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Commentary

COMMENTARY

Pre-college urban ecology research mentoring: promoting broader participation in the field of ecology for an urban future

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Abstract

The field of ecology is poised to substantially contribute to the creation of a socially and environmentally equitable urban future. To realize this contribution, the field of ecology must create strategies that ensure inclusion of underrepresented minorities so that a broad array of experiences and ideas collectively address challenges inherent to a sustainable urban future. Despite efforts to recruit and retain underrepresented racial minorities (URM) in the sciences, graduation rates have only slightly increased over the last several decades. While research mentoring programs at the undergraduate level do increase retention of URM already majoring in the sciences, influences that develop before college may inhibit URM from electing to study the sciences or pursue ecology-related careers in the first place. To increase diversity in the field of ecology, it is, therefore, critical to reach students *before* they make decisions about college. Compared with the country as a whole, cities larger than 400 000 tend to have K-12 public school populations that are more racially diverse. In cities, place-based learning—where students are engaged as participant learners in local community and environmental issues—has been successfully used for out-of-school urban environmental education programming to foster pro-environmental attitudes, foster science identity and teach scientific knowledge. Utilizing a near-peer, relational mentoring model, we argue that pre-college urban ecology research mentoring provides a place-based, authentic research experience that strengthens URM science identity and intent to pursue ecology-related majors.

Key words: diversity, place-based, urban ecology, mentoring, education, STEM

Introduction

As humans concentrate in urban areas (United Nations 2010) and other pressing global challenges such as climate change and natural disasters threaten environmental quality and human well-being (Reid et al. 2005), the field of ecology is poised to substantially contribute to creating urban areas that are equitable, safe and resilient ecosystems (Schewenius, McPhearson, and Elmqvist 2014; McDonnell and MacGregor-Fors 2016). For example, ecological theory can help to guide research priorities that inform policy and planning decisions in urban areas

(Felson, Bradford, and Terway 2013; McPhearson et al. 2016; Pickett et al. 2016). However, in order to comprehensively address the broad array of problems that arise in complex urban socio-ecological systems, the field of ecology must broaden participation and create purposeful strategies aimed at the inclusion of groups that are historically underrepresented in the field of ecology, and the sciences, more broadly (Berkowitz, Nilon, and Hollweg 2003; Intemann 2009; Krasny and Tidball 2009; Tidball and Krasny 2010). Despite the value that diversity brings to the field, membership in the Ecological Society of America (ESA) is noticeably homogeneous (Pickett 2003; Armstrong et al. 2007).

To address the underinvolvement of underrepresented minorities in the sciences and related disciplines, broadening participation has been an objective of the National Science Foundation (NSF) since the passage of the Science and Engineering Equal Opportunity Act of 1980. Increasing the participation of underrepresented minorities in the sciences is, first and foremost, morally just in a democratic society (Ravitch 1990). Additionally, Intemann (2009) argues that broader participation of underrepresented minorities in the sciences increases the capacity of the scientific community in three ways: raising the profile of social justice issues, strengthening the objectivity of the scientific community and creating the most talented workforce (CEOSE 2013). While NSF defines underrepresented minorities as African Americans, Hispanics, Native Americans (American Indians, Alaska Natives, Native Hawaiians and other Pacific Islanders), women and persons with disabilities, these groups each face unique challenges. In this article, we have elected to focus on underrepresented racial minorities (URM)—African Americans, Hispanics and Native Americans (American Indians, Alaska Natives, Native Hawaiians and other Pacific Islanders).

In this article, we offer a new model that combines three critical components—a pre-college audience, urban ecology and near-peer, relational research mentoring—to broaden participation in the field of ecology. We first discuss how each of the key components of our strategy can contribute to broadening participation. Then, we present a short case study of our NSF-funded Project TRUE (Teens Researching Urban Ecology) program as an example of how this combined model can be implemented to increase URM interest in science and ecology-related majors and careers.

Why pre-college?

Research mentoring programs, such as Research Experiences for Undergraduates (REU), are a widely adopted strategy for increasing the graduation rates of URM already pursuing science degrees in college (Gregerman et al. 1998; Summers and Hrabowski 2006; Armstrong et al. 2007); however, the number of science bachelor's degrees awarded to URM has increased by just 4.6 percentage points (17.1–21.7%) between 2004 and 2014 (US DOE 2016). While this increase is encouraging, URM made up 42.3% of the public K-12 student population in 2014, but only 32.2% of the total undergraduate enrollment, 21.6% of bachelor's degrees, and 21.6% of science bachelor's degrees. In contrast, in 2014 whites made up 49.5% of the public K-12 student population, 55.4% of total undergraduate enrollment, 61.5% of bachelor's degree and 58.1% of science bachelor's degrees (US DOE 2016). Clearly, a disparity exists between whites and URM in the pursuit of a science bachelor's degrees. REU programs encourage persistence during college, and previous research has typically focused on strategies that promote science majors and retention once students enter college (Pender et al. 2010). However, interventions that support science career interest and identity may be even more important *before* college, when students begin exploring specific careers (Rask 2010; Wai et al. 2010; Maltese and Tai 2011; CEOSE 2017).

Research suggests that the choice to pursue science degrees in college often begins in high school and can be influenced by course selection (Maltese and Tai 2011; Lichtenberger and George-Jackson 2012; Bottia et al. 2015). In the United States, high school graduation requirements vary by state and course offerings within a state vary among schools. For example, affluent neighborhoods and districts, and private or specialized schools may offer an array of advanced placement classes that poorer schools or districts, which often have a higher proportion of URM, may not be able to offer. In addition to experiences in high school that can help put students on a path to future science learning, out-of-school experiences can also have significant impacts on science learning, motivation, attitudes and identity (Hull and Schultz 2001; Braund and Reiss 2006; Eshach 2007; NRC 2009).

Family, friends, teachers and media exert considerable influence on students' decisions (Gregerman et al. 1998; Cooper, Denner, and Lopez 1999; Bright et al. 2005). However, family, friends and teachers may not have enough understanding of the wide range of STEM fields to support high school students in exploring STEM career pathways (Hall et al. 2011). Nonetheless, families sometimes pressure students to avoid an ecology major (Armstrong et al. 2007) either because of a lack of understanding of ecology-related careers or because parents want their children to pursue a more traditional career path, such as law or medicine.

Internalized perceptions at the individual level, including a positive or negative sense of science identity and belonging may also play an important role in deciding to pursue a science degree (Zaniewski and Reinholz 2016). For example, undergraduate and graduate URM often do not see themselves as scientists or as part of the scientific community (Estrada-Hollenbeck et al. 2011; Hazari, Sadler, and Sonnert 2013), and many URM report feelings of marginalization and isolation (Cookson and Persell 1991; Nora and Cabrera 1996), otherness (Johnsrud and Sadao 1998), and imposter syndrome (Ewing et al. 1996) in predominantly white settings. This is further supported by studies since the 1950s that have consistently shown that people tend to perceive a scientist as an old, white male chemist (Wyss, Heulskamp, and Siebert 2012)—an image that may not resonate with young URM as they decide their academic and career paths.

Clearly, barriers develop before college and persist throughout the academic pathway (Cook and Córdova 2007), suggesting that interventions designed to mitigate negative consequences of these factors at all major educational steps—not just in college—are warranted (Flowers et al. 2016; Murray, Obare, and Hageman 2016). For example, Wyss, Heulskamp, and Siebert (2012) recommend exposing students to role models and science careers early on in their schooling to re-shape their perceptions about scientists and science careers, before decisions need to be made about college and career.

Why urban ecology?

In general, cities with populations greater than 400 000 are more racially diverse compared with the country as a whole (United States Census Bureau 2012). For example, African American and Latinx individuals made up 68.1% of the New

York City (NYC) K-12 public school population in 2014, but only 42.3% of the national K-12 public school population (US DOE 2016; NYC DOE 2017). By creating training and mentoring experiences embedded in the diverse communities of cities, the field of ecology may be able to broaden participation in the sciences by creating pathways for URM toward science and ecology-related careers. To create such programs, it is useful to recall the origin of ecology.

Stemming from the Greek word *oikos*, meaning ‘home’ or ‘place to live’, the underpinnings of ecology are rooted in the study of place. Even before ecology was defined as a science, Darwin spent decades conducting experiments in the backyard of his country home to understand the natural world (Costa 2017). Similarly, place-based learning is widely used to engage students as participant learners in local community and environmental issues, and often uses hands-on and open-ended learning methodologies (Smith 2002, 2007; Sobel 2004) that are inherently similar to research inquiry. Compared with traditional in-school learning, these methods stimulate student interest and allow students to take ownership of their learning (Powers 2004; Monk et al. 2014). While, out-of-school, place-based education programs in cities can take many forms (Russ 2015), in this article we focus on the value of conducting place-based research in urban socio-ecological systems (Middendorf and Nilon 2005).

For example, pre-college students investigating the ecology of an urban area might hypothesize that the amount of human activity affects species composition of an urban park. To address this question, a student must design an appropriate experiment that takes into account spatial and temporal variation; identify appropriate sampling methodologies; plan for potential confounding factors; analyze data; and interpret those data in the context of an urban socio-ecological system that is influenced by ecological processes (e.g. competition) and social processes (e.g. economics, politics and urban planning). As a result, this kind of research could contribute to an increase in ‘ecological literacy’ (Berkowitz, Ford, and Brewer 2005), which is defined by three key dimensions: knowledge of key ecological systems, understanding the nature of ecological science and how it interfaces with society, and ecological thinking skills.

Place-based urban ecology research experiences also expose pre-college students to parks and natural spaces that they might not have sought out otherwise and can influence the symbolic meaning students ascribe to the urban ecosystem (Kudryavtsev, Stedman, and Krasny 2012; Russ et al. 2015). Exposure to nature in cities (a common component of place-based urban environmental education) is associated with positive attitudes toward nature that can last from months (Awasthy, Popovic, and Linklater 2012) to years (Nancy and Kristi 2006). These attitudes may then lead to a student’s involvement in pro-environmental community organizing, activism or an environmental career, ultimately resulting in positive changes to ecological processes in urban areas (Krasny and Tidball 2009; Tidball and Krasny 2010). While utilizing urban ecology research experiences to encourage URM to pursue science majors and careers is the focus of this article, many URM will invariably choose alternate career pathways. Nonetheless, as more people grow-up and reside in cities, it is critical that the general public is ecologically literate and appreciates nature so that there is broad-based support for government actions aimed at ecosystem and biodiversity conservation (Miller 2005; Reid et al. 2005; Louv 2008; Jordan et al. 2009; McBride et al. 2013; Soga and Gaston 2016).

In summary, urban ecology research experiences allow pre-college URM to be active participants in place-based scientific investigations. Such experiences may help to mitigate factors that limit interest in the sciences by fostering a positive attitude toward science. Moreover, exposure to natural areas in cities may strengthen URM connection to nature and strengthen their understanding of, and ability to contribute to solving, pressing socio-ecological issues, regardless of their career trajectory.

Why mentoring?

The positive effect of mentoring on URM academic and career trajectories in science fields is well documented (Gregerman et al. 1998; Daley, Wingard, and Reznik 2006; Summers and Hrabowski 2006; Beech et al. 2013; Shanahan et al. 2015). For example, URM who are part of a formalized mentoring program are more likely to graduate with a science degree than those who are not part of a mentoring program (Summers and Hrabowski 2006). Moreover, there have been calls from within the ESA membership to create URM mentoring programs at all academic levels, including pre-college (Torres and Bingham 2008); however, evidence indicates that URM typically receive less mentoring than non-URM peers (Beech et al. 2013).

College faculty often serve as research mentors, but may be poorly positioned to mentor pre-college URM because of lack of training, time-constraints and a large gap between their ages, maturity, diversity profiles and professional experience levels. Near-peer mentoring—pairing mentors and mentees that are closer in discipline-specific developmental level (e.g. a pre-college student with an undergraduate student)—can be used to facilitate increased learning for the mentee (Tenenbaum et al. 2014; Aikens et al. 2016). Near-peer mentors can draw on experiences that hindered their own learning at the mentees’ level and, therefore, they may be better able to effectively mentor (Santora, Mason, and Sheahan 2013). For example, near-peer mentors reported becoming ‘caring friends’ while helping mentees develop a stronger sense of science identity and belonging, both of which correlate with retention in the sciences (Zaniewski and Reinholz 2016). Additionally, mentees may be better able to imagine their own career trajectory if they understand the immediate next step in their career process as modeled by their near-peer mentor.

While near-peer mentoring may help to foster more meaningful relationships with pre-college students, URM face additional challenges that hinder the development of a strong mentoring relationship. Implicit bias [unconscious beliefs about others (Greenwald and Krieger 2006)] by mentors coupled with stereotype threat [an internalized risk of confirming a negative stereotype about one’s social or racial group (Byars-Winston 2014)] can undermine the positive effects of mentoring. For example, many URM report feelings of marginalization and isolation (Cookson and Persell 1991; Nora and Cabrera 1996), and otherness (Johnsrud and Sadao 1998) in predominantly white settings. Moreover, the traditional hierarchical, one-directional view of mentoring, where an older, more experienced individual mentors a younger, less experienced mentee, could reinforce these negative feelings. In contrast, relational mentoring—a bi-directional view of mentoring where mentor and mentee are in an interdependent and generative developmental relationship that promotes mutual growth, learning and development (Fletcher and Ragins 2007)—helps promote perceptions of equal status between mentor and mentee, which may lower stereotype threat (Baysu et al. 2016).

We argue that these two types of mentoring—near-peer and relational—are particularly useful for engaging pre-college URM. While undergraduate near-peer mentors may not have

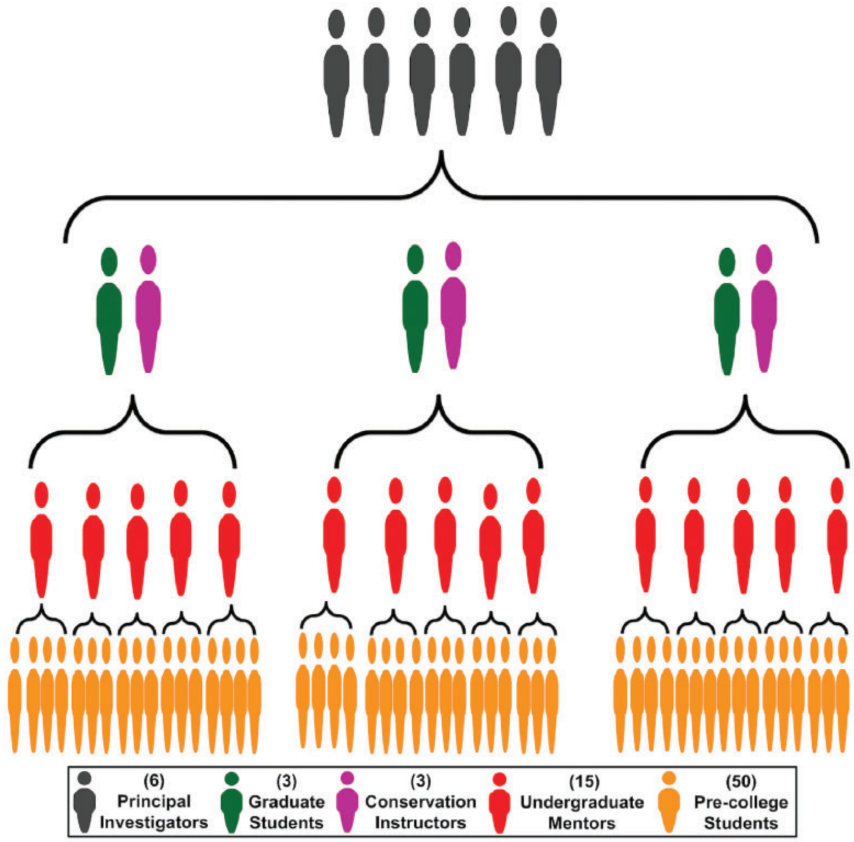

Figure 1: Project TRUE structural model outlining the grouping of near-peer mentors at three distinct research facilities in New York City

the same level of disciplinary-specific knowledge and mentoring experience as faculty mentors, these factors are outweighed by their ability to serve as a more relatable role model for pre-college students. Additionally, evidence-based mentoring training programs can help undergraduate students become more effective mentors (Pfund et al. 2006, 2016) and reduce implicit bias (Carnes et al. 2012).

Project TRUE: utilizing near-peer research mentoring in an urban environment

In this article, we described the importance of pre-college interventions and the potential utility of urban ecology and near-peer, relational research mentoring to broaden participation in the field of ecology and the sciences, more broadly. We now present a brief case study of an existing pre-college urban ecology research mentoring program and provide evidence to support the positive effects of such a program. Funded by NSF as a collaborative program between the Wildlife Conservation Society (WCS) and Fordham University, Project TRUE (Teens Researching Urban Ecology) is an urban ecology summer research mentoring program in NYC aimed at URM entering their final year of high school. Project TRUE recruits students from NYC, and the application process involves short essay questions, a one-on-one and group interview, and a recommendation form. Over the last 3 years, 142 students have participated in Project TRUE representing 75 schools, 23% English as second language, 71% female, 42% Hispanic or Latino, 25% African American, 25% Asian, 6% White and 2% American Indians/Alaska Natives or Native Hawaiians/Pacific Islanders.

Near-peer, relational research mentoring model

In Project TRUE, small groups of high school students are paired with a Fordham University undergraduate student, who serves as a near-peer research mentor. Two more levels in the Project TRUE mentoring model provide additional support (Fig. 1). First, Fordham graduate students and WCS conservation educators (hereafter referred to as 'project leaders') serve as near-peer mentors for the undergraduates. Second, Fordham University faculty and WCS education administrators (hereafter referred to as 'principal investigators') serve as near-peer mentors to the project leaders (Fig. 1). While designed primarily as a near-peer mentoring model, all participants interact (Fig. 2), demonstrating a range of career steps and creating a mentoring ecosystem. Mentors are trained to recognize the dual role inherent in relational mentoring (Fig. 2) and on the effective strategies to navigate the mentor–mentee relationship such as interpersonal communication, cultural responsiveness, research skills, and psychosocial and career development (Pfund et al. 2016).

Urban ecology research model

Project TRUE research projects follow a guided-inquiry approach (Lewis and Lewis 2005) to give participants ownership over their research. The summer program is split into two parts: a 4-week undergraduate training session during the month of June, and a 7-week research session that includes the pre-college students during July and August. Prior to the summer, principal investigators assign project leaders a broad research topic (Fig. 3; e.g. Does species composition differ between two urban parks?). During the 4-week training session, project

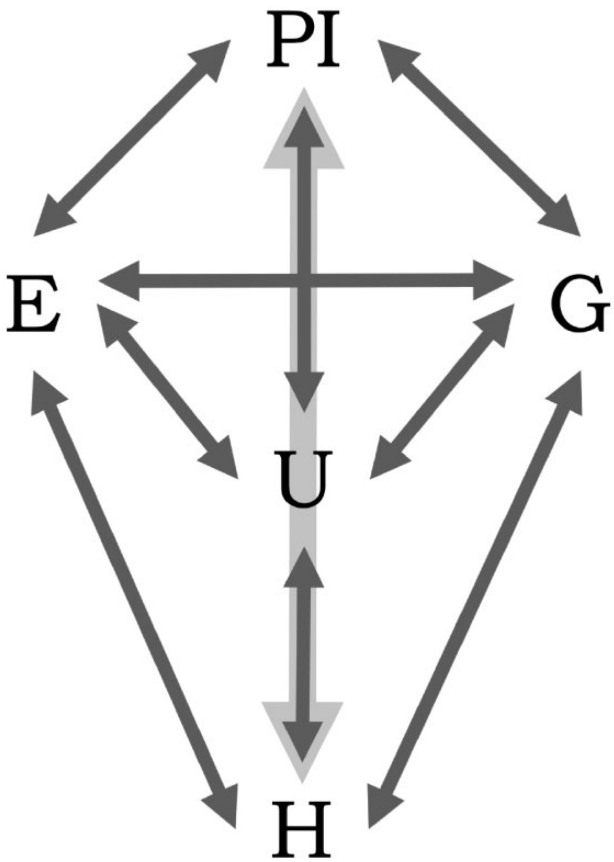

Figure 2: Project TRUE near-peer, relational mentoring model. Arrows represent the bi-directional nature of relational mentoring and the length of the arrows represents the intensity of the mentoring relationship, with shorter lines representing increased primacy of the mentor–mentee relationship in the model. All participants interact with each other, creating a mentoring ecosystem. Principal investigators (PI) primarily mentor conservation educators (E) and graduate students (G) and to a lesser extent undergraduates (U). Pre-college students (H) are primarily mentored by undergraduates with assistance from conservation educators and graduate students. This model is adapted from triad models described by Aikens et al. (2016)

leaders assist each undergraduate in identifying a sub-question nested within the broader research topic assigned to each team (Fig. 3). These sub-questions typically focus on a single taxonomic group (e.g. birds, crustaceans) or ecosystem type (e.g. pond). During this process, project leaders and principal investigators train and mentor undergraduates, with a focus on both research and mentoring skills. Mentoring training uses a modified curriculum originally developed by the National Research Mentoring Network that emphasizes the development of a personalized mentoring philosophy.

In July, pre-college students begin the 7-week summer program. Each undergraduate mentor guides a team of three or four pre-college students in learning more about their specific project topic and then helps the pre-college students develop hypotheses nested within the undergraduate's research question (Fig. 3). Pre-college student research projects tend to focus on the relationship between aspects of urbanization and measures of species composition and ecosystem quality (e.g. the association between light pollution and species diversity or noise level and animal behavior). The undergraduate mentors use a guided-inquiry approach to emphasize the process of science and to help the pre-college students develop research questions, methods and analysis plans. At the completion of the 7-week summer program, each team of pre-college students produces a conference-quality research poster to present at a public symposium.

Short-term and sustained effects of Project TRUE on pre-college students

To study the effects of Project TRUE on pre-college students, an independent research team administered pre- and post-surveys at the beginning and end of the summer program to determine changes, if any, in academic or career intentions. Since 2015, three cohorts of pre-college students have taken part in Project TRUE ($n = 139$) and completed the pre- and post-surveys. Prior to Project TRUE, 96% (134 of 139) of students reported an intention to pursue a science and engineering major or a science and engineering-related major as defined by NSF (National Science Board 2015), yet only 26% (36 of 139) intended to pursue a Project TRUE-related degree (ecology, environmental science, wildlife biology, zoology, botany, marine biology or field research).

Immediately following the completion of Project TRUE, 78% (108 of 139) of respondents indicated a change in academic or career intention. These changes include added interest (e.g. from 'Zoology' to 'Ecology/Environmental Biology/ Zoology'), more focus (e.g. from 'biology and genetics' to 'Ornithology, with genetics'), deeper commitment (e.g. from 'Have not changed at all but I feel more confident in pursuing biology in college') to an existing academic or career intention, or changed intention (e.g. from 'Psychology' to 'Biology and Chemistry'). About 48% (66 of 139) of respondents indicated that they intended to pursue a Project TRUE-related major or career. Of the 66 students that intended to pursue a Project TRUE-related major or career, 31 reported that they had not intended to pursue such a pathway prior to participating in Project TRUE. While a suite of influences can affect career pathways (Gregerman et al. 1998; Cooper, Denner, and Lopez 1999; Bright et al. 2005), these data suggest that Project TRUE honed or expanded pre-college student interest in science and ecology-related majors and careers. Moreover, about 1 in 4 students changed their intention toward the pursuit of a Project TRUE-related major after participating in the program.

In addition to academic and career intent, we used two validated scales, *perception of science and research* (8 items) and *science identity* (9 items), on post-surveys to investigate the extent to which Project TRUE affected participants' perceptions of science and research and science identity (Table 1). On a 7-point Likert Scale (1 = 'not at all', 7 = 'a lot'), respondents reported that Project TRUE had a strong influence on their perceptions of science and research (mean = 6.3) and science identity (mean = 6.1, Table 1). For example, respondents reported a mean influence of 6.6 for 'Participating in Project TRUE has increased my understanding of what researchers in science and conservation jobs actually do' and 6.3 for 'Participating in Project TRUE has increased my confidence in doing science' (Table 1). Similarly, respondents reported a mean influence of 6.4 when asked if 'Project TRUE has helped me feel I have better research skills' and 6.3 for 'Project TRUE has helped me feel I have better science skills'. These results indicate that pre-college students perceived that they gained a broader understanding of possible science and science-related careers, and gained confidence in their abilities to pursue such careers.

Ecological literacy is important for science professionals and an informed citizenry (Berkowitz, Ford, and Brewer 2005; Jordan

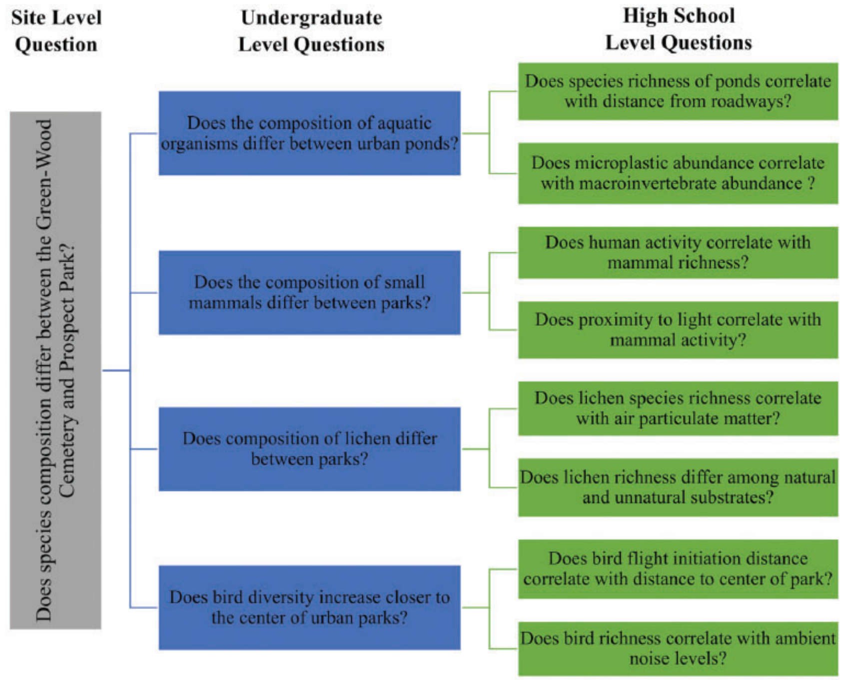

Figure 3: Example of nested research question design for Project TRUE

Table 1: Pre-college student (a) perception of science and research and (b) science identity based on self-reported Likert scale (1 = not at all, 7 = a lot) immediately following participation in Project TRUE

	n	Mean	SD
Perception of science and research (Cronbach's alpha = 0.831)	139	6.3	0.9
Participating in Project TRUE increased my . . .			
Understanding of what researchers in science and conservation jobs actually do	139	6.6	0.9
Understanding what scientific research is	139	6.5	0.9
Knowledge of science	139	6.4	1.1
Confidence in doing science	139	6.3	1.0
Awareness of possible jobs or careers	139	6.3	1.2
Intention to study more science	137	6.1	1.5
Desire to have a career in science or conservation[a]	139	6.0	1.5
Intention to go to college	139	5.7	2.0
Science identity (Cronbach's alpha = 0.919)	139	6.1	1.0
Participating in Project TRUE has helped me feel . . .			
I have better research skills	139	6.4	1.0
I have better science skills	139	6.3	1.0
I want to take care of the environment[a]	138	6.2	1.2
I have a good future ahead of me	139	6.2	1.2
I am part of nature[a]	139	6.1	1.0
Able to accept responsibility	139	6.0	1.3
Willing to take on a leadership role	139	5.9	1.3
Confident to try new things	139	5.8	1.4
More sure of my strengths and weakness are	139	5.6	1.4

[a]Indicates item relating to environmental identity.

Table 2: Mentor quality of near-peer undergraduate mentors reported by pre-college students based on self-reported Likert scale (1 = strongly disagree, 7 = strongly agree) means immediately following participation in Project TRUE

	n	Mean	SD
Mentoring quality (Cronbach's alpha = 0.822)	138	5.9	1.1
When something was bugging me, my mentor listened to me	138	6.0	1.3
My mentor had lots of good ideas about how to solve a problem	138	6.1	1.2
My mentor helped me take my mind off things	138	5.6	1.5

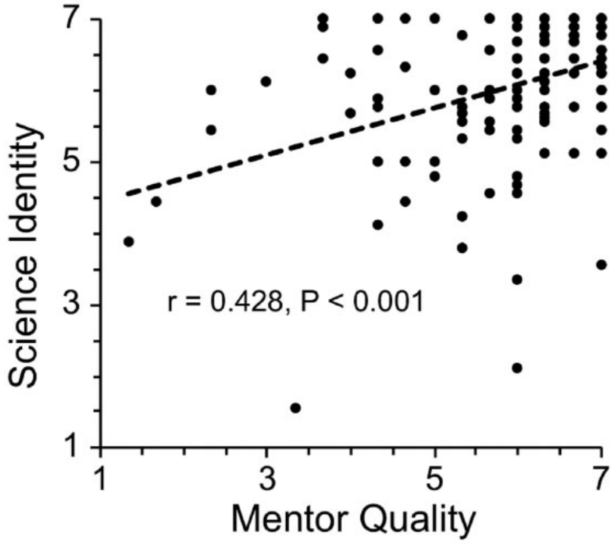

Figure 4: Correlation between mentoring quality and science identity

et al. 2009; McBride et al. 2013) and while we did not explicitly assess it, student research posters were assessed for content using rubrics and reflect an understanding of the dimensions of ecological literacy (posters available at: https://bronxzoo.com/teens/project-true/science, accessed 6 November 2018). However, knowledge and skills may be less important compared with science identity in predicting science career outcomes, especially for URM who face unique challenges in predominately white settings (Cookson and Persell 1991; Nora and Cabrera 1996; Johnsrud and Sadao 1998). Pathways to a science career can be long and difficult, and a strong sense of science identity can have long-lasting, positive effects on individual resiliency (Catalano et al. 2004).

Pre-college student experiences of Project TRUE are, in part, dependent upon their near-peer undergraduate mentors. On post-surveys, pre-college respondents reported a *mean mentor quality* (3 items; Rhodes et al. 2005) of 5.9 (Table 2), and we observed a positive correlation between student perception of mentor quality and science identity (Fig. 4). This suggests that the mentor relationship may be an important mediator of short-term effects on science identity in pre-college research mentoring programs. These effects could be sustained if mentors continue to play a role in the pre-college students' career trajectory, as mentors often do. It was, for example, encouraging that on post-surveys, 91% of pre-college student respondents ($n = 95$, cohorts 2016 and 2017 only) reported an intention to maintain contact with a Project TRUE mentor.

Respondents also reported strong effects of Project TRUE on environmental identity-related items such as 'Project TRUE helped me feel I want to help take care of the environment' (mean = 6.2) and 'Project TRUE helped me feel I am part of nature' (mean = 6.1). While pro-environmental attitudes are influenced by a suite of factors (Gifford and Nilsson 2014), these results suggest that spending time conducting ecological research in urban parks and natural spaces can influence pro-environmental attitudes. This may be particularly important for combating 'the extinction of experience' for people who grow-up in urban areas (Schuttler et al. 2018) or for in individuals who end-up pursuing careers in nonenvironmental related fields.

In summary, these initial findings suggest that Project TRUE's use of a pre-college urban ecology research mentoring program has a positive impact on participants' science-related career intentions, identity and perceptions of science and nature. These data will be incorporated into subsequent analyses of data that are collected from yearly follow-up surveys aimed at providing greater detail on the sustained effects of Project TRUE on career trajectory.

Conclusion

Broadening participation is critical for developing a socially just, objective and talented community of scientists and ecologists that will be able to address pressing global challenges in an urban future. Pathways to science-related careers begin long before college and are often built by meaningful experiences and exposure to role models that shape identity over time. We assert that purposeful interventions that create pathways to science careers for URM *before college* are essential for broadening participation. Pre-college urban ecology research mentoring programs may be a particularly inclusive and meaningful intervention in cities because they provide students with place-based and relational experiences that strengthen science identity and interest in science careers at a key decision point in their academic and career trajectory.

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Data acceptability

The data in this manuscript are available through Harvard Dataverse (https://dataverse.harvard.edu).

Conflict of interest statement. None declared.

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