Chapter 18
Extending Classrooms into Parks Through Informal Science Learning and Place-Based Education

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Picture an urban environment. While an elevated subway may come to mind, you may not think of this juxtaposed with a graceful snowy egret standing in a salt marsh or a mud flat dotted with snails as windsurfers sail by in the background. New York City is considered one of the busiest cities in the world and yet within its borders is a 25,000 acre wildlife refuge that hosts a large number and diversity of animal and plant species. The Jamaica Bay Wildlife Refuge is a part of the National Park Service Gateway Unit. Because of the expanse of water and marshlands, it is hard to believe you are still within the borders of a dense urban center. The refuge was established as a National Recreation Area in 1972 in order to "preserve and protect for the use and enjoyment of present and future generations an area possessing outstanding natural and recreational features" (Kornblum & Van Hooreweghe, 2010, p. 1). Through the subsequent decades the park has undergone periods of neglect and renewal and is currently an important recreational place for many communities in Brooklyn and Queens—those boroughs in which the park is located.

Science learning in connection to greenspace is often enacted from a "green curriculum" approach that is usually removed from the lived experiences of students, especially those who live in urban, multicultural contexts (Paperson, 2014). Environmental education frequently promotes the dominant Western cultural values of an idealized nature (Low, Taplin, & Scheld, 2005) and promotes a quantitative paradigm of pro-environmental behaviors. According to Low et al. (2005) "cultural values are our best indicators as to what people think and feel about a landscape such

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as a park" (p. 15). Thus the dominant cultural narrative assumes that there is a universal notion of how people should "behave" towards the environment; the ways that other cultures interact with parks and greenspaces are at best undervalued but all too frequently ignored. Science teachers and their students could play a critical role in changing how people view and relate to urban parks. In New York City, we have that opportunity in that we have a site for ecological place-based education that is steeped in the urban context. Teachers can facilitate experiences where their students use science as a lens to study the park and other urban greenspaces. This allows diverse students to take ownership of greenspaces that are usually perceived as being created by and for the dominant culture; White and middle-class.

Parks offer unique opportunities for authentic science learning in that students are able to interact with natural ecosystems and engage in authentic data collection practices, while enjoying being in the outdoors. Parks are spaces where lived experiences and science learning could come together in ways not afforded by brick and mortar informal science institutions. People use parks for recreation, relaxation, spiritual activities, and family gatherings and, for the most part, access to parks are free. Urban parks could play a key role in fostering positive intercultural interactions through the valuing of cultural histories and difference (Low et al., 2005) through the realization that people value greenspaces for different reasons and use these spaces in different ways. Science educators could play a pivotal role in fostering this relationship by introducing their students to these spaces in ways that allow them to build meaningful attachments and knowledge about the ecology and impacts of human interactions in parks.

The Millennium Ecosystem Assessment identifies three different ecosystem services—provisioning, regulating, and cultural—that describe the benefits humans receive from ecosystems. Cultural services is described as, "the nonmaterial benefits people obtain from ecosystems through spiritual enrichment, cognitive development, reflection, recreation, and aesthetic experiences" (Millennium Ecosystem Assessment, 2003, p. 58), with education values and sense of place as key examples. Moving towards promoting a discourse around the human, non-human and environment relationship that is more interdependent, a framework of place attachment could allow us to view our relationship with parks with co-dependency in mind; the need for stewardship of natural urban greenspaces in order to continue to reap the benefits that these greenspaces afford.

Greenspace is often a premium in urban settings. Thus, parks present opportunities for educators to facilitate experiences with nature that are unparalleled in the classroom and teach students about the interdependence between humans and their natural (and built) surroundings. Educating science teachers to use urban natural spaces to teach science could be a way of unifying cultures around the scientific resources found in natural spaces, while valuing the different ways that people use these same natural places and spaces to enact and maintain culture. If we think about the nature of place and how people form attachments with place, we could think about the role education could play in shaping the relationships that people have with parks, both as places of science learning and places of recreation.

Nature of Place and Place Attachment

A theoretical lens of place, place attachment and identity is salient to describe how teachers could form attachments to and build identities around places for science learning and place value on facilitating such experiences for their students. From a phenomenological perspective, Seamon (2014) describes place as "any environmental locus through which individual or group actions, experiences, intentions and meanings are drawn together spatially" (p. 12). Place is the context for the enactment of lived experiences; it is the "person-or-people-experiencing place" (p. 12), a complex, dynamic set of processes that continually define and redefine both places and people as it is very connected to the experience of being human (Malpas, 1999). People experience place, make meaning of place and form bonds or attachment to place through a lens of sense of place (Adams, 2013). Through this lens, people view place as a resource for enacting a particular activity that is often tied to an identity. Environmental psychologists describe sense of place in terms of place attachment and place meaning where place attachment is the bond that people develop with place; the extent to which place becomes a part of one's identity (Kudryavtsev, Stedman, & Krasny, 2012). Place meaning is the value that people place on or meanings that people ascribe to particular places (Kudryavtsev et al., 2012); this is also tied to identity as a place may symbolize a site to enact a particular identity (Adams, 2013). In extending this to teacher learning, a park may represent a place to enact an identity that is associated with a particular approach to teaching, for example an inquiry-based teacher, an environmentally-conscious teacher or a field-based teacher. Place attachment, place meaning, and place identity are all a part of the lived dialectics of our relationship with place.

In thinking about teachers' relationships to parks, we have found it helpful to weave between phenomenological and environmental psychological perspectives of place, experience and place-identity. Place attachment is a process as peoples' feelings towards, experiences within and the places themselves shift and change over time (Seamon, 2014). Seamon (2014) describes six processes that define peoples' changing relationship with places. Although he describes both generative and destructive processes, we are concerned with building teacher connectedness to the park through the generative processes. Table 18.1 provides a look at the processes as described by Seamon (2014) with a brief description of how these processes could be enacted in teacher learning experiences.

As these six processes demonstrate, developing a relationship with place requires not only encounters with the physical place (or idea of the place) but also encounters with people and other living and non-living agents that define a place. As place attachment and identity are intertwined, these processes could also provide a lens to describe how a place, like a National Park, can become an integral part of a teacher's identity and thus an important resource in her teaching. As "social boundaries can extend beyond geographical or management boundaries of a place" (Mihaylov & Perkins, 2014, p. 65), it is important to think about the relationship with teachers and the park as extending the boundaries of both. Social boundaries

Table 18.1 Place attachment and teacher learning (adapted from Seamon, 2014)

Process	Relevance to park and teacher learning
1. Place interaction-the typical goings-on in a place and involves a constellation of regular actions, behaviors, situations, etc. that typically unfold	Becoming familiar with the park as a place and the enactment of science teaching in the park; using the park as a resource for teaching—teaching in the park becomes a regular part of one's teaching practice; a regular place encountered in teaching and learning
2. Place identity-the process by which people associated with a place take up that place as a significant part of their lived experience; recognize the place as important to her individual or communal identity	Teacher views the park as a place to enact a particular teaching identity, to demonstrate who he is as a teacher
3. Place release-environmental serendipity of unexpected encounters and events	Unexpected encounters with nature (seeing an endangered animal, tasting an edible wild plant) learning interesting factoids about the park through informal discussions that evoke a feeling of having exclusive or insider knowledge; unplanned synergistic encounters with like-minded peers and park staff that lead to collaborative efforts
4. Place realization-the palpable presence of place; the distinctive characteristics of the place and the human beings who know and appreciate that place	Teacher recognizes the value of resources in the park (both the physical and human (i.e. Rangers) for STEM learning; teacher connects with other educators who share similar teaching values and feelings towards the park and similar places
5. Place creation-human action in relation to place; sense of commitment to maintaining, improving, advocating for the preservation or betterment of a place	Teacher actively becomes involved in civic engagement and actively involves her students; becomes engaged in STEM education curriculum writing and policy that emphasizes the park as a resource for STEM learning
6. Place intensification-power of policy, design, and fabrication to revive and strengthen place	Teachers develop lesson plans, units and curricula that connects learning standards to the resources of the park. The park values these resources and makes them publically available and design policy to facilitate field trips to the park

include social identities—these extend from one place to another and serve as brokers across the boundaries, linking one context to another.

Boundaries and diasporas structuring places and place attachment

A metaphor that adequately describes developing collaborations between different institutions is creolization, which Hall (1990) defines as a complicated process of cultural negotiation and transculturation. It is a converging of institutional cultures in order to create something new—program, activity or approach to learning—while remaining true to the strengths, values and mission of each institution. Through both professional development and deep engagement in the park

with students, teachers develop place attachment with the park, while the park values the presence of schools and teachers and develops policy and pedagogy to intensify their experiences with the park as a place. Paragraph recent informal science learning literature has revisited the notion of boundaries, borders and boundary objects/activities to describe formal informal collaborations and partnerships (Kisiel, 2014). In informal science learning environments settings, these are objects (i.e. curricula or lesson plans) or activities (i.e. field trips or Citizen Science activities) that serve as points of negotiation of institutional cultures. The persons who work to develop such objects and activities are boundary crossers who, as Wenger (1998) describes, "find their value in spanning boundaries and linking communities of practice" (p. 154). Teachers gain the agency to access and appropriate the resources of the park to meet their goals of science learning and learning through professional learning experiences. As teachers engage in learning activities in the park, they are also changing the park to be a science-rich resource from an educational standpoint and change the approach that the park takes to education.

Classroom and Parks Meet at the Boundary

To form place attachments in environmental education, Kudryavtsev et al. (2012) recommend having programs or activities with both direct, experiential experiences, and instructional activities. Teachers learn how to engage in data collection and science inquiry through direct, experiential place-based learning. Teachers often have positive learning experiences and desire to recreate similar experiences with students. Through instructional approaches, teaching goals are predetermined and connections to place are made though discussions, text such as articles and maps, discussions, the observation and creation of art and by other means, ways, etc. A combination of these approaches help teachers establish connections to a place though developing their own meanings while learning about the meanings other people, stakeholders, and disciplines have about the same place. Thus, a teacher can see a place as a valuable resource for science teaching and learning while also learning about the historical or aesthetic significance of that place.

Gateway National Recreation Area: Gateway to STEM Learning

Gateway National Recreation Area (Gateway), a unit of the National Park Service includes Jamaica Bay, an urban wildlife refuge that offers students and teachers unique opportunities to learn about the natural world. Gateway is a hybrid of national and local city park because it both preserves vital environmental resources

while also emphasizing recreation (Low et al., 2005). With approximately 25,000 acres and over 45 miles of shoreline, excluding marsh islands Jamaica Bay has a vast array of natural resources and spaces for deep, place-based, informal and formal science (and social studies) learning. As place at the edge of a dense urban context, the refuge offers students and teachers a unique opportunity to interact with the natural environment. It provides vital habitats for spawning and mature fish, migrating birds, and shorebirds, including the endangered piping plover. This urban greenspace is also an important habitat for many invertebrates, including a diverse array of gastropods, crustaceans and insects. As a recreational area, the park has spaces for people in pursuit of a variety of leisure activities, including bird watching, fishing, gardening, kayaking, boating, swimming and beach combing. However, being situated in a populous urban environment, Jamaica Bay is also vulnerable to a number of human and natural stressors including, wastewater discharges, invasion of non-native species, sea level rise, severe weather events, and land use changes. For example, extensive areas of highly productive salt marsh habitat were filled in to create John F. Kennedy International Airport along the edges of Jamaica Bay. With the variety of spaces and places situated in the park and environs as well as environmental issues to grapple with, there are ample opportunities for students to engage in hands-on, real-world science studying the wildlife, ecological spaces and dynamic human-nature interactions in the Bay.

In 2014, Gateway issued an education strategic plan entitled, "Gateway National Recreation Area: A Laboratory for Learning" to guide planning and implementation of its education programs. The mission statement reads, "Gateway's education programs encourage new generations to become informed and passionate citizens who will understand, value and promote healthy parks and environmentally resilient communities" (GNRA, 2014). This mission has become more imperative in the wake of Hurricane Sandy, which left much damage in the park and surrounding communities, and with a specter of weather events of increasing frequency and intensity (Rosenzweig & Solecki, 2015). Goals to meet this aim include targeting underserved schools with diverse populations, empowering teachers through professional development and the production of high-quality education materials and developing a community of teachers interested in enacting place-based, service learning projects in the park. Developing a sense of place attachment for the park, both for teachers and students is an important part of achieving these goals. This means developing opportunities for teachers and their students to experience the place-attachment processes that will allow them to become intimately familiar with the park and see it as a place of maintaining identity and achieving personal and professional goals. The Gateway enactment of the national "A Park in Every Classroom" (PEC) initiative was one of the initial means of developing a community of teachers who have a strong place-identity with the park and to develop those activities and curricula that would serve as boundary objects between the park and classroom.

A Park in Every Classroom

Jamaica Bay has a history of providing professional development activities for teachers around using the resources of the park. These activities are led by Rangers and guest educators and have largely been day-long workshops that include guest lecturers, site-based investigations and discussions about curricular connections. In spite of these efforts, the Gateway staff felt that Jamaica Bay and environs are underutilized in STEM teaching and learning. The NPS developed a nation-wide initiative called "A Park for Every Classroom" (PEC) to connect teachers to the cultural, historical and scientific resources of the National Parks. Rangers were partnered with teachers to develop activities and curricula around the unique resources of the different parks involved. In Gateway, the overarching goal of the "A Park for Every Classroom" (PEC) is to encourage collaboration and the creation of a learning community amongst scientists, teachers, and students in the gathering, analyzing and using data to raise awareness about environmental change. The initiative started with a series of day-long professional development workshops or "Seminars in Science" on topics of scientific relevance to Jamaica Bay, such as:

- Supporting the Horseshoe Crab and Bringing Back Oysters to NYC
- Evidence of Environmental Change: Plant Phenology and Invasive Species
- Climate Change and Bird Migration Patterns

These workshops were co-facilitated by Rangers, master teachers, and field scientists actively engaged in park-related research with the goal of empowering teachers to use the park's resources to conduct STEM research and engage in civic actions with their students. During these workshops, teachers were introduced to science content through experiential activities and resources to bring back to the classroom. The activities allowed them to explore different areas of the park, including beaches, marsh areas and nature trails while experiencing different activities they could adapt and use with their students. Workshop facilitators had discussions with teachers around connecting the Jamaica Bay explorations to the Next Generation Science Standards and Common Core, a requirement for NYC teachers. For a number of teachers, these workshops were their first visit to Jamaica Bay. One teacher noted on her/his survey, "First time visitor—blown away by the view." Others commented on how much they liked being in the park and that the workshops provided "a chance to experience the different [eco]systems at Gateway." Many teachers who attended the workshops did so because either the topic was of interest or they wanted the opportunity to visit Jamaica Bay. Thus, the workshops provided not only an opportunity for teachers to begin to learn about the culture of the park as a STEM learning space, but also the occasion to experience the aesthetics of this urban greenspace and view this as a valuable space for both STEM education and enjoying outdoors activities.

An important goal of Gateway is to co-develop high-quality lesson plans and activities with teachers. Teachers who participated in these workshops were invited to join a cohort of Master Teachers who would work closely with NPS staff and

faculty to create and pilot lesson plans and units focused on the ecological resources of Jamaica Bay. These classroom documents would be grade-appropriate, based on current research in Jamaica Bay, and enable teachers to use real scientific data in their classrooms. These documents would be available and accessible to all teachers on the Park's website (http://www.nps.gov/gate/index.htm). During the initial year, teachers did projects on invasive species, marine debris and water quality. The teachers chose topics that were of interest to them and their students and of scientific relevance to the park. What follows are a couple of examples of teachers' projects and the influence of their projects on student learning and motivation. All of the teachers described teach in public high-needs schools with large numbers of African American, Latina/o, immigrant and lower income students—students in "racialized communities that our society continues to systematically exclude and marginalize" from meaningful and relevant learning opportunities (M. Dumas, personal communication, June 13, 2015).

Art Transformation: Recycled Artworks in Jamaica Bay!

Water is spiritually significant in a number of religions and, as Low et al. (2005) notes, in urban contexts, seashore parks play a key role in the continuity of cultural practices for particular communities. As such, several religious and cultural groups actively use the Bay for water-based rituals. Hindu devotees are one of these groups as they view Jamaica Bay as a manifestation of the sacred Ganges in India (Kornblum & Van Hooreweghe, 2010). They perform pujas or special offering by placing offerings in the water. The North Channel Bridge is a public beach and commonly used for these pujas. Statues, fabrics, candles, fruits, flowers and other items are included in pujas, through dialogues between Jamaica Bay and the local Hindu community mostly biodegradable items are now used for pujas. However, because of the water circulation patterns many of these offerings—coconut shells, candles, clay pots used as candle holders, flags—end up on some of the beaches.

During a professional development field excursion to the North Channel Bridge, eighth-grade teacher Karen noted the clay candleholders and became interested in thinking about how she could use these artifacts with her students. Hence, when she joined the Master Teachers group she wanted to do an art/science based project that would incorporate these clay pots. She developed "Students Will Be Able To's" (SWBAT) as follows:

- Develop an ethic of personal responsibility and stewardship towards all aspects of the environment.
- Conduct a short "field" research project to determine the level of human impact on the environment.

She presented information to her students about the potential impacts of the pujas and other marine debris on Jamaica Bay including decreased water quality,

impacts on bird life and potential hazards to humans (i.e. broken ceramics and glass). She also had a discussion with her students about the significance of the Bay to the Hindu community. She noted that students in her class who belonged to the Hindu community enjoyed sharing their culture and traditions with their classmates. Her students conducted a marine debris survey and water quality testing to make inferences about the water quality of the Bay. They categorized, counted and sketched the marine debris they encountered and brainstormed the ways that some of the items could be recycled. In addition to the (unfortunately) usual plastics and other household waste, students encountered a number of objects that originated with pujas. The park service removed the debris from the beach but through coordination they were able to save the candleholders and coconut shells for Karen's classroom. The students painted them and used them as planters for goldenrod seeds.

The seaside goldenrod (*Solidago sempervirens*) is a native perennial in the park and plays an important ecological role in sand dunes and salt marshes. As a part of restoration of sand dunes that were lost during Hurricane Sandy, there is a planting and replanting effort of native plants in existing sand dunes. Karen and her students painted the found artifacts, filled them with compost soil and goldenrod seeds and nursed the seedlings in the classroom until they were mature enough to be planted in the park. They took a field trip to Fort Tilden in Jamaica Bay to plant the goldenrods and help restore the dunes. Karen described the impact of this activity on her students in her evaluation,

> My students lived through the devastation of [Hurricane] Sandy, they truly have a sense of pride restoring their environment and community. Gateway is in their backyard; Fort Tilden is next to Riis Park, where my students frequent during the summer. The fact that they were supposed to restore the dunes that Sandy stripped away hit home for them and they were looking forward to the culminating activity. I plan on taking those students back this year for restoration as well as the new class coming up.

Karen and her students learned a number of valuable things about the park during their active engagement. They experienced place realization towards the park as a valuable resource for science learning, the significance of this place in cultural continuity for the Hindu community and the importance of caring for this place that is both sacred and vulnerable in respect to community activity and natural events. Karen's students played a key role in the place creation through the dune restoration project. Adding these layers of knowledge allowed Karen and her students to develop an attachment with the park and expanded their school sense of place to include Jamaica Bay. As the park has become integral to Karen's teaching, she now plans on returning to the site each year so that her students can see the results of their planting and their younger peers could continue the place creation begun by their predecessors. This process will allow the dunes to become an extension of the school.

Place Release and Non-human Living Things

Alyssa, a high school joined the Master Teachers group after attending one of the Seminars in Science workshops. During the workshop they learned about the ecology of the tidal zone and salt marsh, including the invasive species found there. One of the Rangers engaged participants in a quadrat study of shore crabs, first with a classroom based activity that used cut-outs to emulate the different species of crabs, both endemic and invasive, and then with the actual activity at the shore. Alyssa teaches a zoology elective class and was immediately engaged and remarked that this was something that her students would enjoy, since middle and high school students are motivated by studying living things (Defelice, Adams, Branco, & Pieroni, 2014). She focused her project on developing lesson plans and activities around shore crab monitoring.

Alyssa wanted to first familiarize her students with important concepts about invasive species so she framed her investigation around invasive species in New York City. Using plants as the focus, she planned and facilitated field trips to the Brooklyn Botanic Garden, Wave Hill Garden in the Bronx and The Highline in Manhattan for her students to gather information through observations and visual documentation. This enabled her to begin the discussion around invasive species and the ethical question of eradicating invasive species, which is a key management issue of the local National Park. She is in a school that encourages field trips and extended units, so she had the support of her administration to conduct multiple field trips. She was able to use a variety of places in the city as resources for science learning and these opportunities allowed her students to make deeper connections with places that were beyond their community and yet still a part of their city. These observational field trips also helped her students to understand the concepts of native, non-native species and importance of biodiversity. This background knowledge was then applied to the shore crab exploration in Jamaica Bay.

Alyssa and her class first did a trial run of the shore crab data collection at East River State Park, located within walking distance of her school. There, students repeated the quadrat studies that Alyssa did in the professional development, and collected, identified and counted the different shore crabs they encountered, specifically looking for the invasive Asian Shore Crab (*Hemigrapsus sanguineus*). She then took an extended field trip to Big Egg Marsh in Jamaica Bay where students did on-site data collection. She found that her students were not only enthusiastic about engaging in the research, but were very focused, detail oriented in their data collection of the crabs, comfortable in handling the crabs and were able to make inferences about crab where the crabs reside on shore (see Table 18.2). In this place release, students encountered a variety of crabs and a number of other living things that they associated with the crabs, as noted in Table 18.2. As an important part of the overarching project was learning about how students could contribute to the management of Jamaica Bay through data collection, she also noted challenges in the data collection process such as failure to follow protocols carefully and missing preliminary data (i.e. weather, location). She noted that it was

helpful that students were able to practice data collection skills in the local park, as it made a difference when the students were in Jamaica Bay. However she lamented, "before this [East River Park trip], I should have done a lesson in the classroom on measurement, as well as an activity that shows the importance of random sampling." The students who were absent for the "practice" sessions were not as productive in the field. Although they were engaged, they were unable to meaningfully contribute to the data collection process.

Reflecting on her experience with students learning in Jamaica Bay, Alyssa felt that the experience provided her students with what she described as "a living vocabulary," which she described on her evaluation,

> My students are bombarded with hundreds of vocabulary words that they have to learn over the course of the year, but only so many include hands-on labs. But time and time again, I am reminded of how important it is for the kids to be able to apply these words to real life situations. Project-based assessments are the most memorable, and as a result, students can use their prior knowledge to relate to other questions about the world.

Alyssa wants to do more of these types of projects with her students and wants to be "more involved with other projects available to teachers around the city that are giving such great opportunities for student involvement." Through this project, Alyssa not only saw Jamaica Bay as a valuable resource for her teaching, but through the experience of a different type of engagement with her students, she will most likely choose professional development opportunities that allow both her and her students to experience more place-based authentic science learning, she noted "The level of engagement and connectedness they felt to this research was really important to my learning as well as theirs."

It has been noted in prior research that students who are disconnected from science in school often become engaged when the science learning occurs outside of the classroom in meaningful ways (Adams & Gupta, 2013; Basu & Calabrese-Barton, 2007). Because Alyssa's course was an elective, the attendance rates were not high, however she noted that her attendance increased during the field trips,

> Students in my elective class tend to be quite transient, so there are only a few that experience each lesson every week. Many come in without the background knowledge of prior classes. When we began our focus on invasive species and Asian Shore Crabs, the students that were there wanted the others to participate and convinced many students to come to our final collection at Jamaica Bay. While they were there, they enjoyed the project, got their hands dirty and tried to execute the collection as best they could (with limited prior knowledge). Many expressed their interest in doing the project again, or staying longer to finish.

Her students shared their enthusiasm with their friends and even "those that didn't normally participate wanted to be a part of what was happening." To her, this was "music to my ears" and strengthened her commitment to seeking professional development for herself in order to facilitate more of these kinds of learning experiences with her students. Similarly, Karen stated that her 7th grade students "created a quite a buzz" about the field experiences causing all of her other grades

Table 18.2 Asian Shore Crab student observations

Group A's observations	Group B's observations
Females dominated the quadrats	More males found under small rocks
Mostly Asian Shore Crabs found	Less crabs were found in dry sand
Only one green crab collected	Only 1 female found
Most like to hide under larger rocks in big numbers	Crabs in their quadrats also usually contained worms, snails, and other worm-like organisms
Prefer damp sand conditions	That squirted water
Native species seem to be located farther from the shoreline	1 or 2 mud crabs found
Usually found near mussels	Mainly Asian Shore Crabs found
Plant cover varies	

to want to participate. The field experience has now become something for her lower grades to look forward to and the school has an emerging identity connected with the park.

Sentinels of Shoreline Change

From the PEC work, we learned that teachers are eager to engage their classes in authentic science research in the field, especially if it has a connection to the greater mission of the park. Alyssa remarked that her students were excited to be a part of research that helped scientists to know more about invasive species in the park. However, there is a lack of access to structured activities, scientific protocols, or scientists that can facilitate meaningful data collection. With these challenges in mind, and with a grant from SENCER-ISE, we developed the Sentinels of Shoreline Change, a project that connects schools with scientific monitoring and stewardship of the Bay. We would work with the PEC teachers to identify, pilot test, and revise a protocol that would be user-friendly for a range of grade levels, supply meaningful data to the scientific community and provide teachers and students the opportunity to use data to lead to civic action. The PEC Master Teachers were eager to participate as they felt that having a unified data collection process would not only with their process of planning and facilitating field experiences, but also allow students participate in a larger project around the monitoring and stewardship of Jamaica Bay.

The project began with a field trip to Plumb Beach in Jamaica Bay were teachers learned about the ecology of the salt marsh and engaged in data collection field methods to model what they might do with their students. After the field trip, teachers, college scientists and park staff debriefed the experience and decided what would be the most meaningful and feasible to do with students. Teachers discussed issues of access, materials and student motivation in the decision process about

what activities they would like to field test in the classroom. We collectively decided to focus on marine debris for the first year because it did not require a lot of materials and equipment and there was an existing protocol from NOAA that had been used in the park by different community groups. Additionally, we agreed that it would be an easier and immediate connection to civic engagement. Teachers participated in professional development on the importance and use of scientific protocols and were introduced to the NOAA protocol and supporting materials.

Each teacher took her class to a different site where they used the NOAA protocol to document the different kinds of debris they found on the shore. Overall, the teachers were excited to have a well-defined protocol and found that their students were very motivated and engaged in the activity. One teacher wrote,

> I thought that the students overall were excited to get outside, but when they would be asked to take more detailed notes and follow protocol, they might not be as enthusiastic. Instead, they were engaged, and invested in getting it right. I teamed up with two boys that frequently missed class, and we established a way to collect debris and they were very thorough going through each step of the processes.

Although the marine debris activity was not focused on living things, this was still a key motivator for student participation, "They simply loved being outdoors and touching and seeing and learning about all the organisms we encountered." This place interaction and place release allowed both the teachers and students to increase their familiarization of the park and enjoy their interactions with organisms that inhabit the place. Alyssa, who studied invasive specie with her class last year noted, "although they were disappointed that they couldn't play with crabs, the students enjoyed themselves, they learned about some organisms they have never seen before." While these encounters were not a planned part of the marine debris activity, they were important in allowing the teachers and students to form attachments with the place. The teachers requested information about the common marine/estuary organisms to share with their students on field trips.

Seeing the value of the park to their science teaching and learning, the Master Teachers were eager to create and share resources with other teachers. They suggested,

> we should develop pre and post-activity lessons that have clear relationships to Living Environment and Earth Science standards so Regents[1] teachers will feel confident, not ambivalent, about incorporating these activities

and "a series of CCLS and Regents aligned lessons that can be used in conjunction with these activities." Through the process of place intensification, the lessons formalized the role of the park in teaching and learning and made it accessible to a larger circle of educators.

[1]Regents or Regents Examinations are New York State-wide assessments in high school core subject areas required for a Regents diploma indicating college readiness. The science exams include Biology/Living Environment, Earth Science, Chemistry and Physics. http://www.nysedregents.org/regents_sci.html.

Engaging Teachers and Students in Place-Based STEM Learning

As the National Park Service begins its second century, it presents a strategic plan with Educational Leadership as one of the key outcomes. This outcome includes the following goals:

- Establish the National Park Service as an educational institution and strengthen parks as places of learning that teach about our American heritage and develop civic engagement, scientific and historical literacy, and citizen stewardship.
- Collaborate with partners and other educational institutions to expand NPS educational programs and the use of parks as places of learning.
- Develop and nurture lifelong connections between the public and parks—especially for young people—through a continuum of engaging recreational, educational, volunteer, service, and work experience (NPS, 2014).

With the emphasis on "places of learning" throughout these goals, it is the vision of the NPS is to be viewed as a valuable place to educators and those involved in teaching and learning through both formal and informal means. This means strengthening the attachment these stakeholder groups feel towards the park through deliberate programing and experiences. The teachers who engaged in the professional experiences described in this chapter learned that there are many different ways and opportunities to engage in science that not only connects to the classroom curriculum, but also connect students to a place of importance to their urban environment, as Alyssa noted, "allows students to experience their city in a new way." Dianne, a middle school Master Teacher wrote, "the most stimulating resource at Gateway is the site itself," it is that interaction with place and developing place identity that the park wants to foster so that there will be generations of stewards to follow. Through teachers' deliberate actions, students learned about places in their city that they did not know existed and teachers were able to develop new teaching identities that connected them not only to Jamaica Bay, but also to new ways of teaching science. Karen describes,

> PEC provided a unique opportunity to relate classroom science with the natural world. As an educator my focused has shifted to fostering my students long-term relationship with their environment. They need to realize what is offered in their backyards and understand the science behind it.

Place Attachment and Stewardship

People will not work to protect a place unless they feel a sense of attachment with a place, furthermore as people have different attachments to places, they may have different notions of stewardship. Increased understandings of place through direct

experiences, including activities and processes that influence the quality of a place empowers people to know what actions to take in order to protect a place. Even if the teachers' projects did not include a direct civic action, it seemed that their students' sense of care towards the park increased with their scientific engagement. Dianne, a high school Master Teacher who did a project on marine debris with her students described,

> After our trip the students were asked to write a reflection about their experiences at Floyd Bennett Field. Almost all of the students commented on the amount of pollution they found on the beach and the adverse effect it could have on the ecology of the Bay. During lunch the students took care to police the area making sure they did not leave any trash behind. In addition, the school has started a recycling program. After or trip I noticed that the students were more conscious of using the proper bins to dispose of the garbage.

During discussions, teachers mentioned that their students were able to make connections with the debris they found on the beach to things that they often encounter in their daily lives like soda bottles, plastic bags and toy parts. This created an awareness about and connection to the trash they generate and what they found on the beach. This also allowed them to begin to develop their own sense of care and stewardship and not one that was being imposed on them.

In much environmental science literature, recycling is perceived as a pro-environmental behavior, without attention to the social, political and economic influences on access and choice. Interestingly, one teacher noted that her students had a negative perception about recycling, seeing as an activity for only poor people (with the bottle buy-back program in NY, many lower income people take to collecting bottles on the street as a way of supplementing income). Engaging in marine debris studies in the park and developing a recycling program at school helped to dispel this myth and allowed students to develop their own notions about what it means to care for the park and their local environment. This is an important aspect of place creation—a teacher affording her students a sense of agency in creating the kind of environment that they want for themselves and their community.

Preparing Teachers and Students for Place-Based Informal Science Learning

Through our engagement with teachers in this school-park collaboration, we learned important lessons both about integrating a resource, like Jamaica Bay, in the classroom. The initial motivating factor for most teachers was the day-long professional development. It allowed them to experience the place through direct activities with scientists and rangers involved in park management and research, and textual information, through lectures, printed and web-based materials about the Park. The activities modeled how teachers could explore the park through a scientific lens and using the same tools as scientists and the schedule allowed time

for the teachers to reflect on the experience and discuss classroom practice with the scientists, park rangers and others who are familiar with the park. As the park is quite large, maps provided important spatial orientations for the teachers in respect to the location of their schools and transportation. Accessibility is one of the challenges to teachers actively using the park with their students so the identification of easily accessible sites was an important part of learning about the park.

The PEC and SENCER-ISE projects provided the necessary space to begin to build a learning community around using Jamaica Bay in the classroom. This provided a dialogic space where teachers deepened their practice and attachment to the park, but also where the park and scientists learned about applicability of different activities and research into the classroom. This was a space for developing and sharing curriculum, reviewing local and national curricula and standards in relation to park-based activities, reading and discussing relevant literature around place-based learning and civic action. The learning community afforded a space to "complet[e] the project with a team of teachers to make me feel more comfortable replicating it with my class." This was also a place where teacher and parks staff discussed the challenges of doing science investigations in the park such as transportation (the park is a large space so there are many sites that are not easily accessible by public transportation), safety with students, especially near water, and having the right equipment to do accurate data collection. One teacher noted,

> The best way to deal with the challenges is pre-planning and preparing the students. In order for the trip to be successful the students must know their assignments and what is expected of them. It is important that they know the ground rules and how to properly handle the equipment.

While the PEC teachers were greatly influenced by working with the park, the park was also influenced by working with teachers. First, the park saw that it had to empower teachers to lead investigation with students while adhering to management and safety policy. The park has limited human resources so it is not feasible for a Ranger or other park staff to accompany each field trip, especially in the case of scaling up the number of teachers who actively use the park for teaching and learning. There have been ongoing discussions about policy around the enactment of science research field trips. In addition, certain activities require permits so it is necessary to create policy on issuing permits to schools and classrooms. In terms of pedagogy, the traditional Ranger-led field trip was done through the framework of interpretation in the traditional sense where a Ranger would lead students on a walk through the park and while pointing out particular information. There is a move more towards inquiry, where a Ranger would be a facilitator of learning; designing and learning activities that allow people to make meaning and develop a more personal interaction with and attachment to the park. The NPS strategic plan describes a more towards a more inquiry-based approach to interpretation: We foster transformative experiences that help people find meaning and make sense of issues that reflect the breadth of the country's natural and cultural resources and its peoples (NPS, 2014, p. 6). The document then discusses activities that point to developing place attachment like promoting "active engagement and memorable

experiences" and "exceed audience expectations for learning." It also speaks to a more interdisciplinary and polysemic approach, "design interpretive programs that tell all American's stories…present multiple points of view and encourage inquiry and civic dialogue" (p. 8). This is a move towards the notion of natural objects and landscapes carrying multiple meanings—ecological, scientific, indigenous, aesthetic, historical and recreational—and that these all changes with time (Van Eijck & Roth, 2010).

For the NPS to achieve these goals, it will be important to foster more collaborative relationships the formal educational institutions and create learning communities where boundaries are obliterated, resources and pedagogies are shared, and there are seamless exchanges of culture and information between the park and schools.

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