

A Place Based Climate Change Exploration for Middle School

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Abstract

Climate change is the undeniable fact impacting future generations of humans. While political leaders debate how to respond to the consequences of this looming crisis, younger generations will bear the brunt of climate impacts. It is paramount that students master the language of climate literacy in order to participate in the conversation. This curricular unit is designed for use in middle school classrooms and seeks to teach students about climate change by looking at consequences and solutions at a local level in Philadelphia, Pennsylvania. It begins by connecting students in the urban environment to the natural world and questioning whether those two worlds are really, in fact, separate. Students will then visit local sites to gain a greater sense of the geography of the city, assessing places which may already be impacted by climate change. Students will receive a “basics” lesson on the science of climate change to familiarize them with the language of climate change and will explore some of the work of contemporary teen climate activists. This unit ends by developing a sense of agency in students and fostering hope that activism and changes at the local level can create a new narrative for a changing planet.

Prospectus

Polar bears are the poster child of climate change. Beautiful, sleek and attractively furry and white, it is easy to feel pain in their plight: death by loss of habitat. The planet is warming, the ice at the poles is melting, the polar bears might not make it. But bears on thin ice also make us, here in a temperate climate on the east coast of the United States, feel like climate change is happening elsewhere, not to us. In this curriculum unit, students will learn that climate change is truly a *global* phenomenon, and Philadelphia is by no means exempt.

Henry C. Lea School is located on the corner of 47th Street and Locust Street in West Philadelphia and provides an education for students from Kindergarten through 8th grade. Many students live within walking distance of the school, though many also commute from surrounding Philadelphia neighborhoods. The immediate neighborhood is mainly residential with single-family homes, apartment buildings, schools, and small businesses. Streets are lined with trees, and there are small pocket-parks close to the school, which has a sizeable schoolyard and community park. However, the Lea School neighborhood is a decidedly urban environment with paved surfaces, sidewalks, grids of

roads, public transportation, parking lots, retail, and commercial businesses, traffic lights, streetlights and lots and lots of cars. Lea School students think of themselves as city dwellers.

Lea students are diverse. Classes includes students whose families have arrived in the United States in the last generation from Sudan, Democratic Republic of Congo, Dominican Republic, Mauritania, Ivory Coast, Bangladesh, Saudi Arabia and Senegal. There are also many students whose families have lived in Philadelphia or other East Coast locales for generations. The School District of Philadelphia reports that fully 100% of Lea's students are "economically disadvantaged." Many Lea students are significantly behind academically as measured on standardized tests. Last year 38% of Lea students reached the level of "*proficient*" on the Pennsylvania State System of Assessment in reading, only 21% reached proficiency in mathematics. While the school has been making academic gains for the past several years, there is much work yet to be done. Leaving from the front entrance of the school on Locust Street and turning east, the neighborhood continues to be mostly residential until University of Pennsylvania buildings appear and the campus proper takes over, extending all the way to the banks of the Schuylkill River. The Schuylkill River divides West Philadelphia from Center City where high rise buildings, corporate headquarters, centers for retail commerce, higher end residential real estate and municipal buildings (including City Hall) all compete for real estate space. This most direct route from Lea School to the Schuylkill River is a little over 2 miles.

Philadelphia is defined by its rivers, both geographically and historically. The Schuylkill River has its headwaters in Schuylkill County to the north and west of Philadelphia. The Delaware River begins in New York State, and is at its widest point the eastern border of Philadelphia. Standing at Penn's Landing and looking east, you see Camden, New Jersey. Philadelphia is the last bit of land separating the two rivers before their confluence at the city's southern tip. But the Delaware and Schuylkill Rivers are hard to access in any way that would be meaningful to a child. Where would you enter the river to enjoy it or learn about if you walked over from Lea School? You cannot swim in the rivers: the water is moving too fast, the pollutants not healthy, there is no "beach," almost all of the banks have been hardened, save for a small pocket at Bartram's Garden in the southwest section of the city. Interstate 76 is the immediate neighbor to the Schuylkill River approaching from the west and the banks are steep, retention walls. How would you get a boat out on the river? Can you rent a boat? Would it be safe? How much would it cost? It depends—on money, on the river, and on the weather. These are likely insurmountable questions for Lea School students.

Our city's rivers are also storied, awash with history. But the Schuylkill in particular often just seems like a grey ribbon we have to cross over on the way to or from Center City with little more than a name attached to it. We often know little more than its funny name. When we drive or take the train over our urban rivers it is hard to see that they are alive with a biodiversity attempting to beat the odds of human impact. They *are* surprisingly resilient; since the passage of the Clean Water Act, they have made

great recoveries. In the last two decades, the disconnect between the river and local communities has been somewhat mitigated by the development of the Schuylkill River Trail on the east side of the river, a definite boon for those who want to enjoy being along side the water, but this trail is likely little used by students from Lea.

Several years ago, I was involved in developing lessons about urban watersheds and helping teachers try these lessons in the classroom through Fairmount Water Works *Understanding the Urban Watershed* curriculum. I noticed what a challenge it was to get children connected to their own city and the natural world that exists within the urban context. The idea of nature, as something beyond humans' touch, is increasingly difficult to uphold; and of course it is also very exclusionary. Students need a sustained way to explore the local streams and rivers and more broadly the natural world that squeezes its way into our concrete cityscape. But how should we help students become aware of the larger, geologic, biologic and chemical worlds in which we live? Can students place Philadelphia on a map based on geographic features? Would they be able to say that Philadelphia has two sizeable rivers intertwined through the city and describe the course of those rivers and what lives in them? Are they aware of the park system and the many opportunities to view “nature” and the city comingling? Native and non-native plant species grow relatively well in this lush, urban environment. Do students see these specimens interacting with the urban environment? I am convinced that visceral connections to the natural world of their daily environment will help expand students’ existing day-to-day knowledge of the city and also create a context for them to learn more about environmental issues faced by cities nationally and globally and the solutions cities offer to manage and steward our planet’s natural resources. With that knowledge base, we can begin to discuss the way that climate change is currently impacting the city and what that will look like over the next ten to twenty five years. It is all too easy to view climate change as something that happens elsewhere on the planet, or that will happen at some point in the future. This unit hopes to change that perception for our middle school students and engage them as agents of change in world that is also changing.

Content Objectives

Climate change has become a daily part of a polarized national conversation. According to the American Meteorological Society report: *State of the Climate in 2017*, “the global temperature across land and ocean surfaces ranked as the second or third highest, depending on the dataset, since records began in the mid-to-late 1800s.” (Blunden, Hartfield, Arndt, xvi) But with climate change deniers as vocal as ever (or even more vocal than ever), we must advocate for science and fact to prevail. There is no escaping the importance of understanding about what this “debate” is really about. The 2020 presidential cycle is already in full swing, and climate change (or its denial) will become an issue front and center for the candidates and for the youth of this country. If the consequences of human consumption of fossil fuels are not mitigated within the next 10-20 years, the consequences will be dire with the most vulnerable populations likely to experience the harshest consequences. (Intergovernmental Panel on Climate

Change, 9). But this issue remains abstract for many. The summers seem a bit warmer, the rain falls a bit harder, but life-altering consequences seem like something from a bad disaster movie. Wildfires in California? That's too bad, but it won't happen here in Philadelphia. Dying polar bears in the Arctic? That's too bad, but it won't happen here. How do we help our students to see that climate change is already creating a stress on our urban infrastructure and that Philadelphia is uniquely situated to face floods, disease, and poverty as a result of a changing climate.

Without a doubt, urban students see nature as *other*, as far away and unattainable. They may in equal measures want to experience the outdoors beyond city life but also be afraid of it. When you see nature/wilderness/the environment as *other*, then you surely have little incentive or desire to engage in saving it, protecting it or understanding the issues that are at stake in preserving the planet. When you are an adolescent, what is in front of you is what's important, and we certainly don't teach urban students that they live *in* nature. Nature is something that happens in some other place. William Cronon provides a critical context for this in his influential essay, "The Trouble with Wilderness; or, Getting Back to the Wrong Nature." He details the complex narrative that leads to wilderness being regarded as synonymous with nature and therefore separate from us, as we do not dwell in wilderness any longer. Cronon also theorizes how only some privileged people have access to that nature/wilderness. As it is separate and away from where we live, one has to travel there and spend time and money in order to enjoy it or learn from it. As he states, "Without our quite realizing it, wilderness tends to privilege some parts of nature at the expense of others" (16). If we only ever see nature as distant, far away, perfect and remote, do we have incentive to care for and engineer our response to it? We have controlled our rivers and paved our streets as if nature could be tamed, subdued and put out of mind. What if we rewrote this "natural" narrative and instead taught students that we have a coexistence with nature—we too are natural? If we are to attempt to mitigate damage and also form adequate and elegant solutions to the growing environmental challenges we face on this warming planet, Cronon suggests, "we need to discover a common middle ground in which all of these things, from the city to the wilderness, can somehow be encompassed in the word 'home.' Home, after all, is the place where finally we make our living" (19).

So what is that nature that we live in here in Philadelphia? This unit will begin to expose students to the city in which they live beginning with an exploration of the push/pull of nature and looking at the places we walk by routinely in a new light. Where can we see evidence of nature in our city? How does that impact how we view the city? Can we begin to conceive of cities as multi-species worlds? Broadening the context for the stated definition of nature and of the city, we will explore the Schuylkill River and other locales throughout the city and ask ourselves, is it nature?

Fully immersed in a sea of houses and retail shops, roads and urban infrastructure, can my students begin to see the push-pull of nature? In so many places,

humans have paved over whatever existed prior. Where is nature nonhuman life pushing back through the cracks in the sidewalk, literally and figuratively? I would like to encourage my students to take the time to begin to observe this interface. We can look at parks and planned plantings, and urban spaces, but can we also just see nature creeping back into the city? In a study published in the *Journal of Experiential Education*, authors Williams and James observed 7th and 8th grade students in an outdoor learning setting specifically designed to motivate them about science concepts and develop a sense of wonder about what they were learning. They state: “Adolescents who had, over the years, come to view school-based learning as meaning- less and disengaging were motivated and immersed in this experiential, in-context, field-based learning” (67). Teaching students about the environment while in the classroom will have little benefit if not paired with an actual experience where students can get their hands “dirty.”

The Schuylkill River is a critical landmark separating Center City from West Philadelphia, and I would like my students to be able to explain the following as they stand by the Schuylkill River. They should be able to explain that the flowing in a south easterly direction making its way to meet the Delaware River and that the water continues flowing to the Delaware Bay, forming an estuary with brackish water and then emptying out to the ocean. I want them to understand that the river’s water flows downhill due to gravity and is essentially on a path to the ocean. The Schuylkill River sometimes looks higher or lower depending on when you view it and students should be able to describe a variety of reasons why that occurs. The river changes, but also remains a constant even as our city and its inhabitants change. These understandings literally ground students in their understanding of the city by being tangible, visible, and concrete: giving them bearings within a changing city.

In further developing a sense of place, students must be able to locate Philadelphia within a larger geographical context. Students should be able to name and map ten to twenty key landmarks in the city; some of which might speak to the question of our interaction with nature. A non-exhaustive list might include: the Schuylkill River, the Delaware River, New Jersey, the confluence of the rivers, the relative location of the Delaware Bay, the location of their school, City Hall, the historic district that includes the Liberty Bell, the site of slave trading in Old City, the ports, the stadium, their own neighborhood and relevant local landmarks such as parks and retail establishments. Students should also be able to orient locations on a map relative to north, south, east and west.

And then there is the final big question I would like my students to be able to answer. Why is climate change happening so rapidly and what can be done about it? While the debate rages on in the United States, most other countries treat climate change as fact. To children it can seem desirable to have a warmer climate: life is easier, you can play outside longer, your parents’ heating bills are lower. Students need to think more deeply about what else comes with a warming climate and why their

generation will face the greatest challenge as well as the chance to dramatically alter the outcomes.

Cities are so often seen as forces of environmental degradation only. But of course humans have to live somewhere, and cities concentrate human impacts, sometimes making them less environmentally damaging and offering condensed solutions. I also hope that my students begin to see themselves as actors in a much larger world. As the 2020 election approaches, the present conversation surrounding climate change is likely to amplify. Students should be able to gain entry into that dialogue. They must understand not only how and why climate change is occurring now, but also what climate impacts are likely in the next five, ten and 20 years, either with scenarios of radical carbon reduction or if we fail to take meaningful action to cut our carbon consumption.

Sources

Blunden, J., D. S. Arndt, and G. Hartfield , Eds., 2018: State of the Climate in 2017. *Bull. Amer. Meteor. Soc.*, **99** (8), Si–S310, doi: 10.1175/2018BAMSStateoftheClimate.1.

This report published by the American Meteorological Association, collects scientific data from a stunning number of scientists across the globe. It compiles studies using data and graphs to document climate change. It reads like a report card on the state of climate and atmosphere and is helpful for those looking for well-researched scientific data regarding climate change.

Catalano, Laura and Zwinkl, Kurt (2009). *Along the Schuylkill River*. Arcadia Publishing, Charleston, SC.

This book is contains photographic compilations of the Schuylkill River of Pennsylvania with brief captions about the photos that help construct the history of the river. The book is divided into sections based on areas of the river.

Cronon, William, ed., *Uncommon Ground: Rethinking the Human Place in Nature*, New York: W. W. Norton & Co., 1995, 69-90

Cronon writes about the history of the terms nature and wilderness, and why the development of these terms excludes certain populations and leads to wilderness as being a term of privilege.

James, Joan K. and Williams, Theresa (2017) School-Based Experiential Outdoor Education: A Neglected Necessity. *Journal of Experiential Education*, Volume 40 (1), pages 58-71.

This article chronicles research about the effects of outdoor education on student attitudes towards learning and classroom engagement.

Kephart, Beth (2007). *Flow: The Life and Times of the Schuylkill River*. Temple University Press, Philadelphia.

This book of poetry chronicles the environmental history of the Schuylkill River of Pennsylvania. The author gives a female voice to the river and she describes her own history, degradation, and rejuvenation. Each poem is accompanied by a brief historical explanation of the condition of the river at the time.

Online Resources:

pdesas.org

This site houses Pennsylvania state standards for academics in the public school arena for students in grades Kindergarten through 12th grade. Assessment anchor standards for standardized testing required in 8th grade science are listed below

[https://www.education.pa.gov/Documents/K-12/Assessment and Accountability/PSSA/Assessment Anchors/Grade 8 Science Assessment Anchors.pdf](https://www.education.pa.gov/Documents/K-12/Assessment%20and%20Accountability/PSSA/Assessment%20Anchors/Grade%208%20Science%20Assessment%20Anchors.pdf)

Pennsylvania State System of Assessment released items from standardized tests.

PhillyH2O.org

Compiled and authored by historian Adam Levine, this website contains written narratives and photographs of Philadelphia water systems and sewer systems dating back several hundred years. An excellent resource for anyone interested in drinking water, waste water, and the development of Philadelphia as a municipality.

<https://www.ipcc.ch/sr15/>

IPCC, 2018: Summary for Policymakers. In: *Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty* [Masson-Delmotte, V., P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J.B.R. Matthews, Y. Chen, X. Zhou, M.I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield (eds.)]. In Press.

Intergovernmental Panel on Climate Change published this report, which includes researched predictions and projections for the impacts of a 1.5 degree Celsius increase in temperature above pre-industrial levels.

resourcewater.org

This site is managed by Fairmount Water Works and Philadelphia Water Department. It provides a comprehensive curriculum *Understanding the Urban Watershed* for middle school with emphasis on Philadelphia's unique history and challenges. The content is available free of charge, but users must register for access to content.

Resources to be used with Lesson #8 and Lesson #9:

<https://climate.nasa.gov>

This site maintained by the National Aeronautics and Space Administration contains detailed information about the causes and effects of climate change.

[https://climate.nasa.gov/images-of-change?id=684 - 684-vavilov-ice-cap-glacier-accelerates](https://climate.nasa.gov/images-of-change?id=684-684-vavilov-ice-cap-glacier-accelerates)

Phenomenal before-and-after satellite images published by NASA of sites all over the world affected by climate change.

<https://www.phila.gov/water/sustainability/Pages/ClimateChange.aspx> AND
<https://www.phila.gov/water/sustainability/Documents/StatementClimateChange.pdf>

This website and attached pdf document what the City of Philadelphia believes will be the most significant changes to the city due to climate change. It also lists some of the efforts the city and Philadelphia Water Department are doing to mitigate the effects.

<https://www.npr.org/2019/06/12/730258832/as-polar-ice-cap-recedes-the-u-s-navy-looks-north>

The US Navy is able to navigate vessels further north as a result of climate change, pushing into areas it could not previously go.

<https://www.npr.org/2019/05/05/720041305/at-the-baltimore-aquarium-climate-change-presents-challenges-both-inside-and-out>

The Baltimore Aquarium thought it would release Sea Turtles to enhance their population in the wild, but are now finding that these turtles will face perils once released due to climate change.

<https://news.nationalgeographic.com/2017/12/polar-bear-starving-arctic-sea-ice-melt-climate-change-spd/>

Video footage and accompanying article depicting the last hours of a polar bear likely perishing due to lack of food created by climate change. Details the problem of melting sea ice for polar bears.

Phillywatersheds.org

This website is maintained by the Philadelphia Water Department. It is a vast resource of the many programs/projects sponsored by PWD including Green City Clean Waters, the attempt to mitigate the effects of stormwater runoff.

Resources at the Intersection of Race, Youth, and the Environment

The websites listed below are a sample of what is available and timely as of the publication of this paper. They serve to show students the scope of those involved in the climate change movement internationally. Teachers may want to conduct current research and target local leaders and sites that may be of interest to their students. These serve merely as suggestions to encourage diversity across all demographics.

<https://www.teenvogue.com/story/people-of-color-save-the-environment>

(Teens of color fight climate change.)

<https://nexusmedianews.com/meet-the-new-generation-of-black-climate-leaders-337c9e077abb>

(Biographies of people of color who are dedicated to educate and fight climate change.)

<http://thisiszerohour.org>

(Website profiling teen activists around the United States protesting against climate change.)

<http://think100.info/>

(Hip-Hop Caucus website devoted to educating about climate change. The website contains information about podcasts relating to climate change.)

<https://groundswell.org/celebrating-black-green-history/>

(More information about climate activists from across the country.)

<https://www.phillyurbancreators.org/home-1>

(Philadelphia urban farm initiative)

<https://www.momscleanairforce.org/climate-justice-and-black-history-month/>

(Mothers fight for clean air!)

https://www.ted.com/talks/majora_carter_s_tale_of_urban_renewal?language=en

(Majora Carter, environmental activist, New York City)

<https://www.inquirer.com/opinion/us-youth-climate-strike-philadelphia-march-greta-thunberg-dianne-20190312.html>

(Greta Thunberg and local Philadelphia teen activists)

<https://www.fridaysforfuture.org>

(Greta Thunberg, Teen Activist)

https://www.huffpost.com/entry/women-climate-change-gun-control-alexandria-ocasio-cortez_n_5c7e8434e4b0129e36bee155

(Alexandria Ocasio-Cortez, US House of Representative from New York)

<https://www.nationalgeographic.com/environment/2019/03/youth-climate-strike-kids-save-the-world/>

(Teen activist Greta Thunberg is profiled in this piece from National Geographic. The article describes her rising voice over the issue of climate change and her encouragement of youth world wide through climate activism.)

Strategies

Journal Writing: Students will gain from the chance to make their own observations about the interface of the natural world and the urban world by writing, drawing and diagramming what they see. Journals serve as a reflection piece for students to record, reflect, and explore. They are only graded for completion and attention to detail, but not specific content.

Photography and Captioning: Students are passionate about the digital recording of everything these days. Why not give them the chance to use the device in their hands for educational purposes? Take out your phone and snap and post for your friends to see. Only this time the photos will be purposeful about climate change.

Small Group Project: Students will be creating a map of Philadelphia and will be required to work with a partner to create this map. Students will need to sort out the role each student will take to create the map and how they will create a shared vision for their presentation.

Oral Presentation: Students will present their maps and their nature sightings during an oral presentation which includes their map and their video or photos of nature.

Field Trips: Students gain from experiential learning. Field trips also help students gain a sense of ownership to their city as well as civic pride.

Shared Reading: Students pair up to read together, taking turns reading alternating paragraphs. They are then asked to pull out significant information and answer questions to better help them understand the content presented.

Lessons for a Place Based Exploration of Climate Change

Prior to beginning this unit, it will be important to establish a “home” for writing, note-taking, observations, and photography in the form of a journal. At the teacher’s discretion, students could create their own journals, purchase them, or repurpose them from other uses. In addition, it may be helpful to establish an online site or account for digital photography or videos. While the photography assignments are not people centered, it is important to let parents know the scope of the project, obtain proper permissions and share student work with parents and administrators. The teacher should always review student work before posting it on any shared site.

Lesson #1

Guiding Question: How does nature interact with human development?

Objective: Students will view photography of nature and write about the interaction of nature and urban development.

- Students will begin by viewing the photos on this website: [Nature fights back.](#) Students can either look at the site on individual computers or teacher can have photos from this site displayed on an interactive whiteboard. If other examples from the local area are available, photos of those would work well too.
- Students will choose a photo and write reactions in their journals. The following prompts may be helpful in engaging students: Describe what you see. What do you think happened here? Does this photo make you laugh? Or feel sad? Why? Does this remind you of anything you have seen?
- Students will share their writings with peers by reading them aloud. Teacher will engage students in a discussion of personal experiences with nature in the city. Questions to ask: How do you think nature “took” over in those photos? Why did people leave it that way? Do we live in nature here in Philadelphia?

Lesson #2

Guiding question: Do we live in nature?

Objectives: This lesson will serve as a chance for students to view their city through a new lens. Students and teachers will take a walking tour of the neighborhood immediately surrounding the school to talk about and observe “nature” in the city and the ways that the urban environment interacts with the natural world. (Permission for walking tour must be obtained through the regular field trip process and chaperones will be needed.)

- Students will take photographs using their phones. Students without phones will be provided with a digital camera. Students should be instructed to photograph the intersection of nature and the city. Students may need instruction in photography, so it may be helpful to meet with the art teacher or a photographer to explain good composition. It will also be helpful to remind teenagers that no people should be in the photo and that they should frame photos so that the focus is on the assignment.
- Students will upload their photo examples onto a shared photo site for teacher review. Students should be instructed to include a caption for their photo which includes: their first name, a description of what they see, an approximate location. (Example: Weeds push up through the cracks in the sidewalk in West Philly by Rachel.)
- Students will be tasked during the walk to think about the following questions. Students should write the answer as notes as they walk and then make more thorough explanations upon return to the classroom:
 - Where do you see evidence of nature in your city, (be specific)? What IS nature?
 - Where do you see evidence of nature pushing back in your city, (such as what we observed in the photos online)?
 - Which aspects of the natural world appear to be controlled by humans and which aspects seem to defy control by humans? Is there anything you see that seems “wild”?
 - Can you think of examples of nature pushing back against the city that you didn’t see today? (For example, I share the story of the morning I walked my dog early in Center City and spooked a possum as he waddled for cover. What is he doing here?)
- Students will return to classroom to write journal reflections on what they saw, draw pictures, and share their photos. Students should more thoroughly answer the 4 questions listed above.
- Teacher will print or digitally display student photos with accompanying captions and writing as a group photo show for display for the school.

- This project can be ongoing. “Homework” can be continuing to upload and caption photos as appropriate.

Lesson #3

Guiding questions: How are we in control of the river? How does the river control us? Is the river “nature”?

Objectives: Students will walk to the Schuylkill River to view a major defining landmark of Philadelphia. Walking on the Schuylkill River Trail, students will observe the river, noting landmarks and places of interest. Students will be photographing **the river**.

- It may be necessary to review the guidelines for photography as listed above: *Students will take photographs using their phones. Students without phones will be provided with a digital camera. Students may need instruction in photography, so it may be helpful to meet with the art teacher or a photographer to explain good composition. It will also be helpful to remind teenagers that no people should be in the photo and that they should frame photos so that the focus is on the assignment.*
- Assignment: Photograph **the river**. What do you think is most important to document about this river? Be prepared to justify why you chose to photograph what you did. Students can submit their three “best” photos with captions.
- Students will also answer the following questions. Again, they may want to take notes while they take their walk and then record more thorough answers in their journals.
 - What evidence of animal life do you see around or in the river?
 - How does the water “look”? Is it moving fast, slow? Does the river look high or low?
 - Can you see the river change as you stand by it? What might be causing those changes? What color does the river appear to be?
 - In what ways is the river being controlled? In what ways is the river not under our control?
 - How have people managed the river? What do you think this river looked like 500 years ago? How do you think it might be different today?

Lesson #4

Guiding questions: What does my city look like in my mind's eye?

Objectives: Students will map out their city through a series of field trips that explore parks and the natural world in Philadelphia.

- Students will be provided with a large-scale map of Philadelphia which they will populate with narratives and photos and sketches about each place after they visit. (Teacher should create a large-scale map of Philadelphia from a bird's eye view with minimal detail: land mass and significant waterways (Schuylkill River, Delaware River) for display in the classroom or hallway. This map will stay up on the wall for the duration of this project. Students will also have a smaller scale map for their individual use so that they can begin to understand the layout of the city. These smaller maps could be pasted in their journals for ongoing reference.)
- This "lesson" will involve visiting 4-5 sites throughout the city (or more). Students will map how we will be traveling to these places, what they looked like, and what evidence of nature we see at each one.
- Two sites will be added during the first lesson during which the map is introduced: Lea School (and our neighborhood walk) and the Schuylkill River Trail walk. Students should locate these sites on their maps and provide photos and captions for their visits to these places.
- Students will add information and photographs to this as they explore the city. For example: students can photograph and write captions for photographs from the Schuylkill River walk to be posted on the map along where students walked. Photos can easily be printed from online sources or at a local pharmacy. These photos might be put in an album or on a poster near the map for display.)
- Teachers will want to choose sites of local interest and accessibility to students.
Suggestions:
 - Cobbs Creek Environmental Center:
<https://www.watershedalliance.org/awe-centers/cobbs-creek-center/>
 - John Heinz National Wildlife National Wildlife Refuge at Tinicum
https://www.fws.gov/refuge/john_heinz/
 - The Schuylkill Center
<http://www.schuylkillcenter.org>

Lesson #5

Guiding question: Why are these students protesting?

Objectives: Students will read an article about Greta Thunberg, teen climate activist. They will also read articles about other teen activists. The goal here is to engage students in learning about one of the most significant environmental and political challenges they are likely to face in their life time.

- Click [here](#) for an online article about Greta. Follow Greta on Twitter @gretathunberg and view her website fridaysforfuture.org keeping students informed about her inspired activism worldwide. Students will be assigned to read the article and view her website to be able to answer:
 - Who is Greta Thunberg?
 - Why is she skipping school and getting recognized for it?
- Students should choose one other article and answer the following question:
 - What is the name of the person you chose to study? Where are they from (country, city, school)?
 - Are they part of an organization?
 - What is this group (or this person) doing and why?
- Students will write responses in their journal and present for the class.

Lesson #6

Guiding question: What do you already know about climate change?

Objectives: Students will likely have heard the term climate change or global warming. This is a chance for them to share what they know and begin to connect to the unit through prior knowledge.

- Teacher creates an online or written survey with the following questions:
 - What do you believe causes global warming?
 - What causes climate change?
 - What are some of the effects of global warming?
 - What are some of the effects of climate change?
 - Will Philadelphia be affected by climate change? How?
 - Is there a way to stop or slow down climate change?
 - Do you know anyone who has been impacted by climate change?
- Teacher will review answers and compile them on one poster for students to view.
- Create two columns on the poster to separate out what students know about the causes of climate change and what they know about the effects of climate change.
- Through class discussions, help students sort out what is a cause and what is an effect and what is a solution.
- Students should make an organized list of two columns in their journals: causes and effects.

Lesson #7

Guiding question: What are some of the causes of climate change?

Objectives: Students will learn about climate change. In a previous lesson, students read about activists. Teacher also had a chance to assess prior knowledge in Lesson #6. In this lesson, students will learn the basics about the cause of climate change.

- Teacher will start with a picture of a CO₂ molecule and ask students if they can identify it. What do you think this is? Students can take notes in their journals.
 - Carbon is an element. Oxygen is an element. They form a covalent bond to make CO₂.
 - CO₂ is created several ways: when animals breathe out, when we burn fossil fuels.
 - Teacher will ask students to do a quick write to answer: Why has there been an increase in CO₂ in recent years?
- Teacher will draw a diagram of the greenhouse effect and how the extra CO₂ creates a greater layer of greenhouse gases.
- Students must include on the diagram the basics and have full command of the following terminology: fossil fuels, carbon emissions, carbon dioxide, greenhouse effect, temperature rise, Fahrenheit vs. Celsius, carbon footprint, global warming vs. climate change. Label these on the diagram of greenhouse effect.
- Teacher should make sure that students can differentiate between weather and climate.
- Students will make a collaborative poster. 4 students must work together to synthesize what they have learned into one image that includes a basic description of climate change, an image that represents climate change, a title, and one question students have about climate change.

Lesson #8

Guiding question: What are some of the more pressing impacts of climate change around the globe?

Objectives: Students will read a series of articles in order to learn about climate change impacts around the world. Students will view photos of a changing planet in order to describe climate change impacts.

Part One:

- Students will view photos published by NASA that show before and after satellite images depicting climate change. Students should work in pairs and choose one image on their computer screen. SEE RESOURCE SECTION.
- Students should answer the following questions:
 - In the “before” photo, I see.....In the “after” photo, I see.....
 - This makes me think.....
- All answers should be recorded in journals.

Part Two:

- Students will be given online resources to read and will be required to report back to the class about their findings.
- Each set of two students will have a different website to review.
- Students will answer the following questions.
 - Where is your climate impact occurring? (Be as specific as possible.)
 - What has changed?
 - How has that been noticed by locals or scientists?
 - Is there any proposed solution for this problem?
 - One other interesting fact or comment you got from the article.
- **SEE RESOURCE SECTION** for websites and articles relating to this lesson. Teachers may find other, more relevant and recent articles.

Lesson #9

Guiding question: How will Philadelphia be affected by climate change?

Objectives: Students may have heard about sea level rise, melting polar ice caps and the threat to polar bears. This lesson will focus on an issue specific to Philadelphia, increased stormwater runoff due to increased frequency and strength of rain storms.

- Post a picture of a polar bear and ask students what is going on here. Is this likely to affect Philadelphia? Today we are going to learn about one way Philadelphia may be affected by climate change.
- Students should read the following information posted on the phila.gov [website](#).
- Have students list the climate change impacts for Philadelphia in their journals.
- Students will take a field trip to Fairmount Water Works to learn about the impacts of stormwater runoff due to increased rainfall.
- Students should also take a video or picture on a rainy day. Their video should trace the flow of water on the street to see where it goes.
- Ask students to theorize where the water goes once it is subterranean.

Lesson #10

Guiding Question: How is Philadelphia attempting to mitigate stormwater runoff and increased flooding?

Objectives: Students will learn about one way that Philadelphia is mitigating climate change (and other issues) through green stormwater infrastructure. Students will learn about the Green City, Clean Waters initiative to capture stormwater throughout the city.

*NOTE: Green City, Clean Waters is an initiative to capture stormwater in Philadelphia. This program is necessary as a mitigation to decrease stormwater runoff which has increased due to climate change. GCCW also has a goal of reducing the number of combined sewer overflow events that release untreated waste water into the Delaware and Schuylkill River. For more on GCCW click [here](#).

- This lesson may also be combined with a field trip to Fairmount Water Works.
- Find sites that students can visit to see examples of mitigation throughout the city. Teachers can use [Big Green Map](#) to explore sites in their area of Philadelphia.
- Students and teachers will walk to sites to look at how stormwater is being managed.

- Students will photograph site and again upload photos with captions to the shared site.
- Include photographs on the shared map from Lesson #4.

Lesson #11

Guiding Question: How is Lea School’s schoolyard designed to mitigate the effects of stormwater runoff?

(This lesson is specific to Lea School as the schoolyard had a significant renovation in 2015. This renovation not only beautified the area, but also created a public common space, and a system for managing stormwater runoff. School sites such as these are scattered throughout the City of Philadelphia and may be available for teachers to use for occasional visits from other schools. The [Big Green Map](#) has those sites listed.)

Objectives: Students go outside every day in the yard! But are they aware of the green stormwater infrastructure hiding under their feet and all around them? Students will have a chance to see how engineers, city planners, and community members are working together to create solutions for climate change and other environmental challenges.

- Students will be assigned to work in groups of two. They will have 20-30 minutes to observe the schoolyard in a new way.
- Students must record all of the ways that they think water might be “captured” in the schoolyard.
 - One specific feature of the schoolyard that might help control/capture stormwater runoff is.....because.....
 - Students will repeat this question 4-5 times, writing their answers in their journals.
 - Upon return to class, students will work in Round Table format to share ONE of their statements with peers.
- Students will then return to the yard and photograph aspects of the yard to add to their collection. They will caption these photos with information based on their observations above.
- Students will add one last set of photos to their maps: their own schoolyard!

Appendices

Pennsylvania Department of Education State Standards

S8.B.3.2.3 Describe the response of organisms to environmental changes (e.g., changes in climate, hibernation, migration, coloration) and how those changes affect survival.

S8.B.3.3.1 Explain how human activities may affect local, regional, and global environments.

S8.C.2.2.1 Describe the Sun as the major source of energy that impacts the environment.

S8.C.2.2.3 Describe the waste (i.e., kind and quantity) derived from the use of renewable and nonrenewable resources and their potential impact on the environment.

S8.D.1.3.1 Describe the water cycle and the physical processes on which it depends (i.e., evaporation, condensation, precipitation, transpiration, runoff, infiltration, energy inputs, and phase changes).

S8.D.1.3.3 Distinguish among different water systems (e.g., wetland systems, ocean systems, river systems, watersheds) and describe their relationships to each other as well as to landforms.

S8.D.1.3.4 Identify the physical characteristics of a stream and how these characteristics determine the types of organisms found within the stream environment (e.g., biological diversity, water quality, flow rate, tributaries, surrounding watershed).

S8.D.2.1.1 Explain the impact of water systems on the local weather or the climate of a region (e.g., lake effect snow, land/ocean breezes).

S8.D.2.1.2 Identify how global patterns of atmospheric movement influence regional weather and climate.

S8.B.3.2.3 Describe the response of organisms to environmental changes (e.g., changes in climate, hibernation, migration, coloration) and how those changes affect survival.

S8.A.3.1.5 Explain how components of natural and human-made systems play different roles in a working system.

S8.A.1.2.2 Identify environmental issues and explain their potential long-term health effects (e.g., pollution, pest controls, vaccinations).