher et al., 2015), and aesthetic enhancements promoting livable, walkable cities (Southworth, 2005). Data-driven management of street trees is vital to sustainable urban forests (Clark et al., 1997). Unfortunately, field data collection is expensive and time-consuming.

Street tree inventories have primarily relied on field work conducted by municipal foresters, consulting arborists, and student interns. Field surveys require substantial commitments of time, labor, and transportation, making them prohibitively expensive for many communities. While field surveys by professionals remain common (e.g., Östberg et al., 2013), there are a growing number of alternative techniques. For example, remote sensing approaches fusing LiDAR data and hyperspectral imagery can generate high-quality data (Alonzo et al., 2016). However, these techniques rely on expensive datasets, specialized software, and technical expertise that is out of reach for all but a select few communities. This is a concern for smaller cities and underserved communities that do not have the means to generate street tree data using field surveys or cutting edge remote sensing approaches.

We propose a new approach to street tree inventories that can make datasets more attainable for communities with limited resources: a 'virtual survey' using Google Street View. This imagery is freely available and accessible for even novice computer users. Google Street View offers ground-level, panoramic photography along streets in most urban areas within the USA. Given that Street View allows a user to see a streetscape from the perspective of a car driving on that street, analysts can manually interpret the imagery to generate street tree data. There are several appealing features of virtual surveys: they can be conducted year-round using leaf-on Street View images (i.e., not limited to the summer field season); they can be repeated quickly in subsequent years to generate information about tree mortality and other population changes; and they use a free and publicly available online interface. Our previous research shows that an analyst with expertise in field botany can produce high-quality data from a virtual survey (Berland and Lange, in revision). There is potential for crowdsourcing virtual surveys, but it is unknown how data quality will differ among analysts with varying levels of expertise.

This research will address two key problems impeding the use of virtual street tree surveys in everyday urban forest management. First, can a virtual survey produce data of high enough quality to be useful for purposes of municipal street tree management? Second, what level of expertise is needed for an analyst to produce quality data?

REFERENCES: See attached list.

Significance of your proposed project as it relates to the profession of arboriculture or urban forestry

While virtual survey data cannot replace on-the-ground expert assessment to identify pruning needs or pest infestations, virtual survey data can complement field data by producing basic tree information more quickly. Based on our pilot study (Berland and Lange, in revision), virtual surveying can generate reasonably accurate data regarding tree locations, abundances, size classes, and taxonomic identification. In some states, such baseline data are a prerequisite to seeking additional funding for municipal forest management. This is particularly important for underserved communities that are interested in proactive urban forest management, but may not have the resources to fund a field inventory.

This project will break new ground in assessing the reliability of street tree data generated using virtual surveys in Google Street View, in particular by examining the quality of data produced by analysts ranging from experts to citizen scientists. Our project will provide research-based guidance about the expected quality of tree variables that can be collected via virtual surveys. In addition, we will compare virtual survey data to field data to document the accuracy of data produced by analysts with varying levels of expertise. These research outcomes will help communities determine whether a virtual survey is right for them, and whether it should be conducted by experts or citizens scientists. Potential applications include city arborists using virtual surveys to update street tree inventories during winter months, and leveraging volunteers or interns to produce a complete virtual survey of street trees where none exists.

REFERENCES: See attached list.

Description of what is currently known about proposed project area

OVERVIEW. The proposed project will evaluate the quality of street tree data generated using virtual surveys in Google Street View, and we will compare the performance of experts and citizen scientists with respect to data quality. Below we briefly summarize existing literature on street trees, research applications of Google Street View, and citizen science in urban forestry.

STREET TREES. Street trees are trees growing in the public right-of-way along streets. In many cities, streets trees are the most abundant and widely distributed trees managed by the municipality. Street trees provide an array of environmental, economic, and social benefits that have received increased attention since the 1990s (Mullaney et al., 2015). Sustainable management of street trees is needed to maintain the provision of these benefits (Clark et al., 1997), but this is difficult because street trees face challenges such as harsh growing conditions, conflicts with urban infrastructure, and destructive invasive pests (Mullaney et al., 2015). An up-to-date street tree inventory is a primary need for prudent management of street trees (Cowett and Bassuk, 2014). Street tree inventories contain information including tree locations, species, sizes, and health condition. An inventory can guide tree planting, pruning and other maintenance, removals, and responses to pest outbreaks. Unfortunately, collecting field data to generate a street tree inventory is too expensive and labor-intensive for many communities. After a field inventory is completed, it may quickly become outdated in a dynamic urban landscape. Repeated inventories that enable analysis of mortality and other aspects of population change are valuable but particularly rare (Roman et al., 2013, 2014).

EMERGING INVENTORY TECHNIQUES. Researchers are developing techniques to generate data about urban trees using remotely sensed imagery and LiDAR (O'Neil-Dunne et al., 2014; Alonzo et al., 2016). This is promising because it eliminates much of the time-consuming field work involved with street tree inventories. But these methods require expensive imagery products and highly specialized computer software, putting these techniques out of reach for most communities. On the other hand, Google Street View is freely and publicly available, easy to use, and offers ground-level panoramic views along streets throughout most of the USA. Street View imagery has recently emerged in urban forestry research as a tool for quantifying greenery along streetscapes (Li et al., 2015) and locating nests of invasive pests (Rousselet et al., 2013).

Google Street View was used in a proof-of-concept study by PI Berland to inventory street trees in metropolitan Cincinnati, OH via manual interpretation of the imagery (Berland and Lange, in revision). Compared to existing field data, the "virtual surveyor" captured 93% of trees inventoried in the field. The virtual survey produced data that were 90% accurate for genus identification and 66% accurate for species identification. Diameter at breast height (DBH) was consistently underestimated in the virtual survey, but the analyst's performance improved with experience. When plotting field DBH vs. virtual survey DBH on a graph, perfect estimation of DBH would yield a slope of 1 and R2 value of 1 for the regression line. In the virtual survey, these numbers improved from slope = 0.38 and R2 = 0.63 for the first 56 trees, and improved to slope = 0.91 and R2 = 0.90 for the final 448 trees (Berland and Lange, in revision). In future projects, training and reference materials will help improve performance at the early stages of the virtual survey. In general, this approach is simple enough to be implemented by anyone with basic skills in computing and tree identification and measurement. The virtual survey was conducted much faster than field surveys, indicating that a community could use it to quickly generate basic variables about the locations, types, and sizes of their street trees.

In a practical example of street-level image interpretation for urban forest management, Philadelphia, PA recently completed a citywide street tree inventory using manual interpretation of Cyclomedia imagery, a product similar to Google Street View (Carolan, 2016). Interns mapped 112,000 trees using a virtual survey. However, due to concerns about intern expertise identifying species and estimating DBH, only tree location and mortality status were recorded (J. Piller, pers. comm.). Our proposed study would enable cities considering virtual surveys to decide which variables to collect, and by which type of analyst, based on quantified information about analyst data quality.

Google Street View imagery can also produce street tree inventories using automated algorithms and machine learning (Wegner et al., 2016). Using this technique, species classification rates were promising (80%), but tree detection rates were only 70% (Wegner et al., 2016), considerably lower than the 93% detection rate found in our manual approach to image interpretation (Berland and Lange, in revision). Additionally, like LiDAR and hyperspectral methods, machine learning requires highly specialized computing, making it impractical for most communities. We focus on manual interpretation of Street View imagery because it is a more practical approach for communities lacking the resources to pay for more advanced techniques, and because our prior proof-of-concept study and the Philadelphia experience demonstrate the strong potential of this method for everyday urban forest management.

CITIZEN SCIENCE IN URBAN FORESTRY. We have evidence that Google Street View can be used to generate street tree data of reasonable quality, but we do not know what level of expertise is needed to produce data that are valuable for the purposes of municipal management. By including expert, intermediate, and novice participants, the proposed research will evaluate the performance of analysts with varying levels of experience inventorying urban trees. This will contribute to a broader push to characterize the benefits and challenges of involving citizen scientists in environmental research in general (Dickinson et al., 2012) and urban forestry in particular (Roman et al., in revision). Citizen science is increasingly used to simultaneously increase public engagement in scientific inquiry, and to generate more extensive datasets than experts can generate on their own. Citizen science has a rich history in urban forestry, as cities have long enlisted volunteers to conduct street tree inventories (Bloniarz and Ryan, 1996).

One persistent concern about citizen science is the reliability of data generated by inexperienced volunteers. Co-PI Roman produced a systematic assessment of citizen science data quality for urban tree inventories in four cities (Roman et al., in revision). In that study, field data generated by citizen scientists were largely consistent with data generated by experts for variables including tree abundance (within 1%), genus identification (90% agreement), and DBH (93% of trees within 1 inch of expert values). The authors provide recommendations for training citizen scientists; for example, emphasizing a consistent definition of “street tree” could produce more consistent tree population counts, and photo examples contrasting species with similar attributes could help novice participants correctly identifying trees (Roman et al., in revision). In the proposed project, we will implement such recommendations to improve the chances of yielding high-quality data.

Where formal assessments of data quality from citizen science projects exist, they typically compare citizen data to expert data, which is assumed to be correct. This is a naïve understanding of error which assumes that expert data is flawless, when indeed, even expert-produced tree inventories have data quality issues (van Doorn, 2014). However, some citizen science and crowdsourcing projects have examined consistency among interpreters, particularly for image interpretation. For example, crowdsourcing is widely used for interpretation of land cover, and crowdsourcing in this context relies on agreement among users for data quality control (Fonte et al., 2015). Cases where several experts agree might be considered authoritative data or a “gold standard” against which volunteer data could be compared. In another example, the Galaxy Zoo project uses volunteers to classify images of galaxies by shape; when shapes are highly consistent across many volunteers, the researchers can be confident in the quality of the volunteered data and follow up to further investigate the identified galaxies (www.galaxyzoo.org). These two examples demonstrate the tremendous value of volunteers interpreting images, with the critical component of evaluating inter-observer consistency as an indication of data quality. In the proposed project, we will advance citizen science in urban forestry by evaluating the quality of data produced among analysts with different levels of expertise, quantifying the consistency of data produced within a given expertise level, and characterizing overall data quality by comparing virtual survey data to field data from the same locations.

In summary, emerging research shows that Google Street View can be used to produce data about street trees at lower cost than field surveys. It may be possible to leverage citizen scientists to conduct virtual street tree surveys using Street View, but we do not know what level of data quality can be generated by volunteers compared to experts. The proposed project will build upon cutting edge research to characterize the feasibility of generating a quality street tree inventory with analysts ranging from novices to experts.

REFERENCES: See attached list.

Summary of project goals	The proposed project will evaluate the quality of street tree data generated virtually by manually interpreting Google Street View imagery. There are three primary goals motivating this work. First, we seek to characterize the overall performance of virtual street tree surveys by comparing imagery-derived data to field-generated reference data. We will focus on tree attributes used widely in management: the number of trees, genus and species, size class, and mortality status. Second, we will study whether virtual surveys of street trees can be reliably conducted by citizen scientists, or if urban forestry expertise is required to generate usable data. To do this, we will determine how data quality differs according to the expertise of the analyst, and also how data quality differs among analysts in the same class of expertise. The third goal is to help urban forest managers understand if our approach is appropriate for their communities. We will evaluate time spent on the virtual survey vs. a field survey, as well as monetary costs of both approaches. We will disseminate our findings broadly among urban forest managers, and generate resources to replicate our approach for local management uses. While we readily acknowledge that a virtual survey should not replace on-the-ground assessments by qualified professionals, our approach may be useful to urban forest managers looking to use a simple and freely available product to generate or update street tree inventories. This may be especially relevant in communities that cannot afford to conduct a field inventory.
Description of measurable outcomes expected	At present, there is only one study documenting the prospects of using Google Street View to conduct virtual surveys of street trees through manual image interpretation (Berland and Lange, in revision). That study – led by PI Berland – showed promise for generating data suitable for street tree management without physically visiting sites, but it was conducted by a single analyst with expertise in urban forestry. The proposed project will build upon this proof-of-concept study by producing the following measurable outcomes: 1. Statistical assessment of the percent agreement between the virtual survey and field data from the same place. This will include data on the following key street tree attributes: number of trees, genus and species, size class, and mortality status. 2. Quantitative analysis of agreement among analysts with varying levels of expertise (novice, intermediate, and expert) for each tree variable listed above. 3. Analysis of percent agreement among analysts with comparable expertise to determine how consistent virtual survey estimates are from one analyst to the next. 4. Evidence-based guidance for communities interested in this

approach, including a list of tree variables that can be reliably collected using virtual surveys of street trees in Google Street View, as well as evaluation of time and costs required for virtual vs. field inventories.

5. Along with these more general outcomes, we will produce field data and virtual survey data for street trees in Dolton, IL, a community interested yet financially unable to collect data that will help improve their urban forest management.

Project plan including design, hypotheses, methodology and analyses

OVERVIEW. In this study, we will generate data about street trees using virtual surveys in Google Street View, and we will compare this information to data collected in the field. We will also compare the performance of analysts with varying expertise in order to evaluate the skill level necessary to produce high-quality virtual survey data. Below we describe the study area, study design, methodology, and data analysis, and conclude by summarizing the central research questions and hypotheses.

STUDY AREA. The study will be conducted in Dolton, IL, which abuts the south side of Chicago. Dolton's population is 23,262 people, of which 25% live in poverty and over 90% are black or African American. Dolton covers an area of 4.7 square miles and contains 93 miles of local roads. Project personnel from Morton Arboretum have been working with Dolton to develop capacity for urban forest management, but the community is conspicuously lacking a street tree inventory, which renders the community ineligible for key state funding opportunities. Community leaders are interested in obtaining street tree data as a pivotal step toward improving municipal forest management.

STUDY DESIGN AND METHODOLOGY. The study will be based on an 18% random sample of Dolton's streets, or about 17 miles of street length. This is substantially higher than the 6% sample recommended for i-Tree Streets studies (i-Tree, 2012), and this sample will allow us to reliably characterize the composition of street trees in Dolton as well as the performance of virtual surveys as described below. Our previous research experiences indicate this sampling effort is appropriate for the project timeline and for generating a representative sample.

Field data will be collected along the study street segments in summer 2017 by two DePaul University students, under the guidance of co-PI Vogt. The students will receive training in field methods and species identification prior to field work. The field crew will visit each randomly selected street segment and survey all street trees present in the public right-of-way. For each tree, they will record genus, species, diameter at breast height (DBH), mortality status, and tree location by street address. We will also enumerate time spent per tree and overall field time (including transportation). Data collection will largely follow the Urban Tree Monitoring Protocol developed by the Urban Tree Growth and Longevity Working Group, an effort led in part by co-PI Roman. Because the field data will be the reference ground-truthed dataset in our analyses, the field crew will take pictures and make notes when they are uncertain of a measurement or tree identification, so that the tree may be revisited to ensure the best field data quality possible. We expect reliable data from the field crew, because prior analysis indicates well-trained paid interns produce data that are highly consistent with expert data (88-100% consistent across several variables) (L. Roman, unpublished data). Data will be collected using the OpenTreeMap mobile application (www.opentreemap.org).

Virtual surveys will be conducted for the same street segments as the field survey. Virtual surveyors (aka analysts) will use Google Earth Pro, which is freely available. Google Earth Pro permits users to view geographic information system (GIS) files within Street View, ensuring that analysts survey the correct street segments by following a line on the computer screen. Users can also place a point on the map with a unique identifier, and those points can later be exported to GIS format to compare tree locations noted by the field crew and multiple virtual surveyors.

Virtual surveys will be conducted by three experts (PI and co-PIs), three intermediate analysts, and three novice analysts, following expertise categories from Urban Tree Monitoring Protocols mentioned above. Intermediate and novice analysts will be recruited from municipal staff and local volunteers such as Openlands TreeKeepers. To accurately characterize expertise, analysts will complete a questionnaire containing questions about relevant education, experiences in urban forestry, and self-reported confidence with tree identification and assessment. Prior to the virtual survey, analysts will receive training similar to our previous citizen science projects (3-4 hours) covering species identification and measurement techniques. We will adapt training materials (slides, field guides) already developed for the protocols used in past citizen science trainings. Species training will emphasize contrasts among species with similar leaf shape or form (e.g., maple vs. maple-like leaves of London planetree). To provide context for estimating DBH in Street View, analysts will also receive a reference guide showing Street View images of trees with the field-measured DBH listed; this substantially improved DBH estimation in our previous research (Berland and Lange, in revision).

To conduct the virtual survey, analysts will manually interpret Google Street View imagery to record the same variables collected by the field crew, including tree attributes and time spent on the survey. Because analysts cannot be expected to estimate DBH precisely using Street View imagery, DBH will be aggregated into the following size classes commonly used in urban forest management: 0-3 inches, 3-6, 6-12, 12-18, 18-24, 24-30, and >30. In addition, they will record the imagery date so we can understand whether older Street View imagery yields poorer data quality. Finally, analysts will have an opportunity to rate their confidence level on tree identification and make notes about trees, for example, when they are not sure if the tree is located in the public right-of-way.

DATA ANALYSIS. Our analysis will focus on five primary tree variables fundamental to management activities: number of trees recorded, genus, species, DBH, and mortality status. For these tree variables, we will assess the level of agreement between the field survey and virtual surveys using both raw percentages and Cohen's kappa (following Berland and Lange, in revision; Roman et al., in revision). Cohen's kappa accounts for chance agreement between two analysts, and thus provides a more genuine portrayal of agreement than raw percentages, particularly when datasets are dominated by a small number of common items such as overrepresented species.

We will also quantify the level of agreement among users in the same expertise category, and among different expertise levels. This will provide an indication of the level of data quality that can be expected from analysts according to their expertise. Communities can use this information to decide whom to enlist as virtual surveyors, given that they may have to balance data quality needs with availability of personnel. Finally, we will compare the time and money spent completing the virtual and field surveys.

SUMMARY OF KEY RESEARCH QUESTIONS AND HYPOTHESES. This study will address the following central questions:

1. Can manual interpretation of Google Street View imagery be used to generate high-quality data about street trees? Drawing on our previous research (Berland and Lange, in revision), we hypothesize that data accuracy (i.e., agreement with field data) will be high (>85%) for the number of trees and genus identification. Accuracy will be less reliable for species identification and DBH estimation. In general, data quality will be poorer for small trees than large trees, and data quality will be higher when Street View imagery is more recent.

2. What is the level of agreement among multiple analysts conducting virtual surveys of the same trees? Similar to #1 above, we hypothesize that agreement among analysts will be high for some variables such as genus identification and mortality status, and lower for species identification, particularly for locally rare species.

3. How does data quality vary among analysts with different levels of expertise? Based on our previous research (Roman et al., in revision), we anticipate that intermediate and novice analysts will generally agree with experts on tree abundances and DBH class, but may be less adept at identifying trees to the species level, especially for less common species. Due to their more extensive training and experience, we hypothesize that experts will agree with one another more often than less experienced analysts agree with one another.

4. What time and cost savings can be expected from virtual surveys compared to field surveys? Based on our previous research (Berland and Lange, in revision), we hypothesize that virtual surveys will offer

	substantial time savings as compared to field surveys, perhaps around 50% faster, which may translate to large cost savings. REFERENCES: See attached list.
Description of plan for disseminating the results of this project	The results of this project will be disseminated in three primary ways. First, we will publish our findings in peer-reviewed journals, and the budgeted open access fees will be used to make our research freely available to practitioners and researchers. We will target scholarly journals with broad readership such as Urban Forestry & Urban Greening and Arboriculture & Urban Forestry, widely-read professional/trade publications such as Arborist News, and newsletters and blogs like the Treebune News by ACTrees. We will prioritize an article documenting the accuracy of a virtual survey of street trees compared to field data, along with analysis of agreement among virtual surveyors according to their level of expertise. Second, PI Berland will travel to a prominent urban forestry conference (International Society of Arboriculture, Partners in Community Forestry, or similar) to present the findings of this work. Sharing our results and perspectives will start a dialogue to help people decide if our techniques might be appropriate and useful in their communities. Third, we will host a workshop at Morton Arboretum that brings together urban forest professionals from greater Chicago. At this workshop, participants will get a hands-on introduction to our methodology, learn about our research outcomes, and have a chance to ask questions as they consider using Google Street View to virtually survey street trees in their communities. Any community guidance documents prepared for the workshop will be made publicly available following the workshop.
Project start date	03/01/2017
Project completion date	02/28/2019
Geographic range of project	USA & Canada

Budget

Compensation/Stipend

Proposed project budget	$11,899
Requesting from TREE Fund	$11,030
Funding from other sources	$0
Value of in-kind support from other sources	$869

Employee Benefits

Proposed project budget	$1,561
Requesting from TREE Fund	$1,257
Funding from other sources	$0

Value of in-kind support from other sources	$304

Travel (> 50 miles)

Proposed project budget	$2,500
Requesting from TREE Fund	$2,500
Funding from other sources	$0
Value of in-kind support from other sources	$0

Local Transportation (< 50 miles)

Proposed project budget	$1,251
Requesting from TREE Fund	$1,251
Funding from other sources	$0
Value of in-kind support from other sources	$0

Equipment (vehicles, growth chambers, etc.)

Proposed project budget	$0
Requesting from TREE Fund	$0
Funding from other sources	$0
Value of in-kind support from other sources	$0

Supplies (paper, ink, toner, etc.)

Proposed project budget	$887
Requesting from TREE Fund	$887
Funding from other sources	$0
Value of in-kind support from other sources	$0

Contract Labor (contractor, speaker, etc.)

Proposed project budget	$0

Requesting from TREE Fund	$0
Funding from other sources	$0
Value of in-kind support from other sources	$0

Other/Misc.

Proposed project budget	$9,782
Requesting from TREE Fund	$6,105
Funding from other sources	$0
Value of in-kind support from other sources	$3,677
Description of other/misc. expenses	Requested from TREE Fund: 1. Indirect costs at allowed rate of 10% for Ball State University and DePaul University budget items. 2. Journal article open access fees. 3. Workshop at Morton Arboretum (facility rental & refreshments for 70 attendees @ $15 each). In-kind support from other sources: 1. Unrecovered indirect costs from Ball State University and DePaul University ($3,677)

Total

Proposed project budget	27880
Requesting from TREE Fund	23030
Funding from other sources	0
Value of in-kind support from other sources	4850

Funds already received from other sources	$0
Funds pending from other sources	$0
Value of in-kind support already received from other sources	$0
Value of in-kind support pending from other sources	$4,850

How did you hear about this grant?	TREE Fund website Word of mouth

Applications will be scored on the following scale:

- Applicant is qualified (10 points)
- Applicant has experience (5 points)
- Project has potential to result in transformative research ideas or approaches (5 points)
- Project directly meets one or all TREE Fund priorities (10 points)
- Project has clearly stated need (10 points)
- Project is clearly linked to arboriculture and/or urban forestry (5 points)
- Research has practical application (10 points)
- Project design is scientifically sound, methods are clear and analysis is appropriate (15 points)
- Project is likely to result in peer reviewed publication (10 points)
- Objectives are achievable within proposed time frame (5 points)
- Objectives are achievable within proposed budget (5 points)
- Requested funds have potential to leverage future support from other funding sources (5 points)
- Requested funds are matched with at least 10% cash or in-kind (5 points)

Your application will not be available for editing after it has been submitted.
Please review your application for completion before submission.