



Urban Resources Initiative: A University Model for Clinical Urban Forestry Education

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Abstract. As urban land cover increases around the globe, it is increasingly important to train competent urban forestry professionals for the future. Urban Resources Initiative (URI), a program of the Yale School of Forestry and Environmental Studies and an affiliated New Haven-based nonprofit, has provided field experience and learning opportunities for professional graduate students in urban and community forestry for over 25 years. URI's clinical training programs are uniquely designed to equip students with both technical skills and social competencies. They do this by working with local residents, municipal staff, and community leaders to promote community-based land and tree stewardship, restore neglected open spaces, and build social cohesion in urban neighborhoods. We used a mixed-method approach, which included semi-structured interviews with current and past URI interns as well as an online survey, to determine long-term impacts and learning outcomes from URI's clinical training programs. We also evaluated archival program documents to examine key programmatic features and confirm interview and survey trends. Survey and interview responses revealed that in addition to having gained key technical field skills, interns also obtained skill sets associated with the social dimensions of urban forestry. One-third of survey respondents identified effective "strategies for community engagement" as the most significant learning outcome from their internship experience. URI's program can serve as a unique and effective model for clinical training in urban forestry higher education, particularly for universities and nongovernment organizations interested in integrating a stronger social or community engagement component to their programs and curricula.

Keywords. Educational Programs; Higher Education; Human Dimensions of Forestry; Social Forestry; Urban and Community Forestry.

INTRODUCTION

In an era of unprecedented global change and rapid urbanization, urban green space, forests, and trees are increasingly recognized for the important functions they serve and support. These include social cohesion and community development (Svendsen and Cambell 2008; Ryan 2015), public health benefits (Escobedo et al. 2011), economic benefits (McPherson et al. 2005; Roy et al. 2012), resiliency in the face of climate change (Brandt et al. 2016), and environmental services such as stormwater management (Kuehler et al. 2017) and urban heat island reduction (Rosenzweig et al. 2010). Simultaneously, an integrated framework for describing the "ecology of cities" is recognized by scholars and professionals alike as essential for better understanding the physical, biological, and social drivers affecting urban landscapes (Machlis et al. 1997; Grimm et al. 2000; Pickett et al. 2001; Burch et al. 2017). As a result, urban foresters

need interdisciplinary skill sets that draw from an understanding of both the biophysical dimensions of their field and the urban societies that they will be serving (Konijnendijk et al. 2005; Vogt et al. 2016).

Fieldwork and internships have long been an invaluable component of the traditional forestry student's schooling (Bragg and Tappe 2015; Bullard 2015). Similarly, urban and community forestry students need "boots on the ground" experiences to complement their classroom-based education (Andresen and Johnson 1982; Andersen et al. 2002). Many internships and field training opportunities in urban forestry help students hone the more technical aspects of the field, such as street tree inventory, tree planting, or pest and pathogen management (Andresen and Johnson 1982). Yet recent studies and polls of forestry educators and professionals confirm that forestry education programs are not doing enough to provide their graduates with social forestry skill sets such as

conflict management, effective listening, participatory planning, leadership, and facilitation (Andersen et al. 2002; Bullard 2015; Sample et al. 2015). In order to address this gap, clinical training programs that integrate the development of technical, social, and broad professional competencies are needed to prepare the next generation of urban forestry professionals.

Past research has explored the content and evolution of urban forestry curricula over time (Williams 1975; Deneke 1978; Andresen and Johnson 1982; Hildebrandt et al. 1993; Miller 1994; Andersen et al. 2002; Elmendorf et al. 2005; Vogt et al. 2016). However, few studies have described clinical training models for urban forestry education, particularly ones that involve working with actual urban communities. In order to address this gap, we share best practices from a program housed in the Yale School of Forestry and Environmental Studies (F&ES) that trains urban foresters in both technical and social skill sets.

The Urban Resources Initiative (URI), a university-nonprofit partnership program, has been providing field experience and learning opportunities for graduate students of natural resource management since 1989. URI's community forestry programs draw heavily from the principles of social forestry, first employed in rural areas of developing countries to help promote agroforestry systems designed to alleviate poverty and food scarcity within marginalized communities (Burch et al. 2017). This approach enables students to develop technical skill sets and hone social competencies, all while working with local residents and the local governmental agencies to promote community-based land stewardship, restore open spaces and natural ecosystems, and build local capacity (Urban Resources Initiative 2017). Our study evaluates the student internship and engagement programs of the Urban Resources Initiative and their effectiveness to serve as unique models for clinical training in urban forestry at the university level.

Program History

URI began as a collaborative community forestry endeavor between the Baltimore Department of Parks and Recreation and the Yale School of Forestry and Environmental Studies (F&ES) (Burch and Grove 1993). Under the supervision of Yale F&ES professor emeritus, Dr. William Burch, student interns from Yale F&ES worked with staff at Baltimore Parks and Recreation and local community members to support

small-scale urban forestry efforts in vacant lots, streetscapes, and parks situated in neighborhoods experiencing a systemic lack of investment in Baltimore, MD, USA. Interns developed skills as organizers and facilitators of participatory green space care, tree planting, and urban forestry practices, emphasizing community participation and two-way learning between natural resource “experts” and residents (Burch and Grove 1993). For his students, Burch emphasized that a system approach to thinking about cities would allow them to better understand the complexity of interacting factors shaping the environment and well-being of its residents. In Baltimore, interns used the city's 276 unique neighborhoods and their associated watersheds as organizing units while “[exploring] the connections between greening and community revitalization and the larger context of these activities” (Burch et al. 2017). In addition to facilitating community forestry and greening projects across the city, interns also engaged in urban ecology research projects, contributed to the development of the first-ever master plan for the Baltimore Department of Parks and Recreation, taught environmental education units to Baltimore youth, and developed a training program for Parks and Recreation staff on ecological approaches to green-space management (Burch et al. 2017).

In 1991, URI shifted its focus from direct involvement in Baltimore to an urban community forestry program based in Yale's host city—New Haven, CT, USA (Figure 1). In a city where low-income neighborhoods are generally correlated with high numbers of vacant lots, fewer public parks, and low tree canopy cover (Chuang et al. 2017), New Haven, like Baltimore, requires an environmental restoration approach that ties greening to community revitalization and empowers local residents to participate in natural resource decision-making. While the URI partnerships in New Haven have grown and evolved over the years, the program has consistently trained graduate students to work as professionals in urban natural resource management. Today, while URI engages students and the surrounding community in a variety of ways, URI's model for training urban and community forestry students consists of two primary programs (see Table 1 for distinct program features and outputs):

1. *Community Greenspace*, a 13-week community forestry and neighborhood revitalization

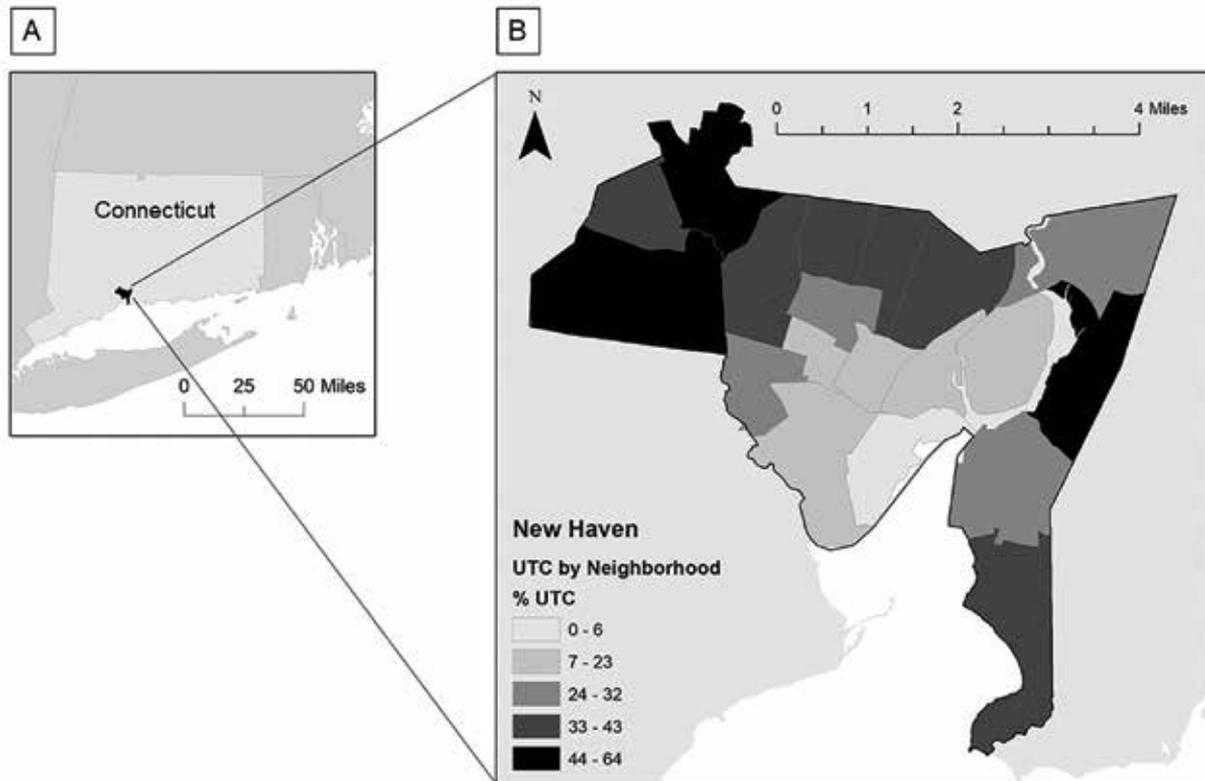


Figure 1. Location of the Urban Resources Initiative in New Haven, CT, USA. The city of New Haven is outlined by neighborhood and associated urban tree canopy cover (UTC) (O’Neil-Dunne and Pelletier, 2009). Darker neighborhoods have relatively higher tree cover than those that are lighter colored.

program employing Yale “community forester” interns and engaging local volunteers to create and maintain urban green spaces.

2. *GreenSkills*, a fall- and spring-season green jobs program, employing high school youth, formerly-incarcerated adults, and Yale “planting supervisor” interns to plant street trees in the city of New Haven.

Program Overview and Outputs

Community Greenspace

In 1995 URI launched the Community Greenspace program to create an opportunity for Yale graduate students to gain urban community forestry skills while being responsive to needs identified by the New Haven community. The program is focused on community-based urban forestry activities, such as planting street trees, transforming vacant lots into pocket parks, and restoring neglected landscapes; in doing so, it is designed to foster mutual pathways of learning with Yale students sharing their urban forestry

knowledge with residents, who in turn share their understanding and local expertise of how to best carry out projects in their unique neighborhoods (Figure 2).

Since the program’s inception 25 years ago, URI has trained 174 Yale interns and engaged thousands of volunteers, with an average of 744 volunteers participating each summer. URI provides the volunteers with material resources to carry out community forestry projects (trees, shrubs, perennials, tools, compost, mulch, stone, stakes, ties, etc.) and technical support through the Yale intern. Each intern, or “community forester,” has a portfolio of 6 or 7 groups to support, typically meeting them on a weekly basis to design and implement planting and stewardship efforts.

The Community Greenspace program has always been grassroots-driven and supports residents to work together on shared goals. Some of the volunteer groups are aligned with other civic groups, such as block watches or park friends groups, while others come together specifically for the Community Greenspace program. Residents identify the type of projects

Table 1. Overview of the desired outcomes and annual outputs from the Urban Resources Initiative's two field-internship programs: Community Greenspace and GreenSkills (Urban Resources Initiative | About 2017).

Program	Desired outcomes	Annual outputs
Community Greenspace	Clinical learning opportunities for Yale students “Healthy vibrant streetscapes and protected open spaces” Community-driven natural resources management Community leadership development Civic engagement Social cohesion	7 urban forestry internships 50+ streetscape, vacant lot, or park improvement projects 50+ neighborhood groups working in community-driven natural resources management
GreenSkills	Clinical learning opportunities for Yale students Maintain or increase tree canopy cover in New Haven Engage teens in local natural resource management and environmental literacy Engage formerly incarcerated adults in natural resource management and environmental literacy	14 urban forestry internships 500+ street trees planted 24+ teens employed 6+ formerly incarcerated adults employed

**Figure 2. Community Greenspace interns supervising volunteers on a street tree planting project (photo credit: Urban Resources Initiative, 2010).**

that they are interested in and where they wish to work. They also carry out the physical labor to achieve their project goals and commit to long-term stewardship and care of their Community Greenspace site. Since the program began, 298 different groups have participated with an average tenure of 4 years and a maximum tenure of 24 years.

The locations that volunteers have identified as priorities for restoration run the gamut from publicly

owned land, such as parks and curb strips, to publicly oriented spaces, such as vacant lots. The majority of groups plant trees as part of their restoration efforts. The average cumulative number of trees planted per group is 9, though one group has planted 109. Given the emphasis of planting on publicly owned land, city agencies including the parks department and housing agency (which has purview over vacant parcels) are program partners providing needed permissions to work on land which these agencies have the public mandate to manage.

GreenSkills

In 2007, after 13 years of partnering closely with the New Haven Parks Department to implement the Community Greenspace program, New Haven Parks invited URI to expand collaboration to include maintaining the citywide street tree inventory and planting new street trees. All new planting is done on behalf of residents and businesses on a request basis. The expanded collaboration was based in part on the high survival rate of trees planted by volunteers working with URI compared to those planted by contractors hired by the city. The proposal created a new mutually beneficial public-private partnership: one that improved New Haven's urban forest while creating a new learning opportunity for Yale students in a different approach to urban forestry. Through the new “GreenSkills” program, Yale students could train

high school students (Figure 3a) and/or adults with barriers to employment (including a history of incarceration; Figure 3b) to plant street trees based on requests by adjacent residents or businesses.

The “request basis” is a critical program feature. Trees are only planted for residents who desire a tree and commit to watering the tree weekly for its first 3 years, to better assure establishment and survival. Moreover, the “adopter” can also participate in the species selection. Unlike the Greenspace internship, where the Yale student facilitates and supports community priority-setting and project implementation, in the GreenSkills internship, the Yale students train others to be proficient in planting 5-cm- to 6.5-cm-diameter trees. The scale of the tree plantings also shifts from planting an average of 120 trees per summer to planting an average of 563 trees annually with GreenSkills participants. URI interns and staff also monitor the trees 1 and 2 years post-planting and prune them for an additional 5 years post-planting. As of January 2020, the GreenSkills program has trained 162 Yale interns and provided paid job training to 302 high school students since 2007, and 164 adult participants since 2010. In total, URI has planted 8,930 trees across New Haven (GreenSkills accounts for 6,033 and Community Greenspace volunteer-led plantings another 2,897) with an overall 2-year survival rate of 90%. Since 2010, URI has taken full responsibility for tree planting and young tree maintenance on all city streets.

Program Evaluation and Assessment

Given URI’s long-standing history of training urban foresters, we sought to critically examine programmatic features from URI’s two clinical training programs and to link these features to learning outcomes experienced by past and present participants. Our aim was to discern both strengths and deficiencies in current programs that could help inform models for other clinical urban forestry programs designed to mutually benefit students and the communities in which they work. Specifically, we asked:

1. What are the critical elements and outputs of URI’s field-based internship programs?
2. What are the specific learning outcomes students experience as program participants?
3. How might URI improve its programs to enhance student learning outcomes?

MATERIALS AND METHODS

Study Design

We employed an iterative, mixed-method approach to assess the effectiveness of URI’s field training opportunities for students in urban and community forestry. This methodology involved gathering data on the history, structure, and learning outcomes of URI’s field-based programs from multiple sources. First, we conducted semi-structured interviews with both current and former URI interns and staff who helped us identify the programs’ strengths and weakness. After preliminary analysis, these responses informed an



Figure 3. GreenSkills supervisor leading high school crew members (a) and adult crew members (b) in street tree plantings in New Haven, CT, USA (photo credit: Urban Resources Initiative, 2016 and 2015 respectively).

anonymous online survey sent to a wider pool of former URI interns with the intent of both confirming and expanding on themes identified in the interviews. In addition to these direct responses from participants of URI's internship programs, we also reviewed URI internal monitoring data, studied archival video footage of conversations with former interns, and drew from firsthand experience of the URI internship program. By collating data from these various sources and perspectives, we sought to capture the most comprehensive snapshot of URI's programming.

Data Collection and Analysis

Interviews

We conducted semi-structured interviews with current graduate student interns and staff from URI's urban forestry clinical training programs to uncover core competencies and unique learning outcomes. Interview subjects were asked about their professional background and interests as well as how their experiences as URI interns contributed to their professional development as urban foresters or otherwise. Interviewees were also asked to describe the most important skills and experiences they gained during their internship as well as where the program may have fallen short. They chose to either provide in-person interviews or respond to interview questions by email. In total, nine in-person semi-structured interviews were conducted with current students (6), current staff (2), and former staff (1).

Additionally, archival video footage taken in 2009 of interviews with former URI interns was transcribed and included in the interview analysis (Urban Resources Initiative 2009). These interviewees (15 in total) represented professionals from a range of fields related to urban forestry, including academia and research (6), municipal urban forestry and natural resource management (4), nonprofit urban forestry and greening (2), international conservation (1), community development (1), K-12 education (1), and renewable energy (1).

All interviews were analyzed for patterns and overarching themes using an open-coded system (Creswell 2013). Interview responses that referenced particular skills or learning outcomes related to urban forestry were coded according to a corresponding core competency theme, as adapted (with some modifications) from Baumeister (2014). These included 1) Arboriculture, Operations, and Urban Forestry Management; 2) Community Engagement; 3) Environmental

Education and Youth; 4) Environmental Sciences and Urban Ecology; 5) Planning, Design, and Aesthetics; 6) Professional Skills; and 7) Social Forestry.

Survey

After conducting a preliminary analysis of interview responses, we next distributed a wider-reaching, anonymous Internet survey to former URI interns. We sought to confirm emerging patterns regarding the unique learning outcomes that interns were reporting. We also hoped to better understand which skills former URI interns were using most often in their professional careers and identify any opportunities for program improvements.

Respondents were former URI interns who were contacted through an internal email database of program alumni. The survey was administered online via Google Forms. A total of 223 former interns were asked to participate with an initial email and three follow-up emails. Of the original 282 recipient addresses, 69 were rejected due to out-of-date records.

The online questionnaire (see Appendix 1) included a mix of checklist-style and open-ended questions. Respondents were asked to indicate and describe the skills and competencies they had developed as URI interns. They were also asked to identify skills they did not develop as interns as well as to provide feedback on possible areas for program improvement. Open-ended responses were coded by common themes, as described above in the "Interviews" section (Creswell 2013).

Historical Documents: Urban Issues Archives

To further explore and confirm trends in the survey and interview responses, we screened and coded articles in *Urban Issues*, URI's semiannual newsletter, for articles that explicitly referenced student learning outcomes. *Urban Issues* provides a forum for students to write articles reflecting on their internship experiences. We screened these archived issues for articles that explicitly referenced student learning outcomes, and with the resulting 24 newsletter articles, we coded each piece as described above in the "Interviews" section (Creswell 2013). Excerpts from these articles can be found in Appendix 2.

RESULTS

Survey Summary Statistics

In total, 56 URI alumni completed the online survey (25% response rate). Eight respondents had been

community foresters in Baltimore between the summers of 1990 and 1994, and the remaining respondents worked with URI in New Haven between 1995 and 2015. Twelve survey respondents (21.4%) reported they were currently working in fields directly related to forestry and urban forestry. Respondents represented a range of professional fields and identified as working in the following sectors: nonprofit (28.6%), academic/research (21.4%), private (21.4%), public (21.4%), K–12 education (3.6%), and religious clergy (3.6%). Eighty percent of survey respondents reported that they used the skills and competencies they had developed as URI interns in their current professional work, and of the top 10 learning outcomes identified by former interns, all but one fell under the “social dimensions” of urban forestry (Table 2).

Program Strengths in Clinical Education

Teaching Strategies for Community Engagement

Across the board, current and former URI interns report having received robust training in community

engagement. During interviews, interns reported developing both technical and professional skills: the top skill mentioned was “tree planting,” followed by “strategies for community engagement” and “working as a team” (Table 3). The anonymous survey revealed similar results, reinforcing the focus on community engagement as an important learning outcome of all URI internship programs. When asked in open-ended format to describe the most significant learning outcome from their URI internship experience, one-third of survey respondents referred to learning “strategies for community engagement” (Table 4). Similarly, when respondents were asked to identify the skills they had developed as URI interns that had turned out to be particularly important in their subsequent careers, community engagement was the most commonly referenced skill (Table 4).

Differences Between Community Greenspace and GreenSkills

Interviews also revealed that URI’s two field-based internship programs emphasize skill-building in different focus areas. GreenSkills interns reported

Table 2. Top 10 skills and competencies acquired by interns while participating in one or more of Urban Resources Initiative’s (URI) field training programs, as identified by survey respondents (a). Top 10 skills and competencies designated as deficient or missing from URI’s field training programs, as identified by survey respondents (b).

a. Program strengths: skill/competency	Theme	Survey respondents
Working as Part of a Team	Professional Skills	75%
Community Engagement	Community Engagement	68%
Project Management	Professional Skills	63%
Working with Diverse and/or Marginalized Communities	Community Engagement	61%
Social and Community Forestry	Social Forestry	61%
Working Independently	Professional Skills	59%
Collaborative Planning	Planning, Design, and Aesthetics	57%
Social/Political Ecology	Environmental Sciences and Urban Ecology	55%
Team Leadership	Professional Skills	52%
Tree Planting	Arboriculture, Operations, and Urban Forest Management	48%
b. Program weaknesses: skill/competency	Theme	Survey respondents
Tree Diseases and Pest Management	Arboriculture, Operations, and Urban Forest Management	27%
Anti-Racism and Environmental Justice	Social Forestry	23%
Spatial Analysis (GIS)	Planning, Design, Aesthetics	21%
Urban Park Silviculture	Arboriculture, Operations, and Urban Forest Management	18%
Conflict Facilitation	Community Engagement	18%
Ecosystem Resiliency	Environmental Sciences and Urban Ecology	18%
Urban Forestry Master Planning	Planning, Design, and Aesthetics	18%
Biophysical Science Methods	Environmental Sciences and Urban Ecology	16%
Budget Planning	Planning, Design, and Aesthetics	16%
Integration of Research and Management	Professional Skills	16%

Table 3. Skills and competencies acquired by interns while participating in the Urban Resources Initiative’s field training programs, as identified and coded from semi-structured interviews. All skills and competencies listed in this table were identified by at least 2 interviewees and are ranked in order of prevalence in interviews, from highest to lowest. Skills/competencies marked with a (*) were identified by different interviewees as both a program strength and a program deficiency.

	Community Greenspace	GreenSkills	Shared
Strengths	Collaborative Planning Techniques	Supervising	Community Engagement
	Project Management	Use of Arboriculture/Landscaping Equipment	Working as Part of a Team
	Invasive Species Control	Youth Mentorship	Best Management Practices
	Conflict Facilitation/Resolution	Communicating Tree-Care and Stewardship Best Practices to Neighborhood Residents	Tree Planting
	Volunteer Management	Pruning	Troubleshooting and Adaptability
	Engaging City Government Agencies	Tree Surveys, Inventory, Measurement*	Working with Diverse and/or Marginalized Communities
	Anti-Racism and Environmental Justice		
Deficiencies		Tree Surveys, Inventory, Measurement*	Native Plant Communities and Tree ID
		Urban Park Silviculture	
		Team Leadership	

Table 4. Open-form survey responses to the following questions (all skills and competencies listed in this table were identified by at least 2 survey respondents)

Question 1: Are there any skills/competencies that you think the Urban Resources Initiative (URI) did a particularly good job in helping you develop? If so, which ones? (Top 10)

Question 2: Are there any skills/competencies that you gained as a URI intern that have been particularly helpful for you in your career since? If so, which ones? (Top 10)

Question 3: Of the skills/competencies missing from your URI internship experience, are there any that have proven to be particularly important for you in your career since? If so, which ones?

Question 1	Question 2	Question 3
Community Engagement (32%)	Community Engagement (25%)	Other (7%)
Landscape Design (7%)	Other (13%)	Anti-Racism and Environmental Justice (5%)
Working with Diverse and/or Marginalized Communities (7%)	Project Management (11%)	Budget Planning (4%)
Environmental Education Curriculum Implementation (7%)	Working as Part of a Team (11%)	
Project Management (7%)	Engaging Municipal Government Departments (9%)	
Working as Part of a Team (7%)	Working with Diverse and/or Marginalized Communities (7%)	
Tree Planting (5%)	Environmental Education Curriculum Implementation (7%)	
Engaging Municipal Government Departments (5%)	Urban Forestry Best Management Practices (5%)	
Team Leadership (5%)	Collaborative Planning (5%)	
Other (5%)	Monitoring and Evaluation (5%)	

developing more skills directly related to arboriculture, operations, and urban forest management, whereas Community Greenspace interns emphasized becoming more proficient in project management, collaborative planning techniques, and volunteer management (Table 3). A review of *Urban Issues*, URI's semi-annual newsletter, tells a similar story. When describing the areas of greatest learning and growth experienced by URI Community Greenspace interns, the top five skills students and staff write about are: "community engagement," "tree planting," "social and community forestry techniques," "environmental restoration," and "working with diverse and/or marginalized communities." When writing about the GreenSkills program, newsletter authors focused on learning outcomes related to "tree planting," "youth mentorship," "supervising," "tree inventory," and "pruning" (Appendix 2).

Opportunities for Program Improvement in Clinical Education

In general, interviewees and survey respondents were less likely to identify deficiencies in URI's internship programs than they were to identify strengths (Tables 2, 3, and 4). The only two areas for program improvement referenced by more than one participant in the open-ended portion of the survey cited opportunities for more explicit anti-racism and environmental justice training as well as support with program budget planning (Table 4). Across all methods of inquiry, the most commonly reported learning outcome gaps identified by interns were, in order of frequency of mention, "anti-racism and environmental justice," "disease and pest management," "spatial analysis (GIS)," "budget planning," and "tree identification" (Tables 2, 3, and 4).

DISCUSSION

As urban areas grow and expand, so too will the need to manage the trees and green spaces within them (Colding and Barthel 2013; Andersson et al. 2014). These urban green spaces are increasingly being recognized as unique components of a landscape where aspects of the biophysical and social environment are closely intertwined (Andresen and Johnson 1982; Pickett et al. 2001; Pickett et al. 2016). As such, effective urban land management extends beyond technical skills and requires that urban land and forest resource managers specifically also be skilled in communication (Konijnendijk 2000), conflict management (Randrup

and Konijnendijk 2004), and community engagement—especially with diverse communities (Konijnendijk 2000; Vogt et al. 2016). These are skills most readily acquired through hands-on clinical training programs, but few programs exist for students in higher education (Newman et al. 2007). We therefore propose two models housed within the Urban Resources Initiative (URI) at Yale University as examples of university programs that provide training in both the technical and social aspects of urban forestry. Results from our mixed methods approach confirm that alumni left their URI experience armed with a range of technical skills and social competencies. We attribute the success of URI's programming in large part to its social forestry roots, its long-term investment in the city of New Haven, and its use of two distinct programs to develop unique skill sets for interns.

While experience in community engagement is cited as frequently lacking in urban forestry education programs (Andresen and Williams 1975; Deneke 1978; Andresen and Johnson 1982), participants in URI's GreenSkills and Greenspace programs consistently ranked it as one of most significant learning outcomes from their internship experiences (Tables 2, 4). While it may seem surprising that community engagement and related skills such as problem-solving and working as a team ranked above skills related to actual tree planting and care (Table 2), this result speaks to URI's overarching philosophy that trees serve more as a vehicle to engage with the community than the main focus of their programs. Emphasis instead is placed on "social learning" (Burch and Grove 1993; Schusler et al. 2003) and builds on principles from social and community forestry that rely heavily on the incorporation of both local and technical knowledge as a way of overcoming environmental challenges (Kellert et al. 2000). In the Greenspace and GreenSkills programs, interns are trained to integrate their technical knowledge and skill sets with local knowledge and understanding from New Haven residents to inform species selection for street trees or to direct park restoration projects. This exchange of knowledge is paramount to the success of the program, as it recognizes that decisions about what species of tree to plant are as much cultural decisions as they are ecological ones (Johnston 1985).

By working closely with the community, interns hone their community engagement skills while also gaining experience in problem-solving and effective

communication. “Community” in urban and nonurban settings rarely refers to a singular homogenous unit. Rather, individual communities more often reflect diverse perspectives, priorities, and values (Flint et al. 2008). This diversity sharpens interns’ problem-solving skills as they manage the expectations of people with different interests and perspectives, especially in the case of Community Greenspace interns who must work closely with local residents and government officials to restore shared spaces. This two-way learning experience is only possible through close communication between the interns and community members. Effective communication is critical in managing rural forestry projects (Bachelard 1994; Farley et al. 2009) and arguably even more important in urban areas (Konijnendijk 2000), but is cited as a common deficiency among job applicants for urban forestry positions (Day 2018). Thus, by routinely engaging in two-way learning, interns have the opportunity to develop effective communication skills before entering the workforce.

Theoretical papers have made a strong case for the application of social forestry in urban settings (Johnston 1985; Coles and Bussey 2000). However, relatively few urban forestry programs actually make this link. One of the reasons that URI is so well-suited to address this gap is because of its long-standing involvement in the city of New Haven. Unlike other programs that rely on internships across organizations and geographies (Southern University A & M 2019; University of Wisconsin 2019; Virginia Tech 2019), URI has built credibility and trust with its partners in New Haven. This local investment allows interns to work closely with neighborhood leaders and government officials to whom they otherwise might not have access. It’s through this type of “place-based” learning that interns also become more adept at thinking within a system perspective that recognizes humans as nested within ecosystems (Andresen and Williams 1975; Coles and Bussey 2000; Tidball and Krasny 2010). This idea is embedded in what Tidball and Krasny have dubbed “civic ecology education,” a framework that recognizes the role that sense of place, social capital, and adaptive capacity can play in overcoming challenging environmental issues (Krasny et al. 2009; Krasny and Tidball 2012). This framework has particular applications for university students, who are transient, typically only living in a location for 2 to 4 years. By providing the institutional investment in a specific location, URI benefits

interns by offering them the opportunity to work within an established framework for the mutual benefit of both their own education and community goals (Burch and Grove 1993). This framework also allows URI and the university at large to reap the benefits of sustained student involvement in the establishing, restoring, maintaining and monitoring of New Haven’s green spaces, while continuing to advance URI’s program.

While community engagement is the cornerstone of both GreenSkills and Greenspace internships, these two internships are distinct from one another in ways that develop and address different competencies for interns. These differences were identified in alumni responses, with interns identifying a different set of key skills depending on whether they participated in the GreenSkills or Greenspace program. Community Greenspace interns are trained to be facilitators and community organizers, and past interns emphasized becoming more proficient in project management, community engagement, and general professional skills. Learning community-organization skills at the university level has been empirically linked to professional developmental outcomes in forestry and other related environmental fields (Kuh 2009; Bragg and Tappe 2015). As a nod to these benefits, curriculums in architecture, urban planning, and rural forestry have built such training and learning experiences into their programs (Forsyth et al. 2000; Farley et al. 2009). By way of running community-oriented field experiences for their students, higher education institutions have cultivated long-standing university-community partnerships (Cherry and Shefner 2004). The Pratt Institute in Brooklyn, NY, for example, houses the Pratt Center for Community Development. Founded in 1963, the Pratt Center for Community Development started as a way to connect graduate students in urban planning with local community organizations to help them navigate planning processes impacting their communities. The Center continues to help students bridge a critical gap between theory and practice as they work closely with local grassroots organizations to provide mapping, architecture, and planning resources (Pratt Center for Community Development 2019). The link between theory and practice is just as critical to effective urban forest management, yet we find few urban forestry programs that offer the same breadth and depth of experience as the Community Greenspace program at URI.

In contrast to Community Greenspace, URI's GreenSkills serves as a job-skills training program rather than a community volunteer initiative. As such, there is a stronger focus on job-site efficiency and the development of best practices for citywide urban forest management. GreenSkills interns reported developing more skills directly related to arboriculture, operations and logistics, and urban forest management. This can be attributed in large part to the fact that the GreenSkills program has been designated New Haven's sole-source contractor for all street tree plantings (Walsh 2013). As a result, interns are exposed to the full range of urban forestry operations activities with all the pressures of a professional urban forester. This type of "problem-based learning" has been touted in a variety of fields—including forestry—as a means of promoting real-life problem-solving skills as well as technical skills (Schmidt 1983; Barrows 1994; Brown 2003).

URI's programming represents a critical stepping-stone in training future urban forestry professionals. However, this study also demonstrates that URI—as well as other educational institutions, nonprofits, and public agencies—has an opportunity to adapt and better address persistent challenges in the field, particularly around issues of equity, racism, and environmental justice (Boone 2008; Landry and Chakraborty 2009; Boone and Fragkias 2012; Nesbitt et al. 2018; Carmichael and McDonough 2019). The environmental justice field provides lessons for how urban forestry institutions can improve their programs. The tactics to achieve these environmental justice goals include promoting equitable distribution of environmental amenities such as trees and other green infrastructure (Landry and Chakraborty 2009), emphasizing participatory decision-making processes (Nesbitt et al. 2018, Carmichael and McDonough 2019), recognizing and elevating voices from marginalized communities (Nesbitt et al. 2018, Carmichael and McDonough 2019), and achieving diverse representation among faculty, staff, and student cohorts (Taylor et al. 2018, Taylor et al. 2019). Structured to be responsive to community-identified priorities, URI has laid important groundwork in each of these areas and will continue to improve its internship programs by enhancing its structured curriculum, including learning materials and practices that more directly and explicitly incorporate environmental justice training and practice.

URI interns would also benefit from understanding *existing* organizational practices through an environmental justice framework. These existing practices include URI's paid green jobs training for local youth and for adults with a history of incarceration, a request-based tree planting model that honors residents' input, outreach activities that prioritize tree planting in low-canopy, low-income neighborhoods, and long-term investment and trust-building with grassroots groups and community partners. Applying an environmental justice framework to URI's programs would complement the underlying democratic and social forestry-based approach to natural resource management that URI practices and models for its student interns.

Finally, by developing strong, long-term ties to residents, community partners, and city officials, URI not only enhances the student learning experience but also ensures that clinical training programs can contribute meaningfully to community development and build upon the effort of each season's work to create lasting positive change on the ground. Urban forestry is, after all, not only about the health of trees and forests, but also—perhaps even more so—about the health and vibrancy of the neighborhoods in which they grow.

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Résumé. La pruche du Canada (*Tsuga canadensis* [L.] Carrière) est une composante importante de l'écosystème riverain. En raison de la présence largement répandue du puceron lanigère de la pruche (*Adelges tsugae* Annand) (PLP) dans l'aire de répartition de la pruche du Canada, les arbres des forêts peuvent être infestés pendant de longues périodes (années), ce qui entraîne leur déclin. Un insecticide systémique néonicotinoïde, l'imidaclopride, peut constituer une stratégie utilisée dans un contexte forestier afin de gérer PLP en attendant que des solutions à plus long terme soit développées, telle la lutte biologique. Les symptômes d'une infestation prolongée incluent le dépérissement sévère et le feuillage clairsemé. Pour cette recherche, des arbres d'un diamètre à hauteur de poitrine (DHP) de 24.7 ± 2.7 SD cm en mauvais état, furent traités avec l'imidaclopride. Les arbres furent traités une fois par injection au tronc (IMA-jet) ou par trempage du sol dans la région de Greenbrier du parc national de Great Smoky Mountains, Gatlinburg au Tennessee, États-Unis. Les changements de la croissance des arbres et de la densité PLP ont été mesurés pendant trois années consécutives. Les arbres traités avec l'imidaclopride se sont rétablis tandis que ceux non-traités ont dépéri. Les traitements à l'imidaclopride ont entraîné un pourcentage moyen de croissance sur trois ans nettement supérieur (65,6 % à 71,7 % des pointes) par rapport aux témoins non traités (10,5 % des pointes). Les moyennes triennales de densité de PLP dans les arbres traités à l'imidaclopride (0,10 à 1,09 par cm) étaient également statistiquement différentes de celles des arbres non traités (2,72 par cm). L'activité prolongée des pruches traitées à l'imidaclopride a été attribuée au stockage dans le symplaste (parenchyme des rayons du xylème) et à la rétention dans les aiguilles persistantes. Cette recherche a démontré que l'injection troncale avec IMA-jet est efficace contre le PLP et est comparable au trempage du sol pour protéger les arbres à long terme (> 4 ans).

Zusammenfassung. Die kanadische Hemlocktanne (*Tsuga canadensis* [L.] Carrière) ist ein wichtiger Bestandteil des Uferökosystems. Aufgrund der weit verbreiteten Etablierung der Hemlocktannen-Gallenlaus (*Adelges tsugae* Annand) (HWA) im gesamten Verbreitungsgebiet der kanadische Hemlocktanne können Waldbäume über längere Zeiträume (Jahre) befallen werden, was zu ihrem Rückgang führt. Imidacloprid, ein systemisches Neonicotinoid-Insektizid, kann in bewaldeten Gebieten als Strategie zur Bekämpfung von HWA eingesetzt werden, während sich

längerfristige Lösungen wie biologische Schädlingsbekämpfungsmittel etablieren können. Zu den Symptomen eines lang anhaltenden Befalls gehören sich ausdehnendes Absterben und ausgedünnte Baumkronen. In dieser Studie wurden Bäume mit einem Durchmesser in Brusthöhe (DBH) von $24,7 \pm 2,7$ SD cm in schlechtem Zustand mit Imidacloprid behandelt. Die Bäume wurden einmal durch Stamminjektion (IMA-jet) oder durch Bodendurchtränkung im Greenbrier-Gebiet des Great Smoky Mountains National Park, Gatlinburg, TN, USA, behandelt. Änderungen des Baumwachstums und der HWA-Dichte wurden in drei aufeinander folgenden Jahren gemessen. Mit Imidacloprid behandelte Bäume erholten sich, während die unbehandelten Bäume zurückgingen. Imidacloprid-Behandlungen führten zu einem signifikant höheren durchschnittlichen prozentualen Wachstum über drei Jahre (65,6% bis 71,7% der Spitzen) im Vergleich zu den unbehandelten Kontrollen (10,5% der Spitzen). Auch die 3-Jahres-Mittelwerte der HWA-Dichte bei den mit Imidacloprid behandelten Bäumen (0,10 bis 1,09 pro cm) unterschieden sich statistisch gesehen von denen der unbehandelten Bäume (2,72 pro cm). Die verlängerte Aktivität der mit Imidacloprid behandelten Hemlocktannen wurde der Einlagerung im Symplast (Xylem-Strahlenparenchym) und der mehrjährigen Nadelretention zugeschrieben. Diese Studie zeigt, dass die Stamminjektion mit IMA-Jet gegen HWA wirksam ist und vergleichbar mit einer Bodenbegrünung Bäume langfristig (> 4 Jahre) schützt.

Resumen. El tsuga oriental (*Tsuga canadensis* [L.] Carrière) es un componente importante del ecosistema ripario. Debido al establecimiento generalizado del adelgido (*Adelges tsugae* Annand) (HWA) a través del rango de distribución de tsuga oriental, los árboles del bosque pueden ser infestados durante períodos prolongados (años), lo que resulta en su declive. El imidacloprid, un insecticida neonicotinoide sistémico, puede utilizarse como estrategia en entornos forestales para gestionar HWA, mientras que se logran soluciones a largo plazo, como los controles biológicos. Los síntomas de la infestación prolongada incluyen muerte regresiva y copas ralas. En este estudio, los árboles con un diámetro a la altura del pecho (DBH) de $24,7 \pm 2,7$ cm en condición pobre de salud fueron tratados con imidacloprid. Los árboles fueron tratados una vez por inyección de tronco (IMA-jet) o por zanjado del suelo en el área de Greenbrier del Great Smoky Mountains National Park, Gatlinburg, TN, EE. UU. Los cambios en el crecimiento de los árboles y la densidad de HWA se midieron durante 3 años consecutivos. Los árboles tratados con imidacloprid se recuperaron, mientras que los árboles no tratados declinaron. Los tratamientos con imidacloprid dieron como resultado un crecimiento promedio significativamente mayor al 3er año (65,6% a 71,7% de las puntas) en comparación con los controles no tratados (10,5% de las puntas). La densidad de HWA de los árboles tratados con imidacloprid (0.10 a 1.09 por cm) también resultó estadísticamente diferentes a los árboles no tratados (2.72 por cm). La actividad prolongada de imidacloprid se atribuyó al almacenamiento en el simplasto (parénquima de rayos de xilema) y a la retención perenne de la aguja. Este estudio demuestra que la inyección al tronco con IMA-jet es eficaz contra HWA, comparable con el zanjado del suelo para proteger los árboles a largo plazo (> 4 años).

Appendix 1. Anonymous online survey administered to former Urban Resources Initiative (URI) interns in Spring 2018 via Google Forms.

BASIC INFORMATION

First, we'd like to know some basic information about the program, location, and timing of your URI field training experience.

In which field training program(s) at URI have you been involved? Please check all that apply.

- Community Greenspace
- GreenSkills
- Open Spaces and Learning Places
- Other

Which city did you work in as a URI intern? Please check all that apply.

- Baltimore, MD
- New Haven, CT

When were you a URI intern? Please provide your intern season(s).
What is your primary career sector?

- Nonprofit
- Government/Public Sector
- Private
- Academic (Education/Research)
- Further Study
- Other

If employed, what is your current role? If not employed, what type of work were you doing most recently?
Do you use the skills you were introduced to and/or developed as a URI intern in your current professional work?

- Yes
- No

UNIQUE SKILLS, COMPETENCIES, AND EXPERIENCES

We would like to know what unique skills and experiences you gained during your URI field training program as well as the impacts they've had in your career since. By checking the boxes below, please indicate whether you developed skills and/or competencies in the following topic areas during your time as a URI intern. You will also have an opportunity to elaborate at the bottom of the page.

Arboriculture, Operations, and Urban Forest Management

- Tree Planting
- Pruning
- Tree Surveys, Inventories, and Measurement
- Tree Assessment
- "Best Management Practices"
- Use of Arboriculture/Landscaping Equipment
- Tree Diseases and Pest Management
- Urban Park Silviculture and Forest Management
- Job Site Safety
- Invasive Species Control
- Other

Environmental Sciences and Urban Ecology

- Social/Political Ecology
- Environmental Restoration
- Native Plant Communities and Plant Identification
- Urban Wildlife and Habitat
- Ecosystem Resiliency
- Environmental/Public Health
- Biophysical Science Methods
- Social Science Methods
- Other

Social Forestry

- Anti-Racism and Environmental Justice
- Human Ecosystem Model Framework
- Social/Community Forestry Practices
- Other

Planning, Design, and Aesthetics

- Site Assessment
- Collaborative Planning Techniques
- Designing and Managing Tree Planting Schemes
- Urban Forestry Master Planning
- Environmental Aesthetics and Landscape Design
- Spatial Analysis (GIS)
- Budget Planning
- Other

Community Engagement

- Community Engagement Strategies
- Social Competency
- Working with Diverse and/or Marginalized Communities
- Conflict Facilitation/Resolution
- Public Opinion Gathering
- Focus Groups and Visioning Workshops
- Decision-Support Tools
- Neighborhood Canvassing
- Volunteer Management
- Event Planning
- Engaging City Government Agencies
- Engaging Private Sector
- Other

Environmental Education and Youth

- Communicating Benefits of Trees and Urban Greening to Diverse Audiences
- Communicating Tree-Care and Stewardship Practices to Neighborhood Residents
- Environmental Curriculum Development
- Environmental Curriculum Implementation
- Youth Mentorship
- Workshop Facilitation
- Other

Professional Skills

- Supervising
- Team Leadership

- Project Management
- Meeting Facilitation
- Working as Part of a Team
- Working Independently
- Monitoring and Evaluation
- Troubleshooting and Adaptability
- Designing and Implementing Experiments
- Integration of Research and Management
- Other

Of the skills and competencies that you indicated, are there any that you think URI did a particularly good job in helping you develop? If yes, please briefly elaborate.

Of the skills and competencies that you indicated, are there any that have been particularly important to you in your career since? If yes, please briefly elaborate.

MISSING SKILLS, COMPETENCIES, AND EXPERIENCES

Now we would like to know where you think URI has opportunities to improve its field training programs. Are there unique skills and experiences you wish you had acquired during your URI field training program but did not receive? Are there competencies for urban and community resource management professionals that you think URI could incorporate into its field training programs? In the boxes below, please indicate these particular topic areas. You will also have an opportunity to elaborate at the bottom of the page.

Arboriculture, Operations, and Urban Forest Management

- Tree Planting
- Pruning
- Tree Surveys, Inventories, and Measurement
- Tree Assessment
- “Best Management Practices”
- Use of Arboriculture/Landscaping Equipment
- Tree Diseases and Pest Management
- Urban Park Silviculture and Forest Management
- Job Site Safety
- Invasive Species Control
- Other

Environmental Sciences and Urban Ecology

- Social/Political Ecology
- Environmental Restoration
- Native Plant Communities and Plant Identification
- Urban Wildlife and Habitat
- Ecosystem Resiliency
- Environmental/Public Health
- Biophysical Science Methods
- Social Science Methods
- Other

Social Forestry

- Anti-Racism and Environmental Justice
- Human Ecosystem Model Framework
- Social/Community Forestry Practices
- Other

Planning, Design, and Aesthetics

- Site Assessment
- Collaborative Planning Techniques
- Designing and Managing Tree Planting Schemes
- Urban Forestry Master Planning
- Environmental Aesthetics and Landscape Design
- Spatial Analysis (GIS)
- Budget Planning
- Other

Community Engagement

- Community Engagement Strategies
- Social Competency
- Working with Diverse and/or Marginalized Communities
- Conflict Facilitation/Resolution
- Public Opinion Gathering
- Focus Groups and Visioning Workshops
- Decision-Support Tools
- Neighborhood Canvassing
- Volunteer Management
- Event Planning
- Engaging City Government Agencies
- Engaging Private Sector
- Other

Environmental Education and Youth

- Communicating Benefits of Trees and Urban Greening to Diverse Audiences
- Communicating Tree-Care and Stewardship Practices to Neighborhood Residents
- Environmental Curriculum Development
- Environmental Curriculum Implementation
- Youth Mentorship
- Workshop Facilitation
- Other

Professional Skills

- Supervising
- Team Leadership
- Project Management
- Meeting Facilitation
- Working as Part of a Team
- Working Independently
- Monitoring and Evaluation
- Troubleshooting and Adaptability
- Designing and Implementing Experiments
- Integration of Research and Management
- Other

Of the skills and competencies that URI did not adequately provide, are there any that have proven to be particularly important to you in your career? If yes, please briefly elaborate:

Do you have unique skill sets related to urban natural resource management that you would be interested in sharing with F&ES students and URI interns? If so, include a brief description below:

Final Thoughts: Is there anything else you would like to share about your experience as a URI intern?

Appendix 2. *Urban Issues*: relevant excerpts. *Urban Issues* is URI's semiannual newsletter and its archives provide a record of URI's program history as well as documentation of student reflections from their urban forestry internships. Twenty-four *Urban Issues* articles published between fall 2001 and fall 2017 explicitly report on student learning outcomes. A selection of relevant excerpts is reprinted below.

COMMUNITY GREENSPACE

“The ‘tool box’ of participatory appraisal techniques is as important to any URI intern as a shovel and root ball carrier. Before any shovels hit the dirt and any ball carriers are loaded with trees, we first reach for the participatory toolbox to help create a neighborhood vision and explore the community groups’ goals for the season.” (The Reality of Participatory Tools: A Look at Transects. Magee 2001)

Core Competencies: Social and Community Forestry, Community Engagement

“After this first effort, a much larger and more comprehensive group formed around a watershed plan for West River. This collection of people came together to air their desires and dreams for the watershed, including increased connectivity and access, improved habitat, and supplementary educational materials and opportunities.... For several weeks members from this coalition joined Stacy and me in planting wetland shrubs for erosion control, beautification, nesting habitat, and phragmites control.” (Bringing Federal and Local Resources Together for Birds. Johansen 2013)

Core Competencies: Environmental Restoration, Collaborative Planning, Urban Wildlife and Habitat

“As an urban forester this summer, planting trees and perennials was the easiest part of my job, while the challenging but most rewarding aspect of urban forestry was figuring out how to make URI's Greenspace Program meaningful to the diverse communities of New Haven.” (Recognizing the Socioeconomic Context of Greening. Moran-Cahusac 2005)

Core Competencies: Tree Planting, Working with Diverse and/or Marginalized Communities

GREENSKILLS

“Each autumn and spring, students from the Yale School of Forestry and Environmental Studies partner with crews of New Haven youth to plant trees and develop and maintain green-spaces. The physical work is immediate and rewarding. However, URI designed the program around goals loftier than beautification. As much as the program is about healthy growth in plants, it is about healthy growth in people.” (Growth: Places and People. Walsh 2009)

Core Competencies: Tree Planting, Youth Mentorship

“The roles of, and positions available to, Yale interns have undergone significant changes since the program's launch a decade ago. For example, interns who have multiple seasons of GreenSkills experience and would like to take on a larger management role can apply for a “field coordinator” position.... Furthermore, Yale students can participate in expanded urban forestry work in support of the GreenSkills program, such as updating the New Haven street-tree inventory and pruning young trees planted by URI. These projects provide a deeper understanding of the full range of urban-forestry operations, and enable Yale students to develop and strengthen specific technical skill sets.” (GreenSkills Turns Ten. Viens 2017)

Core Competencies: Project Management, Supervising, Inventory, Pruning, Tree Planting