

**PROPOSAL TEMPLATE**

Forest Service use only.

Control Number: \_\_\_\_\_

**COVER SHEET**

**2015 U.S. Forest Service**

**National Urban and Community Forestry Challenge Cost-Share Grant Program**

**Proposals are due by May 15, 2014, 11:59 PM Eastern**

**INNOVATION GRANT CATEGORY:**

- Category 1:** Incorporating Urban Forests as Green Infrastructure into Urban Planning Practices that will result in improvements for ecologically underserved communities and regions
- Category 2:** Green Infrastructure Jobs Analysis
- Category 3:** Utilizing Green Infrastructure to Manage and Mitigate Stormwater to Improve Water Quality

**PROJECT CONTACT NAME, ORGANIZATION, ADDRESS, PHONE NUMBER, FAX**

**NUMBER AND EMAIL ADDRESS:** Robert Fahey, Ph.D., Forest Ecologist, The Morton Arboretum, Lisle, IL. Phone: (630) 719-2419, Fax: (630) 719-2450, Email: [rfahey@mortonarb.org](mailto:rfahey@mortonarb.org)

**PROJECT TITLE:**

Planning for equitable urban landscapes: Identifying communities underserved by urban forest green infrastructure, assessing future risks, and optimizing management strategies

**FUNDING REQUEST AND MATCH** (Note: Matching amount must at a minimum equal requested amount.)

**REQUESTED:** \$ ~~292,174~~298,525 + **MATCHING:** \$ ~~295,049~~305,962 = **TOTAL PROJECT:** \$ ~~587,220~~604,487

**OUTREACH:**

Is this project being developed to reach a minority or underserved population?  Yes \_\_\_ No

Is this pre-proposal being submitted by a minority or underserved population (owned/operated/directed) business, organization or college/university? \_\_\_ Yes  No

**PROJECT PARTNERS:**

1. Dr. Satoshi Hirabayashi, GIS/Environmental Modeler - The Davey Institute - Davey Tree Expert Company, 5 Moon Library, SUNY-ESF 1 Forestry Dr. Syracuse, NY 13210

Phone: (315) 448-3211, Email: [satoshi.hirabayashi@davey.com](mailto:satoshi.hirabayashi@davey.com), LETTER OF SUPPORT INCLUDED: **YES** NO

2. Scott Maco, Director of Research and Development - Davey Tree Expert Company, Phone: 425-605-0383, Email: [scott.maco@davey.com](mailto:scott.maco@davey.com), LETTER OF SUPPORT INCLUDED: **YES** NO
3. Dr. David Nowak, Project Leader - USDA Forest Service Northern Research Station, 5 Moon Library, SUNY-ESF, Syracuse, NY 13215, Phone: (315) 448-3212, Email: [dnowak@fs.fed.us](mailto:dnowak@fs.fed.us), LETTER OF SUPPORT INCLUDED: **YES** NO
4. Bill Toomey, Director, Forest Health Protection, The Nature Conservancy, Arlington, VA, Phone: (203)-482-5221, Email: [btoomey@tnc.org](mailto:btoomey@tnc.org), LETTER OF SUPPORT INCLUDED: **YES** NO
5. Randall Blankenhorn, Executive Director, Chicago Metropolitan Agency for Planning, 233 S. Wacker Drive, Suite 800, Chicago, IL 60606. Phone: (312) 454-0400, Email: [rblankenhorn@cmap.illinois.gov](mailto:rblankenhorn@cmap.illinois.gov), LETTER OF SUPPORT INCLUDED: **YES** NO
- ~~5-6.~~ Dr. Christie Klimas, Assistant Professor, Department of Environmental Science and Studies, DePaul University, McGowan South, Room 203 D, 1110 West Belden Avenue, Chicago, Illinois 60614, Phone: (773) 325-8423, Email: [cklimas@depaul.edu](mailto:cklimas@depaul.edu), LETTER OF SUPPORT INCLUDED: **YES** NO

#### **STAKEHOLDER SUPPORT:**

1. Suzanne Malec-McKenna, Ph.D.: Executive Director - Chicago Wilderness, 8 S. Michigan Ave. Chicago, IL 60603, Phone: (312)-580-2156, Email: [suzanne.malec-mckenna@chicagowilderness.org](mailto:suzanne.malec-mckenna@chicagowilderness.org), LETTER OF SUPPORT INCLUDED: **YES** NO
2. Daniella Pereira: Regional Forester – Openlands, 25 E. Washington Street, Suite 1650, Chicago, IL 60602, Phone: 312.863.6271, Email: [dpereira@openlands.org](mailto:dpereira@openlands.org), LETTER OF SUPPORT INCLUDED: **YES** NO
3. Nancy Williamson, Regional Watershed Coordinator - Illinois Department of Natural Resources - Millenium Reserve/Calumet Core, 2050 W. Stearns Rd. Bartlett, IL 60103 Phone: (815)-263-9857, Email: [nancy.williamson@illinois.gov](mailto:nancy.williamson@illinois.gov), LETTER OF SUPPORT INCLUDED: **YES** NO
4. Lynne M. Westphal, Ph.D.: Project Leader & Research Social Scientist, USDA Forest Service, Northern Research Station “People and Their Environments” Research Program, 1033 University Place, suite 360, Evanston IL 60201, Phone (847) 866-9311 x11, Email: [lwestphal@fs.fed.us](mailto:lwestphal@fs.fed.us), LETTER OF SUPPORT INCLUDED: **YES** NO
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6. Jacqueline Carrera: President and CEO – Parks and People Foundation, Stieff Silver Building, 800 Wyman Park Drive, Suite 010, Baltimore, MD 21211 Phone: (410) 448-5663, Email: [jackie.carrera@parksandpeople.org](mailto:jackie.carrera@parksandpeople.org), LETTER OF SUPPORT INCLUDED: **YES** NO
7. Stephen Harris, City-County Arborist – Department of Parks and Recreation, City of Syracuse, 412 Spencer Street, Syracuse, NY 13204, Phone: (315) 473-4330 x3017, Email: [ParksArborist@syrgov.net](mailto:ParksArborist@syrgov.net), LETTER OF SUPPORT INCLUDED: **YES** NO
8. Abigail Derby-Lewis, Conservation Ecologist - The Field Museum. 1400 S. Lake Shore Drive, Chicago, IL 60605, Phone: (312) 665-7488, [aderby@fieldmuseum.org](mailto:aderby@fieldmuseum.org), LETTER OF SUPPORT INCLUDED: **YES** NO

**ABSTRACT:**

This project will develop new tools and maps focused on identifying communities underserved by urban forest green infrastructure, evaluating resilience under future scenarios, and optimizing management strategies to mitigate disparities and risks. Specific project objectives are to: 1) develop tools within the US Forest Service’s i-Tree platform to identify current ecologically underserved locations and prioritize urban forest management practices; 2) incorporate future scenarios of tree species composition, climate, pests and urban development into tools developed in objective 1 ; 3) create databases of underserved communities within 5-10 US urban areas, evaluate likely risks and resilience for these communities under climate and development scenarios, and develop optimized urban forest management strategies based on current and future estimates of composition and age structure, plantable space, and benefits; 4) disseminate developed tools and results through the i-Tree software platform, partnerships with regional urban planning agencies, a national planning workshop, conference presentations, journal articles, and webinars. Underserved communities will be engaged through The Nature Conservancy’s Leaders in Environmental Action for the Future program and community stakeholders. Deliverables from this project will provide urban managers/planners across the country a toolset to identify underserved communities and optimize investments focused on mitigating current conditions and future risks.

## Proposal Narrative:

### 1. Project Description (20 points), only one category may be selected per submission:

Metropolitan areas and their citizens rely greatly on green infrastructure for a variety of ecosystem services that improve the livability of these regions and provide benefits to both the local and global environment. Urban trees and forests within these metropolitan areas are an essential component of green infrastructure that perform functions such as: removing air pollutants, reducing energy use, improving water quality and controlling stormwater, providing wildlife habitat, sequestering C, increasing property values; and improving community health and well-being (e.g., McPherson et al. 1994, Nowak and Dwyer 2007). Increasingly, these services are quantified and incorporated into infrastructure planning and municipal budgets (Nowak 2006). However, within large urban areas there are often very great disparities in the distribution of this green infrastructure and its associated benefits. Many communities are underserved by existing green infrastructure for a variety of ecological, social, and economic reasons (Heynen et al. 2006). A better understanding of how to identify underserved communities and quantify the various ways in which these areas are underserved by current green infrastructure is an important goal for urban planners focused on making urban regions more livable and equitable (Schwab 2009).

This novel project will develop new tools and maps focused on identifying communities underserved by urban forest green infrastructure and evaluating resilience under future landscape change and management scenarios. The project will be developed within the US Forest Service's i-Tree platform, which will be used to bring the tools and results to the national urban planning and urban forest management communities. The tools and analyses build on a very deep history of work in urban forest assessment and will utilize a combination of field data and remote urban tree canopy assessments to evaluate current and future tree species composition and benefits in relation to pest impacts, climate change, and development scenarios. These data sources will be applied to the specific project objectives focused on understanding distributions of urban forest green infrastructure and the resilience of this infrastructure at the community-level.

The project's specific objectives are:

- 1) To develop tools focused on identifying localities underserved by current urban forest green infrastructure
- 2) Incorporate future scenarios of tree species composition, climate, pests and urban development into the tools developed in objective 1.
- 3) To produce maps and databases for a set of US urban areas identifying communities and locations within communities that are currently underserved by urban forest green infrastructure, evaluate likely risks and resilience for these communities under climate and development scenarios, and develop optimized urban forest management strategies for these communities
- 4) To disseminate the developed tools and results through the i-Tree platform, partnerships with regional urban planning agencies, [partnerships with national and local outreach and education groups](#), a national urban planning workshop, national conferences, journal articles, and webinars.

The proposed project aligns with the goals of the 2015 National Urban and Community Forestry Advisory Council's Innovation Grant Category 1: Incorporating Urban Forests as Green Infrastructure into Urban Planning Practices that will result in improvements for ecologically

underserved communities and regions. The project will provide urban managers/planners across the country a toolset to identify underserved communities and optimize investments focused on mitigating current conditions and future risks. Direct engagement with the urban planning community through partnerships such as the Chicago Regional Trees Initiative and The Nature Conservancy's Healthy Trees/Healthy Cities Initiative (<http://healthytreeshealthycities.org/>) will allow for effective transfer of tools and knowledge to this important audience. In addition, connections with initiatives focused on improving green infrastructure in underserved communities (such as the Millennium Reserve/Calumet Core program in the Chicago region - <http://www2.illinois.gov/gov/millennium-reserve>) and engaging urban populations in conservation (such as the Leaders in Environmental Action for the Future program - <http://www.nature.org/about-us/careers/leaf/>) will allow the results of the work to be applied directly to underserved communities in partnership with those communities.

The project will be conducted in three phases. The modeling projects that make up Objectives 1 and 2 will be addressed concurrently. Following development of the modeling tools, they will be applied in Objective 3 to case study urban regions. Finally, following completion of these pilot assessments the modeling tools and products will be shared with the urban planning community and public in Objective 4. The methods and process for the specific objectives are addressed in more detail below.

*Objective 1: Develop tools focused on identifying localities underserved by current urban forest green infrastructure*

The goal is to develop tools to identify ecologically underserved areas and to prioritize urban forest management practices under current conditions by overlaying population density and other socioeconomic factors with urban tree cover and several ecosystem service layers including air pollutant removal, urban heat island mitigation, ultraviolet (UV) reduction, avoided stormwater runoff and building energy savings. To evaluate current urban forest composition and structure, data from i-Tree field sampling will be combined with remotely-sensed urban tree canopy (UTC) assessment using the i-Tree Landscape platform (under development by Davey) and compositional imputation models (under development by Chicago Regional Trees Initiative at The Morton Arboretum and Field Museum). Modeling will be applied at multiple resolutions – resulting data will be produced at the scale of communities, census block groups, and i-Tree Landscape pixels. Figure 1 illustrates a scheme for prioritization of underserved locations; areas classified as A (with high population density and low ecosystem services) are ecologically underserved areas, and thus have a higher priority for planting. In areas classified as B, high populations are currently well served by trees so the focus should be on tree protection and maintenance. Areas in groups C and D are lower priority, and may be more suitable for future development. In the course of the project we will assess different thresholds and combinations of factors for identifying underserved locations – these methods will be tested and refined using case studies (Objective 3). The tools will allow users to assess priority for intervention by focusing on a single or combining multiple factors. These tools provide an advanced platform for urban managers and planners to help determine priority management areas and will be incorporated into i-Tree Landscape and are applied to case study areas in Objective 3.

*Objective 2: Incorporate future scenarios of tree species composition, climate, pests and urban development into the tools developed in objective 1.*

The goal of this objective is to enhance the tools developed in Objective 1 to assess risks associated with future changes to the landscape and incorporate tools to allow modeling of future

scenarios and the effect of specific potential urban forest management strategies. Future tree cover will be modeled based on natural regeneration/mortality rates, planting strategies, climate change, pest susceptibility, and urban development. All of these factors, in turn, affect ecosystem benefits provided by urban forests. The i-Tree Forecast model that is under development will be utilized to assess the impact of these future scenarios using a combination of predicted climate patterns from the North American Regional Climate Change Assessment Program (NARCCAP) (NARCCAP 2014) and species specific responses (Prasad et al. 2007), development patterns from the EPA Global Change Research Program's ICLUS predictions (US EPA 2014), and local data from regional planning agencies (where available), and pest risk based on the list of 64 tree pests from the i-Tree (pest detection) module as well as the National Insect and Disease Risk Map (NIDRM) from Forest Health Technology Enterprise Team (FHTET) (USFS FHTET 2014). With the tools enhanced in this phase, underserved communities can be identified, risks and potential future conditions can be modeled (including potential future transitions into or out of underserved status), and urban forest management/investment plans can be created to alleviate inequality and mitigate risks. Resulting community-level future analysis model will be incorporated into i-Tree Landscape and applied to case study areas in Objective 3.

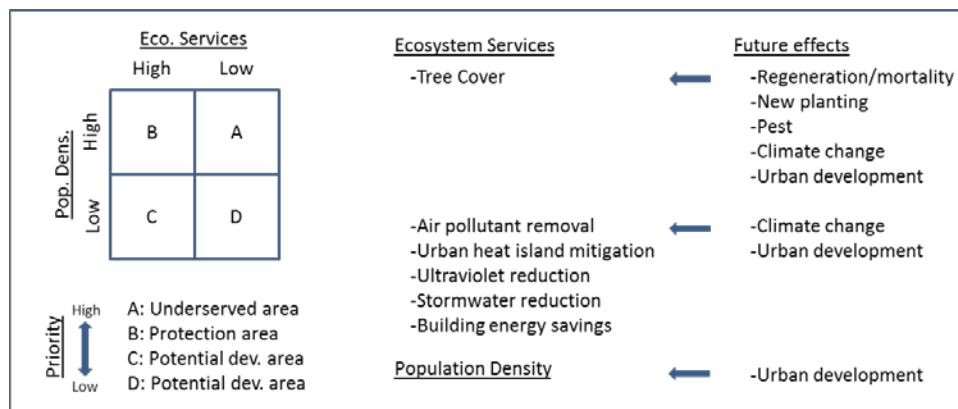


Figure 1. Priority planting/protection identification scheme in tool developed in Objectives 1 and 2

*Objective 3: Produce maps and databases for a set of US urban areas identifying communities and locations within communities that are currently underserved by urban forest green infrastructure, evaluate likely risks and resilience for these communities under climate and development scenarios, and develop optimized urban forest management strategies for these communities*

In this objective the modeling tools developed in Objectives 1 and 2 will be applied in a set of case studies in urban areas across the US to better understand the distribution of underserved communities in these regions and the risks they face. The results of these analyses will also be applied to optimize urban forest management strategies for various goals and benefits in future scenarios using the i-Tree Forecast modeling platform. The goal is to demonstrate and refine the applicability of the new i-Tree models (Obj. 1 & 2) to assess underserved communities based on forest inventory and urban tree canopy data and provide proactive management strategies to

mitigate urban forest risk. We will create community-level data sets focused on the years 2010 and 2060 in the urban areas listed in Table 1. In these selected regions, field studies for i-Tree and/or TNC's Healthy Trees, Healthy Cities initiative projects have been or are being performed, remotely-sensed urban tree canopy (UTC) assessments have been or are being performed, and several peer-reviewed publications have been created on a variety of urban ecosystem service analyses. We will create scenarios of potential urban forest management strategies (planting strategies and volumes, canopy cover goals, compositional/diversity goals, pest/disease response, climate adaptation goals) based on expert opinion (surveys of urban forest managers/planners in each case study region). i-Tree Forecast will be used to assess the effect that implementation of these scenarios would have on composition and cover, risk and resilience, and provision of services across each case-study region. Within case study areas we will also test the potential of additional lower-resolution land cover datasets to be utilized in the modeling process. This will allow us to assess the necessity of very high resolution UTC data for other urban regions to conduct modeling and develop strategies for areas to conduct modeling using lower resolution datasets. *Reviewer comment: Please clarify the areas that are going to be covered by the tool. Remember there are interested parties that are not part of the continental USA and can be benefited. Hawaii, Puerto Rico, Virgin Islands, Pacific Islands, etc. Also, to expand the utility of the project outputs to a much broader range of cities we will include a number of other cities in case study modeling that have either iTree data or UTC data in part to assess how successful modeling efforts can be using other data sources (in this case National Land Cover Dataset and/or Land Cover Database of North America instead of UTC and MODIS-based LAI instead of i-Tree plot data). This will allow us to expand to arid regions, non-conterminous US areas, and cities with a broader range of sizes and socioeconomic conditions (see Table 1). Also see below discussion of the national scope of tools that will be developed.*

*Reviewer comment: There seems to be a strong focus on Chicago. The other noted areas seemed to be an afterthought- Baltimore, NY, Syracuse NY, Philly. For this to be a national project the applicant would need to strengthen the inclusion of other sites around the country. The modeling process will be carried out in collaboration with project partners and with input from stakeholders from each of the cities listed in the expanded Table 1. Results will be directly applicable to management decisions and the planning process in those areas. We will collaborate directly with professionals (both in the public and private sphere) in each of the study areas through partner organizations, webinars, and the national planning workshop. In addition to the focus on the full urban areas outlined in Table 1, within the Chicago metropolitan region a detailed neighborhood-scale focus will be applied to the Millenium Reserve/Calumet Core region, which is a priority region for green infrastructure investment in the region and an area with high concentrations of underserved minority populations.*

*Reviewer comment: A large percentage of the US population lives in arid and semi-arid areas and there are no cities/states from these areas listed in the proposal, nor any cities from the tropical areas or Island nations. How can iTree be refined for air pollution or storm water if only using eastern or Midwestern cities? These are proposed as national tools and should reflect climate conditions for the entire country and the Islands.- The applicant needs to develop the proposal, so it can applied elsewhere. The analysis tools developed in the project will be national in scope and thus we have expanded the project to include a larger set of urban areas (Table 1) that includes cities from arid and semi-arid locations and non-conterminous parts of the country. Because the tools and data resources are national in scope, further efforts can easily*

expand to any other areas of interest, including additional non-conterminous areas of the US and its territories (such as Alaska and Puerto Rico). To expand to these areas currently will require employing coarser or older data (as described above), and more appropriate or current data will likely become available in the near future. Even though the case studies that we are planning to develop only cover a subset of metropolitan regions in the nation, covering a national scale with the project is within the revised project plan and the tools developed as part of the project will be of use to any municipality in the country through the freely available i-Tree tools that will be developed.

Reviewer comment: I feel there is some confusion about the word "underserved." The proposers clicked the box under "outreach" claiming they are developing this to reach a "minority or underserved population" which infers "low income." BUT, in the proposal itself, underserved refers specifically to areas essentially devoid of tree canopy which may or may not have any relation to socio-economic status. In addition to a focus on identifying communities that are underserved by urban forest green infrastructure (Obj. 1), the project will assess whether communities that are underserved in a traditional socioeconomic sense are also those that are most underserved by urban forest green infrastructure (this relationship will also be a focus of education/outreach activities – see Obj. 4). As part of this objective we will conduct research on the social, economic, and geographic factors that are most strongly associated with communities' status as underserved -by urban forest green infrastructure. We will then evaluate how these factors vary within the case-study urban regions and across the full suite of study areas at a national scale. The goal of this analysis will be to better understand the underlying socio-economic and geographic factors that are behind inequity in green infrastructure allocation and that must be overcome to produce more equitable urban landscapes.

Table 1. Urban areas to be assessed as case studies for Objective 3 and sources for i-Tree plot data and urban tree canopy assessment data.

City/State	i-Tree Year	No. i-Tree plots	UTC?, Data Year	Healthy Trees, Healthy Cities
Chicago region, IL	2007/2010	2,076	Regional, ongoing – 2009 data	Yes
Syracuse, NY	2009	198	2010	
Baltimore, MD	2009	195	2007	
New York, NY	1996	206		Yes
Philadelphia, PA	1996	210	2008	Yes
<a href="#">Los Angeles, CA</a>	<a href="#">2007/2008</a>	<a href="#">348</a>	<a href="#">2006</a>	<a href="#">Yes</a>
<a href="#">Atlanta, GA</a>	<a href="#">1997</a>	<a href="#">205</a>	<a href="#">No</a>	
<a href="#">Golden, CO</a>	<a href="#">2007</a>	<a href="#">115</a>	<a href="#">No</a>	
<a href="#">Boise region, ID</a>	<a href="#">2013</a>	<a href="#">250</a>	<a href="#">2013</a>	
<a href="#">Honolulu, HI</a>	<a href="#">None</a>		<a href="#">2012</a>	

*Objective 4: To disseminate the developed tools and results through the i-Tree platform, partnerships with regional urban planning agencies, [partnerships with national and local outreach and education groups](#), a national urban planning workshop, national conferences, journal articles, and webinars.*



This objective will focus on disseminating the tools and results of Objectives 1-3 to a wide variety of audiences and stakeholders through a number of platforms. The urban planning community will be specifically targeted for engagement through both direct partnerships with regional planning agencies in the urban areas used as case studies and also through a nationally-focused workshop to be hosted by The Morton Arboretum with assistance from the Chicago Metropolitan Agency for Planning (CMAP) in engaging the national urban planning community. The results of Objective 3 will be directly incorporated into the planning strategies of regional and local agencies in the case-study areas through existing partnerships (CMAP, Healthy Trees, Healthy Cities, city foresters) and new connections that will be developed in the course of the project. The workshop will illustrate the modeling tools and inform planners on how best to incorporate the tools and results into practice. The workshop will also utilize the case studies to highlight the process and outcomes of the work as it would be applied in other regions across the US. Individual communities in the case-study regions will be engaged to help apply the findings of the modeling to specific planning and urban forest management projects. In addition, the models will be made available through the i-Tree platform for use by all interested stakeholders. The models and results will be presented at national conferences, in peer-reviewed journal articles, and through publically available webinars.

*Reviewer comment: Please clarify if the applicant is really serving underserved communities, if so, then how are they going to outreach to them. As a part of this objective the project team and many partners will conduct direct outreach to underserved communities in a variety of ways. One primary national-scale avenue will be the Nature Conservancy's Leaders for Environmental Actions for the Future (LEAF) program. This program is focused on under-represented urban youth from diverse backgrounds and preparing these students to be the next generation of environmental leaders. The program includes students from environmental high schools in cities across the United States (including partner schools in case study cities – Chicago, New York, Philadelphia, Denver (Golden), and Los Angeles). With lead from partner Bill Toomey of TNC the project will develop curriculum for use in the LEAF program. This will include lesson plans based on Obj. 1 that could be used in programs around the country and direct engagement with LEAF students to conduct field verification of model outputs.*

*Another regional-scale avenue that the project will use to engage underserved communities is through the Community Trees program at The Morton Arboretum, the Chicago Region Trees Initiative, and the Millennium Reserve/Calumet Core program in Illinois. The CT/CRTI programs focus on engagement of professionals and the public in the entirety of the Chicago metropolitan region (PI Fahey is a research lead on CRTI). The MR program focuses on green infrastructure in a large number of communities on the south side of the Chicago metropolitan region – many of which are underserved socioeconomically. The results of modeling for the communities engaged by CT and included in the MR program will be presented directly to these communities through public meetings organized by Community Trees and the Field Museum Science Action Center (letter of support included from A. Derby-Lewis) and Illinois Department of Natural Resources (letter of support included from N. Williamson). The goal of the meetings will be to engage professionals and the public in a discussion of the types of ecological services that the community is currently missing because of lack of tree canopy, likely future changes to the canopy based on modeling results, and strategies for alleviating current deficits in canopy and potential future damage.*

A local-scale outreach/engagement strategy will be collaboration with DePaul University and the Gary Comer Youth Center in the Grand Crossing neighborhood on the South Side of Chicago (letter of support included) and the Calumet Environmental Education Program directed by staff at the Field Museum Science Action Center. GCYC is located in a low-income African-American community characterized by high crime and abandoned buildings where approximately 78% of residents live below poverty level. In partnership with C. Klimas (letter of support attached) and with support from staff at the Field Museum Science Action Center we will develop lesson plans and field-based learning activities that will build on the i-Tree platform and focus on the local case study scenario modeling results from Objective 3. Through collaboration with DePaul we will engage with the Green Teens program at GCYC, where students use the Center's green roof and urban garden as outdoor laboratories to enrich their educational experience and prepare them for college and careers. We will engage students in the Green Teens program and other local education programs in activities focused on the i-Tree model and its use by urban forest professionals and urban planners.

All materials developed for use in these national/regional/local engagement plans will be structured such that the lessons are easily replicable in any community in the nation with the input of local data. These products will be made freely available through the i-Tree platform and will be disseminated and promoted to partner organizations and at national workshops and conferences. These products will act as a template for community engagement using the i-Tree software suite.

## **2. Originality and Innovation (5 points):**

Currently there is no nationwide means expressly designed to assist urban planners and forest managers in identifying communities and locations within communities that are underserved by urban forest green infrastructure or are at high risk to the influence of future stressors such as climate change, pests, and development. The results from this novel project will include community-based forest assessment tools to assess provision of urban forest benefits and risk and resilience to current and future natural and anthropogenic disturbances.

Taking advantage of the collaborators' resources and expertise, a wide-range of nationally available databases as well as current and future stressors will be integrated into the ongoing web-based mapping application i-Tree Landscape. With a user-friendly interface, the web-based mapping system will provide urban forest managers across the United States a comprehensive means to identify underserved communities, quantify community resilience to the impact of future scenarios, and plan management strategies to alleviate these conditions.

Newly developed tools will be integrated into the public domain i-Tree software suite, the de facto standard tool for assessing urban forests in the United States and around the globe. Since its initial release in 2006, i-Tree has achieved a dominant position through continuous integration of new science, accessibility, and public acceptance. i-Tree has evolved with new analysis domains, ecosystem services, modeling architectures as well as cutting edge computer platforms. New additions to i-Tree from this project will provide not only enhanced functionality of the i-Tree tool but a broader user-base. *Reviewer comment: Why is the applicant only using iTree? By utilizing i-Tree, we leverage a developed, accessible, and scientifically-based urban forest analysis platform to identify underserved communities and promote equitable distribution of ecosystem services and their stewardship. i-Tree provides the existing framework for collaborative development, support and dissemination of the proposed new functionality. This*

[non-proprietary, public domain software ensures that the tools will be freely accessible and evolve with newly available science through the future. This platform is widely used by urban forest managers and scientists and further developing its functionality to include identification of underserved areas and forecasting future benefits will be of great value to these users and new users that may be attracted by this additional functionality.](#) We will conduct proactive outreach to key user groups such as urban planners, urban forest professionals, arborists, local regulatory agencies, resource managers, and environmental consultants. *Reviewer comment: Are there are other software developers available that planners used? These should be explored to determine if they can be a stand-alone software, complimentary to i-Tree or if they are not compatible.* The extensions to i-Tree that are developed in this project will be very useful to planners and other professionals using other model suites, especially because many models that attempt to value green infrastructure already rely on i-Tree as a base for understanding urban forest values. There is definitely great value in further evaluating the potential for linking i-Tree (or at least i-Tree outputs) with commonly used urban planning models (for example Envision Tomorrow, UrbanSim, CityEngine, CommunityViz) and this will be a focus of the national planning workshop that will be convened as part of the project. We expect that connections with planning professionals (such as our partner the Chicago Metropolitan Agency for Planning), the national workshop focused on planners (in partnership with CMAP), and presentations of models and results at national meetings (including that of the American Planning Association) will allow us to further develop both the use of i-Tree by planners and its integration with software tools already in use by this group. We also plan to develop new educational tools based on the i-Tree platform and focused on assess future urban forest benefits. These will be developed with partners from The Nature Conservancy, DePaul University, and the Field Museum.

### **3. Literature Review (5 points):**

See appendix

### **4. Project planning and timeline (10 points):**

As detailed above, the research goals of the project will be fulfilled through three specific objectives conducted in two phases. In addition, dissemination of the project's deliverables will be ongoing throughout the project term through development and integration with existing software platforms. Figure 2 illustrates a timeline of the project implementation.

Phase 1 is planned to be completed in 20 months. In this phase, a variety of models and datasets will be integrated into the i-Tree Landscape/Forecast platform to identify communities underserved by urban forest green infrastructure. Urban tree composition and structure will be estimate based on field data and remote canopy assessment. Air pollutant, temperature, UV, stormwater, and energy saving models developed under the i-Tree projects will be refined/enhanced to integrate into the new system. Several databases will be compiled based on the nationally available climate (NARCCAP), urban development (ICLUS) and pest datasets. The development of i-Tree Landscape and Forecast will be carried out throughout the phase to integrate/facilitate the developed models and databases.

Concurrently with development of the new tools in i-Tree in phase 1, phase 2 is planned for a 23-month period to apply the new system to the case study regions, develop mapping and data products, and summarize findings in a technical report. Products will include maps and databases identifying underserved communities and evaluating these factors for the years 2010 and 2060 in the 10 case study urban regions. Along with these case studies, we will test the developed model and make modifications to model interfaces, databases and routines as deemed necessary. The

tools developed in phase 1 and case studies in phase 2 will be presented at conferences and submitted for publication as peer-reviewed journal articles and a technical report.

Phase/Task	2015			2016												2017												2018									
	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	
Objective 1:																																					
i-Tree field plot mapping to UTC																																					
Air pollutant model refine																																					
Temperature model refine																																					
UV model development/refine																																					
Stormwater model dev/refine																																					
Energy model dev/refine																																					
i-Tree Landscape development																																					
Objective 2:																																					
NARCCAP process/assimilation																																					
ICLUS process/assimilation																																					
Pest database update																																					
i-Tree Forecast development																																					
Objective 3:																																					
Case study data acquisition/integration																																					
Case study modeling/data analysis																																					
Case study map creation/data output																																					
Objective 4:																																					
Webinars																																					
Outreach/Education Tool Development																																					
Outreach/Education Tool Implementation																																					
Workshop/Planning																																					
Case study report																																					
Conferences																																					
Journal articles																																					
Management:																																					
Evaluation																																					
Biannual Report																																					
Final Report																																					

Figure 2. Timeline of proposed project

Throughout the project, we will evaluate the progress and deliverables of the project as well as solve issues that impede smooth and efficient implementation of the project. In addition, project management tasks include biannual and final reports on the progress and achievements of the project. The tasks that will be completed by each of the partners are discussed in section 6.

**5. Products (10 points):**

The products from the first phase of the project (Obj. 1 & 2) will be two i-Tree tools that will be freely available to users of i-Tree and will be advertised to stakeholders and potential users through the i-Tree platform (<http://www.itreetools.org>). Both tools will be focused at the community-scale and will thus be highly useful for both urban forest managers and local and regional urban planners. The tool developed for Objective 1 will focus on identifying communities that are underserved by current green infrastructure and prioritizing planting within those areas to alleviate these issues. This tool will be used by regional planners (e.g., to focus regional tree planting initiatives) and by community foresters (e.g., to prioritize specific planting locations and species within the community). The tool developed in Objective 2 will focus on highlighting communities that are under particular risk to future changes in the urban landscape. This tool will also be of use to both regional planners (e.g., highlighting areas that may need greater management resources and will need to be addressed by future planting programs) and community foresters (e.g., planning for future tree removals and illustrating strategies for

planting to increase resilience). Together these tools will be especially useful for both audiences in planning for resource allocation in the near and long-term. Following completion of the development phase for each tool, potential users will be engaged through webinars focused on the implementation of the tools (more detail in section 7).

The second phase of the project focuses on applying the tools to a set of case study regions across the country. The products of this phase will include community-scale datasets and maps for each case study region that highlight underserved communities (under various definitions of underserved status) and communities at risk to future stressors (for each stressor and a composite of all). These products will be made available to project partners and stakeholders from each region both through direct interaction and through a workshop that will focus on the findings for each region and how to apply to tools to other areas (workshop materials will also be made available as a webinar). Finally, a technical report on the case study modeling will be developed and published that will illustrate the results for each region, synthesize the findings, and give recommendations for applying the process to other regions of the country with different types of data resources.

We envision numerous scholarly publications resulting from this project. These publications will provide the scientific evidence to support the applicability and validity of the data and methods employed in the development of the tools and application in the case studies. We also plan to address in a publication the factors that are related to a community being underserved by green infrastructure and variation in these relationships across and within the case study regions.

We will present our findings at relevant national conferences throughout the project. We have budgeted to attend one conference each during 2016 and 2017 and two conferences during 2018. We will select conferences to attend based on our ability to expose our work to a large and diverse audience. [Reviewer comment: Consider additional conference venues to consider - ACES, AGU, AAG, Partners in Community Forestry.](#) Potential forums for presentations include (but are not limited to) meetings of the following organizations: Ecological Society of America, International Society of Arboriculture, International Association of Landscape Ecology, and American Planning Association, [American Geophysical Union](#), [American Association of Geographers](#), [ACES](#), and [Partners in Community Forestry](#).

#### **6. Collaboration (15 points):**

This project will be implemented through a collaboration of The Morton Arboretum (Morton), The Nature Conservancy (TNC), The Davey Tree Expert Company (Davey), the USDA Forest Service Northern Research Station (USFS), and the Chicago Metropolitan Agency for Planning (CMAP). PIs Fahey and Hirabayashi have ongoing research and outreach collaborations with Dr. Dave Nowak, Project Leader of the Northern Research Station. Dr. Nowak is a founder and on-going creator of the i-Tree model. He has a long history of advancing our knowledge and ability to assess the effects of urban and community forests. We will work closely with Dr. Nowak who will provide oversight and guidance. A letter of support from Dr. Nowak is included in this proposal.

Morton will be responsible for conducting analyses and developing products for the case studies, overseeing the project's administrative and financial aspects, development of strategies and management practices for use by urban forestry leaders and practitioners, stakeholder outreach and engagement via workshop/webinars, and presentation of results through conference presentations, journal articles, and technical reports.

Davey will be responsible for overall development of tools, software, and databases as well as support for case study analyses. Davey will also lead the dissemination of the products and results through i-Tree's web site in addition to conferences/journal articles.

TNC will be responsible for integration of the tools and products into the Conservancy's urban conservation and Healthy Trees, Healthy Cities initiative in cities across the United States. Connections with regional partners in Healthy Trees, Healthy Cities initiative locations (Table 1) will be utilized to distribute case study results and engage stakeholders. The Leaders in Environmental Action for the Future program is focused on preparing the next generation of environmental leaders, focusing specifically on under-represented urban youth from diverse backgrounds in cities across the United States. The program enables educators from environmental high schools (including partner schools in case study cities – Chicago, New York, and Philadelphia) to share best practices and scientific resources; provides urban youth with real-world experience through paid summer internships in the conservation field; and increases student awareness of higher education and career paths in conservation.

CMAP will partner on the project by helping organize the proposed workshop focused on illustrating the modeling tools and engaging with the national urban planning community on how best to incorporate the tools and results into practice. The workshop will also utilize case studies to highlight the process and outcomes of the work as it could be applied in other regions and we will help the project PIs expand this work to other urban regions using our existing connections with other regional planning agencies.

#### **7. National Distribution/Technology Transfer of Your Findings (10 Points):**

The distribution and technology transfer of our findings is partially discussed in section “5-Products” of this proposal. One primary distribution/technology transfer forum for our findings will be the i-Tree platform. Web-based applications will provide users the ability to explore community attributes (how well served by green infrastructure in various senses, risk to various potential stressors, etc.) through maps, download models, user manuals, and background information on our newly developed products as well as a variety of related Forest Service tools. By collaborating with i-Tree's lead developers, Davey and the Forest Service, we will ensure that this tool gets fully integrated into the full framework of nation-wide dissemination, refinement and support of these tools. As such, the tools will be freely accessible, peer-reviewed, transparent, supported and refined by the i-Tree team to keep products adapted and current to new science and management advances. The new tools developed as a part of the project will each also be presented to potential users and stakeholders in a webinar at the completion of the tool development phase (see Figure 2 – Timeline). These webinars will be focused on instructing potential users on the data requirements and functionality of the tools.

Through a variety of conference presentations and publications we will inform the urban forest research and practitioner communities of the results of this project. The technical report based on the regional case studies will be publically available through the USFS-NRS website and will be distributed to all stakeholders in the case study regions. Results will also be made available to stakeholders in case study areas through the Chicago Regional Trees Initiative, USFS collaborations, and the TNC Healthy Trees, Healthy Cities program. The national urban planning community will be specifically targeted by the urban planning workshop to be developed by Morton/CMAP (see 1 - Project Description – Objective 4). [We expect that connections with planning professionals \(such as our partner the Chicago Metropolitan Agency for Planning\), the national workshop focused on planners \(in partnership with CMAP\), and](#)

[presentations of models and results at national meetings \(including that of the American Planning Association\)](#) will allow us to further develop both the use of i-Tree by planners and its [integration with software tools already in use by this group.](#)

While the primary target of the proposed tools are urban planners and urban forest managers, we envision these tools to be used widely as a way to connect a broader community of users with an understanding of urban tree benefits, forest risk, climate change, and managing for resiliency. In Chicago, we will engage directly with underserved communities through connections with the Chicago Wilderness Alliance and the IDNR Millenium Reserve/Calumet Core project, which will be a specific focus of the Chicago region case study, [and partnerships with education/outreach focused groups at the Field Museum, Morton Arboretum, DePaul University, and the Gary Comer Youth Center](#) (see [letter of support and Project Description – Objective 3](#)). Underserved communities will [also](#) be engaged through community planners and foresters and also through the TNC Leaders in Environmental Action for the Future program. This program is focused on underserved urban youth and the tools and results from this project will be incorporated into the curriculum of this program in partner cities.

#### **8. Project Evaluation (10 points):**

We will use clear performance criteria and regular evaluations to monitor progress toward project objectives. Project evaluation centers on attaining our objectives, which are described in section “4- Project Planning and Timeline”. We will follow “SMART” goals for project evaluation. We have defined *specific* project objectives, each of which contributes to the final product. Our objectives are *measurable*, and for each objective we define steps to obtain that objective. We have the ability, skills, oversight, and computational and financial resources to *attain* each of these steps. While our objectives are expansive, they are also *realistic* based on our past record of success. Finally, the steps in our project are *timely*, with Figure 2 outlining a time line of steps for each objective. Reports detailing progress, describing successes, and indicating problems encountered will be produced biannually by Morton and submitted to the National Urban Forestry Program Manager. Formal project evaluation will be conducted biannually in conjunction with the production of progress reports and evaluation by all partners will be documented in progress reports. Feedback from stakeholders (planners, foresters, and citizens from case study communities) on the utility of the final modeling tools and results will be gathered as part of the final project evaluation process for the case study regions using online survey tools. A final project evaluation report will be submitted to the NUCFAC executive staff at the end of the grant period.

#### **9. Experience/Personnel/Adequacy of Resources (5 points):**

The Morton Arboretum is a national leader in urban forestry research and outreach through its Research department, the Center for Tree Science initiative, and Community Trees program. Morton is also a leader in regional planning efforts focused on urban forests in the Chicago metropolitan region. These efforts include the Regional Trees Initiative, a region-wide, multi-stakeholder strategy to improve the vitality and sustainability of the urban forest conducted in partnership with all regional stakeholders with Openlands as a primary collaborator (letter of support attached) and the Chicago Wilderness Alliance, an umbrella organization for conservation groups focused on protecting nature and enriching life in the greater Chicago region (letter of support attached). Co-PI Fahey is a forest ecologist with extensive experience in spatial data analysis, landscape ecology, urban ecology, and research on climate impacts on urban forests. He is the leader of the Regional Trees Initiative Forest Composition analysis effort, is

partnering with the USFS Northern Institute of Applied Climate Science on developing an Urban Climate Change Response Framework (letter of support attached), and is the co-PI of a regional Oak Ecosystem Mapping and Recovery program with Chicago Wilderness.

Co-PI Hirabayashi is a broadly trained environmental modeler and software engineer. He is a primary developer of i-Tree's air pollution databases, weather pre-processors, and air quality models, integrating skills of software engineering, GIS, and environmental sciences. Hirabayashi has the backing of Davey's Ecosystem Services staff and will leverage the collective skills and knowledge of the i-Tree development team at all project phases to ensure seamless integration, dissemination and support of the tools.

Nowak is Project Leader of the Northern Research Station. Dr. Nowak is a founder and ongoing creator of the i-Tree model. He has a long history of advancing our knowledge and ability to assess the effects of urban and community forests.

Toomey is currently the Director of Forest Health Protection working as part of the Conservancy's North American Forest Priority. He leads the Conservancy's Forest Health Protection program which includes the following action areas: leading a North America based partnership on forest health (the Continental Dialogue on Non-Native Forest Insects and Diseases), implementing a national Don't Move Firewood program, advancing the Healthy Trees, Healthy Cities Initiative in several US cities.

Davey and the USDA Forest Service Northern Research Station are equipped with a large capacity of computational resources, with several work stations with multi-core (4 to 8), multi-thread processors. The computational ability is adequate to support this project's requirements.

CMAP is the official regional planning organization for the northeastern Illinois counties of Cook, DuPage, Kane, Kendall, Lake, McHenry, and Will. CMAP staff have diverse capabilities in comprehensive planning, data research and analysis, and many related disciplines.

#### **10. Budget Justification (10 points):**

The total project cost is ~~\$587,220~~604,487 (Appendix, Budget Table). We are requesting ~~\$292,171~~298,525 of this amount from the USDA Forest Service National Urban and Community Forestry Challenge Cost-Share Grant Program. The non-federal match of ~~\$295,049~~305,962 is from The Morton Arboretum, Davey Tree Expert Company, and The Nature Conservancy. The majority of the project costs are for labor devoted to development of new tools within the i-Tree modeling suite (\$288,000), application of these tools to a set of case study urban areas (~~\$157,787~~164,387), and development of outreach/technology transfer (documents, webinars, workshop, and distribution of tools through i-Tree platform). Outreach/Community engagement will be led by The Nature Conservancy through its Healthy Trees, Healthy Cities initiative and Leaders in Environmental Action for the Future program and DePaul University through collaboration with the Gary Comer Youth Center. Financial support for labor to integrate the project with these programs and costs to produce related outreach materials is included (~~\$40,000~~55,876). Travel expenses (\$13,500) are for presentation of results at national scientific and practitioner meetings and travel for project collaborators for development meetings and annual project meetings. Workshop costs are estimated at \$20,000 for hosting at The Morton Arboretum based on extensive experience hosting similar meetings. The Federal Indirect Overhead Cost Recovery Rate for Morton is ~~51.1547~~31% (~~\$59,933~~54,724) to be applied as a match. No funds will be spent to purchase trees or plants, food, equipment greater than \$5,000 or on capital improvements to property. Details and further explanation of all these costs are provided in the Appendix Budget Table and Narrative.



Appendix:

**Budget Narrative:**

Applicant: The Morton Arboretum

Project: Planning for equitable urban landscapes: Identifying communities underserved by urban forest green infrastructure, assessing future risks, and optimizing management strategies

**Budget Table**

	Federal Funds (requested)	Non-federal Match		Total	Source of Matching Funds
		Cash	In-kind		
Personnel*	99,671		<del>58,116</del> 64,716	<del>164,387</del> 157,787	Morton
Travel**	<del>13,500</del> 12,000		1,500	13,500	Morton
Distribution***	0		8,000	8,000	Davey
Workshop&	10,000		10,000	20,000	Morton
i-Tree Development#	144,000		144,000	288,000	Davey
Outreach/Community Engagement@	<del>25,000</del> 32,854		<del>15,000</del> 23,022	<del>40,000</del> 55,876	TNC, DePaul
Indirect Costs^			<del>59,933</del> 54,724	<del>59,933</del> 54,724	Morton
Total Direct Cost =		Total Match =		<del>587,220</del> 604,487	
<del>292,171</del> 298,525		<del>295,049</del> 305,962			

\* Personnel:

- Research Assistant for case study data preparation:
  - 1950 hours @ \$23.94/hr - 50% applied as match = \$46,683
- Project Coordinator/Research Assistant for case study analysis and report preparation
  - 2763 hours @ \$27.63/hr = \$76,330
- PI salary applied as match:
  - ~~650-800~~ hours @ \$43.98/hr = ~~\$28,584~~35,184
- Head of Community Trees/Regional Trees initiative salary applied as match:
  - 60 hours @ \$36/hr = \$2,160
- Regional Trees Initiative Project Coordinator salary applied as match:
  - 155 hours @ \$26/hr = \$4,030

\*\*Travel:

- Morton: three scientific meetings @ \$1500/trip = \$4500 (one paid for by The Morton Arboretum and applied as match); three annual project meetings @ \$1000/trip = \$3000
- Davey: two development meetings for two persons @ \$1,500/trip = \$6,000

\*\*\*Distribution:

- Davey: Develop, brand and integrate user's manual, website content, online accessibility, and support framework for dissemination through i-Tree
  - 80 hrs @ 100% discount rate of \$0 per hour = \$8,000

&Workshop:

- Speaker travel and lodging (\$10,000)
- Meals (\$7,500) – as match
- Printing and mailing (\$2,500) – as match

#i-Tree Development:

- Phase I - Development of models and datasets that will be integrated into the i-Tree Landscape/Forecast platform to identify communities underserved by urban forest green infrastructure.
  - 1292 hours @ 50% discount rate of \$60/hour (senior developer) = \$77,520
- Phase II – Application of new models to the case study regions and developing mapping and data products.
  - 748 hours @ 50% discount rate of 60/hour (senior developer) = \$44,880
- Phase III – Case study application & model refinement
  - 360 hours @ 50% discount rate of 60/hour = \$21,600

@Outreach/Community Engagement: The Nature Conservancy – Healthy Trees-Healthy Cities (HTHC) Initiative and Leaders in Environmental Action for the Future (LEAF) Program and DePaul University

- HTHC Project Coordinator salary:
  - 187 hours @ \$31/hr = \$5,785
- LEAF intern
  - 840 hours @ \$15.82/hr = \$13,288
- HTHC Project Director salary as match:
  - \$15,000
- DePaul University Undergraduate Interns:
  - 400 hours @ \$12.37/hr = \$4947
  - Fringe and Indirect Costs = \$2907
- DePaul – C. Klimas salary and benefits as match
  - \$8,022
- Outreach materials = \$5,927

^Indirect overhead: federal indirect overhead cost recovery rate is ~~51.15~~47.31% of project subtotal (~~\$149,199~~115,671) to be applied as a match.

### **Morton Arboretum Detail**

A Research Assistant in Dr. Fahey's Forest Ecology Lab at The Morton Arboretum will be partially supported for 12 months to prepare for the case study modeling. The RA will be responsible for acquisition and preparation of data from case study regions to be used in modeling. Half of the salary and fringe benefits will be supported by NUCFAC and the other half by The Morton Arboretum/Regional Trees Initiative (applied as an in-kind match). The annual salary for the position is \$37,050 with 26% fringe benefits – the NUCFAC share will be \$18,525 plus \$4,817 in fringe (\$23,341 total). A full time Project Coordinator/Research Assistant for the Case Study modeling phase of the project (Obj. 3) will be supported for 17 months in Dr. Fahey's Forest Ecology Lab at The Morton Arboretum. The annual salary for the position is \$42,762 with 26% fringe benefits (\$76,330 total for 17 months). This RA will be responsible for case study modeling and map/data output creation, development of case study technical report, and will co-author scientific publications.

Travel costs are included to support presentations of Case Study results by the Research Assistant/Project Coordinator at a scientific meeting (\$1500) and a practitioner focused meeting (\$1500) and overall project findings by PIs at a scientific meeting (\$1500). Also costs for PI to travel to Syracuse for 3 annual project meetings (\$1000).

Matching contributions from The Morton Arboretum/Regional Trees Initiative include half of the RA salary and fringe (\$23,342), ~~1-month~~250 hours of Dr. Fahey's time for the first two years and ~~2-months~~300 hours in the final year (~~\$67k/yr w/ 26% fringe = \$7146/mo \* 4 mo~~800 hrs @ \$43.98/hr = \$28,58435,184), 20 hours of time/yr from Lydia Scott – Head of the Morton Arboretum Community Trees Program/Regional Trees Initiative (60 hours @ \$36/hr = \$2,160), and 40 hours of time for the first two years (for webinar development) and 75 hours for the third year (for workshop planning) for the Regional Trees Initiative Project Coordinator (155 hours @ \$26/hr = \$4,030). Dr. Fahey will be responsible for supervising the Research Assistant/Project Coordinator, interpreting analysis results and parameterizing models, supervising execution of the grant, evaluating progress and producing biannual reports, scientific integrity and quality assurance of products, and co-authoring of publications. Scott and RTI Coordinator will assist with workshop planning and webinar development. Indirect costs for The Morton Arboretum at the negotiated indirect cost rate (51.15%) are included as a match.

### **i-Tree Development Tasks Detail – Davey Tree Expert Company:**

Objective 1 – Underserved community identification tool/database developments

- i-Tree field plot mapping to urban tree canopy
- Air pollutant model refine – employing EPA's ozone/PM2.5 fused air quality data
- Temperature model refine – resampling for a block group resolution
- UV model development/refine – database development, valuation; coding in C#
- Stormwater model development/refine – incorporating STI, code integration

- Energy model development/refine – building footprint wedge creation, valuation with urban tree canopy
- Integration of data and models in i-Tree Landscape

Total costs: \$155,040 less Davey cost share of \$77,520= \$77,520 in Federal need

Objective 2 – Incorporating future scenarios

- NARCCAP process/assimilation – data processing, database creation
- ICLUS process/assimilation – data processing, database creation
- Pest database update – future pest range
- i-Tree Forecast development – canned scenarios for climate and pest changes

Total costs: \$89,760 less Davey cost share of \$44,880 = \$44,880 in Federal need

Objective 3: – Case study application & model refinement

- Pilot city implementation
- Feedback and model/tool refinements

Total costs: \$43,200 less Davey cost share of \$21,600 = \$21,600 in Federal need

Objective 4: – Distribution

- Develop, brand and integrate user’s manual, website content, online accessibility, and support framework for dissemination through i-Tree

Total costs: \$8,000 less Davey cost share of \$8,000 = \$0 in Federal need

[DePaul University Detail:](#)

[Senior Personnel](#)

[Dr. Christie Klimas will commit 3.2% of her academic year effort to this project in Years 1 and 3. Dr. Klimas will help disseminate developed tools and results. Her effort on the project is cost shared by DePaul University.](#)

[Other Personnel](#)

[Funding is requested for an undergraduate student to work during the summers of Years 1 and 3 at a rate of \\$12 per hour, 25 hours a week, for 8 weeks each year. This student will assist with science outreach. An annual increase of 3% per year is factored into future years.](#)

[Fringe benefits](#)

[DePaul’s fringe benefit rate is 36% for full-time faculty working during the academic year and 7.65% for students working during the summer.](#)

[Indirect Costs](#)

[DePaul University’s federally negotiated indirect cost rate is 47.5%, MTDC \(Modified Total Direct Costs\).](#)

### **3. Literature Review**

#### **3.1 Importance of urban forest green infrastructure**

Urban areas rely greatly on green infrastructure for a variety of ecosystem services that improve the livability of these regions and provide benefits to the global environment and local ecosystems. Urban trees and forests within cities are an essential component of green infrastructure that performs functions such as: removing air pollutants, reducing energy use, improving water quality and controlling stormwater, providing wildlife habitat, sequestering C, increasing property values, and improving community health and well-being (e.g., McPherson et al. 1994, 1997, Nowak and Dwyer 2007, Davis et al. 2012). Increasingly, urban forest ecosystem services are quantified and incorporated into infrastructure planning and municipal budgets (Nowak 2006). However, green infrastructure is often not distributed equally across large urban regions and understanding how to identify underserved communities and quantify the various ways in which they are underserved is an important goal for urban planners focused on making urban regions more livable and equitable (Heynen et al. 2006). In addition, the future of urban forest green infrastructure may be at risk to climate change, pest and disease introductions, and cuts to municipal budgets needed for replanting and maintenance (Nowak et al. 2013a). Understanding how to mitigate risks and promote resilience in urban forest green infrastructure will be a significant challenge facing urban planners and foresters in the near future.

#### **3.2 Identifying underserved communities**

Within urban areas there are often very great disparities in the distribution of green infrastructure and its associated benefits (Pedelowski et al. 2002, Perkins et al. 2004, Heynen et al. 2006). Many communities are underserved by existing green infrastructure for a variety of ecological, social, and economic reasons (Talarchek 1990, Perkins et al. 2004). In addition, the ecological benefits provided by this green infrastructure can vary greatly across urban regions (Davis et al. 2012). An important goal for urban planners focused on making urban regions more livable and equitable should be a better understanding of the drivers of these inequities. For example, although race and socioeconomic status can be highly related to green infrastructure benefits, historical development patterns and pre-urban vegetation can also be associated with these disparities (Iverson and Cook 2000, Boone et al. 2010, Fahey et al. 2012). Identifying underserved communities can also be complicated by varying definitions of underserved status. Urban areas can be directly underserved by urban forests, such as by having a deficit of canopy cover or few tree stems (Iverson and Cook 2000). Alternatively, the trees that are present can be species of low ecological value or in poor health due to management deficiencies (Heynen et al. 2006). Finally, communities can be underserved by the various benefits provided by urban forests, for instance if the trees are not located optimally to provide shade or stormwater mitigation (McPherson et al. 1994). Quantifying the various ways in which communities can be underserved by green infrastructure and investigating to what extent these factors co-vary will be essential for including this often nebulous concept in practical planning efforts.

To effectively quantify how well a community is being served by its urban forest green infrastructure, data is needed on the forest itself, environmental conditions, landuse and plantable space, and socio-economic factors (Grove et al. 2006, Heynen et al. 2006). Models that incorporate all of these factors will be most effective at illustrating the benefits associated with the urban forest and the potential benefits that could be gained with additions or alterations to the

urban forest (Perkins et al. 2004). This latter factor is often not addressed in modeling focused on urban forests, but is essential to quantifying underserved communities, because a community can only be realistically considered underserved if the potential exists to add to green infrastructure without extensive modifications to the existing land base (e.g., removing industry or residential space to add parks or open space).

### **3.3 Vulnerability/risk assessment in urban forests**

Assessment of the vulnerability of forests and tree species to future climate conditions, pest and disease outbreaks, and development patterns has been a subject of intense study over the past few decades (e.g., Prasad et al. 2007, Thompson et al. 2011, Duvenek et al. 2014). However, most of these efforts have not explicitly dealt with vulnerability for urban forests and assessments focused directly on urban systems have been limited primarily to the effects of pests (e.g., Nowak et al. 2001, Poland and McCullough 2006). Recently, efforts have been directed toward the assessment of climate change risk in urban forests – including alteration of species vulnerability assessments (Iverson et al. 2011), development of Urban Climate Change Response Framework and Vulnerability assessments (USDA Forest Service – Northern Institute of Applied Climate Science: <http://forestadaptation.org/urban>), and incorporation of climate modeling and development data into urban forest modeling (such as proposed here for the i-Tree platform).

The impact of climate change on urban forests is of concern to planners and managers. To assess likely changes in climate, output from General Circulation Models (GCMs) is analyzed - often in downscaled form (e.g., Hellmann et al. 2010). The North American Regional Climate Change Assessment Program (NARCCAP) produces 50 km horizontal resolution precipitation, temperature, and wind grids on a 3-hour time step. These grids provide both historic (1970-2000) and future (2040-2070) meteorological predictions (NARCCAP 2014), and can provide us with expected shifts in climate regimes across the US and the ability to predict the change in intensity, duration, and magnitude of meteorological events in specific urban regions. In particular, drought and temperature are likely to be much more extreme in many areas under future climates, with likely negative consequences for forests and trees (Hanson and Weltzin, 2000). Climate change is predicted to influence future forest conditions in part through affecting climatic suitability for specific common tree species (Prasad et al. 2007). Data from i-Tree and other urban forest censuses provide data on current inventory of live trees for each species and DBH by land-use for many urban regions across the United States (Nowak et al. 2013b). These data combined with an urban adaptation of the USDA Forest Service Climate Change Tree Atlas (in development by NIACS – based on modifying factors approach of Iverson et al. 2011) can provide assessments of current and potential future distribution of common tree species in the urban regions of the United States.

Climate change may also affect urban forests through adaptive management plans as well as the structural alteration of urban landscapes. Development patterns are likely to interact with changes in climatic conditions to have especially intense impacts of future forest viability and services (Thompson et al. 2011). The US EPA Global Change Research Program's Integrated Climate and Land Use Scenarios (ICLUS) project provides predictions on housing density and impervious surface changes across the country based on IPCC's A1/A2/B1/B2 scenarios from the current to the year 2100 (US EPA 2014). This database can be employed to illustrate areas within urban regions that will have a high probability of being impacted by development and predict future changes in locations that can support high levels of canopy cover/biomass.

Another important disturbance is insect and disease outbreaks, with impacts expected to be especially intense in urban forests (Liebhold et al. 1995). The USDA Forest Service Forest Health Technology Enterprise Team (FHTET) provides national insect and disease risk maps derived with numerous models. These maps can be used to predict how individual tree species will react to various mortality agents (USFS FHTET 2014).

### **3.4 Combining field and remotely-sensed data for urban forest assessment**

In metropolitan regions appropriate spatially explicit data sets are generally not available or lack sufficient information to quantify urban forest benefits and their variation at multiple scales across the region. Fine-scale remotely sensed canopy cover and land use data are highly valuable for identifying plantable space, optimizing investments in green infrastructure, and quantifying certain values and services (Grove et al. 2006). However, these assessments do not provide information on species composition or size structure, both of which are essential for understanding future risk to climate change and pest outbreaks. Field-based urban forest censuses are designed in such a way that information on species composition is only available at broad scales (city or county level) and not linked to fine-scale canopy cover data. Effectively combining these data products will be essential to understanding spatial variation in species composition and size structure. Such information is needed to assess the potential impacts of climate change, urban development, and invasive pest and disease outbreaks on urban forests, their habitat value, and other associated ecosystem services at a community or within community (e.g., census block group) scale. In addition, multi-scale, spatial data sets are essential for region-wide planning efforts, especially in most effectively highlighting areas that are underserved by green infrastructure and targeting areas for conservation or restoration that could provide the most added benefits and most greatly influence landscape and habitat connectivity.

### **3.5 Forecasting and scenario modeling to optimize green infrastructure**

Data on current urban forest composition, structure, and benefits and predictions of risk related to future climate, development and pest impacts would allow for modeling to forecast the effects of various scenarios of change on future forest conditions. Scenario planning has recently become popular as a method to analyze outcomes in potential alternative futures, and represents a paradigm shift from prediction-oriented environmental modeling (Peterson et al. 2003, Alcamo 2008, Schulp et al. 2008, Thompson et al. 2011). Rather than extrapolating from past trends, scenario planning examines potential changes that may arise from new types of risks, new management strategies, changing demographics or social conditions, or changing political, market or economic conditions (Schoemaker 1995). In modeling focused on urban forests, these scenarios could focus on environmental conditions, development patterns, and the actions of urban forest managers and planners – including different planting strategies, management goals, pest outbreak responses, resource/funding availability, etc. By combining groupings of different scenarios for each factor, case-study modeling can then illustrate the impact of different strategies in producing alternate future conditions with variable urban forest green infrastructure and provision of ecosystem services. These methods have been widely applied to understanding potential future conditions in rural forests under climate, pest, and development scenarios (Thompson et al. 2011, Duvenek et al. 2014, etc.). However, these analyses have not included urban forests as dynamics entities (generally represented by static biomass levels, if at all) and

scenario-based modeling of potential future urban forest conditions is needed to project future changes in urban forest biomass, C storage, and provision of other ecosystem services.

### **3.6 i-Tree modeling approaches**

i-Tree is a state-of-the-art, peer-reviewed software suite from the USDA Forest Service and the Davey Tree Expert Company that provides urban and community forest analysis and benefit assessment tools (iTree 2014). The i-Tree tools assist communities of all sizes to strengthen their urban forest management and advocacy efforts by quantifying the structure of the forest and the ecosystem services that trees provide. i-Tree Eco is one of the flagship applications of i-Tree software suite, which provides excellent community-scale information for urban planners and managers. With a spatially lumped approach, the entire study area is simulated as a single unit. This program is currently designed to provide estimates of urban forest structure, such as species composition, number of trees, tree density and tree health, and ecosystem services that trees provide including air quality improvement and associated public health incidence reduction and economic benefits, carbon storage and sequestration, building energy savings and consequent effects on carbon dioxide emissions from power plants, and storm flow reductions due to rainfall interception by tree canopies. In addition, the pest risk analysis based on host susceptibility, pest/disease range and tree structural value are also reported. In phase 1 of the proposed project, the risk analysis feature will be further extended to consider species' resistances to natural and anthropogenic disturbance under current and future climate scenarios.

The newly developed i-Tree Landscape is a future flagship application of the i-Tree software suite, which allows users to visually assess their urban forest structure and ecosystem services via a web-based mapping interface. While i-Tree Eco provides excellent information for urban managers at a community-scale, i-Tree Landscape will provide similar assessments at a finer scale at which local forest management plans are applied. This program is under development with a spatially distributed approach, in which input and output data are represented with grid-based raster layers and can be aggregated by larger polygons (e.g., counties, cities, census block groups, and watersheds).

i-Tree Species (i-Tree 2014) is a software utility designed to aid users in selecting the proper species to produce the functions they desire. By providing a relative rating for environmental benefits of each tree species at maturity, this program is designed to complement existing tree selection programs that rank species for esthetics and/or other features. The user enters city and state, from which the program determines the hardiness zone and eliminates all species not sufficiently hardy. The combination of hardiness and selected functionality produces a ranked list of appropriate species. A database that enables i-Tree Species is the i-Tree species database that contains index values for about 1,600 individual species. This large species database covers a broad range of native, naturalized and exotic trees. Pest and disease susceptibility of tree species derived from the USDA Forest Service FHTET program (USFS FHTET 2014) is also stored in this database.

i-Tree Forecast is an application under development that simulates future forest structure and ecosystem services based on projections of current forest structure data – including tree growth, mortality, and establishment (planting and natural regeneration). Each of these model inputs can be altered to reflect scenarios of future climate, pest outbreaks, and management strategies (see section 3.5). Annual tree diameter growth is estimated for the region based on the length of growing season, species average growth rates, competition, tree condition, and current



tree height relative to maximum tree height. Mortality rates are based on tree condition and species-specific mortality rates, which can be adjusted to account for the impact of pest or disease outbreaks. Establishment patterns are tied to estimates of canopy cover, plantable space, and canopy goals and species specific establishment can be adjusted to reflect species' natural regeneration rates, planting priorities, and planting material availability.

### **3.7 Incorporating urban forest green infrastructure in the planning process**

In order to fully incorporate urban forest green infrastructure into the urban design process, urban forests need to be viewed as an important part of the economic and social fabric of the city (Nowak 2006). Urban forests also need to be portrayed as the dynamic systems that they are – to align their value with the dynamic nature of urban systems. Quantifying underserved localities and urban forests that are at risk to future changes will help address these issues and will promote the incorporation of urban forest green infrastructure into the planning process. Both of these factors can be seen as important drivers that can stimulate the influx of resources into urban forest management (Schwab 2009). Tying urban forest management to socially underserved communities should be a goal of urban planners, both to improve quality of life in the communities and also increase funding opportunities for improving green infrastructure. The type of data output that is the focus of this project will be useful in all strategic points of intervention in the planning process (Schwab 2009). For example, maps of localities with urban forests that are at high risk to future climate change could help with visioning/goal setting by indicating the need for proactive management at a regional-scale, with plan making by identifying subareas with specific need, and with implementation by illustrating priority planting locations within at-risk localities. Forecast modeling based on projected future conditions and planting/management scenarios (see section 3.5) will be especially useful in the planning process to drive subarea planning and successful implementation. In addition, understanding how socially and economically underserved communities overlap with ecologically underserved locations is an important research question. It will be very important to understand better how the relationship between urban forest green infrastructure and economic and social characteristics of communities differs within and among urban regions across the country of different sizes, with differing development histories, and variable underlying economic and social conditions.

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## **Experience/Personnel/Adequacy of Resources support documents**

### **The Morton Arboretum**

*Robert Fahey – Project PI and contact, Forest Ecologist*

Robert Fahey is the Principal Investigator for the Morton Arboretum Forest Ecology Lab (<http://www.mortonarbforestecology.org/>). He has significant expertise in forest ecology, stand dynamics, landscape ecology, and modeling ecosystem processes. He is engaged in several projects focused on the ecology and management of urban forest landscapes and is co-PI on an ongoing NUCFAC project entitled “Carbon Sequestration and Resiliency of the Urban Forest” that will be completed in March 2015. He is a lead scientific investigator on the Chicago Regional Trees Initiative and a lead on the Chicago Wilderness Regional Oak Ecosystem Recovery project. Previous research has focused on landscape ecology and dendrochronology in forests of the upper Great Lakes region (Fahey et al. 2012, Fahey and Lorimer 2013, Fahey and Lorimer 2014, Fahey and Lorimer *in press*), effects of land-use on resilience of trees in urban locations (Fahey et al. 2013), impacts of pre-urban vegetation on modern urban forest composition and structure (Fahey et al. 2012), and assessment of the effects of structural complexity on ecosystem processes in forests. Robert earned a Ph.D. in Forest Ecology and Management from the University of Wisconsin-Madison, a Master of Science degree in Forest Science from Oregon State University, and a Bachelor of Science in Natural Resources from Cornell University.

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**Robert T. Fahey – Curriculum vitae**

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**Education**

<b>PhD</b>	<b>2011</b>
<i>University of Wisconsin-Madison</i>	
<i>Major: Forest and Wildlife Ecology</i>	
<i>Dissertation: "Establishment and persistence of early successional pine species in late-successional landscapes of the Great Lakes region" 212 p.</i>	
<b>Master of Science</b>	<b>2005</b>
<i>Oregon State University</i>	
<i>Major: Forest Science, Minor: Botany</i>	
<i>Thesis: "Patterns in understory vegetation communities across canopy gaps in young, Douglas-fir forests of western Oregon" 153 p.</i>	
<b>Bachelor of Science</b>	<b>2001</b>
<i>Cornell University</i>	
<i>Major: Natural Resources</i>	

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**Publications**

- Fahey, R.T.**, A. Fotis, and K.D. Woods. (In press). Quantifying canopy structural complexity in late-successional forests: effects on productivity and disturbance resilience. *Ecological Applications*. <http://dx.doi.org/10.1890/14-1012.1>
- Fahey, R.T.** 2014. Composition, structure, and trajectories of Great Lakes coastal pine forests in relation to historical baselines and disturbance history. *American Midland Naturalist* 172(2): 285–302
- Fahey, R.T.** and C.G. Lorimer. 2014. Habitat associations and 150 years of compositional change in white pine-hemlock-hardwood forests based on resurvey of public land survey corners. *Journal of the Torrey Botanical Society* 141(4): 277-293.
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- Bohlen, P.J., P.M. Groffman, T.J. Fahey, M.C. Fisk, E.R. Suarez, D.M. Pelletier, and **R.T. Fahey**. 2004. Ecosystem consequences of exotic earthworm invasion of north temperate forests. *Ecosystems*, 7:1-12
- Publications in review**
- Fahey, R.T.** (In review). Assessing inter- and intra-specific variation in tree phenology in response to recent climatic changes. *Global Change Biology*.
- D. Carter, K. Driesilker, M. B. Bialecki, and **R.T. Fahey** (In review). Evaluating trade-offs between oak regeneration and C sequestration in relation to management and historical land-use. *Forest Ecology and Management*.
- Goodrich-Stuart, E.J., A. De La Cruz, **R.T. Fahey**, and C.M. Gough. (In review). Disturbance severity and net primary production resilience of a Great Lakes forest ecosystem. *Ecology*.
- N. Barber and **R.T. Fahey**. (In review). Consequences of phenology variation and oxidative defenses in *Quercus*. *Chemoecology*.

Panchen, Z. A., R. Primack, A. Gallinat, B. Nordt, A.D. Stevens, Y. Du., **R.T. Fahey**. (In review). Substantial variation in leaf senescence times among 1360 temperate woody plant species: Implications for phenology and ecosystem processes. *Annals of Botany*.

#### **Presentations**

- M.B. Bialecki and **Fahey, R.T.**, August 2014. Tree growth and resilience to extreme drought across an urban land-use gradient. Contributed Oral Presentation at Ecological Society of America Annual Meeting, Sacramento, CA
- M. Casali and **Fahey, R.T.** March 2014. Mapping temporal change in oak-dominated ecosystems in the Chicago metropolitan region. Contributed Poster at Central Hardwood Forest Conference. Carbondale, IL.
- Goodrich-Stuart, E.J., A. De La Cruz, **R.T. Fahey**, and C.M. Gough. December 2013. Disturbance severity and net primary production resilience of a Great Lakes forest ecosystem. American Geophysical Union.
- M.B. Bialecki and **Fahey, R.T.**, August 2013. Tree growth and resilience to extreme drought across an urban land-use gradient. Contributed Poster at Ecological Society of America Annual Meeting, Minneapolis-St. Paul, MN
- Fahey, R.T.** A. Fotis, and K. Woods. June 2013. Drivers of canopy structural complexity in old-growth forests. Contributed Oral Presentation at the North American Forest Ecology Workshop, Bloomington, IN..
- Fahey, R.T.** and M. Bowles, November 2012. Understanding the Chicago urban forest continuum. Contributed Oral Presentation at the Chicago Wilderness Congress, Chicago, IL.
- Fahey, R.T.** November 2012. Assessing inter- and intra-specific variation in tree phenology in response to recent climatic changes. Contributed Oral Presentation at the Chicago Wilderness Congress, Chicago, IL.
- Fahey, R.T.** and M. Bowles, September 2011. Understanding the Chicago urban forest continuum. Contributed Oral Presentation at the Urban Tree Growth Workshop, Lisle, IL.
- Fahey, R.T.** and C.G. Lorimer, June 2011. Competitive status of underplanted eastern white pine in mesic hemlock-hardwood forests: can gap-based restoration succeed? Contributed Oral Presentation at the North American Forest Ecology Workshop, Roanoke, VA.
- Fahey, R.T.** C.G. Lorimer, and D.J. Mladenoff. August 2010. Persistence of Eastern White Pine in Hemlock-Hardwood Forests: An Early-successional Species in a Late-successional Landscape. Contributed Oral Presentation at Ecological Society of America Annual Meeting, Pittsburgh, PA.
- Fahey, R.T., and** C.G. Lorimer. August 2008. Eastern White Pine in Hemlock-Northern Hardwood Forests: Habitat Relationships and Change from Pre-settlement Condition. Contributed Poster at Ecological Society of America Annual Meeting, Milwaukee, WI



- Fahey, R.T.**, C.G. Lorimer. April 2008. Pre-settlement distributions of eastern white pine and development of predictive habitat models. Contributed Paper at US Regional Association of the International Association for Landscape Ecology Annual Symposium, Madison, WI.
- Fahey, R.T.**, K.J. Puettmann, and S.D. Berryman. August 2005. Patterns in understory vegetation distributions across gap openings in variable density thinned forest stands in western Oregon. Contributed Paper at Ecological Society of America Annual Meeting, Montreal, Quebec.
- Fahey, R.T.** and K.J. Puettmann. April 2005. Patterns in understory vegetation across gap openings in a variable-density thinned stand in western Oregon. Poster for: Science and the Northwest Forest Plan: Knowledge Gained Over a Decade, Portland, OR.
- Fahey, R.T.**, K.J. Puettmann, and S.D. Berryman. March 2005. Patterns in understory vegetation across gap openings in a variable-density thinned stand in western Oregon. Poster for: Northwest Scientific Association Annual Meeting, Corvallis, OR.
- Berryman, S.D., **R.T. Fahey**, and K.J. Puettmann. August 2004. Characterizing vegetation response to variable density thinning in young Douglas-fir forests of western Oregon. Poster for: Balancing Ecosystem Values: Innovative Experiments for Sustainable Forestry, Portland, OR.

#### **Reports**

- Derby Lewis, A., **R.T. Fahey**, L. Scott, A. Kerber, J. Miesbauer and L. Darling. Adapting Urban Forests to a Changing Climate. Chapter for revision of: Swanston et al. Forest Adaptation Resources: Tools and Approaches for Land Managers. Gen. Tech. Rep. NRS-87. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northern Research Station.
- R.T. Fahey**. Composition, structure, and trajectories of Great Lakes coastal pine forests in relation to historical baselines and disturbance history. Report to Illinois-Indiana Sea Grant. 2011. 20 p.
- R.T. Fahey**. Analysis of composition, structure, and drivers of vegetation patterns in the Southern Des Plaines River Project Area. Report to the Lake County Forest Preserve District. 2011. 100 p.
- Bauer, T., Z. Clark, M. Fishman, R. Gingerich, A. Tracy, D. Rubens, and **R.T. Fahey**. Planning for the Future: Assessing potential impacts and management options for invasive forest pests at the Offield Nature Preserve. UMBS Forest Ecosystems Report to the Little Traverse Conservancy. 2012. 24p.

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#### **Funding**

**Awarded (Total - \$387,630)**

*Fahey CV*

- Fahey, R.T. and B. Scharenbroch. 2012-14 (Co-PIs). Carbon Sequestration and Resiliency of the Urban Forest. USDA Forest Service - National Urban and Community Forestry Advisory Council. \$143,150.
  - Fahey, R.T. 2012-14. Assessing Oak Resources of Northeast Illinois and Implementing a Cooperative Strategy to Restore Oak Dominance to the Region's Tree Canopy. USDA Forest Service – State and Private Forestry. Received as subaward through Chicago Wilderness Trust. \$115,000.
  - Fahey, R.T. 2013-15. Oak Woodland Ecosystem Restoration Experiment: implementation and monitoring. Lake County Forest Preserve District. \$30,431
  - Fahey, R.T. 2012. Dendrochronological analysis of Illinois Natural Areas Inventory sites. Illinois DNR – Illinois Wildlife Preservation Fund. \$2,000
  - Fahey, R.T. 2012-13. Assessing drivers and implications of canopy structural complexity in late-successional hemlock-northern hardwood forests. Huron Mountain Wildlife Foundation. \$5,400
  - Fahey, R.T. 2011. Restoration of native pine species in Great Lakes coastal environments. Illinois-Indiana Sea Grant College Program. \$8,795
  - Fahey, R.T. 2011-12. Adaptive management of Southern Des Plaines River Forest Preserves: Data analysis and restoration experiment design. Lake County Forest Preserve District. \$69,871
  - Fahey, R.T. and C.G. Lorimer. 2007-8. The origin and perpetuation of emergent white pines in hemlock-northern hardwood forests. Huron Mountain Wildlife Foundation. \$4,983
  - Fahey, R.T. 2006. Ecology and restoration of supercanopy white pine in mesic hemlock-northern hardwood forests. Garden Club of America: Ecological Restoration Grant. \$8,000
- 

**Teaching**

- Forest Ecosystems. EEB 348. University of Michigan - Biological Station. Instructor. Summer 2012, 2013.
- Woodland Conservation and Management. The Morton Arboretum – Woodland Stewardship Program. Co-instructor. Spring 2011, 2012, 2013.
- Forest and Wildlife Ecology 410: Principles of Silviculture. UW-Madison. Volunteer lab teaching assistant and occasional lecturer. Spring 2007, 2008, 2009, 2010.
- Plant Pathology 123: Plants, Pathogens, and People. UW-Madison. Co-instructor. Fall 2008.

**Mentoring**

- Morton Arboretum Undergraduate Research Fellowship Program – co-PI
  - Stuart Hupp – Virginia Tech - 2014
- UMBS REU Program
  - Aubrie De La Cruz – Cal Poly – Pomona - 2013
  - Elizabeth Stockton – Tufts University - 2012

- Graduate committees
  - Douglas Lynch, Ph.D. candidate – University of Illinois-Chicago
  - Lindsay Darling, M.S. candidate – Northwestern University
- Undergraduate research interns
  - Jillian Pastick – Lake Forest College
  - Tatia Bauer – University of Michigan
  - Brian Bash – Northern Illinois University
  - David Carter – UW-Madison
  - David Gudex-Cross – UW-Madison
  - Albert Muelendyke – UW-Madison

### **Employment**

- **Forest Ecologist** – *October 2010-present*. The Morton Arboretum, Lisle, IL
  - **Lecturer** – *June 2012-present*. University of Michigan – Biological Station, Pellston, MI
  - **Graduate Research Assistant** - *June 2006-2010*. Dept. of Forest and Wildlife Ecology, University of Wisconsin-Madison
  - **Graduate Research Assistant** – *Jan. 2004-Dec. 2005*. Dept. of Forest Science, Oregon State University, Corvallis, OR
  - **Field Crew Leader** - *Fall 2003 & Summer 2004*. Silviculture Lab, Dept. of Forest Science, Oregon State Univ., Corvallis, OR
  - **Field Crew Leader/Technician** - *Summer 2002 & 2003*. HJ Andrews EF, Blue River, OR
  - **Field Technician** - *Spring 2002*. TERRA-PNW Lab - Oregon State Univ., Corvallis, OR
  - **Field/Lab Technician** - *Fall 1997-Fall 2001*. Dept. of Natural Resources, Cornell Univ., Ithaca, NY
  - **Research Intern** - *Summer 2000*. Cornell Univ. – Arnot Teaching and Research Forest, Van Etten, NY
  - **Field Technician** - *Summer 1999*. Department of Environmental Science, Policy, and Management, UC Berkeley, Berkeley, CA
  - **Field Technician** - *Summer 1997 & 1998* Hubbard Brook EF, Thornton, NH
- 

### **Honors/Awards**

- Huron Mountain Wildlife Foundation: Manierre Award - 2013
  - UW Vilas Travel Award - 2010
  - HHMI Program in Scientific Teaching Fellow - 2009
  - Garden Club of America Fellowship in Ecological Restoration - 2007
  - Oregon State University Department of Forest Science Hayes Fellowship - 2005
  - Member Xi Sigma Pi Forestry Honor Society – 2005
-

**Professional Memberships/Service**

- Ecological Society of America
- Forest Guild
- Chicago Regional Trees Initiative – Director of Forest Composition and Modeling Program
- Chicago Wilderness Oak Ecosystem Recovery Working Group – Co-chair
- Chicago Wilderness Climate Change Taskforce
- Chicago Wilderness Trees and Green Infrastructure Taskforce
- Woodland Stewards Program – The Morton Arboretum
- Wisconsin Ecology Group Graduate Representative for the Forest and Wildlife Ecology Department

**Reviewer for:**

- Ecology
  - Journal of Ecology
  - Plant Ecology
  - Journal of Vegetation Science
  - Applied Vegetation Science
  - Forest Ecology and Management
  - Rhodora
  - European Journal of Forest Research
  - Journal of the Torrey Botanical Society
  - Northeastern Naturalist
  - Ecological Engineering
-

## **The Davey Tree Expert Company: 2015 NUCFAC Project Team**

### **Project Lead and co-PI**

#### *Satoshi Hirabayashi – Coordinator, Environmental Modeling*

Satoshi Hirabayashi is an Environmental Modeler with 10 years of experience in solving urban environmental issues with computer- and GIS-based models as well as several analytical techniques such as statistical, sensitivity and time-series analyses. In addition, Satoshi brings skills and experience in a broad range of software development and project management from his past career at Motorola, Sony, and Accenture. Currently with the Davey Institute, based at the USDA Forest Service, his primary responsibility is development of core computer models of i-Tree Tools software suite, including atmospheric stability, solar radiation, mixing height, evapotranspiration, leaf area index, air pollutant concentration, dispersion, deposition, and biogenic emission, precipitation interception, and public health benefits. He is also engaged in several US nationwide assessments of air quality improvement by urban forests such as the EnviroAtlas project lead by US EPA. Satoshi published several research papers on environmental modeling and GIS applications in peer-reviewed technical journals. Satoshi earned a Ph.D. and Master of Science degrees in Environmental Resource Engineering from the State University of New York College of Environmental Science and Forestry, and a Bachelor of Science degree in Electronics and Communication Engineering from Tokyo City University in Japan.

### **Primary Staff**

#### *Scott Maco – Director of Research and Development*

Scott Maco provides management and leadership for Research and Development at the Davey Institute. His focus on applied research and development of urban forest assessment and management tools. Specifically, Scott works to create new technologies that provide better access and understanding of trees' environmental benefits and how ecosystem services can be enhanced by managing urban forest structure. Scott has 15 years of experience in planning, design, and implementation of urban forestry enhancement projects and developing the tools to facilitate effective resource management. Scott collaborates to lead development of the i-Tree Tools software suite and provides leadership for many ongoing federal, state, university and private sector cooperative research projects for Davey. Scott is the author of several peer-reviewed articles on urban forest assessment and a frequent contributing writer for industry journals and magazines. Amongst other awards, Scott was a recipient of the 2008 Forest Service Chief's Honor Award for "Engaging Urban America." Scott holds a Master of Science in Horticulture and Agronomy from the University of California, Davis and a Bachelor of Science in Urban Forestry from the College of Forest Resources, University of Washington.

## *Davey Experience*

### *Mike Binkley – Manager of Technology Development*

Mike Binkley is a Manager of Technology Development with 15 years of experience whose primary responsibility is the application of new technology to Davey endeavors. Past projects include the use of GIS analysis to resolve environmental and natural resource management issues, the development of Davey's GIS-based Asset Manager software and handheld field data collection software, as well as online mapping and web design, GPS vehicle tracking, satellite derived land cover classification, and cartographic design. As such, he strives to maintain extensive knowledge of contemporary GIS software as well as common operating system software and hardware platforms. In addition, he teaches GIS programming part-time at Kent State University. Mr. Binkley holds a Master of Arts in Geography – GIS from Kent State University and a Bachelor of Science with Honors in Natural Resource Conservation with minors in Climatology and Geography from the same institution.

### *Lianghu Tian - Research and Development Analyst, IT*

Lianghu Tian brings 14 years of expertise in information technology, digital image processing, remote sensing and Geographic Information Systems (GIS) to Davey. Currently, Lianghu is a Research & Development Analyst. He manages IT activities, application design, and research and development projects for The Davey Institute. Tian specializes in computer programming, network administration, SQL database server administration, remote sensing satellite image processing, neural networks, web design and GIS. Before joining Davey, Tian completed various research projects in the United States (including Managing Urban Sprawl and Land Resource Changes by Remote Sensing and Geographic Information Systems; Great American Secchi Dip-in Program and Satellite Image Processing and Geographic Information Systems), as well as research projects in China including Gold Mine Detection by Remote Sensing, Urban Information Systems and Land Resource Information Systems. He has published numerous articles in his fields of expertise and has won several distinguished awards. Tian holds a PhD from Kent State University, a Master of Arts from Kent State University and earned both Master and Bachelor of Science degrees in information and image processing and remote sensing from Zhejiang University in China.

### *Al Zelaya - Research Urban Forester*

Al Zelaya is a Research Urban Forester for The Davey Tree Expert Company. His primary responsibilities include development, research, training, website administration and providing technical support for urban forestry environmental service projects. His current focus includes support and integration tasks related to i-Tree, IPED (pest detection protocol) and SDAP (storm damage assessment protocols) initiatives. Al has more than 10 years experience working in urban forestry, arboriculture and natural areas management. Most recently, he was a Regional Urban Forestry Coordinator for the Wisconsin Department of Natural Resources and a County Forestry Crew Chief in Northern Illinois. He is also a graduate from the Municipal Foresters Institute (MFI) program and currently is a member of the MFI instructor cadre. Mr. Zelaya has a Bachelor

### *Davey Experience*

of Arts Degree from DePaul University in Chicago, Ill., and is currently working on completing a master's degree in Natural Resources and Environmental Sciences from the University of Illinois. Al is an ISA certified arborist and a member of the Society of Municipal Arborists, the International Society of Arboriculture and the Society of American Foresters.

#### *David Ellingsworth – Lead i-Tree Programmer*

David Ellingsworth is a lead programmer for the i-Tree development team. His primary responsibilities include the development and maintenance of i-Tree Streets. David has experience developing with variety of programming languages including Java, .Net, C++, C, PHP, Perl, HTML, and CSS. He holds a Bachelors of Science in Computer Science from The University of Akron, an Associates of Business in Software Development and an Associates of Business in Network Communications Technology from Lorain County Community College. Prior to joining the i-Tree team, he developed web-based applications in .Net and ASP for Software Answers.

#### *Michael Kerr – Lead i-Tree Programmer*

Michael Kerr is a lead programmer for the i-Tree development team. His primary responsibilities include development for i-Tree Eco, i-Tree Hydro, and i-Tree's Pocket PC applications. He also develops and maintains the i-Tree Installation package. Michael studied Computer Science at Youngstown State University. He specializes in programming C#, VB.NET, VB6, and VBA applications along with configuration, installation, and software maintenance. Past projects include converting i-Tree Eco and i-Tree Streets to the .NET Compact Framework, the i-Tree Eco Report Generator, an XML to MDB conversion library, and a Pocket PC communication library.

#### *Jason Henning – Research Urban Forester*

Jason Henning is a Research Urban Forester with the USDA Forest Service and The Davey Tree Expert Company. He has a Ph.D. in Forestry and an M.S. in Statistics from Virginia Tech. Jason has 15 years of experience in teaching and research involving the quantitative assessment and modeling of forest resources. He has published peer reviewed research on forest growth modeling, silviculture, forest ecology, and remote sensing. He spent six years at the University of Tennessee teaching courses in forest and natural resource inventory, and researching methods for quantifying and modeling forest resources. Recently, he returned to his home state of Pennsylvania and his current position at the Forest Service's Philadelphia Urban Field Station. His current work focuses on applied scientific research and communication of scientific topics to support the informed management of urban forests. He also contributes to support and outreach involving the i-Tree suite of tools and manages projects employing i-Tree software in the Philadelphia area.

#### *Allison Bodine – Research Forester*

### *Davey Experience*

Allison Bodine is a Research Forester with the USDA Forest Service and The Davey Tree Expert Company. Her contributions to the development of i-Tree include providing application testing and feedback, as well as data mining to update species and location databases. She has also worked specifically with i-Tree Eco to develop methods to analyze pest risk, identify invasive tree and shrub species, and quantify the impacts of air pollution removal on human health using the U.S. EPA's Environmental Benefits Mapping and Analysis Program (BenMAP). Allison has a master's degree in Natural Resource Management from the SUNY College of Environmental Science and Forestry in Syracuse, NY and a Bachelor of Arts in Environmental Design and Geography from the University at Buffalo.

#### *Alexis Ellis – Research Urban Forester, GIS*

Alexis Ellis is a research urban forester with 17 years of experience in the fields of forestry, information technology and Geographic Information Systems (GIS). In her current position with Davey and the USDA Forest Service she is responsible for projects relating to software development, database management, geospatial analysis, image processing and environmental modeling. Currently, her chief responsibilities include; developing the iTree Forecast model, energy modeling for iTree Design and analyzing temperature patterns following changes in tree canopy. In addition, she teaches GIS part-time at SUNY College of Environmental Science and Forestry (ESF). Alexis has a Master of Science in Forest and Natural Resource Management from SUNY ESF and a Bachelor of Arts Degree in Geography from Queen's University. Previously, Alexis worked for the US Geological Survey as a Remote Sensing and GIS Specialist developing web mapping applications, software, and map products in support of various natural hazards support, hydrologic analysis and natural resource conservation projects.

#### *Michael Leff – Research Urban Forester*

Michael Leff is a member of the Davey Institute Ecosystem Services team, based at the USDA Forest Service Philadelphia Field Station. Among his current responsibilities is leading the development of "Sustainable Urban Forestry Standards," intended to serve as a scalable guide for all communities. He is also Ambassador of the newly launched Delaware River Basin Urban Waters Federal Partnership site, which encompasses four cities in the region. Previously, Michael was urban forestry program manager at the Pennsylvania Horticultural Society, watershed program manager at the Pennsylvania Environmental Council, and land manager at Awbury Arboretum in Philadelphia. Michael currently serves as president of the Pennsylvania Urban & Community Forests Council. He is also highly involved in the Society for Ecological Restoration, both as president of the SER Mid-Atlantic Chapter and Northeast North America regional representative on the SER International board. Michael is an ISA-certified arborist and a member of the International Society of Arboriculture, the Society of American Foresters, and the Forest Guild. Prior to his environmental career, Michael worked for many years in all facets of communications, especially involving editorial responsibilities with print publications and related media. He holds a B.A. from the University of Virginia.



## *Davey Experience*

### *Yang Yang – Water Resource Engineer*

Yang Yang is a Ph.D. on Environmental Engineering and now a Water Resource Engineer with the USDA Forest Service and the Davey tree Expert Company. Her expertise is on water resource engineering and ecosystem services modeling. She has more than six years' experience on investigating and modeling ecosystem services of vegetation in urban environment. She was one of the developers and maintainers of i-Tree Hydro, and the developer of PASATH (the Physics-based Analytical Spatial Air Temperature and Humidity model). Her research results have been applied intensively by government agencies and consulting companies to assist decision making and urban planning. She has solid programming skills in several languages, such as C++, Matlab and SAS. Besides developing models, she also has a proven track record of publications in top journals.

### *Kevin Whalen – Software Developer*

Kevin Whalen is a software developer for the i-Tree team. His primary responsibilities are the engineering, and development of i-Tree Landscape. Kevin has experience writing in a variety of programming languages including C/C++, Java, C#, Javascript, Python, PHP, and Bash. He also has experience working with differing web technologies, frameworks, and libraries. Kevin has an Associate of Science in Computer Information Services from the National Institute of Technology, and a Bachelor of Science in Computer Science from Kent State University. He is perusing a Master of Science in Computer Science, with a focus on high performance computing, at Kent State University. Prior to working for the Davey Tree Expert Company, Kevin worked as a Database Analyst for CVS Caremark, and a Hardware Technician for the CVS Business Integration Center Repair Shop.

## **The Nature Conservancy**

*Bill Toomey – Director, Forest Health Protection Program*

Bill Toomey is currently the Director of Forest Health Protection for The Nature Conservancy, working as part of the Conservancy's North American Forest Priority. He leads the Conservancy's Forest Health Protection program which includes the following action areas: leading a North America based partnership on forest health (the Continental Dialogue on Non-Native Forest Insects and Diseases), implementing a national Don't Move Firewood program, advancing the Healthy Trees, Healthy Cities Initiative in several US cities. Most recently, Bill served as the Executive Director of the Highstead Foundation, a conservation non-profit based in Connecticut, which advanced forest conservation work throughout New England. Prior to that he worked for The Nature Conservancy for 10 years in the Connecticut and Massachusetts Chapters where he held positions as stewardship ecologist, landscape project director, and major gift fundraiser. He has also worked for the City of San Jose, California where he managed the residential recycling and composting program. Bill holds a bachelor's degree in Biology from Fairfield University and a master's degree in Soil Science and Ecology from North Carolina State University. Bill is also an ISA certified Arborist and is a member of the CT Urban Forest Council.

## **DePaul University**

*Personnel Qualifications for Dr. Christie Klimas*

My research brings together ecology and economics, in urban and tropical settings, to address questions of sustainable resource use. Due to the economic drivers underlying resource use, economic knowledge is an essential component of sustainability. Indeed, economic studies have moved to the forefront of sustainable ecosystem management and recent research has focused on quantifying the monetary benefit of ecosystem services like pollination, water filtration, and carbon storage. From valuing tropical forests for their economic potential to quantifying the benefits of urban green space, a commonality in my research interests is working toward ecologically sustainable resource management that recognizes the role of citizen stakeholders. I am co-leading a collaborative effort with funds from Environmental Protection Agency's P3 (People, Prosperity and the Planet) Program. The overarching vision of this project is to train a network of capable citizen scientists qualified to adaptively manage their part of the urban landscape via soil quality assessment. This grant would also provide educational opportunities for undergraduates to train community members and high school students in soil testing techniques, bioremediation, or appropriate use of polluted landscapes. Indeed, one of my research priorities is working with undergraduate students on projects that will give them the skills to conduct and use science throughout their careers.

## **Partner and Stakeholder Support Letters**

### Partner Support Letters:

- Dr. Satoshi Hirabayashi (GIS/Environmental Modeler ) and Scott Maco (Director of Research and Development): The Davey Institute - Davey Tree Expert Company
- Dr. David Nowak, Project Leader - USDA Forest Service Northern Research Station
- Bill Toomey, Director, Forest Health Protection, The Nature Conservancy
- Randall Blankenhorn, Executive Director, Chicago Metropolitan Agency for Planning
- Dr. Christie Klimas, Assistant Professor, DePaul University

### Stakeholder Support Letters:

- Suzanne Malec-McKenna, Ph.D.: Executive Director - Chicago Wilderness
- Daniella Pereira: Regional Forester – Openlands
- Nancy Williamson, Regional Watershed Coordinator - Illinois Department of Natural Resources - Millenium Reserve/Calumet Core
- Lynne M. Westphal, Ph.D.: Project Leader & Research Social Scientist, USDA Forest Service, Northern Research Station “People and Their Environments” Research Program
- Chris Swanston, Ph.D., Director - USDA Forest Service - Northern Institute of Applied Climate Science
- Jacqueline Carrera: President and CEO – Parks and People Foundation
- Stephen Harris, City-County Arborist – Department of Parks and Recreation, City of Syracuse
- Abigail Derby-Lewis, Conservation Ecologist, The Field Museum



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Toll Free: 800-828-8312  
FAX: 330-673-0860

National Urban and Community Forestry Advisory Council  
201 14th street, SW  
Sidney Yates Building 3rd Floor, NW (MS-1151)  
Washington D.C. 20250-1151

May 13, 2014

Subject: Letter of Partnership

To Whom It May Concern:

On behalf of Dr. Satoshi Hirabayashi and the Davey Institute Team, I am writing to inform you of our interest and willingness to collaborate on and support the project entitled *Planning for equitable urban landscapes: Identifying communities underserved by urban forest green infrastructure, assessing future risks, and optimizing management strategies* with the Morton Arboretum and the Nature Conservancy. This important project will help urban planners identify regions underserved by green infrastructure and optimize their efforts and budgets to maximize community's livability and equitability.

Establishing green infrastructure is critical for urban communities that seek sustainable and economically sound developments. However, green infrastructure often is not distributed equally within the neighborhoods, communities or regions. To overcome this, urban planners must be able to identify underserved areas and understand how to optimize tree canopy to mitigate disparities in services and risk. The project proposed here satisfies this need by developing and disseminating new means to visually identify underserved localities based on current and future urban forest scenarios, and assess associated risks and benefits utilizing the widely adopted i-Tree platform. For the first time, managers will have the tools to understand how ecosystem services provided by urban green infrastructure are distributed, and develop informed plans to make the community more livable and equitable.

With the team of partners assembled for this project, we have the opportunity to leverage the highest level of expertise and collaboration with respect to developing and disseminating the science and management tools proposed in this project. We will leverage a unique network of scientists, engineers, software developers and science delivery specialists for the benefit of the urban forest community. I have no doubt that the results of this project will provide critical information and timely tools that are needed to better manage our nation's urban forests in the face of climate change and increasing urban development.

As project collaborators, we will be responsible for 1) overall development of models, maps, software and information databases; and 2) the dissemination of the products and results through the i-Tree platform.

Thank you for your consideration.

Sincerely,

/s/ *Scott Maco*

Scott Maco  
Director of Research & Development  
Davey Tree Expert Company  
Phone: 425-605-0383  
Email: scott.maco@davey.com



"Do It Right Or Not At All"  
An Employee-Owned Company



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Syracuse, NY 13210

[us.fs.fed.us/nrs/urban/](http://us.fs.fed.us/nrs/urban/)

[dnowak@fs.fed.us](mailto:dnowak@fs.fed.us)

Fax: (315) 448-3216

Phone: (315) 448-3200

Date: May 12, 2014

Nancy Stremple  
National Urban & Community Forestry Advisory Council  
U.S. Forest Service  
201 14<sup>th</sup> Street SW  
Sidney Yates Building (MS-1151)  
Washington, D.C. 20250-1151

Re: Support of 2015 U.S. Forest Service National Urban & Community Forestry Challenge Cost-Share Grant Program Proposal

Dear Nancy:

This letter is in strong support of the NUCFAC proposal titled: "Planning for equitable urban landscapes: Identifying communities underserved by urban forest green infrastructure, assessing future risks, and optimizing management strategies" with The Morton Arboretum, the Davey Tree Expert Company and The Nature Conservancy. This research and development links well with our i-Tree work and will be important to help improve urban forest management and help serve underserved communities throughout the nation. This work will also help identify and mitigate future risks to the urban forest.

I and my research unit staff will work closely with the research team and contribute to the project at no cost to NUCFAC. We have worked with most of this research team in past and have a productive history. We will be closely involved with the assessing the test cities and ensuring integration of this work within i-Tree. I hope NUCFAC will fund this important project.

Sincerely,

David J. Nowak  
Project Leader



Caring for the Land and Serving People



Chicago Metropolitan  
Agency for Planning

233 South Wacker Drive  
Suite 800  
Chicago, IL 60606  
312-464-0400  
www.cmap.illinois.gov

May 13, 2014

Ms. Nancy Stremple, Executive Staff to NUCFAC  
USDA Forest Service  
201 14<sup>th</sup> Street, S.W.  
Sidney Yates Building, 3<sup>rd</sup> Floor, N.W. (MS-1151)  
Washington, D.C. 20250-1151

RE: The Morton Arboretum Proposal for the National Urban and  
Community Forestry Challenge Cost-Share Grant Program

Dear Ms. Stremple:

On behalf of the Chicago Metropolitan Agency for Planning (CMAA), I am writing to express our support for The Morton Arboretum's Proposal for the National Urban and Community Forestry Challenge Cost-Share Grant Program, Category 1: Incorporating Urban Forests as Green Infrastructure into Urban Planning Practices, which will result in improvements for ecologically underserved communities and regions.

CMAA has partnered with The Morton Arboretum in development of a Regional Trees Initiative that is working to improve the Chicago Region urban forest. An important part of this effort is assisting communities to better understand the value and function of their forest and the need to plan and manage the urban forest as a collective effort to support green infrastructure. Both institutions have also been highly involved in creating a Green Infrastructure Vision for the Chicago metropolitan region. The work proposed here would be very valuable in both of these efforts.

The Arboretum and its partners propose to develop new green infrastructure analysis tools that will utilize i-Tree and remote canopy assessments to identify locations that are underserved with respect to urban forest green infrastructure and their resiliency regarding future scenarios such as climate change and development impacts. This tool will be an important resource to assist CMAA and other local and regional planning agencies in evaluating risks, optimizing investments, and developing forest management strategies that will support the urban forest and improved environmental services at the community scale.

CMAA will partner on the project by participating in the proposed workshop focused on illustrating the modeling tools and engaging with the national urban planning community on how best to incorporate the tools and results into

Board Members

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Raul Raymundo  
Rick Reinbold  
William Rodeghier  
Carolyn Schofield  
Peter Silvestri  
Rae Rupp Srch  
Thomas Weisner

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André Ashmore  
Sean O'Shea  
Leanne Redden

Executive Director

Randy Blankenhorn



Forest Health Protection Program  
7 Skytop Drive  
Sandy Hook, CT 06482

tel [203] 428-5221  
nature.org

May 13, 2014

USDA Forest Service National Urban and Community Forestry Assistance Program  
National Urban and Community Forestry Advisory Council  
Washington, DC 20250-1151

Subject: Letter of Partnership

Dear National Urban and Community Forestry Advisory Council Members:

I am writing to inform you of The Nature Conservancy's interest and willingness to collaborate and support the Morton Arboretum's project entitled: Planning for equitable urban landscapes: Identifying communities underserved by urban forest green infrastructure, assessing future risks, and optimizing management strategies. I believe the team has prepared a compelling and effective proposal to advance the goals of NUCFAC and has developed an innovative proposal to incorporate urban forests as green infrastructure into urban planning practices that will result in improvements for ecologically underserved communities and regions across the US. I look forward to working with the other partners and am excited to collaborate on this important project.

The Nature Conservancy's collaboration and involvement in the work will focus on utilizing our existing conservation science expertise and Healthy Trees, Healthy Cities work to assist the development of key elements of the action plan, assist in involving partners and stakeholders in the process and helping to disseminate this information and plan to the urban forestry community.

We greatly appreciate the opportunity to contribute to this proposal and look forward to working in collaboration with the team to complete this important work. Should you have any questions or require additional information, please don't hesitate to contact me at (203) 482-5221 or by email at [btoomey@tnc.org](mailto:btoomey@tnc.org).

Sincerely,

Bill Toomey  
Director, Forest Health Protection Program  
The Nature Conservancy

DEPAUL  
UNIVERSITY



Department of Environmental Science and  
Studies  
1110 West Belden Avenue, Suite 203  
Chicago, Illinois 60614-2245  
773/325-7447  
FAX: 773/325-7448

Dear NUCFAC Review Team,

I enthusiastically support The Morton Arboretum's Proposal for the National Urban and Community Forestry Challenge Cost-Share Grant Program, titled Planning for equitable urban landscapes: Identifying communities underserved by urban forest green infrastructure, assessing future risks, and optimizing management strategies. I will work with the Morton Arboretum and supporting organizations to help disseminate tools and results through the i-Tree software platform by running two 2-week immersion science summer programs with partner organizations in the community (Gary Comer Youth Center). This will directly involve students underserved by green infrastructure in quantifying where this could be improved, training them in cutting edge science and economic valuation techniques. Equally important, they will spend part of the 2 weeks at DePaul where they will meet individuals from admissions, financial aid, the office for minority student success, and many others. This will help them to envision themselves at college. This builds on DePaul's existing strong partnership with the Gary Comer Youth Center.

I am excited and enthusiastic about the potential to collaborate with the Morton Arboretum in disseminating research results to underserved communities and students. Feel free to contact me if you have questions or would like additional information.

Sincerely,

A handwritten signature in cursive script that reads "Christie Klimas".

Dr. Christie Klimas, Assistant Professor  
Environmental Science and Studies Department, DePaul University  
773-235-8423  
cklimas@depaul.edu

Field Code Changed



## Chicago Wilderness

May 15, 2014

Nancy Stremple,  
Executive Staff to NUCFAC  
USDA Forest Service  
201 14th street, SW  
Sidney Yates Building 3rd Floor, NW (MS-1151)  
Washington D.C. 20250-1151

Re: The Morton Arboretum Proposal for the National Urban and Community Forestry Challenge  
Cost-Share Grant Program

Dear Ms. Stremple:

Chicago Wilderness would like to provide this letter of support for The Morton Arboretum's Proposal for the National Urban and Community Forestry Challenge Cost-Share Grant Program, Category 1: Incorporating Urban Forests as Green Infrastructure into Urban Planning Practices that will result in improvements for ecologically underserved communities and regions.

The Morton Arboretum is a member of Chicago Wilderness, a regional alliance of more than 300 public and private organizations in Illinois, Indiana, Wisconsin and Michigan working together to protect and restore biodiversity across the greater Chicago metropolitan region. The Morton Arboretum has partnered with Chicago Wilderness in development of a Regional Trees Initiative that is working to improve the Chicago Regional urban forest. An important part of this effort is assisting communities to better understand the value and function of their forest and the need to plan and manage the urban forest as a collective effort to support green infrastructure.

The Arboretum proposes to develop a forest green infrastructure analysis tool that will utilize i-Tree and remote canopy assessments to identify locations that are underserved with respect to urban forest green infrastructure and their resiliency to future scenarios such as climate change and development impacts. This tool will be an important resource to assist local and regional planning agencies in evaluating risks and developing forest management strategies which will support the urban forest and improved environmental services at the community scale recognizing the interconnected nature of our communities and the importance of green infrastructure.

I appreciate your consideration of this worthwhile project.

Sincerely,



Suzanne Malec-McKenna  
Executive Director



Suite 1650 | 25 East Washington Street | Chicago, IL 60602-1703 | Tel: 312-862-0263 | Fax: 312-863-8251 | [www.openlands.org](http://www.openlands.org)

May 13, 2014

Nancy Stremple,  
Executive Staff to NUCFAC  
USDA Forest Service  
201 14<sup>th</sup> street, SW  
Sidney Yates Building 3<sup>rd</sup> Floor, NW (MS-1151)  
Washington D.C. 20250-1151

Re: The Morton Arboretum Proposal for the National Urban and Community Forestry Challenge Cost-Share Grant Program

Dear Ms. Stremple,

Openlands would like to provide this letter of support for The Morton Arboretum's proposal for the National Urban and Community Forestry Challenge Cost-Share Grant Program, Category 1: Incorporating Urban Forests as Green Infrastructure into Urban Planning Practices that will result in improvements for ecologically underserved communities and regions.

The Morton Arboretum has partnered with Openlands to develop the Regional Trees Initiative, working to understand and improve the Chicago region urban forest by 2040. An important part of this effort is assisting communities to better understand the value and function of their forest and the need to plan and manage the urban forest as a collective effort to support green infrastructure.

The Morton Arboretum proposes to develop a green infrastructure analysis tool that will utilize i-Tree and remote canopy assessments to identify locations that are underserved with respect to urban forest green infrastructure and their resiliency to future scenarios such as climate change and development impacts. This tool will be an important resource to assist local and regional planning agencies in evaluating risks and developing forest management strategies which will support the urban forest and improved environmental services at the community scale.

We encourage you to consider this proposal thoughtfully and its importance to our region and other regions across the country where this resource may be utilized.

Sincerely,

Daniella Pereira

Regional Forester  
Openlands



Illinois Department of  
**Natural Resources**

One Natural Resources Way Springfield, Illinois 62702-1271  
www.dnr.illinois.gov

Pat Quinn, Governor  
Marc Miller, Director

May 6, 2014

Nancy Stremple,  
Executive Staff to NUCTAC  
USDA Forest Service  
201 14<sup>th</sup> street, SW  
Sidney Yates Building 3<sup>rd</sup> Floor, NW (MS-1151)  
Washington D.C. 20250-1151

Re: The Morton Arboretum Proposal for the National Urban and Community Forestry Challenge  
Cost-Share Grant Program

Dear Ms. Stremple:

The Illinois Department of Natural Resources would like to provide this letter of support for The Morton Arboretum's Proposal for the National Urban and Community Forestry Challenge Cost-Share Grant Program, Category 1: Incorporating Urban Forests as Green Infrastructure into Urban Planning Practices that will result in improvements for ecologically underserved communities and regions.

The Morton Arboretum has partnered with Openlands in development of a Regional Trees Initiative that is working to improve the Chicago Regional urban forest. The Arboretum is working with IDNR and others to help communities better understand the value and function of their forest, its importance in sustaining wildlife, and the need to plan and manage their urban forest as supporting green infrastructure.

In Illinois' Wildlife Action Plan, the Green Cities Campaign recognizes the importance of our urban areas, the value of urban trees for community health, and our urban tree canopy's role as a critical component of our migratory flyways. The Arboretum proposes to develop a forest green infrastructure analysis tool that will utilize i-Tree and remote canopy assessments to identify locations that are underserved with respect to urban forest green infrastructure and their resiliency to future scenarios such as climate change and development impacts. This tool will provide a step to develop strategies that will support the urban forest sustainability and improved environmental services at the community scale, and will be targeting areas in proximity of sites that are of statewide ecological importance.

Local jurisdictions are becoming increasingly aware of the value and necessity of their urban canopies through work from trusted institutions such as the Arboretum and we encourage you to consider this proposal for its importance to our urban regions and other urban regions across the country.

A handwritten signature in black ink, appearing to read "Nancy Williamson".

Nancy Williamson  
Green Cities Campaign Manager, Illinois Wildlife Action Plan  
Illinois Department of Natural Resources  
nancy.williamson@illinois.gov  
Cell 815-263-8857



United States  
Department of  
Agriculture

Forest  
Service

Northern Research Station

1033 University Place #360  
Evanston IL 60201  
847 866 9311 x11

February 13, 2014

Dear NUCFAC Review Team:

I am pleased to support The Morton Arboretum's Proposal for the National Urban and Community Forestry Challenge Cost-Share Grant Program, Category 1: Incorporating Urban Forests as Green Infrastructure into Urban Planning Practices that will result in improvements for ecologically underserved communities and regions. This project will build in meaningful ways on existing Forest Service investments, and will be developing and testing methods that are nationally applicable. Furthermore, and perhaps most importantly, this project seeks to develop tools that will help prevent future environmental injustice by combining climate change risk, tree benefits, and analysis of underserved areas.

The Morton Arboretum and broad array of partners have begun development of a Regional Trees Initiative that is working to improve the Chicago Region urban forest. An important part of this effort is assisting communities to better understand the value and function of their forest and the need to plan and manage the urban forest as a collective effort to support green infrastructure. This project grows this regional sustainability management approach to other cities, with a focus on underserved communities.

The Arboretum and its partners propose to develop new green infrastructure analysis tools that will utilize i-Tree and remote canopy assessments to identify locations that are underserved with respect to urban forest green infrastructure and their resiliency to future scenarios such as climate change and development impacts. This work builds on prior and ongoing USFS projects in the region, including i-Tree field plots sampling and a regional Urban Tree Canopy assessment. A growing number of communities have these tools – or could realistically get them – allowing the analysis tools developed in this project to be readily applied broadly from coast to coast.

Sincerely,

LYNNE M. WESTPHAL, PhD  
Project Leader & Research Social Scientist





**Chris Swanston**  
410 MacInnes Drive, Houghton MI 49931  
906-482-6303 x20 | [eswanston@fs.fed.us](mailto:eswanston@fs.fed.us)

[www.nrs.fs.fed.us/niacs](http://www.nrs.fs.fed.us/niacs)

May 8, 2014

Nancy Stremple,  
Executive Staff to NUCFAC  
USDA Forest Service  
201 14th street, SW  
Sidney Yates Building 3rd Floor, NW (MS-1151)  
Washington D.C. 20250-1151

RE: Fahey/Nowak Proposal to NUCFAC

The Northern Institute of Applied Climate Science is pleased to offer support for the NUCFAC proposal focused on modeling communities at risk or underserved by urban forest green infrastructure. The focus on risk and resiliency for the urban forest coincides especially well with our work. We are currently engaged in developing an urban forestry climate change response framework (see [forestadaptation.org/urban](http://forestadaptation.org/urban)), with a pilot project focused on the Chicago region. The Morton Arboretum (and Dr. Fahey specifically) is a primary collaborator on this pilot project, and Dr. Nowak has contributed significantly to the process as well. The modeling proposed for the Chicago region will be very useful in refining the pilot climate change response framework project in the future and will aid in development of community-scale vulnerability assessments (another focus of the pilot project being conducted in collaboration with The Morton Arboretum, Chicago Wilderness, and the Chicago Regional Trees Initiative). In addition, the urban forestry climate change response framework will be expanded to other cities in the near future. The outputs of the modeling tools and case studies included in this proposal will be extremely useful in that process.

Sincerely,

A handwritten signature in blue ink, appearing to read "CS", is written over a light blue horizontal line.

Dr. Chris Swanston  
Director, Northern Institute of Applied Climate Science



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Celebrating 30 Years

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May 15, 2014

Nancy Stremple  
Executive Staff: National Urban & Community Forestry Advisory Council  
U.S. Forest Service  
201 14<sup>th</sup> Street SW  
Sidney Yates Building (MS-1151)  
Washington, D.C. 20250-1151

Re: 2015 U.S. Forest Service National Urban & Community Forestry  
Challenge Cost-Share Grant Program

Dear Ms. Stemple:

On behalf of the Parks & People Foundation, I would like to express our strong support for The Morton Arboretum, the Davey Tree Expert Company and The Nature Conservancy's proposal for this grant program called, "Planning for equitable urban landscapes: Identifying communities underserved by urban forest green infrastructure, assessing future risks, and optimizing management strategies."

This proposed project to develop a new national assessment tool set will provide us with a more accessible and comprehensive way to assess the distribution of green infrastructure and its associated benefits that can assist in planning our tree planting and management in Baltimore City. We are happy to provide this team with data on Baltimore City's urban forest to assess and improve the livability and equitability of the community based on current and future urban environments. We look forward to working with this team on the development of these tools and using them in Baltimore's street tree, green infrastructure, and forest restoration planning and design. Parks & People is currently implementing green infrastructure 90 projects with \$8 million and have recently installed 15 projects costing \$1.5 million.

Urban forests and green infrastructure are key elements in achieving Baltimore City's urban tree canopy expansion and Parks & People's "One Park" concept. Should you have any questions, please feel free to contact us.

Sincerely,

Jacqueline M. Carrera  
President & CEO

Taye Muhammad  
Commissioner



John Walsh  
Deputy Commissioner

**PARKS, RECREATION AND YOUTH PROGRAMS**

**Stephanie A. Miner, Mayor**

May 14, 2014

Nancy Strimple  
Executive Staff, National Urban & Community Forestry Advisory Council  
U.S. Forest Service  
201 14<sup>th</sup> Street SW  
Sidney Yates Building (MS-1151)  
Washington, D.C. 20250-1151

Re: 2015 U.S. Forest Service National Urban & Community Forestry Challenge Cost-Share Grant Program

Dear Nancy:

On behalf of the City of Syracuse, I would like to offer my strong support for The Morton Arboretum, the Davey Tree Expert Company and The Nature Conservancy's proposal, "Planning for equitable urban landscapes: Identifying communities underserved by urban forest green infrastructure, assessing future risks, and optimizing management strategies."

The proposed national assessment tool-set produced through this project will provide an accessible and comprehensive method to determine how green infrastructure (and its benefits) are distributed throughout the city. The Syracuse Parks Department will use this information to inform our tree planting and management investments with the intent on optimizing these benefits for the entire community.

We are happy to provide this team with our recently inventoried (2013) and up to date street tree and park tree data. Improved livability through a better distribution of our green investments will be the outcome.

We look forward to working with this team on the development of these tools and using them in our street tree, green infrastructure, and forest restoration planning and design.

Sincerely,

A handwritten signature in cursive script that reads "Stephen Harris".

Stephen Harris, City County Arborist



Nancy Stremple,  
Executive Staff to NUCFAC  
USDA Forest Service  
201 14th street, SW  
Sidney Yates Building 3rd Floor, NW (MS-1151)  
Washington D.C. 20250-1151

Re: The Morton Arboretum Proposal for the National Urban and Community Forestry Challenge Cost-Share Grant Program

Dear Ms. Stremple:

The Field Museum would like to provide this letter of support for The Morton Arboretum's Proposal for the National Urban and Community Forestry Challenge Cost-Share Grant Program, Category 1: Incorporating Urban Forests as Green Infrastructure into Urban Planning Practices that will result in improvements for ecologically underserved communities and regions.

The Morton Arboretum and many other regional agencies are developing a Regional Trees Initiative that is working to improve the Chicago Region urban forest and integrate information about the values of urban forests into the regional Chicago Wilderness Green Infrastructure Vision. An important part of this effort is assisting communities to better understand the value and function of their forest and the need to plan and manage the urban forest as a collective effort to support green infrastructure. The work proposed here would be very valuable in these efforts.

The Arboretum and its partners propose to develop new green infrastructure analysis tools that will utilize i-Tree and remote canopy assessments to identify locations that are underserved with respect to urban forest green infrastructure and their resiliency to future scenarios such as climate change and development impacts. This tool will be an important resource to assist local and regional planning agencies in evaluating risks, optimizing investments, and developing forest management strategies, which will support the urban forest and improved environmental services at the community scale.

For example, this project could support an ongoing Millennium Reserve (MR) green infrastructure project, which involves 33 communities in Chicago's South Suburbs. I serve as a climate change technical advisor for the MR project and have guided the integration of climate considerations into the green infrastructure planning and prioritization process. Our work with these communities to refine a map product that graphically illustrates the area's interconnected green infrastructure network has revealed that many community organizations and residents desire to improve the urban tree canopy in their community, and need local technical assistance to enable them to do so. I believe The Morton Arboretum's proposal for the National Urban and Community Forestry Challenge Cost-Share Grant Program will provide a much-needed resource for the region, particularly in underserved communities in Chicago's South Suburbs, to help address community needs and build capacity to improve the resiliency of the Chicago region urban tree canopy.

Sincerely,  
Abigail Derby Lewis  
Conservation Ecologist