



Ecology in Urban Spaces: Contributions of Urban Green Spaces to Ecological and Community Health

Yelena Janumyan, Zachary C. Conley, Heidi Carlone, Hannah Hayeon Ziegler, Tessaly Jen, Liwei Zhang & Jingyi Chen

To cite this article: Yelena Janumyan, Zachary C. Conley, Heidi Carlone, Hannah Hayeon Ziegler, Tessaly Jen, Liwei Zhang & Jingyi Chen (2024) Ecology in Urban Spaces: Contributions of Urban Green Spaces to Ecological and Community Health, Science Scope, 47:4, 48-55, DOI: [10.1080/08872376.2024.2363109](https://doi.org/10.1080/08872376.2024.2363109)

To link to this article: <https://doi.org/10.1080/08872376.2024.2363109>



View supplementary material [↗](#)



Published online: 11 Jul 2024.



Submit your article to this journal [↗](#)



Article views: 141



View related articles [↗](#)



View Crossmark data [↗](#)



Ecology in Urban Spaces:

Contributions of Urban Green Spaces to Ecological and Community Health

BY YELENA JANUMYAN, ZACHARY C. CONLEY, HEIDI CARLONE, HANNAH HAYEON ZIEGLER,
TESSALY JEN, LIWEI ZHANG, AND JINGYI CHEN

ABSTRACT

Our program seeks to introduce middle school students to a range of STEM topics and careers. We planned and enacted a five-lesson unit themed around the contributions of trees/green spaces to ecological and community health. Humans thrive in ecologically healthy communities; however, not all communities have access to healthy ecosystems. Students were introduced to basic ecology tools and concepts, investigated urban parks to make ecological and sociological observations, and analyzed and interpreted the data for shared patterns of interest. The centerpieces of this unit were field work in parks where we followed a question-driven, observational study with scientific investigations into the effect of tree canopy on surface temperature, followed by independent student research to create final products allowing students to blend creativity, technology, and their newly acquired ecological understanding toward making a lasting impact.

KEYWORDS: Urban Ecology; Environmental Justice; Middle School Science Education; Urban Green Spaces; Tree Canopy Cover; Urban Heat Islands; CIIA Framework

Urban schools are uniquely situated to examine the interplay between urban ecology and environmental justice. These schools, and the homes of their students, are located in areas where nature and civilization are intertwined—parks, backyards, or other pockets of nature surrounded by the urban landscape. Simply glancing out the classroom window can spur conversations about who has access to green spaces and the interconnected social and economic equity (Learning in Places Collaborative 2021). This article discusses an urban ecology unit that aims to teach middle school students about ecology and environmental justice by studying tree canopy and urban heat islands in their schoolyard and in nearby parks (Stroupe and Carlone 2022). In this unit, students practiced developing scientific questions based on observations; planning and carrying out scientific investigations; analyzing and interpreting data, as well as constructing explanations based on the data; and communicating their learning. This unit, however, did not address a singular research question; instead, we focused on smaller collective assignments, which developed the aforementioned practices and were connected by a larger overarching theme: the contribution of urban green spaces to ecological and community health.

The unit was built around the CIIA (Connect, Investigate, Interrogate, Act) framework we developed

(Figure 1) to ensure cohesive and coherent lesson sequences, pique student interest in relevant science concepts, and practice critical discussion of fairness issues surrounding access to trees. This framework included (1) developing an emotional connection to urban green spaces through their relation to oneself, one another, the city, and local ecosystems (Connect); (2) scientifically investigating the effects of green spaces on surface temperature to understand and communicate accurate information (Investigate); (3) closely analyzing how urban green spaces' accessibility issues and their solutions are distributed across different communities and demographics (Interrogate); and (4) advocating for equitable access to urban green spaces through action that focused on story-making, place-making, and other forms of scientific communication (Act). The CIIA framework as we enacted it required students to understand the urban tree canopy from the lens of an urban ecologist and an environmental sociologist.

We enacted the unit in collaboration with a pullout STEM enrichment program housed in a university, with local urban middle school students in grades seven and eight. Middle school students arrived on the university campus once per week from three different middle schools and worked with us for three hours before returning to school. Our unit was designed as a five-lesson series (15 classroom hours including the field trip) themed around the contributions of urban green spaces to ecological and community health

FIGURE 1: The CIIA curricular design framework.

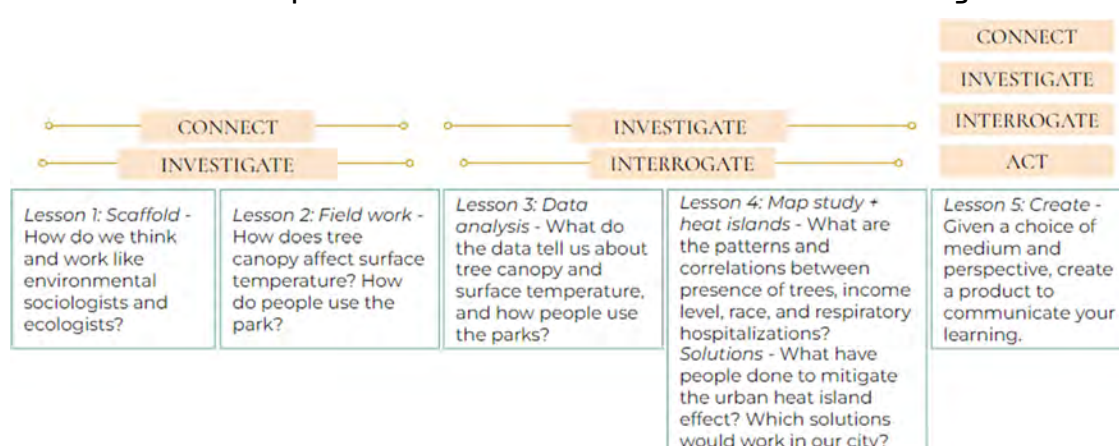


(Figure 2). The unit was designed to expand students' understanding of science, scientific practices, and where science learning occurs. Too often, students' experiences in school science focus on laboratory-based science. Stroupe and Carlone (2022) argued that field science can encourage wonder, disrupt typical knowledge production hierarchies, and reframe scientific knowledge production as a community endeavor.

Lesson 1: Bridging science and justice in urban environments (Connect & Investigate)

The first lesson focused on helping students connect with place, gauging student knowledge of ecology and sociology, and presenting potential career options. Students went to the schoolyard to explore and make

FIGURE 2: Lesson sequence and connections to the CIIA curricular design framework.



observations (see “Handout to guide students’ schoolyard investigations in Lesson 1” in [Supplemental Materials](#)). Instructors directed students to think like an ecologist and a sociologist when making observations: “What should we look at?” “How should we measure?” and “What inferences can we draw?” Students shared their thoughts in terms of Notice and Wonder statements, generating questions about what they observed—such as the amount and variety of tree species, the insects and animals that make homes in the trees, and the percentage of tree canopy cover in the schoolyard. After recording students’ observations and questions on the whiteboard, we guided students to modify their initial observations into testable questions that could be investigated. For example, the observation that “the mulch pile is warm” developed into “What chemical process is causing a temperature increase in the mulch pile?” We presented ecology tools, including thermometer guns, measuring tape, tree canopy coverage grids, and local tree identification field guides for students to use to investigate their questions. Images of the tools in use and demonstrations were used to support English language learners when collecting data to answer the investigative questions.

Using tools and making observations, students worked in small groups to answer questions concerning trees in the schoolyard, such as, “How many different species of trees are present?” and “Is tree circumference related to tree species?” By the end of this lesson, students were able to form scientific questions and testable hypotheses from field observations. In addition, the temperature guns and canopy cover measuring tools guided students to develop the question: “Does the amount of tree canopy cover affect surface temperature?” We prompted students to use this question to design the experiment that was carried out in Lesson 2, which provided an opportunity to assess students’ understanding of testable questions and experimental design.

Lesson 2: Field work in local public parks (Connect & Investigate)

The second week, we took each class to a different urban public park within the city. Students connected with the environments they would be

studying, while also investigating them for both ecological and sociological data to be analyzed in subsequent weeks. Students knew about the trip several weeks prior, and a secondary permission slip was signed by parents or guardians. For safety purposes, we required sunblock, water bottles, closed-toe shoes, and clothing that could get dirty. Instructors provided a first-aid kit and backup water bottles and sunblock. To ensure students were never alone, we used a buddy system. The parks contained hiking trails, unprocessed forests (a forest that developed over time without human interference), and creek areas, allowing flexibility for students with any physical limitations. While students were encouraged to step outside their comfort zones, they were given freedom to decide how deeply they wished to explore their surroundings and were not required to venture into all areas of the park.

We chose the parks on the basis of the potential for students to surface environmental assets and injustices. For example, park A has unrestricted access and off-trail access to a creek that students explored with glee, while park B is located near a quarry and next to a juvenile detention facility but also has open spaces and off-trail access to a creek. Park C has beautiful, curved paths that include a bridge overlooking a creek. However, thousands of plastic bags, takeout containers, and utensils litter the creek at Park C due to a regional flood that unleashed plastics from a nearby restaurant supply warehouse, which stopped cleaning up debris after their insurance reached the cap on the policy used to pay for cleanup efforts.

We began with a group activity of silent reflection, during which we encouraged students to just be present in the space—to observe, listen, and wonder. Together, we read Emily Dickinson’s poem “Nature is What We See” to cultivate another way to see, understand, and connect to place (Sobel 2005). After allowing students to ask questions about the poem, we sent them to find a semi-isolated location within sight of adults where they sat for five minutes of silence and reflected on what they could sense (Stapleton and Lynch 2021). In an effort to connect students to surrounding nature, we provided them with notebooks to sketch or write in as a way to connect them to surrounding nature.

After the initial reflection, the lesson was divided into sociological and ecological investigations (see “Handouts for students’ notebooks that accompany Lesson 2 during field work” in [Supplemental Materials](#)). We divided students into two groups that swapped activities after roughly 45 min. We found that students worked well in pairs or small groups of about two to four students with supervision and with specific goals to accomplish. Following completion of these goals, students responded positively to being given agency to either sit and reflect on the site or undergo supervised exploration of areas not yet visited. The ecological study at each park focused on investigating the park from the perspective of an urban ecologist who studies human and nature interactions in urban green spaces. We took a group of students to a selected spot on the nature trail, where students explored land, water, and plant features. Following a brief safety and instructional discussion, the students carried out the experiment planned in Lesson 1. They used temperature guns and tree canopy coverage grids ([Figure 3](#)) to identify five different sites where the tree canopy was fully, partially, or not at all covering the ground. At each site, students measured and recorded the percentage of tree canopy coverage and corresponding ground temperature. We also encouraged students to use field guides for tree identification. The second study was focused on the sociological perspective. In areas with clear signs of human impact, such as garbage, picnic tables, and physical modifications of the environment, students interviewed park-goers. Students used an interview protocol (see “Handouts for students’ notebooks that accompany Lesson 2 during field work” in [Supplemental Materials](#)) to ask questions of people visiting the park to better understand the social and cultural connections with community members who use the park. The questions included asking people why they were at the park, how often they visited, what they enjoyed, and what they would change. To further investigate like environmental sociologists, students made observations about the park’s features and inferences about how humans benefit from and impact the land and water, how the area has changed over time, and what kinds of features might improve the park in the future. Following the collection of the sociological data, students answered the following questions:

FIGURE 3: Student using a transparency with a 10 cm × 10 cm grid to estimate the percentage of tree canopy coverage.



Who is this land for/not for?
 Who is allowed/not allowed on this land?
 Who might/might not feel comfortable on this land and why?
 Who might benefit from this land most/least?
 Where might people gather (to eat, play sports)?
 How might people have changed this area over time?
 How do people take care of this park?
 How might you make this park better?

Students also collected soundscape and audio data on their phones in different locations as another form of comparative data for analysis in Lesson 3.

Lesson 3: Data analysis [Investigate & Interrogate]

In the third week’s lesson, students continued their investigation into the relationship between tree canopy cover and surface temperature, and analyzed the data collected by four different classes across the

three different parks during Lesson 2. In this lesson, we prompted students to look at data from multiple perspectives—that is, from the perspective of animals that live in the park, nearby residents, and temporary visitors to the park—to make the park more inclusive and/or attractive. In other words, they used the data to investigate trends and interrogate the meanings of those trends for community and ecological health. This analysis included making predictions and generating linear correlations between surface temperature and tree canopy percentage and making inferences about the relationships they found across park data. Using instructor-provided guiding questions (see “Directions and questions for each station and instructor’s guide” in [Supplemental Materials](#)), students analyzed sociological data gathered at each site (including notes, photos, and soundscape/audio data) and supplemented with internet reviews, satellite map images, and local news articles. We challenged students to consider similarities and differences of each park location, as well as develop definitions of a healthy community. Reviewing data from each park (see “Five-star reviews to help students summarize their analyses” in [Supplemental Materials](#)), students

generated their own park reviews, focusing on their perspectives of the socioecological health of each community.

By the end of the lesson, students reached conclusions about the connection between tree canopy and surface temperature, as well as the connection between community health and availability of green spaces. While future iterations of this work may include deeper scientific analyses of data, we accomplished a primary goal of helping students understand how data collected in the field is followed up by interpretation in the classroom. We note that we were able to gather and share data from three field visits, something which may be cost-prohibitive for most classrooms. Visiting different sites with multiple classes is not required for this lesson, as ecological and sociological data from a single site is sufficient for the next steps and can be supplemented by students’ online research of other locations if necessary.

Lesson 4: Map study (Investigate & Interrogate)

The fourth lesson expanded the conclusions from the third week into the larger urban environment,

FIGURE 4: Pathways to guide students’ final product creation.

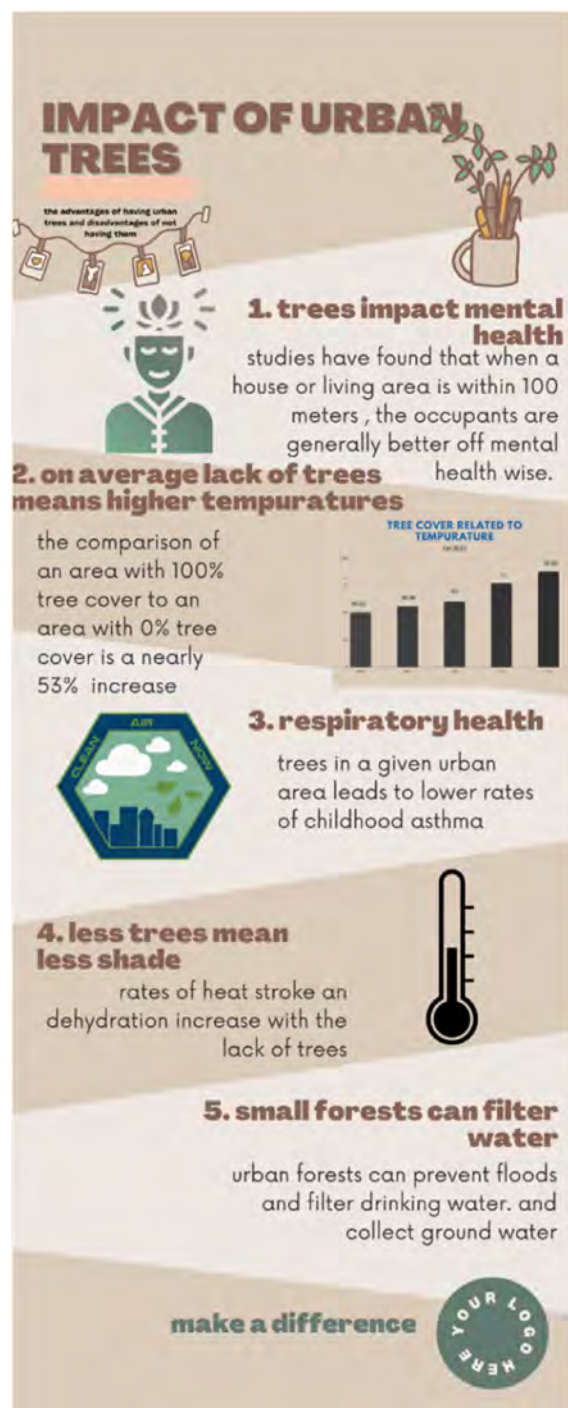
Pathway	Connect	Investigate	Interrogate	Act
Guiding Question	How can you persuade others through storytelling?	How can you explain the problem to others with a scientific argument?	How does urban heat island and tree canopy affect different communities differently?	How can we inspire others to take action through storytelling?
Product Options	• Video • Podcast/Soundscape • Pixton Comic • Poem • Artwork with voice narration • You choose—be creative!	• Canva infographic • Video/remixed video production • Podcast • Pixton Comic • Scientific model on paper with voice narration • You choose—be creative!	• Infographic or poster • Podcast • Comics/Graphic • Pixton Comic • Video/Movie • You choose—be creative!	• Public Service Announcement • Canva Flyer/Brochure • “How to” Video about Engineering/Urban Planning • Pixton Comic • Scripted Play (Must be video recorded) • You choose—be creative!
Criteria	Choose a specific perspective of a living being or thing affected by a urban tree canopy and heat island issue. Connect to the emotions of the perspective you take to persuade others. Try to make your audience empathize. Include at least 3 pieces of evidence to support how the perspective you’ve taken has been affected by the issue. Consider how you can show your audience rather than just telling them the story through creative description and details. Think about how you can creatively use visuals, music, sound effects, acting, text and/or voice in effective ways to make your story entertaining and persuasive.	Choose a specific problem related to urban tree canopy and heat island. Explain what the problem is and why it is important to pay attention to. Try to make your audience think logically. Include at least 5 pieces of data to support your argument or explanation. Consider how you can present to your audience in an interactive way rather than just listing the facts. Think about how you can creatively use visuals, charts, models, text, sound effects, and/or voice in effective ways to make your delivery engaging and persuasive.	Choose a story in which lack of tree canopy or urban heat island has affected a specific community. Tell their story and explain the problem the community is facing. Use at least 3 pieces of data to tell the story and support your explanation. Consider how to present the story in a way the audience will understand. Think about how to emotionally engage the audience through storytelling.	Your audience should be able to fully understand and become emotionally invested in the problem you choose. Provide one solution with a thorough explanation of how and why it works for your problem. Be creative in your solution as well as your final product. Include at least 3 pieces of evidence that support your solution. Your solution should consider: Affordability, Maintenance, Appropriateness, Understandability, Practicality, and Endurance. Include one small action that your audience can take immediately in their everyday lives to improve the environment/community. Think about how you can creatively use visuals, sound, text and movement in effective ways to make your project entertaining and persuasive.

interrogating its impact in our community. Students were provided with a map of the larger metropolitan area, with the location of the parks in question highlighted. Additional maps printed on transparencies represented: tree canopy coverage, average temperature, incidence rates of lung disease hospitalization, income, and race. Students first investigated the relationship between tree canopy and temperature to build on their conclusions from the previous week. While students did not have to directly connect their quantitative data from previous weeks with the information on the map, they were encouraged to remember the general themes of how tree canopy contributes to urban heat and community health. Afterward, students were allowed to form their own questions and conclusions based on the provided demographic data. Most students spent some time identifying their own neighborhoods on the maps, as well as looking at the accessibility to tree coverage. Several students compared the availability of tree canopy across either economic or racial diversity. Following the map study, students had the opportunity to engage in the science and engineering practices of obtaining, evaluating, and communicating information by comparing and contrasting four different solutions for dealing with urban heat (tiny urban forests, green roofs, cool roofs, and vertical farming), and they discussed ways to deal with green space inequality.

Lesson 5: Product creation

During the final week of the unit, students were given the opportunity to act on something they had learned that inspired them related to the importance of trees for community and environmental health. Instructors discussed different ways to reach an audience based on the educational perspectives used in the lesson itself (Figure 4). These methods included emotional appeal (connect), logical appeal (investigate), ethical appeal (interrogate), and problem solving (act). In groups, the students were encouraged to discuss the issues presented in the past four weeks using one of these appeals and a format of their choice. Since the topic for the final product was relatively open, some students needed to perform additional research to generate evidence for their claims. As students created their work, they were asked the following

FIGURE 5: Sample of students' final products.



prompting questions: “Who is your audience?,” “What issue are you discussing?,” and “How will you connect the audience with your issue?” Future iterations of this lesson should include a more rigorous feedback/improvement process for these final

products, which was not done due to time constraints. A potential rubric for improvement of these final products can be found in [Supplemental Materials](#) (see “Rubric for evaluating student work”). Student-created products included comics, podcasts, stop motion videos, and posters, among other creative outlets. See [Figure 5](#) for an example.

Conclusion

Our unit aimed to teach students about ecology and environmental sociology in an urban setting. By using the green spaces around their schools and in nearby parks, students learned about the interplay between urban ecology and environmental justice in their own backyard. By implementing creative final products, we provided students agency for sharing their own conclusions about this experience. We emphasized connections between students and place while providing students with opportunities to develop scientific questions; to implement scientific investigations; to analyze and interpret their data; and finally, to communicate their learning.

There are several areas where this unit can be enhanced to provide the optimal experience for students in a formal education setting. As a pilot study, there was a certain disconnect between gathering data from the urban green space, interpreting the data, and carrying it through to the final project. While the flexibility provided to the students for their final products is ideal for their motivation, future scaffolding may encourage them to better utilize the data and research that they have gathered from previous weeks. A period of feedback will also allow teachers to increase the depth of the information presented in the products. There is also a need to further balance the sociological interrogation with the research investigation when expanding the gathered data to larger issues. This pilot does,

however, demonstrate a way to bridge place-based learning, inquiry-driven lessons, and creative output. Overall, this unit empowered students to ask questions and develop new ideas for improving the health of their own community. •

FUNDING

This material is based upon work supported by the National Science Foundation under Grant #2241814. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author[s] and do not necessarily reflect the views of the National Science Foundation.

SUPPLEMENTAL MATERIALS

- Handout to guide students’ schoolyard investigations in Lesson 1.
- Handouts for students’ notebooks that accompany Lesson 2 during field work.
- Directions and questions for each station and instructor’s guide.
- Five-star reviews to help students summarize their analyses. Rubric for evaluating student work.
- Supplementary data for this article can be accessed online at <https://10.1080/08872376.2024.2363109>

REFERENCES

- Learning in Places Collaborative. 2021. *Framework Nature—Culture Relations*. Bothell, WA and Evanston, IL: Learning in Places. <https://tinyurl.com/mryjd3ua>.
- Sobel, D. 2005. *Place-Based Education: Connecting Classrooms & Communities*. 2nd ed. Great Barrington, MA: Orion Society.
- Stapleton, S. R., and K. Lynch. 2021. “Fostering Relationships Between Elementary Students and the More-than-Human World Using Movement and Stillness.” *The Journal of Environmental Education* 52 [4]: 272–289. <https://doi.org/10.1080/00958964.2021.1955650>.
- Stroupe, D., and H. B. Carlone. 2022. “Leaving the Laboratory: Using Field Science to Disrupt and Expand Historically Enduring Narratives of Science Teaching and Learning.” *Science & Education* 31 [4]: 893–921. <https://doi.org/10.1007/s11191-021-00296-x>.

© 2024 National Science Teaching Association

Yelena Janumyan [yelena.j.doe@vanderbilt.edu] is an instructor and **Zachary C. Conley** is an instructor, both with the Collaborative for STEM Education and Outreach [CSEO] at Vanderbilt University in Nashville, Tennessee. **Heidi Carlone** is the Katherine Johnson Chair of Science Education, **Hannah Hayeon Ziegler** is a graduate student, **Tessaly Jen** is a graduate student, **Liwei Zhang** is a graduate student, and **Jingyi Chen** is a graduate student, all in the Department of Teaching and Learning at Vanderbilt University Peabody College in Nashville, Tennessee.