Development of sense of place through an urban citizen science program

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DEVELOPMENT OF SENSE OF PLACE THROUGH AN URBAN CITIZEN SCIENCE PROGRAM

By

Cornelia B. Harris

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ABSTRACT

Citizen science programs are a way for participants to develop a sense of place, which has been theorized to lead to pro-environmental behaviors. In this mixed-methods study, I document how a citizen science program encourages urban youth to connect with their place, and notice how both joy and wonder are developed as they experience a stunning migratory event with a unique organism, the American eel. Students were excited to be in a creek and to ‘discover’ a new creature in a place that they had walked past for years, one that was merely a backdrop to their lives prior to participating. The creek, and the river to which it connects, is an ecological mystery, and yet it contains amazing stories that can captivate and inspire youth. Providing opportunities for youth to use science to explore nature in their place is a mechanism to develop equity, as it uses an asset mindset to highlight the value of their community. In places where disinvestment and segregation based on race and class has perpetuated the mistaken belief that there is nothing of ecological value, encouraging and providing space for the development of sense of place through citizen science can reconnect youth with nature and with each other.

Over the course of the sampling season, youth developed empathy for both the eel and the eel’s home, and realized that the experience allowed them to consider the other types of life that might exist in the creek and the river. Besides feelings of empathy, students gained ecological knowledge about the eel and its habitat and developed confidence in the sampling activities as autonomy, relatedness, and competence were fostered by the program leaders. As a result, participants described their place in more positive ways at the end of the program, increased their sense of empathy with and knowledge about the American eel, and expressed a heightened pride in the ecosystem where it lives. There was an iterative process that connected place attachment, meaning, and the experiences students were having in the creek, and as students learned more,
they asked more questions and also began to own the knowledge they had gained. However, students’ willingness to engage in pro-environmental behaviors was limited to certain individual behaviors, which suggests that citizen science programs may not be able to encourage behavior change without explicit attention to this as an outcome and opportunities for students to discuss both the complexity of challenges facing the eel possible solutions. There were also discrepancies between the qualitative and quantitative results in this study, which suggests that sense of place, and particularly the affective components of place attachment, are not readily measured with positivist survey approaches. Thus, this study also highlights the limitations of surveys to explore sense of place with urban youth, suggests incorporating qualitative tools for sense of place work, and suggests specific ways that sense of place may be operationalized in order to capture this important outcome in citizen science work.
DEDICATION

For Selina and Jacob, may your curiosity and care about the world never leave you.

For Tom, for all your love and support. I would not be here without you.
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I am incredibly grateful for all of the love and support I have received over the past five years as I have worked on this degree. To be able to spend this time learning how to become a better teacher, and to really understand how people learn, has been a true joy, and I believe the door has only just opened. I could not have done any of this without my husband Tom, who is the foundation upon which all of this is built – he supported me during all the late nights, weekends, and summer days when I had to write, attend class, or just lock myself away to focus. I hope that through this, our children will recognize the power of education, and realize that even adults need (and want!) to continue to learn and work hard. I also want to thank my mother, Brigitte, who was always there for me, kept encouraging me, and gave me space when I needed it to finish this thesis. To my scientist friends – Rhea Esposito, Shannon LaDeau, Collete Salyk - thank you for your thoughtful discussions, your moral support, and your time spent helping me. I also need to thank the friends and graduate school colleagues who kept pushing me and were always ready with a conversation or feedback when I needed it, particularly Susan and Chris Grove, Lauren Collete-Gildard, and Adele Touhey. I am lucky to have a community of people who love ideas and were willing to help whenever a need arose.

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Chapter 1
INTRODUCTION

There is a growing disconnect between people and the places in which we live, coupled with low awareness about how we depend on nature. To live in isolation from nature erases our innate biophilia and the benefits that we can reap from interacting with the natural world (Chawla, 1998; Kahn & Kellert, 2002). Evidence suggests that developing a sense of place combats this disconnect, as individuals who foster deep affective and cognitive connections to a particular place seek to protect that place (Chawla, 2006; Prévot et al., 2018; Stedman, 2002).

People who live in urban areas, however, have more barriers to overcome if they want to experience nature, as unmanaged greenspaces are often few and far between and interactions with nature are oftentimes part of an ‘other’ lived experience (Dai, 2011; Pandya, 2012; Strife & Downey, 2009). The fact that urban youth are not interacting with nature is a social justice issue, since a lack of awareness and pride in place can perpetuate environmental justice issues and other inequities, and further promote the misconception that urban areas do not have wildlife or beauty and thus are not valued (Carlone et al., 2015; Watson, 2006).

Citizen science programs have been touted as a way to reconnect youth with nature and promote their sense of place, as participants are directly involved in place-based activities and may then take action on environment-related civic issues (Jordan, Gray, Howe, Brooks, & Ehrenfeld, 2011). One potential mechanism for taking action is participants’ development of sense of place, which is the attachment people have to a particular location and the reasons for this attachment (B. Jorgensen & Stedman, 2001). The stronger an individual’s sense of place, the more likely they are to want to act in a way that preserves that place and to engage in pro-environmental behaviors (Stedman, 2002). The link between participation in citizen science and sense of place has been hypothesized, and some correlations have been documented in adult
participants, but the mechanisms have not been explored with youth nor has the theoretical construct been carefully applied or operationalized (Evans et al., 2005; Haywood et al., 2016). This dissertation seeks to understand how an urban citizen science program, which gathers data about a local organism in a stream ecosystem, develops a sense of place in youth. Sense of place will then be connected to students’ willingness to engage in pro-environmental behaviors as a result of participating, which would allow us to understand how citizen science programs can be a tool for developing environmental stewardship. This study is unique in that it focuses on urban youth and their relationship to a charismatic organism, the American eel, and the affective nature of developing a sense of place through empathy and pride.

In this chapter I will review the kinds of experiences youth have in nature both during and outside of school, why spending time in nature is important, and how citizen science programs can be an effective means of creating a sense of place among youth.

**Rationale**

Many scholars point to the problem of the increasing disconnect between people and the nature that exists in the places where they live (Balmford, 2002; Celis-Diez et al., 2016; Soga & Gaston, 2016). Repeated experiences in nature allows people to develop relationships with a place, and in particular, the organisms and ecology of a place, and has been linked to caring about the environment (Chawla, 2006; Masterson et al., 2017). Consequently, finding ways for people to experience nature in the places where they live allows them to recognize that nature is not just a place that is far away or an ‘other’, but is surrounding them all the time. This is the first step to building a relationship of love and care for the natural world, and ultimately, a desire to conserve the environment. This connection has been conceptualized as sense of place.
Sense of place is a much discussed and debated construct, but most scholars agree that it includes both place attachment and place meaning (Hernández et al., 2007a; B. Jorgensen & Stedman, 2001; Kudryavtsev, Stedman, et al., 2012; Masterson et al., 2017). Place attachment refers to whether someone has a connection with a particular place, and often includes dependence and identity. Place dependence tries to capture whether people feel like a place is important for satisfying their needs, while identity refers to how valuable a place is for a person’s self (Masterson et al., 2017). Place meaning is why people are connected to a particular place (Kudryavtsev, Stedman, et al., 2012; Masterson et al., 2017; Stedman, 2002). Sense of place is a unique construct because it includes the affective, emotional aspect of connectedness to nature. Although there is a large body of work in the field of environmental psychology on connectedness to nature, it does not include the importance of a local connection or the affective component of sense of place, and thus will not be reviewed in my study.

Unfortunately, in a typical child’s day, there is little space for outdoor exploration, or even free time to think, create, and wonder in their local place without supervision or explicit guidance. When youth go outside, the most common activities that they engage in include “hanging out”, biking, or listening to music. Activities that might allow youth to deeply engage with and experience the natural world, such as hiking or fishing, or just creatively exploring the natural world, do not occur as frequently (Cordell, 2012; Gonzalez, 2019). In a national survey, the most common outdoor activity for youth aged 6-17 was participating in physical education at school, which is arguably not an activity that deeply engages participants in experiencing the natural world (The Outdoor Foundation, 2016). In addition to going outside less often, fewer people are visiting National Parks, and families are spending less time outdoors together, either for recreational purposes or to grow or hunt food (Soga & Gaston, 2016b). A two-year study in
England found that more than 10% of children had not been in a natural environment (park, forest, beach) in 12 months, and the lack of outdoor time is conspicuous across the developed world (Ray & Jakubec, 2018).

Why aren’t youth going outside? Children are spending more time studying, doing homework, playing sports, and watching TV or playing video games (Bassett et al., 2015; Hofferth, 2009; Soga & Gaston, 2016b). Over half of youth between the ages of 2-15 spent more than 14 hours a week in front of a screen in the mid 2000’s, which is about the same amount of time they spent engaged in outdoor activities of any kind (Sisson et al., 2009). As smart phones become more common, screen time increases: teenagers now spend an average of 3 hours a day on screens for leisure (Livingston, 2019). Besides phones and screens, there is also a general lack of interest and motivation in youth to go outside (The Outdoor Foundation, 2016). When asked why they don’t spend more time outside, boys said they would rather play video games or watch television, while girls said they would rather participate in activities such as music, art, or reading (Cordell, 2012). Minority youth said that either they weren’t interested, it was too expensive, they didn’t have the time, or they didn’t have the skills to participate in outdoor activities (The Outdoor Foundation, 2016).

Who goes outside for recreation is also important, and the perception of certain outdoor activities is part of the problem. People who identify as white, and those who have at least some college education, are more likely to engage in outdoor activities (The Outdoor Foundation, 2016). Access to the outdoors is another issue, as people become more concentrated in urban areas where unmanaged green spaces are difficult to access, and parks are often not available (Dai, 2011; Gonzalez, 2019). Urban areas tend to have higher exposure risks to environmental pollutants, more safety concerns such as traffic or violence, and fewer opportunities for residents
to explore the natural areas that do exist (Pandya, 2012; Strife & Downey, 2009). A recent paper from China demonstrated that along an urban-rural gradient, children had fewer experiences with nature as population density increased (W. Zhang et al., 2014). In the United States, urban areas often tend to have higher levels of minority residents, and these “racial enclaves” are often lower-income and plagued with higher crime rates and poor environmental quality (Nasir et al., 2016; Rothwell, 2011). Many parents thus perceive the outdoors to be unsafe and dirty, and this may be their reality if they live in an area where abandoned lots filled with trash are more common than greenspace. Perhaps as a result, African-American children spend more time watching television than their white peers, and report more problems with access to the outdoors (Cordell, 2012; Sisson et al., 2009).

If youth aren’t going outside, and they aren’t having many direct experiences in nature, are they learning about the natural world from literature and media? The rise of television programs about nature coupled with the decrease in actual experience with nature means that much of what children learn comes from virtual sources (Kahn & Keller, 2002; Wason-Ellam, 2010). While there is some promising research that suggests blending videos and actual experiences improves student learning, self-efficacy, and interest in science, much of the media youth engage in is not coupled with anything else (Flagg, 2016; Grotzer et al., 2013). Some children’s television programs do encourage youth to go outside and explore nature, but unfortunately, this has not led to a demonstrated increase in youth exploring the outdoors. One of the most cited examples of this is a study in which researchers asked youth to identify Pokémon characters and local organisms (Balmford, 2002). Unfortunately, students were able to identify more Pokémon characters. Studies have demonstrated that watching nature shows can increase knowledge about the environment and can lead to some environmental behaviors like
donating money to a specific cause, but there is little evidence that media alone can develop a sense of care about nature (Arendt & Matthes, 2016). However, it is possible that youth are engaging in studying nature in schools, through both direct and indirect experiences.

*Schools and Nature*

Although children may have some lessons in school that are outside or trips to outdoor places, these are few and far between, and this concern over a lack of actual outdoor experience is not new (Pyle, 2002). All ages of students report going outside less frequently, with standardized testing being the main reason (Rios & Brewer, 2014; Scott, Boyd, Colquhoun, & Scott, 2015). However, teachers also cite a lack of appropriate equipment and outdoor space, and concerns regarding safety and costs. Furthermore, many teachers report not feeling comfortable outside themselves, and worry about how and what to teach in an outdoor setting (Ray & Jakubec, 2018). Thus, teachers routinely use cook-book labs or prescribed labs disguised as inquiry and remain in the classroom, nevertheless feeling constrained and unsure of how to change their own practice (Ham et al., 1988; Hume & Coll, 2008; McNeill et al., 2013).

Since students don’t learn natural history in school, they generally do not experience and know who lives in their ecosystem (King & Achiam, 2017; Leather & Quicke, 2010; Middendorf & Pohlad, 2014). Lorsbach & Jinks recounted that many of their students “know more about the wildlife found in rainforests and the plains of Africa than they know about the wildlife in Illinois” (Lorsbach & Jinks, 2013). Many children’s books and related media are full of large, exotic, charismatic fauna, often to the exclusion of local biodiversity (Celis-Diez et al., 2016; Dove, 2011; Huxham et al., 2006; Lindemann-Matthies, 2005; Randler, 2008a). A review of Chilean picture books found that 89% of the subjects were of exotic species or landscapes, either from North America or Africa (Celis-Diez et al., 2016). In a kindergarten lesson I recently
taught about birds and bird nests, when I showed students a picture of a cardinal and asked what kind of bird it was, students answered “Angry Bird!” In my own review of the science textbooks used in the Poughkeepsie school district, there were no explicit examples of local organisms or New York State ecosystems. Unfortunately, this focus on distant organisms is despite the fact that the textbooks are a version specifically created for New York State. As Cutter-Mackenzie et al. described, the stories that we use for teaching and learning help us understand “our relationship to one another and the world” (Cutter-Mackenzie et al., 2010). While past generations of children may have talked about outdoor experiences with their peers, Wason-Ellam (2010) remarked that today’s children have a common currency that allows them to have a shared history in virtual places and fictional characters, such as those from Disney or popular video games. Thus, children don’t have informal conversations about the nature around them, and are not learning about the organisms that live in their place in school or from media, which means they have few opportunities to develop a connection with their local ecosystem.

Consequences

Why does not going outside, and not experiencing nature or the organisms that live there, even matter? It matters because human beings are social organisms, who evolved in a landscape of which we needed direct and intimate knowledge in order to survive. We had to understand what we could eat, where the animals lived, how to find water, and what the cycles of the year meant for our lives. This “fundamental, genetically based human need and propensity to affiliate with life” is biophilia, and forms the basis of much research on the value of nature (Kahn, 1999). Biophilia extends the idea of relying on nature for survival to include the emotional connections we have to nature, including love and awe but also fear and aversion (Kahn & Kellert, 2002). We recognize that we enjoy seeing beautiful things in nature, but that we may also be afraid of
things that can cause us pain or injury in nature. In our modern world, engagement with nature and the organisms that live there is generally superficial, and thus we lose the benefits that we gain from immersing ourselves in the natural world.

These benefits include improvements to our physiological health, physical health, social and emotional health, and learning (Kahn et al., 2011). Immersion in nature has been shown to lead to faster recovery after surgery and an increase in social competence. Fields such as eco-therapy and Japanese method of “forest bathing” have reminded us of the physiological benefits of going outside (Li, 2018; Swami et al., 2016). Several studies have demonstrated that just being able to see nature through a window offers psychological benefits, allows people to be more creative and calmer, and enables them to deal with stress more effectively (Kahn, 1999; Kuo, 2001). The relaxing effect of being in nature extends to children with learning disabilities such as Attention Deficit Disorder and Attention Deficit Hyperactivity Disorder (ADHD), who can see a reduction in symptoms from just a short time outdoors. Researchers at the University of Illinois took children with ADHD on twenty-minute walks in a park, in a downtown area, and in a residential neighborhood. After the walk, the children took a test designed to demonstrate their attention. Regardless of whether the children took the nature walk first, second, or last, they always concentrated better after spending time in a natural setting (Taylor & Kuo, 2009). The Center for Nature and Health at the University of California at San Francisco Benioff Children’s Hospital of Oakland has started writing prescriptions for children to spend time in nature, and has found that even the parents of patients who visited parks saw significant decreases in stress (Razani et al., 2018).

Besides losing out on the emotional and psychological benefits, youth who don’t experience nature in a direct way lose the ability to know about the place in which they live. It
takes repeated experiences in nature to develop a sense of care about a particular place (Chawla, 1998). In school, the continued focus on facts instead of connecting content with relevant experience has resulted in a generation of students who are unable to reason about how nature relates to their everyday lives (Anderson, 2007; Danaia et al., 2013). For example, students can identify the terms and are familiar with the typical cyclical representation of water in textbooks, but cannot explain where their own water comes from or where it might go (Covitt et al., 2009; Gunckel et al., 2012). Students cannot explain where common foods come from, or the environmental or social consequences of producing food (Hess & Trexler, 2011). While students are proficient at identifying predator-prey relationships in ecosystems, they struggle with dynamism and systems-thinking, and have little appreciation for the complexity and diversity of life (Demetriou et al., 2009; Eilam, 2012; Hmelo-Silver et al., 2007; Hogan, 2000; R. Jordan et al., 2009; Miller, 2005).

This leads to the importance of experiences with actual organisms. Spending time with organisms, especially with animals, has not received the same amount of attention in the environmental education literature as spending time in nature (Spannring, 2017). But the desire to interact with animals is an extension of biophilia, and has been a part of our culture and history across millennia (Myers & Saunders, 2002). Children have an immense amount of excitement and interest in animals, particularly ones that they can hold, touch, or interact with, and making these connections at a young age can foster a sense of care and respect for living things (Myers & Saunders, 2002; Watson, 2006). Developing relationships with animals helps children develop empathy, as children attribute feelings to the animals and consider how the animal might feel in a particular situation (Born, 2018; Myers & Saunders, 2002). And, similar
to the general benefits of interacting with nature, interacting with animals has been shown to reduce stress, improve mood, and reduce feelings of depression (Blouin, 2012; Born, 2018).

The first step in recognizing the organisms in any place is naming them, as learning to name a local animal helps provide context and understanding to a particular place (Randler, 2008a). When scientists begin research in a new place, they first learn who lives there – and as Linnaeus made clear, knowing exactly what organism you are looking at is important for developing understanding about it, and making connections between the organism and the rest of the ecosystem. Various researchers have demonstrated that if students can recognize and name the organisms in their own backyards, they are more likely to appreciate those organisms (Chawla, 2006; Lindemann-Matthies, 2005). Lindemann-Matthies investigated how students changed their perception of living things as they were taught to identify local organisms on their walks to and from school, and found that as the program progressed and teachers spent more time on the program in class, students noticed more and more species (Lindemann-Matthies, 2002). Naming is anchored in the power of language, because the person who names can also be said to own the knowledge (Freire, 2000). As an example, in a summer environmental class, Carlone et al noted that students became more comfortable in their role as environmental scientists as they began naming local reptiles and amphibians (Carlone et al., 2015).

However, because students spend little time learning the names of local organisms, they end up recognizing only large, basic groups of organisms, and struggle to provide specific names for what lives around them (Le et al., 2018; Wandersee & Schussler, 1999a). In one study which investigated student knowledge about local organisms, Bermudez, Battistón, García Capocasa, & de Longhi examined the responses from more than 300 high school students who were asked to “write down the names of ten animals native to Cordoba Province, Argentina”. Many students
were not able to list ten animals, and ninety-eight percent of the animals listed were chordates, with mammals as the most common (53.88%). Similarly, Le et al surveyed more than 600 middle and high school students throughout the United States, and found that students were more likely to name vertebrates than plants or microorganisms. All ages of students named significantly fewer specific organisms as compared to general organisms (Le et al., 2018). This and other studies point out the prevalence of ‘plant blindness’, where students see plants only as backdrop or scenery, and they also point out the general lack of awareness of the diversity of living things and the ability to name local, specific organisms (Randler, 2008b; Wandersee & Schussler, 1999a).

One could argue that youth can learn to identify organisms through looking at pictures, textbooks, or media, and that naming doesn’t really matter. This ignores, though, the importance of the type of experience, because how children experience the natural world is important. Randler (2008b) suggested that children learn about a handful of local organisms through direct experience and observation. As Myers & Saunders, (2002) noted when discussing how children felt about interacting with animals at zoos, “…observing animals is not as immediate and potent for the self as interacting with them” (p. 167). Dewey (1916) points out that for an experience to have meaning, it needs to have a purpose and continuity. To illustrate, imagine visiting a zoo or watching a nature program. Yes, you see organisms, and you may learn about them, hear them, or even touch them. But without connecting this experience to a personal purpose, and reflecting on the experience, it becomes only an experience, and not an educative one (Arendt & Matthes, 2016; Dewey, 1916). Without reflection, without purpose, and without a connection between the experience and one’s own life, the experience is not meaningful. Being able to see, touch, learn about, and care for a local organism is different from just watching a television program or
seeing an animal in a zoo. This “direct sensory contact” is important for developing empathy for organisms, as well as a sense of responsibility, and may be a way to promote pro-environmental behaviors (Barthel et al., 2018). The citizen science program I am focusing on allows students to experience an animal which is not only threatened with extinction but also lives in the stream which runs through the city where the youth live. Consequently, it is connected to their daily lives because it is part of their same environment, and through the project, they engage with it in very tangible way.

**Citizen Science**

As we have seen, children have few opportunities to spend time in nature, let alone repeated visits to a local place, and do not learn who lives in their backyard or get the chance to directly experience these organisms. For my dissertation, I am interested in whether a citizen science program that allows students to have an extended experience in nature with a local organism can ameliorate this problem, and thus develop a sense of place, which may lead to pro-environmental behaviors. I will now briefly describe citizen science programs, and also provide an overview of what we know about how individuals change as a result of participating.

Citizen science is either “a movement to democratize science” or “public participation in scientific research”, depending on who defines it (Bonney et al., 2016). Many citizen science programs were created by scientists as a way to get more work done, to collect data in more places or over a longer period of time, and there are numerous successful examples of ways in which citizens have helped advance science in some way (Bonney et al., 2016), often environmental science. Other programs were developed with an eye towards improving the public’s perception of science, to build social capital or improve participants’ environmental literacy (Bonney, Ballard, et al., 2009). The bulk of the outcomes research on citizen science has
focused on whether participants have gained knowledge, but there are many other potential benefits (Bonney, Ballard, et al., 2009; Groulx et al., 2017; R. C. Jordan et al., 2012b; National Research Council, 2009). First, due to their informal nature, participants may develop confidence in doing science and be more likely to engage in the processes of science since the programs are not connected to standardized tests or traditional classroom pressures (National Research Council, 2009). The fact that many of the programs take place outdoors is also important, since repeated outdoor experiences are essential to building connections with nature (Chawla, 1998). Then, there is the social nature of the activities. People often work together to gather scientific data, and develop relationships over time that may encourage them to work towards larger goals (Stepenuck & Green, 2015). Consequently, there are social, cognitive, and affective benefits of participating in a citizen science program.

Whether and how an outdoor, environmental citizen science program increases youth participants’ sense of place is the focus of this research. We know that some citizen science programs have documented a change in adult participants’ sense of place, but these papers have relied on self-reported data and have not clearly articulated what sense of place might include (Evans et al., 2005; Haywood et al., 2016). Furthermore, it is unclear whether the sense of place in these studies, or environmental citizen science programs in general, promote or lead to a greater willingness to engage in pro-environmental behaviors. Despite this uncertainty, some funding has already pushed for more citizen science programs with the justification that they will support participants in becoming more “literate”. The Australian government provided $4 million dollars for programs that “provide opportunities for the public to engage in science and inspire STEM literacy and engagement in all Australians” (V. Y. Martin, 2017). For example, Jordan et al. (2011) found that after spending two years in an invasive-plant monitoring project,
participants were more likely to be able to identify invasive plants, but also a feeling of hopelessness due to the pervasiveness of the invasive species (Jordan et al., 2011). As another example, the COASST project found that almost all of the participants felt attached to the citizen science sampling site, but few were able to translate that feeling of stewardship to any specific action (Haywood et al., 2016).

**This Dissertation Study**

This study explored how sense of place developed in urban youth as a result of participating in a citizen science program, and how sense of place is linked to an increased willingness to engage in pro-environmental behavior. We don’t know much about how urban youth benefit from participating, since there is limited research which has documented how urban youth were affected by a citizen science program. We also don’t know how a program that uses a local animal impacts the participants, and there is scant research on sense of place and pro-environmental behaviors as a result of citizen science. Thus, my research sought to document the relationship the youth develop with the eel, starting with learning that it exists, lives in a particular place, and has needs (Kollmuss & Agyeman, 2002; Lindemann-Matthies, 2002). Then, I explored how students talk about the ecological place in the program, namely the creek where they are sampling, and whether this changed over the course of the program. Observing the social factors at work, along with the cognitive and affective components, helped me understand what factors are important in developing sense of place (Carlone et al., 2015; Kudryavtsev, Krasny, et al., 2012). In this study, I sought to answer the following research questions:

1. How does youth sense of place change as a result of this citizen science program?
a. What are the prior experiences of youth with the flora and fauna of their local place, the stream where sampling is happening?

b. How does youth attachment to place, and ecological place meaning, change as a result of this citizen science program?

2. How does youth likelihood to engage in pro-environmental behaviors change as a result of this citizen science program?

3. Is there a relationship between place attachment, ecological place meaning, and likelihood to engage in pro-environmental behaviors? What kind of behaviors are students willing to engage in – personally responsible, community level, or civic engagement oriented?

In the next chapter, I will review the literature on sense of place, how it has been theorized to develop, what evidence exists for its development in the literature, and how this may connect with citizen science, experiential education, self-determination theory, and pro-environmental behaviors. I will also spend some time reviewing the literature on what factors are important for people who consider themselves to be environmentalists.
Chapter 2
LITERATURE REVIEW

In this chapter, I present a review of scholarly research on how citizen science programs can develop a sense of place and pro-environmental behavior in urban youth. The theoretical proposition taken is that as youth gain awareness and appreciation for a place through experience, they come to value it, and want to protect it and the larger ecosystem. This develops as youth learn about a new organism, by walking in the stream where the organism lives, picking it up, and participating in a scientific survey of the animal, within a social structure that applies self-determination theory through autonomy, relatedness, and competence.

There are several main ideas in this chapter. First, I will review the literature on sense of place, its history, constructs, and the factors that are considered important in its development. Second, I will review the literature on pro-environmental behaviors and the ways in which sense of place affects this development. Finally, I will explore the reasons why citizen science programs may be a useful tool towards developing a sense of place, and through that, pro-environmental behaviors. Woven throughout each of these sections are the ideas of experiential learning and self-determination theory, and how citizen science programs might create educative experiences.

**Sense of Place**

Sense of place is a multidimensional construct that has been discussed and argued over for the past several decades (Hernández et al., 2007a; B. Jorgensen & Stedman, 2001; Kudryavtsev, Stedman, et al., 2012). Central to the idea is the acknowledgement that places matter, as people develop a connection with where they live and the things in a place which is important them (Relph, 1976; Tuan, 1977). It draws on the history of nature study, experiential education, and a host of traditions in different disciplines, and has been used as a reason for
implementing many environmental education programs. The concepts within the ‘sense of place’ construct lack a cohesive theoretical framework, and therefore there are many different definitions and approaches. First, I will describe the history of sense of place in education, and then review its theoretical basis, with a focus on its use in outdoor environmental education, since this is most directly connected to outdoor citizen science programs. Then, I will describe which factors are important for the development of sense of place.

Place is a construct that is used not only in science and environmental education but also in geography, history, and language arts education (Ardoin, 2006; Semken, 2005). Using place as an organizing feature in education is not a new idea – as Dewey observed more than one hundred years ago, “No number of object-lessons, got up as object-lessons for the sake of giving information, can afford even the shadow of a substitute for acquaintance with the plants and animals of the farm and garden, acquired through actual living among them and caring for them” (pg 24, Dewey, 1915). The theoretical construct of sense of place, however, has been operationalized in different ways by a wide array of educators as people seek to correct the place-less-ness that has consumed our educational system (Barton & Tan, 2010; Relph, 1976; Sanger, 1997). Thus, it is helpful to examine the way in which place-based education has developed over time, in order to ground the recent interest in developing sense of place as a robust and theoretically sound construct.

Place-based education refers to teaching that connects learners with the “local ecological, cultural, and historical contexts in which schooling itself takes place” (Elfer, 2011). It emphasizes hands-on, real-world learning experiences, provides students with the ability to see the relevance and context of what they are learning, and encourages them to become more engaged in the learning process (Elfer, 2011; Powers, 2004). Researchers and educators alike
have pointed to the importance of place as a potential means of developing in students a sense of community identity, responsibility for the earth, and empathy for living things (Ardoin, 2006; Kudryavtsev, Stedman, et al., 2012; Lewicka, 2011; Masterson et al., 2017; Walker & Chapman, 2003). It is thus theorized that a positive sense of place will lead to pro-environmental behaviors, as a person wants to protect or maintain what they love and respect (Relph, 1976; Walker & Chapman, 2003).

Place-based, nature-focused teaching and learning has its roots in schools and writings from over a hundred years ago (Gruenewald, 2003a; Kudryavtsev et al., 2012; Lorsbach & Jinks, 2013). “Nature study” was first developed in the late 1800s when educators realized that students were becoming disconnected from the their place as teachers used textbooks instead of the real world to teach science (Lorsbach & Jinks, 2013). Through the development of a field school for teachers, the Anderson School of Natural History in MA began advocating for “the direct observation of natural phenomenon rather than learning about the outdoors from textbooks” in the 1870s (Lorsbach & Jinks, 2013). Twenty-four editions of the Handbook of Nature Study by Anna Comstock were published starting in 1911, and these guides were used by teachers to go outside and study local organisms with their students (Gruenewald, 2003a). Comstock, among others at the time, believed that studying nature would be beneficial to both children and their teachers. In an indication that a crowded curriculum was already a concern at the turn of the 20th century, she recounted how teachers would often tell her they had no time for nature study (Lorsbach & Jinks, 2013). Others noticed the disconnect as well: “We are more likely to know the wonders of China and Brazil than of our own brooks and woods” (Bailey, 1911).
As he developed his ideas on experiential education, John Dewey highlighted why students should go outside and study what was familiar and important to them, calling attention to the need for students to experience nature in their daily lives. Dewey recognized that separating real experience in an actual place from the curriculum means that teaching becomes homogenized, and nothing more than a collection of facts useful mainly for regurgitation on exams (Dewey, 1915). This is particularly ironic for science classes, because the place in which we live is the first way we experience science as a child, as we observe what grows where and when, how the sun moves across the sky and changes our shadows, what birds live in our backyards or fly overhead. Dewey encouraged schools to reconnect what was happening inside the school with the rest of a child’s experience.

Thus I have attempted to indicate how the school may be connected with life so that the experience gained by the child in a familiar, commonplace way is carried over and made use of there, and what the child learns in the school is carried back and applied in everyday life, making the school an organic whole, instead of a composite of isolated parts. The isolation of studies as well as of parts of the school system disappears (p.58, Dewey, 1915).

Dewey wanted schools to embed students’ learning in the real world, using experiences that have continuity and purpose, and encourage reflective thinking. Key to true learning is making space for reflection, which can happen in any number of ways, from discussion to writing. While the progressive movement made some progress towards this end, many of the same concerns remain true today, especially when considering how the outdoors are used in schools.

Since Dewey’s time, there have been other efforts to use the outdoors more regularly for instruction, but these have not caught on in a comprehensive way. One example is the school camping movement, which included the nature study movement but also gave rise to outdoor education and other iterations of field trips that involved overnight stays in nature (Donaldson & Donaldson, 1982). Informal, non-school based outdoor education programs are alive and well,
and field trips to zoos, science center, or nature centers are popular activities in schools across the U.S. (DeWitt & Storksdieck, 2008). The problem, however, is that outdoor field trips are often couched in learning facts, or are focused more on character building and teamwork, and do not allow for a place-based experience that has purpose and continuity (DeWitt & Storksdieck, 2008). Often, the experiences end and the students move on to the next part of their day, and don’t have time to consider what they learned or why. The other concern is that while these programs take place outside of the classroom, they do not necessarily engage the students in learning about a place in a way that is relevant and meaningful to them, and thus their experience could be that of ‘anyplace’ outside, instead of supporting a connection to a particular local place.

Place-based education is invoked frequently in environmental education programs as educators seek to connect what they are doing in their informal programs with the larger community (Kudryavtsev, 2013; Powers, 2004). But, this term is used loosely by practitioners, and while there is a nod to the underlying theory and mechanisms at work, most are not explicit about its use. Educators have been known to add the term “place” to their teaching to justify a wide range of activities, and this reinforces the misleading idea that any outdoor activity helps students understand their place (Ardoin, 2006; Kudryavtsev, 2013; Kudryavtsev et al., 2012). Place-based teaching is also criticized as a lens because it often ignores the historical and cultural foundations of places, and focuses only on one way of experiencing a place (Ardoin, 2006; Gruenewald, 2003b; Semken, 2005). With some exceptions (such as the Foxfire program), environmental education programs often ignore any recognition that a place has multiple meanings or relevance, especially from a non-Western perspective, or that there might be different ways of feeling about a place outside of an ecological view (Bowers, 2002, 2008; Gruenewald, 2003a). “…when we accept the existence of places as unproblematic – places such
as the farm, the bank, the landfill, the strip mall, the gated community, the new car lot – we also become complicit in the political processes, however problematic, that stewarded these places into being and that continue to legitimize them” (Gruenewald, 2003a). Place is another way to reinforce the power relationships in a community, with ownership of a particular place central to this idea (Gruenewald, 2003a). Thus, often inadvertently, teaching in a place-based way can subsume the legitimacy of other ways of knowing the world, and potentially ignore the multiple perspectives that should be a necessary constant.

It is important, therefore, to move beyond vague descriptions of place and discuss the theoretical foundation of place (Ardoin, 2006; Jorgensen & Stedman, 2001; Kudryavtsev et al., 2012). There are many ways to think about how people connect with the places they live, the places they are from, or the places that they encounter during their lives, but sense of place is a commonly used umbrella term that has seen over forty years of research (Jorgensen & Stedman, 2001; Kudryavtsev et al., 2012; Masterson et al., 2017). Numerous researchers have said that sense of place research has suffered from a lack of construct clarity, due to the multidisciplinary nature of the research base and differing theoretical and methodological approaches (Ardoin, 2006; Lewicka, 2011; Masterson et al., 2017; Stedman, 2002). There are both positivist and phenomenological approaches to sense of place research: positivistic research uses “researcher-designed variables, quantitative methods, and traditional hypothesis testing”, while phenomenological approaches are more qualitative (B. Jorgensen & Stedman, 2001). As a mixed-methods study, I combined aspects of the phenomenological and positivist approaches, hoping to understand how sense of place developed and whether there was a relationship between variables.
I agree with the scholars who argue that sense of place includes both place attachment and place meaning, but will offer additional explanatory concepts that will make the place concepts more concrete (Ardoin, 2006; Kudryavtsev, Krasny, et al., 2012; Kudryavtsev et al., 2012; Masterson et al., 2017; Stedman, 2002; Vaske & Kobrin, 2001). I will briefly describe each, and then discuss the history of these concepts as they relate to place. Attachment and meaning have a reciprocal and entwined relationship; including both concepts in my research recognizes that the construct includes cognitive and affective components (Ardoin, 2006; B. Jorgensen & Stedman, 2001; Stedman, 2002). It is essential to understand why someone is attached to a place, or what meanings they ascribe to a place, and not just whether they are attached. For example, Kudryavtsev et al. (Figure 1) posited that meaning and attachment were both necessary for a sense of place, but did not highlight the connections between the two concepts (Kudryavtsev, Stedman, et al., 2012):

![Figure 1: Sense of place diagram, modified from Kudryavtsev et al., 2012.](image)

However, I believe that meaning is entwined with attachment, and the concepts within attachment strongly overlap and affect people’s place meaning. Within place attachment, scholars generally include the concepts of place dependence and identity, since these are important factors that influence attachment (Hernández et al., 2007a; Lewicka, 2011; Masterson et al., 2017; Stedman, 2002; Vaske & Kobrin, 2001). The diagram (Fig 2) from Masterson et al. demonstrates the relationship between attachment and meaning more completely, and also
includes a feedback loop between sense of place and behavior (2017). Masterson also includes dependence and identity, but does not explain what might illustrate each of these concepts.

![Figure 2: Sense of place diagram modified from Masterson et.al (2017).](image)

Next, I will explore both attachment and meaning, and then how sense of place is potentially connected to place-related behavior.

Place attachment is the bond between a person and a place, or how important a place is to someone, and is usually positive (Kudryavtsev et al., 2012; Masterson et al., 2017). Almost 30 years ago, Altman and Low described place attachment as the “bonding of people to places”, and since then, it has been the subject of much scholarship (Altman & Low, 1992; Bertling & Devine-Wright, 2014; Lewicka, 2011; Manzo & Devine-Wright, 2013). Because it is an emotional component, it pays attention to the affective side of people, and how they feel as they engage with a particular place. A place can generate feelings of pride and optimism (Gibson & Barr, 2015). Recent literature has begun to explore the nuances of place attachment as scholars recognize that not all attachment is positive (Stedman et al., 2013). For example, youth in New York City held both positive and negative feelings about their neighborhoods, such as the way the increase in new development displaces older businesses or disinvestment encourages littering (Lim & Barton, 2010). Lewicka (2011) also pointed out that place attachment can lead people to
support very different futures for their place – if they are positively attached, they generally resist any changes, but others may welcome the same change.

What does it mean to be attached to a place? Some people are attached to a place because they depend on it for their livelihood, while others have emotional connections to the land or to events that happened in the place (Lewicka, 2011; Scannell & Gifford, 2010; Worster & Abrams, 2005). These are the concepts of dependence and identity. Dependence is “the potential of a place to satisfy an individual’s needs by providing settings for his or her preferred activities” (Kudryavtsev, Stedman, et al., 2012). New England fishermen and farmers, for example, had strong place dependence, but it developed over time as they became more and more immersed in their jobs and the environment that they worked in, and recognized that leaving their profession would impact not only their economic security but also emotional well-being (Worster & Abrams, 2005). This is an example of how dependence is often deeply entwined with place identity, which is “the extent to which a place becomes part of personal identity or embodied in the definition of the self” (Kudryavtsev et al., 2012). As Jorgensen and Stedman (2001) demonstrated among lakeshore homeowners, a place can also be a part of a person’s identity because it provides emotional benefits such as relaxation or feelings of calm. Along with this overlap, there continues to be debate about whether one precedes the other, is subsumed by the other, etc. (Hernández et al., 2007a; Lewicka, 2011; Masterson et al., 2017; Stedman, 2002; Vaske & Kobrin, 2001). Other researchers have argued that place identity is multi-faceted and inclusive of numerous concepts, such as self-esteem and self-efficacy from identity process theory (Lalli, 1992; Twigger-Ross & Uzzell, 1996).

Some researchers claim that attachment studies have been too limited. For example, many studies assume a positive connection between a place and its residents, although many
places exist that have both complex and negative connotations for their residents (Brown et al., 2003). Others ignore immigrant populations or transient communities, leading to an oversimplification of causality (Hernández et al., 2007a). Are you more attached because you have lived somewhere longer, or do you make more connections with the people and place because you’re more attached (Lewicka, 2011)? Stedman (2002) and Jorgensen & Stedman (2001) surveyed lakefront property owners in their attachment studies, the majority of whom were using the properties as second homes. Both papers found strong place attachment, which could be expected within a group who selected a second home in order to relax, enjoy the lake, and escape their otherwise busy lives. Would the authors have found similar results if they had studied residents in a city who loved their urban neighborhood, or loved living in an apartment building? In a study of “native” and “non-native” residents, Hernandez et al. found differences between attachment and identity, and posited that one does not necessarily require the other. The authors compared native residents who had always lived in a particular place with non-natives, defined as people who had been born elsewhere but now lived in the study city. For the native residents, attachment and identity were synonymous, but for the “non-native” residents, attachment was stronger than identity (Hernández et al., 2007a). Hernandez et al. believe that people who are new to an area feel strongly attached to the place, despite it not being part of who they are at the current time. However, the sample size of the study was relatively small, and the study employed only survey tools. Consequently, additional work needs to be done with more diverse populations to fully understand the concepts within place attachment.

Place meaning, which refers to what a particular place symbolizes or means for an individual, is the other essential component of sense of place. “One cannot understand sense of place without knowing its cognitive content; meanings put the “sense” into sense of place”
Masterson et al. (2017) explain that meanings can be descriptive – how people describe their place – or symbolic, to explain what a place represents to a person. Place meaning is often described as the reason for place attachment, and it can be multi-faceted and change over time (Stedman, 2002). Meanings can include historical, cultural, social, ecological, political, economic, and physical attributes (Russ et al., 2015; L. E. Sullivan, 2010). As an example, Lim & Barton (2010) found that children connected to very different places and spaces in the same neighborhood, depending on what they wanted to do or how they felt at a particular time. One child had a very favorable opinion of his home neighborhood, because he had worked on a wall mural that decorated his apartment building. Another child felt proud to be known by the people in her neighborhood, as that gave her a sense of belonging. Similarly, Sullivan (2010) pointed out that the Hudson River may be a place for relaxing or recreation for some, or a commercial hub for others. The same place can thus have a different meaning to different people, because of the things in it and the memories these things hold.

Assessment of sense of place has been done in many ways. Attachment is usually assessed through Likert-scale surveys that include both dependence and identity items (Kudryavtsev, Stedman, et al., 2012). Since attachment is “fundamentally evaluative”, surveys can be used to determine whether people have a good or bad attachment to a place, or whether it is important or unimportant to them (Stedman, 2016). Meanings have also been determined through surveys, such as giving participants a choice between statements that describe a place. Stedman (2002) provided statements such as “My lake is extremely peaceful” and “My lake is a place to escape from civilization”. However, these kinds of statements may or may not encompass all of the ways a person is connected to a place, and they may lead participants to answer in a certain way, which is why many researchers also include open-ended questions on
surveys and use interviews or other methods such as photo essays to probe sense of place more carefully (Kudryavtsev, Stedman, et al., 2012; Lim & Barton, 2010).

There are a number of factors that influence sense of place in an individual, and these can be personal, at the level of the group, or at a larger political level (community, city, nation) (Vorkinn & Riese, 2001). Ardoin (2006) provided a useful framework for considering the multitude of influences on a person’s sense of place, organizing the influences along overlapping spheres (Figure 3):

![Figure 3: Dimensions of sense of place, modified from Ardoin (2006).](image)

The physical space, or biophysical setting in Ardoin’s model, necessarily mediates all of these interactions, recognizing that what people find meaningful varies. Some people may value a natural feature such as an old tree or a stream, while others may point to a neighborhood café or a street corner (Scannell & Gifford, 2010). In my study, I am interested in exploring the ecological place meaning that youth hold, and how that contributes to their willingness to engage in pro-environmental behaviors. Ecological sense of place was defined by Russ et al. (Russ et al., 2015) as “the extent to which ecosystem-related phenomena are viewed as valued or
important components of place”. In their work in the Bronx, they found that environmental education programs increased students’ ecological place meaning and thus some aspects of sense of place. Thus, I am focused on the natural components of the landscape, and how youth understand the ecosystem and develop a relationship with it over time.

Another dimension of sense of place is the social connections people have with each other in a particular place, because these experiences form the foundation of memory and thus meaning. “First, the individual functions as part of society, which develops, portrays, and often promotes an aggregate understanding of place. Second, the cultural and symbolic elements sustain society’s views of and beliefs related to place” (p116, Ardoin, 2006). Worster & Abrams (2005) found that the relationships people had with each other in their place led to the development of their identity, as they relied on people to help them understand crucial components of making a living off the land such as where to find fish or when to plant. And as Carlone et al. noted, youth participating in a summer herpetology program developed strong interpersonal connections which reinforced their interest in the animals and the program in general, and helped them develop a positive science identity (Carlone et al., 2015).

Consequently, having or developing friendships in a place leads to a feedback loop that increases positive feelings for that place. These feelings of relatedness and competence will be explored in the next section.

Ardoin also points to the political and economic elements, which can interact with the individual and sociocultural as people join advocacy efforts or work to change (or maintain) their communities. Scannell & Gifford (2010) investigated natural versus civic place attachment, and found that while communities had strong civic attachment, the reasons for some residents were more related to natural aspects of their place, while for others, economic and political factors
were more important. Social networks necessarily overlap with political elements, and as individuals become more involved in community efforts, they develop relationships that may encourage them to work towards larger goals (Stepenuck & Green, 2015).

Besides these elements, there are the individual (psychological) components, such as how long someone has lived in a place and the types of experiences they have there. Many of these factors are similar to those that influence pro-environmental behaviors. Predictors of place attachment include rootedness or residence time, mobility, and social belonging or connections (Hernández et al., 2007a; Lewicka, 2011). Residence time, or how long you live in a particular place, is often linked with attachment (Lewicka, 2011). However, the term itself has nuance – it is important not just how long you have lived somewhere but what you do during the time when you lived there. For example, people tend to be more attached if they spent more time outdoors, and children develop stronger attachment if they can safely explore outdoors (Korpela et al., 2009; Lim & Barton, 2010; P. Morgan, 2010). Hernandez et al. (2007) found that mobility along with shared meaning was an important driver. Just because you have lived in a place for a long time, it doesn’t necessarily mean that you will be deeply attached to it, and conversely, if you have recently moved, that you can’t or won’t care about a new place (Ardoin, 2006). As discussed earlier, experiences in a place matter a great deal, and if a person develops a positive sense of place through personal experience, what does that mean? Does it indicate that they will be likely to protect a place, and if so, to what degree? First, I will review what pro-environmental behaviors are and how they are theorized to develop, and then explore the research on the connections between sense of place and pro-environmental behaviors, along with how this connects to citizen science.

Pro-environmental Behaviors
Behaviors that are pro-environmental range from simple actions like recycling or turning off the lights to advocating for changing a current law or regulation. Unfortunately, many papers do not define what the authors mean by pro-environmental behaviors, using a variety of terms to describe similar ideas, including environmentally responsible behavior, environmental citizenship, and environmentally conscious behavior, among others (Chawla & Cushing, 2007; Cheng & Wu, 2015; Lee et al., 2014; Stern, 2000; Wells & Lekies, 2006). Kollmuss & Agyeman defined pro-environmental behavior as “behavior that consciously seeks to minimize the negative impact of one’s actions on the natural and built world” (p.240). Stern (2000) used the term environmentally significant behavior, and included positive and negative behaviors in his analysis, distinguishing between environmental activism, public (but not activist) behaviors, private environmentalism, including consumer choices, and behaviors in organizations including joining environmental groups. The ways in which researchers assess pro-environmental behavior also varies quite a bit, although most rely on survey tools (Kaiser et al., 2007; Kollmuss & Agyeman, 2002; Stern, 2000; Wells & Lekies, 2006). For example, Wells & Lekies (2006) asked participants three questions about their environmental attitudes and four questions about their behaviors, such as whether they had voted for someone based on their environmental views or if they recycled.

In general, there are papers that focus on individual behaviors that affect the environment, and those that focus on a collective, social approach to solving environmental issues (Groulx et al., 2017; Kenis & Mathijs, 2012). This is similar to the levels of citizenship proposed by Westheimer: the personally responsible citizen, the participatory citizen, and the social justice-oriented citizen. In an attempt to go beyond letter-writing or helping with a park cleanup, Westheimer wants to encourage citizens to move towards a level of engagement that is
both individual and collective, where they think about root causes and then question and seek solutions (Westheimer, 2015). Similarly, Freire asked students and teachers to actively struggle with the incredible inequities in our society, ranging from social to economic to environmental, and consider ways to create positive change (Freire, 2000). The idea that pro-environmental behaviors should move beyond simple, individual actions is also justified when considering the neoliberal context of much environmental education, which suggests that complex, global environmental problems can be solved through personal choices (Schindel Dimick, 2015).

The neoliberal focus within our culture leads students to believe that environmental problems are ‘solvable’ through individual actions, while at the same time erasing or minimizing the important affective and emotional connections to the environment (Schindel Dimick, 2015; Spannring, 2017). Many researchers have pointed out that while individual behaviors are important, they are not enough to solve the large, complex problems facing our global community (Chawla & Cushing, 2007; Dillon et al., 2016; Schindel Dimick, 2015; Stern, 2000). “If environmental educators confine themselves to fostering private sphere environmentalism, they may in fact be leading students astray” (Chawla & Cushing, 2007). Unfortunately, students are generally not engaged in political issues or empowered to support collective change in their communities, and thus social-justice actions are uncommon (Barton & Tan, 2010; Carpenter, 2012; Schindel Dimick, 2015). Civic educators have also noted that the kind of behavior that educators foster is on the personal level, instead of on the underlying structural issues (Levine, 2007; Westheimer, 2015). For my purposes, I adopted the broad definition of pro-environmental behaviors from Stern, which encompasses both individual choices and public actions: any behavior which “changes the availability of materials or energy from the environment or alters the structure and dynamics of ecosystems or the biosphere itself” (p.408). This addresses the
neoliberal critique and encompasses a broad suite of possible pro-environmental behaviors. In Chapter 3, I will detail the types of behaviors I focused on, including individual actions but also participatory actions and those that are considered collective, civic behaviors.

Determining what influences the development of pro-environmental behaviors is a complex question, but some broad themes can be pulled from the literature. How people feel about nature and the environment, their attitudes towards it, their social environment and the norms of their peer groups, their knowledge about the environment and their understanding of the consequences of environmental change, their experiences in nature, as well as external factors such as an individual’s economic situation and the social constraints are all important (Kollmuss & Agyeman, 2002). The linear knowledge-attitudes-behavior model, which posits that as people increase their knowledge, they develop improved environmental attitudes and then pro-environmental behaviors, has been a powerful framework in environmental education and education in general (Hungerford & Volk, 1990; Kollmuss & Agyeman, 2002). However, we now know that behavior change is much more complex.

In an effort to focus this work on how a citizen science program that uses a local organism can potentially influence pro-environmental behaviors, I think it is important to move beyond the Kollmuss & Agyeman knowledge-attitude-behavior model to incorporate specific aspects of experiential education. There is the importance of formative experiences in nature during childhood within a social network, the development of relationships with organisms, internal motivations, and the value of gaining understanding about the natural world (Chawla & Cushing, 2007; Masson & Otto, 2021). Below, I illustrate the model (Fig 4) that I used in this study, where attachment and meaning were linked, influenced by specific experiences, and connected to pro-environmental behaviors that then subsequently and iteratively influence sense
of place. It is based on the work of Masterson et. al (2017) and Kudryavtsev et.al (2012), paying homage to the importance of science content knowledge, but also incorporating Batson et al.’s empathy-altruism hypothesis and specific aspects of experiential education.

Figure 4: The relationships between sense of place, pro-environmental behaviors, and experiential education through citizen science that formed my initial research model.

Wells and Lekies developed a model of the connections between childhood nature experiences and adult environmentalism, surveying 2,000 adults living in urban areas. They found that adults who had spent time in what they call “wild” nature as children had a positive attitude towards the environment, more so than adults who had experience only with “domesticated” nature (Wells & Lekies, 2006). “Wild” nature experiences included camping, hiking, hunting/fishing, and playing in the woods or other natural areas, while “domesticated” nature experiences included picking flowers or food from a garden, and taking care of indoor or
outdoor plants. Interestingly, Wells & Lekies found no relationship between participation in environmental education programs or experiences in nature with other people and adult environmental attitudes, and they did not investigate pro-environmental behaviors. It is possible that the way their survey was constructed led to these outcomes, because other researchers, detailed next, have found significant connections between time outdoors with others and pro-environmental behaviors.

In a review of what encourages pro-environmental behaviors, Chawla (1998) describes a number of studies which highlight the importance of outdoor experiences with nature along with adult mentors. One early study consisted of mailed surveys to people who were working in conservation fields, which found that most of these people (78%) had significant experiences with natural areas during their youth. Another survey study asked members of an environmental education group to self-report their environmental behaviors, and then linked these answers to their self-reported “experiences that led to this practical concern” (Chawla, 1998, pg1124). Over 90% of the respondents included the outdoors as part of their reason for taking personal environmental action, with the category of `childhood outdoors’ having the highest rating. In Chawla’s subsequent work with interviewing environmental activists, she confirms that outdoor experiences with family and friends are one of the most important reasons for pro-environmentally responsible behaviors (Chawla, 2006).

In another seminal paper in understanding what encourages positive environmental behavior, Kals et al devised a questionnaire in which participants were asked about their pro-environmental activities, separated into public and private behaviors, along with questions about their present and past experiences in nature, emotions, and interest in nature. The results from 281 respondents showed that emotional affinity toward nature had the highest relationship to
environmentally friendly behaviors when compared with interest in nature and indignation about insufficient protection of nature. Furthermore, emotional affinity was developed by “present as well as past experiences with nature” and present and past “accompaniment during nature experiences” either with family or friends (p196). Although this study was conducted exclusively in Germany, it highlights the importance of an emotional connection to the outdoors as a catalyst for caring about the natural world.

Besides being outdoors, interacting with real organisms is another important way to develop a sense of care towards the environment (Vining, 2003). Batson’s empathy-altruism hypothesis extends to animals, and points out that altruism does not only happen when reciprocity is expected (Batson et al., 2015). Consequently, encouraging youth to interact with living things allows them to care about them, and may motivate them to take action that preserves them or their habitat. In a qualitative study of children who participated in rescuing trapped salamanders, Barthel et al. found that the youth developed feelings towards the animals as they worked on the project, stating that they would help salamanders even two years after the end of the project (Barthel et al., 2018). The children felt that they were part of something bigger than themselves, and they enjoyed this responsibility (Barthel et al., 2018). Watson (2006) found that during a summer camp, urban children used the animals “to engage with the local natural world that surrounds them”. The animals provided the youth with a window into nature, a way of understanding a place that was very different from their normal, everyday experience (Watson, 2006). While Carlone et al. did not consider the affective response of the youth to the reptiles and amphibians they were studying, it is clear that as they learned about the animals and gained confidence in handling them, they began to empathize with the animals. When the students learned that a snapping turtle is not “mean” but simply trying to protect itself,
the discourse changed from fear or disgust to “He’s just upset about being held” (Carlone et al., 2015).

Similar to how multiple outdoor experiences affect people’s attitudes towards the environment, youth need repeated opportunities to engage with living creatures to foster a sense of empathy. Barthel et al. found that youth needed time to become comfortable in their role as caretakers of the salamanders, and Carlone et al. noted that providing tools (“boundary objects”) for students to use as they learned how to sample for amphibians and reptiles supported an increase in their comfort with the animals (Barthel et al., 2018; Carlone et al., 2015). Direct contact with living creatures helps youth develop positive attitudes towards them, especially those organisms that youth may be afraid of or consider disgusting or useless (Tomazic, 2011). Unfortunately, the idea of caring is often contradicted by the way schools and society frames students’ interactions with living things and the environment, for instance by using animals for dissection and as products to eat, wear, etc (Kincheloe, 2008; Noddings, 2015). Critical scholars point out that our insistence on separating people from the natural world reinforces the capitalist, neoliberal mindset where humans have dominion over other living things and are at the center of all life (Kellert, 1997; Pedersen, 2010). In most cases, our culture sees animals as commodities that can and should be eaten, dissected, or kept in captivity for entertainment (Myers & Saunders, 2002; Spannring, 2017). Consequently, developing a caring relationship with animals disrupts this norm and allows students to connect with the environment in a positive way.

Youth also need knowledge about animals and the environment in order to counteract preconceived notions about them, or change their attitudes towards them (Carlone et al., 2015; J. M. Morgan & Gramann, 1989). As was described in Chapter 1, children who learn the names of local organisms start paying more attention to them, and naming can lead to caring (Carlone et
al., 2015; Lindemann-Matthies, 2005). Besides naming, students also need to have an understanding of the processes operating in ecological systems – the movement of matter and energy and the connections between different scales and time frames. Unfortunately, students tend to see the world as made up of discrete parts, with abiotic resources and conditions as separate from living things, and cannot often reason about the consequences of disturbances (Hokayem & Gotwals, 2016; Zangori & Forbes, 2016). Consequently, knowing what lives in one’s own backyard, and being able to reason about how those organisms fit into the larger ecosystem, is part of developing a sense of caring about a place (Kahn & Kellert, 2002; Lindemann-Matthies, 2002). And, as people build their understanding of organisms, they are developing a library of resources from which they can draw on to explain their world. Dewey believed that once you have an interaction with the world, you need time to make meaning of that interaction, which is the essential component of reflection. An experience “involves interaction between the self and another person, the material world, the natural world, an idea, or whatever constitutes the environment at hand” (Rodgers, 2002, p. 846). In this project, students were having an experience with the natural world, exploring the ecosystem and the organisms that live there, and sharing that experience with others.

The importance of relationships found in Chawla and Kals’ work highlights how social networks can encourage positive attitudes towards the environment through outdoor experiences. People experience the world both individually and collectively, and make sense of it based on the norms in their community and their needs (Rogoff, 1990; Tidball & Krasny, 2011). As was mentioned in Chapter I, many youth don’t spend a lot of time outdoors, so going outside and spending time in “wild” nature can be a very new and uncomfortable experience (Cordell, 2012; Gonzalez, 2019; Wells & Lekies, 2006). Both adult and peer role models can support the
development of personal competence in youth as they move towards feeling comfortable and successful in a new environment (Chawla & Cushing, 2007). Youth also need to have fun and trust others as they work towards goals they think are important, with support from adult leaders who can help break goals down into manageable chunks (Chawla & Cushing, 2007). Carlone (2015) found that the support between peers in an outdoor setting helped facilitate understanding and confidence, illustrating the value of informal relationships. Numerous researchers are exploring ways to empower youth through community collaborations, allowing youth to develop their own decisions and disrupt unsustainable practices (Calabrese Barton, 2012; Hobson et al., 2016). Supporting the development of peer and adult mentors and relationships is thus crucial to creating positive connections with the environment.

Citizen science

Because they are inherently hands-on, citizen science programs can encourage the development of a positive connection with the environment, their communities, and the organisms that live there (Phillips, Ballard, Lewenstein, & Bonney, 2019). There is evidence that many citizen science programs increase participants’ awareness of organisms or ecosystems, which is an important step towards understanding. For example, people participating in the Birdhouse Network were able to identify more birds, and citizens working on invasive plant studies were better able to identify them after participating (Brossard et al., 2005; R. C. Jordan et al., 2011; Spellman, 2015). People who collect weather data for the Community Collaborative Rain, Hail, and Snow Network increase their understanding of weather patterns, and people who help survey for monarch eggs and larvae increase their understanding of monarch butterfly biology (Bonney, Ballard, et al., 2009). Besides content knowledge, participants also gain an
understanding and awareness of science as a process, in addition to science process and data literacy skills.

In addition, numerous citizen science programs have documented an increase in social capital, which is an important benefit of volunteering. There is considerable debate about the definition of social capital, but for the purposes of this work I used the definition from Krasny et al (2012): “features of social organization such as networks, norms, and social trust that facilitate coordination and cooperation for mutual benefit.” People who start working together develop relationships over time that may encourage them to work towards larger goals (Russ et al., 2015; Stepenuck & Green, 2015). It is very probable that the social nature of gathering scientific data, especially outdoors, is both an initial motivator and a means to persist in the activity. Consequently, many projects measure whether people demonstrate some aspect of social capital, including: connections between volunteers, between volunteers and scientists or project staff, trust in other stakeholders, pride in participating, etc (Krasny et al., 2015; Stepenuck & Green, 2015). Phillips et al. (2019) found that many participants reported engaging in social activities such as sharing information about the project, and that these activities were personally important to them. Bonney et al. (2016) found that some projects, such as those that were co-created between volunteers and scientists, were especially valuable for participants, leading them to work on influencing local policy.

This leads to the importance of the structure and the types of outcomes of the citizen science program: structure drives the types of activities, the nature of the interactions between scientists and volunteers, and the potential of the projects to create change. There are programs that only do data collection, some that focus on data processing, curriculum-based projects, and community science or participatory projects (Bonney, Ballard, et al., 2009). Numerous scholars
have suggested that participants in citizen science programs should be brought to the table from the outset, so that they can help create questions and build knowledge alongside the scientific experts (Calabrese Barton, 2012; Dillon et al., 2016; R. Jordan et al., 2016). Doing so would encourage ownership and connections between the community and the project, and develop “individuals with a collective expertise characterized by a deep connection to place, the capacity to use this connection to engage community members, and the knowledge of scientific processes to take action on local issues” (Calabrese Barton, 2012). Projects that are collaborative tend to provide a higher level of engagement in addition to building knowledge (Calabrese Barton, 2012; Dillon et al., 2016).

Types of outcomes are also important, ranging from increasing the understanding of the process of science to science identity to developing relationships to increasing trust between scientists and the public. Jordan et al. (2012) specified three different types of outcomes, mirroring what Bonney et al. suggested in 2009: individual learning outcomes, programmatic outcomes, and community-level outcomes. Some programs may be focused on scientific questions or need, in which case, the scientific programmatic outcomes will be the focus. Other programs may seek to influence scientific skills like how to collect water quality data, in which case, the individual learning outcomes may be the focus. However, I do not think this framework is helpful if we want to consider how best to support participants in making pro-environmental behaviors and feel confident in taking collective action. What we really need is a way to help program developers understand that there is an important difference between outcomes like content knowledge or using a probe and outcomes like improving empathy with a species or collectively organizing to improve the environment or community. If, for example, you are running a bird ID program, and you want to make sure all of your participants learn to
identify bird species, there are simple steps you could take to ensure that happens. But, if you want to influence your participants to change their personal behaviors – perhaps by keeping their cat indoors or promoting legislation to require spaying and neutering all cats – then you need to engage your participants in very different tasks, and structure your program appropriately.

Whether individuals engaged in citizen science programs engage in any of the types of pro-environmental behaviors also relates to their connections with others and their community. Many papers suggest that citizen scientists develop “real and meaningful opportunities … to enact change in their communities and their identities” (Wallace & Bodzin, 2017). Haywood et al. (2015) found that as a result of participating in a citizen science program, more than a third of participants were likely to continue participating, and there were a host of “next steps” that were mentioned by participants, including communicating with elected officials about biodiversity issues. The community generated within the participant network is crucial to developing participants who remain engaged and committed to the project, and who can then use their experiences to take additional steps towards pro-environmental behaviors. Fostering a positive team atmosphere where participants want to persist can happen in a number of ways, but developing youth autonomy, relatedness, and competence through self-determination theory is well documented as a mechanism for developing individuals who are socially responsible (Deci et al., 1991; Deci & Ryan, 2012; Masson & Otto, 2021). Thus, structuring a program with the features of self-determination theory will likely enhance place attachment through identity and dependence (Carlone et al., 2015).

Self-determination theory is a way of understanding how people become motivated to grow and change, focusing on three interrelated needs: the need to feel connected (relatedness, or
feeling related to others), the need to feel competent, and the need to feel in control of one’s own decisions (autonomy). Autonomy involves feelings of willingness and choice in regards to activities undertaken; relatedness refers to feelings of closeness to other people; and competence involves feeling able to master challenges and having effective interactions with the environment (Katz and Assor 2007). In self-determination theory, students’ internal motivation to learn through curiosity and exploration are fostered by supporting these needs (Ryan & Deci, 2013). Thus, environments where youth are encouraged through “autonomy supportive” actions versus those that are more controlling end up developing students who are more interested in learning on their own (Ryan & Deci, 2013). Through the research on self-determination theory, we have evidence that students who are encouraged to make their own decisions, who connect with others, and who are supported to develop confidence and understanding of skills and concepts, “learn better and are more creative” (Ryan & Deci, 2013). How adult leaders, be they teachers or parents, support youth in these activities is crucial, because the structure imposed on participants dictates the success of the outcomes.

Besides the structure and the interactions between participants in a citizen science program, it is also important to consider how citizen science programs might help participants develop a sense of place. Some evidence exists that some programs may build individuals’ place attachment and meaning. For example, Evans et al., 2005 found that after participating in the Neighborhood Nestwatch program, people had an increased awareness of their own place (83%), and 56% indicated that they were likely to change their backyard so that it could become a better habitat for birds. This illustrates that participants were more attached and attributed meaning to their backyards because they learned how important the habitat was for the birds. Haywood, Parrish, & Dolliver, 2016 found that almost 75% of their participants “articulated a deepened
sense of place arising out their regular participation” in their program, which involved making observations of coastal birds along a stretch of beach. Although Haywood et al. did not explore what participants meant about feeling more connected to the beach, it was suggested that the repeated walks coupled with learning about the nesting seabirds increased participants attachment and meaning. Overall, though, sense of place is an under-studied component of citizen science programs. In a review of 64 nature-based citizen science programs, Groulx et al found that fewer than 3% of the articles mentioned participants’ connection (or reconnection) to place.

Similarly, while many programs measure the knowledge increase in participants, few assess whether people are encouraged to mobilize towards collective action or changing behaviors (Groulx et al., 2017). Groulx et al define collective action in the context of climate change as “a formal or informal arrangement of people working together to promote climate mitigation or adaptation, often in the face of future uncertainty and with limited information”. Especially for the topic of climate change, which is connected to so many socio-ecological problems, it is important that people feel empowered and engaged in a community instead of fearful, because this can lead to apathy and denial (O’Neill & Nicholson-Cole, 2009). Although more than sixty-four papers were included in Groulx et al’s review, only 5% of papers demonstrated community level outcomes, or showed that participants’ ideas, beliefs, values, or feelings were impacted. The most common outcome was that new knowledge was developed, followed by new skills, all measured at the scale of the individual (Groulx et al., 2017).

Ballard et al. (2017) evaluated two programs that worked with youth in citizen science settings and found that the youth developed “different aspects of environmental science agency”, which the authors coin as “ways that young people use science learning and participation as a
foundation for action related to environmental sustainability”. The authors focused on three separate components: understanding environmental science content and science inquiry, understanding their own expertise within environmental science, and using citizen science as a means for change. They found that students at all sites became experts in a particular data collection or analysis method, learned new ecological content knowledge, and took on more responsibility and gained confidence as the program progressed. They also noticed that some youth took on leadership roles within the group from year to year, shared research with others, “gained new perspective” on ways they could implement change, and developed a deeper relationship to the creeks and beaches they were studying. However, using citizen science as a motivation for creating change was not common among the youth, and the actions that youth did discuss were often individual. Ballard et al. found that the students who saw the most growth in this area were students who worked on disseminating their findings to others, along with those who were given responsibility for ensuring the accuracy and quality of their own work (Ballard et al., 2017).

In conclusion, the above literature shows that there is considerable evidence that citizen science programs, because of their features, may support the development of sense of place and through that, pro-environmental behaviors. The repeated experiences outdoors, the sociocultural components, the development of content knowledge, and the empathetic experiences with an organism, are all potential ways in which youth may develop a sense of place. Feeling pride in their place, caring about the organism, and having an overall positive relationship with their place can lead to a desire to protect and conserve the environment. However, it is unclear whether citizen science programs support a true educational experience for urban youth, whether
and how sense of place is developed, and whether and how this may impact students’ willingness to engage in pro-environmental behaviors.
Chapter 3
METHODOLOGY

Introduction

The literature review in Chapter 2 describes how sense of place develops, and why sense of place may foster pro-environmental behaviors through a citizen science program (Chawla & Cushing, 2007; Kudryavtsev, Krasny, et al., 2012; Lim & Barton, 2010; Masterson et al., 2017). In an effort to advance this literature, this study sought to understand how participation in an urban citizen science program relates to adolescent place attachment, ecological place meaning, and willingness to engage in environmentally responsible behaviors. This chapter first describes the citizen science project and the participants, and then explains how this study was organized, how the data were collected and analyzed, and how the data tools were developed using the literature and existing tools.

This was a mixed-methods case study, employing a phenomenological approach for the focal group (Creswell, 2013; Creswell & Clark, 2011; Miles & Huberman, 1994). The pilot study, completed in the spring of 2017, was initially focused on whether students gained content knowledge about the ecosystem as a result of participating in the citizen science program, but through the observations and interviews, it emerged that while students did gain some knowledge, sense of place was a key outcome that was mentioned by almost all participants in some manner. Through the process of experiencing the stream with their peers, students became more interested in the ecosystem, wanted to share what they were doing with others, expressed care and concern for the eel, and felt pride in their place. How students were supported in these activities by the adults leading the project lead me to frame their scaffolds with self-determination theory. Informed by this pilot study, my dissertation sought to explore how sense of place developed in these students through participating in the citizen science program, as well
as how this might shift their pro-environmental behaviors, and how the experience supported these changes.

For this study, survey data were collected of all participants to understand whether sense of place and willingness to engage in pro-environmental behaviors changed over the course of the program, and interviews and observations were conducted with a focal group to understand the processes at work. Data for this study were collected in the spring of 2019, using both a case-oriented and variable-oriented approach, looking at the focal students on an individual case basis, and all of the students using a variable approach. The following questions, which are both variance and process questions as they seek to understand both whether relationships exist and how the relationships develop, guided the research:

1. How does youth sense of place change as a result of this citizen science program?
   a. What are the prior experiences of youth with the flora and fauna of their local place, the stream where sampling is happening?
   b. How does youth attachment to place and ecological place meaning change as a result of this citizen science program?

2. How does youth willingness to engage in pro-environmental behaviors change as a result of this citizen science program?

3. Is there a relationship between place attachment, ecological place meaning, and likelihood to engage in pro-environmental behaviors?
   a. What kind of behaviors are students willing to engage in – individual, community level, or civic engagement oriented?

The table below explains my timeline for this project.
Table 1: Data Collection & Analysis Timeline

<table>
<thead>
<tr>
<th>Date</th>
<th>Phase</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/19</td>
<td>Observations of school-wide assembly, pre-interviews</td>
</tr>
<tr>
<td>Week of 4/1/19</td>
<td>Pre-surveys handed out during first sampling session</td>
</tr>
<tr>
<td>4/19-6/19</td>
<td>Observations of weekly sampling sessions, eel celebration</td>
</tr>
<tr>
<td>6/19</td>
<td>Post-surveys, Post-interviews</td>
</tr>
<tr>
<td>6/19-8/19</td>
<td>Data transcription and begin analysis</td>
</tr>
<tr>
<td>9/19-8/21</td>
<td>Write-up</td>
</tr>
</tbody>
</table>

Program Overview

The Hudson Eel Project is a citizen science conservation effort aimed at conserving the American eel (*Anguilla rostrata*), which was added to the International Union for Conservation Network’s Red List in 2014 due to pressures from overfishing, habitat loss, dams, invasive species, pollution, and climate change (Sneed, 2014). As part of this project, volunteers coordinated through the New York State Department of Environmental Conservation collect, weigh, measure, and count juvenile (glass) eels each week at a number of locations along streams during the spring migration (Bowser, 2018b). These baby eels are often only a few inches in length, although older animals can be 5-6 inches long. Since it began in 2008 with two monitoring sites, the project has expanded to 14 sites and more than 750 volunteers; to date, the project has counted more than 650,000 glass eels (Bowser, 2018b).

In order to catch the eels, a large net, called a fyke net, is set up in the stream. This net acts as a funnel so that the eels, who are migrating north into the creek, are caught in a small trap. The mouth of the net is about 13 feet wide, but ends in the trap which is about a square foot in size. Students empty the baby eels from the trap into buckets each day, and scrub the net to make sure that algae and other debris doesn’t restrict water flow. The eels are then scooped from the bucket with a small net, and each is counted. The Poughkeepsie site also has one eel “mop” for collecting baby eels. This is a device that is made from polypropylene rope and mimics sea
grass, and thus invites the baby eels to seek shelter. To remove the eels from the mop, students place it in a large tub of water and gently shake it, then drain the water through a net into an aquarium (Bowser, 2018a).

There are two groups of eels which are caught in both the net and the mop: glass eels and elvers. Most of the eels are glass eels, deriving their name from the fact that they are see-through at this point in their life cycle. They are young of the year eels who are in the midst of their migration from the Sargasso Sea. As they get older, the eels gain a brown pigmentation; these older eels are called elvers. Elvers are at least one year old and have been in the Hudson River estuary for at least one year. Once the eels are removed from the net and counted, twenty of the glass eels are carefully dried and weighed to determine how the body mass of the eels changes each year. Finally, students record air and water temperature each day. These data are shared with the Atlantic States Marine Fisheries Commission, which also sets the procedures for collecting the eels and coordinates between coastal states to ensure that eel numbers are healthy (Bowser, 2018b).

The Hudson Eel Project is organized by two senior staff members from the Hudson River Estuary Program (HREP), and also employs several seasonal employees from the Student Conservation Association. At each site, other adults act as leaders who coordinate site activities and volunteers; in Poughkeepsie, this person is a science teacher at the high school. Consequently, there are both adults who are familiar with the youth volunteers and adults who are focused on the eel sampling process. The Eel Project is something that the Poughkeepsie High School community has been participating in for eleven years, and several teachers mentioned that it has become “part of the culture of science” at the school. All of the science teachers try to participate in some way, from being at the stream to watch the students do their
work to supporting the end of the season party by ordering food. In order to recruit students for
the project each year, the HREP staff comes in during the school day and does an assembly to
which all science classes are invited. Some science teachers incentivize participation by offering
extra credit or count the experience as lab minutes. After the assembly, students sign up and
receive paperwork that their parents need to complete before they can participate.

The specific research site for this study is at the mouth of the Fallkill Creek, where it
meets the Hudson River in the city of Poughkeepsie. This creek runs through the city but is
almost inaccessible to its residents, since it is constrained by high walls for most of its length.
Before it empties into the Hudson River, it cascades down an impressive natural dam, which was
used as a mill during the city’s industrial period. Prior to the Dutch settling in the region in the
late 17th century, the area was inhabited by the Wappinger people, who were part of the Lenape
nation. They called this waterfall “Pooghkepesign”, from which the city derives its name (Diaz,
n.d.). Today, the area around the creek is home to a public park, and is one of the only places in
the area where residents can walk down to the water. The creek itself was not designed to be
accessible, but the banks are not very steep and are covered in large rocks. Thus, students and
other members of the public, who often use the area for fishing, can access the creek for eel
sampling. The site is easily reached by foot and public transport, and is adjacent to a parking lot
on one side and the park on the other. A footbridge crosses the creek and a sidewalk runs along
both sides, which allows residents of the city to interact with the Hudson Eel Project volunteers
easily and freely. A covered pavilion, belonging to the Mid-Hudson Children’s Museum, is also
adjacent to the creek, and provides shelter from inclement weather.

This study focused on the eel monitoring site in the city of Poughkeepsie for three main
reasons. First, I have extensive experience with the community and the coordinators of the
project, and have observed the project for four spring sampling seasons. Second, the Poughkeepsie site offers access to a unique population of volunteers – a largely minority population of urban students, who are not generally documented as being involved in citizen science programs (Pandya, 2012). Third, the program focuses on a charismatic organism, one that can be handled and observed up close but is generally unknown and overlooked by local residents (Kollmuss & Agyeman, 2002; Lindemann-Matthies, 2002; Watson, 2006). Thus, the Poughkeepsie site offered a unique window into how citizen science programs may positively influence urban youth.

**Participants**

The students of Poughkeepsie High School have been voluntarily participating in the after school citizen science program for the past eleven years. Participants for this study were recruited from those who joined the project in the spring of 2019, most for the first time. Poughkeepsie High School is a Title 1 school; it is 90% minority and 77% low-income, providing a unique population of students who are not normally involved with citizen science programs (Evans et al., 2005; *NYSED Data Site*, n.d.; Pandya, 2012). Poughkeepsie High School ranks below state averages in all testing categories, has a graduation rate of 56%, and sees a chronic absenteeism rate of 42%, making it one of the poorest performing schools in New York State (New York State Education Department [NYSED], 2021). The students participating in this project were likely those who were doing fairly well in school, or at least, coming to school often enough to know about and participate in a volunteer activity. Sampling of students from a public high school with a large population of students who are traditionally under-represented in science was purposive, as I was interested in understanding more about how urban youth changed as a result of this program (Maxwell, 2013).
Students were recruited from those who attended the initial assembly which introduced them to the eel program. All students who consented to participate and maintained their attendance in the program at for at least three weeks completed the survey before and after the program. Usually, between 8-12 students come to the creek each day per week after school to help with sampling. Teachers assign the students a particular day, and they have to make the commitment to come each week. Thirty-three students completed both the pre and post-survey, and ten students were part of the smaller focal group for interviews and observations. The characteristics of these students are summarized in the tables below, followed by a brief summary of the survey group and for each focal group student. In addition to the students, four adults were interviewed, who either worked for the organization that sponsored the program or the high school the students attended. A brief summary of these adults is also provided in this section.

*Survey group* – Ninety-one percent self-identified as minority, and 53% self-identified as male (see Table 2). This is representative of the high school, where 92% of the students are minority and 53% are male. Almost all of the students (82%) were participating for the first time. Most of the students (88%) wanted to go to college, and many (39%) indicated an interest in some sort of career related to science or engineering. Most of the students (87%) indicated that they were passing their science class at the time when they were participating in the project. Playing sports was the most common thing that students listed when asked about their favorite out-of-school activity, and only three students (less than 10%) talked about spending time outdoors; two of those talked about doing so with friends. One of those students said that she liked swimming and hiking the most.
Table 2: Participants

<table>
<thead>
<tr>
<th>Group</th>
<th>Age (in years)</th>
<th>Sex (%)</th>
<th>Ethnicity (%)</th>
<th>Number years participating (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Entire study group (n = 33)</td>
<td>Mean = 15.79</td>
<td>Male = 51.5</td>
<td>White = 9.1</td>
<td>1st year = 81.8</td>
</tr>
<tr>
<td></td>
<td>Min age = 14</td>
<td>Female = 48.5</td>
<td>Black = 30.3</td>
<td>2nd year = 12.1</td>
</tr>
<tr>
<td></td>
<td>Max age = 18</td>
<td></td>
<td>Hispanic = 57.6</td>
<td>3rd year = 3</td>
</tr>
<tr>
<td></td>
<td>SD = 1.193</td>
<td></td>
<td>Pacific islander = 3</td>
<td>4th year = 3</td>
</tr>
<tr>
<td>Focal group (n=10)</td>
<td>Mean = 16</td>
<td>Male = 70</td>
<td>White = 20</td>
<td>1st year = 80</td>
</tr>
<tr>
<td></td>
<td>Min age = 14</td>
<td>Female = 30</td>
<td>Black = 30</td>
<td>2nd year = 10</td>
</tr>
<tr>
<td></td>
<td>Max age = 17</td>
<td></td>
<td>Hispanic = 40</td>
<td>3rd year = 0</td>
</tr>
<tr>
<td></td>
<td>SD = 1.05</td>
<td></td>
<td>Pacific islander = 10</td>
<td>4th year = 10</td>
</tr>
</tbody>
</table>

Focal group – The focal group included ten students, eight of whom identified as minority, and seven of whom identified as male (see Table 3). There was one freshman in the group, and two of the students (Alan and Maddox) had done the project before. All but one student (Miles) was passing their science class, but only two students in this group wanted to study science in college.

Table 3: Descriptors of students in the focal group

<table>
<thead>
<tr>
<th>Pseudonym</th>
<th>Gender</th>
<th>Ethnicity</th>
<th>Grade in school</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alan</td>
<td>Male</td>
<td>White</td>
<td>Senior</td>
<td>Brother of Holly; has done the program every year</td>
</tr>
<tr>
<td>Holly</td>
<td>Female</td>
<td>White</td>
<td>Junior</td>
<td>Sister of Alan; dating Manuel</td>
</tr>
<tr>
<td>James</td>
<td>Male</td>
<td>Hispanic</td>
<td>Junior</td>
<td>Wants to study studio art</td>
</tr>
<tr>
<td>Joshua</td>
<td>Male</td>
<td>African</td>
<td>Junior</td>
<td>Recently emigrated from Kenya</td>
</tr>
<tr>
<td>Manuel</td>
<td>Male</td>
<td>Black/Hispanic</td>
<td>Senior</td>
<td>Brother of Nadine; dating Holly</td>
</tr>
<tr>
<td>Miles</td>
<td>Male</td>
<td>Hispanic</td>
<td>Sophomore</td>
<td>Best friends with Maddox</td>
</tr>
<tr>
<td>Maddox</td>
<td>Male</td>
<td>Hispanic</td>
<td>Sophomore</td>
<td>Best friends with Miles</td>
</tr>
<tr>
<td>Nadine</td>
<td>Female</td>
<td>Black/Hispanic</td>
<td>Sophomore</td>
<td>Sister of Manuel, friends with Holly</td>
</tr>
<tr>
<td>Nolan</td>
<td>Male</td>
<td>Pacific Islander</td>
<td>Junior</td>
<td>Living in a group home; recent arrival</td>
</tr>
<tr>
<td>Taylor</td>
<td>Female</td>
<td>Black/Caribbean</td>
<td>Freshman</td>
<td>Recently emigrated from Antigua</td>
</tr>
</tbody>
</table>
**Alan** – Alan was a senior, white, and started attending Poughkeepsie schools during high school. When seen in the school hallways, he kept his head down and did not make eye contact, which would suggest that he was a quiet young man in the larger setting. In person and one-on-one, he was quite gregarious and enjoyed talking at length about his hobbies and interests. He did fine in school but struggled academically and socially and recognized that he had some limitations (his sister later shared that he has Asperger’s syndrome). He aspired to working in his parents’ car dealership business. As a child, he was enrolled in scouts, but he did not enjoy sleeping outside on camping trips. He had a couple of pets as a child, talking mostly about his dog and how much he loved her. As a veteran of the Hudson Eel Project, the other kids deferred to him and asked him for help with sampling tasks.

**Holly** – Holly was an excellent student, a junior, and was consistently at the top of her class. She was a member of the crew team as the coxswain, and was thrilled that she could participate as a medical condition kept her from doing most other sports. She was dating Manuel during the time of the sampling, and is the sister of Alan. She was almost the opposite of her brother – while both are friendly, she was outgoing and positive, laughed a lot, and was incredibly involved at school. She had transferred to Poughkeepsie HS from a local private school, where the students had been “nasty” and were always bullying her. She loved her school and her group of friends. As a child she didn’t go outside much, although she did mention the boy scouts her brother did and doing some of the activities with him. She talked about her cat, which she loved a lot, and the family dog. She was really interested in science and wanted to become a doctor.

**James** – James was a junior, Hispanic, and wanted to study studio art. He recently moved here from New Jersey and liked his old high school better. He wasn’t involved in other
school activities but he did enjoy doing mixed martial arts; he was a great artist and took a lot of pride in his drawings. He had a favorite playground when he was a kid but he didn’t have a favorite spot within that playground. His family did not have a dog, although they used to have one. He was generally a reserved kid, and didn’t talk or smile unless you spoke directly to him and engaged him.

Joshua — Joshua recently moved to the United States from Kenya, where several of his family members remain. He was a very religious young man, worked hard at school, and was also a long-distance runner. He was involved in his local church, which sponsored his move with his mother. He said he was frustrated that other students didn’t take their education very seriously, and he had a very positive view of Poughkeepsie. In Kenya, he lived in a small, rural agricultural community, and was mostly outside as a child. He loved that Poughkeepsie had so many trees and water, and talked about how he felt the city was “prosperous”. He talked about having pets as a child, but that few of the animals were pets in the American sense of living inside the home.

Manuel — Manuel was a member of the boys’ crew team, and a high-performing student who took several advanced placement courses at the school. Manuel is a senior, black/Hispanic student, very articulate, and really enjoys talking (despite being a very quiet young man in the group). He said that he wanted to study something in the medical field and had secured a scholarship to very competitive college. He liked some aspects of Poughkeepsie, like the ability to walk down Main Street to get food. He talked about going outside with his family and mentioned that one of his parents had a garden. Besides crew, he also enjoyed playing basketball.
Miles – Miles, a sophomore, did not describe himself as a good student. A quiet young man, he was friends with Maddox, and identified as mixed race. He was the only student who admitted that the “real reason” he was doing the project was because his grade in science wasn’t good, and he needed some extra credit. He had lived in the Hudson Valley most of his life, and had been in Poughkeepsie schools. He said he spent most of his childhood playing video games or playing sports. He enjoyed going to the beach with his family in the summer and swimming. He said he never had a secret hideout or spot when he was younger, and when people visit him in Poughkeepsie, they go out to eat. The only time he mentioned the river is when he was watching his sister row crew. He had some dogs as a kid but doesn’t have any pets anymore.

Maddox – Maddox said that he struggled in school, especially in science. Maddox was a sophomore, identified as Hispanic, and enjoyed playing sports. He grew up in NYC and moved to Poughkeepsie a few years ago. He did spend time outside as a child but mostly to play basketball or football; he didn’t have a special outdoor place that he remembered. He grew up with four dogs, but the family didn’t have any at the time of the interview. He was always smiling and joking around, and loved to be the center of attention with his peers and his teachers. He wanted to learn how to fish and do other outdoor activities.

Nadine – Nadine also rowed crew and did well in school. She was the sister of Manuel. She talked about playing in the trees in her backyard or in the park near her home as a child, and mentioned hiking with her family when she was younger. She said she felt very comfortable in the water because she does lots of water sports (swimming and crew). She has a big family (six kids total) and has a dog at home right now. She was friends with Holly.

Nolan – Nolan recently came to Poughkeepsie High School and was living in a group home. He had moved around a lot due to his housing situation but wanted to become a wildlife
biologist. He was not, however, interested in studying science in school. He thought Poughkeepsie was a good place because it reminded him of home, had good energy, and felt “live”. He was the only student who talked about going into the woods as a child with his friends and building forts and digging holes.

…behind my house there were some woods, and me and my friends would always just like go behind my house and like adventure, like dig holes and climb trees and stuff. I had like…we had … me and my friends had a really big hole and we had a tarp over it and a blanket down and we would sit in the hole and just chill.

He loved animals and grew up with two dogs; now his mom has cats. He said he recently realized that if he loves animals so much he can do something with it, he can make it his career. He was also the only student who shared a positive experience with animals in the wild, when he went on a hike with members of another group home:

…there was a big pond and I saw frogs! So I went to go catch a couple, and a whole, and like this WHOLE corner of the creek coming out of the pond was FILLED with frog eggs. It was crazy. I would pick them up and it was like a whole sac of hundreds and hundreds of eggs and it was like this big and it all over, and it was crazy and I was like, that’s a LOT of frogs!

Taylor – Taylor was another recent immigrant to the United States from the Caribbean island of Antigua. She was incredibly polite and engaging, and loved to talk. She spent a lot of time at her church; she said that is similar to how she spent her time on the island; she just went to school or church. She did not spend a lot of time outside in her home country, and did not have many experiences with fishing or swimming. She realized that people have a somewhat negative view of the city but says it is “what you show people and what you do, that reflects on your community”. She thought she wanted to do something “medical” when she got to college, but was not sure what field she wanted to focus on, and was not enrolled in advanced science
classes at school. She loved animals and talked about caring for lots of dogs in Antigua, and thought that everyone should take care of living creatures because they belonged to God.

Based on this information, I believe that I had a representative sample of students from Poughkeepsie High School, with some who were good at academics, some who struggled, and some who were doing fine but not excelling. Some students had outdoor experiences as children or ‘special outdoor places’ in their childhood, but none had direct experience with the river (outside of rowing crew) or the organisms that live in the river. Students had a mostly positive view of their hometown, but the river and stream did not feature prominently in their descriptions except as a scenic backdrop. Most had experiences with animals through their domestic pets.

The adult leaders of the program were also interviewed, which includes the lead teacher from the high school and the three New York State Department of Environmental Conservation staff who facilitated the sampling at the creek. These individuals, with whom I have worked for many years in a variety of capacities, were the gatekeepers for the study, and facilitated the consent process and overall organization for this project (Creswell, 2013). The lead staff person, Colin, had started the Hudson Eel Project in 2008, and is a gregarious, warm educator who loves both science and working with volunteers. He is a white male in his mid-forties who considers himself an environmentalist and educator, and sees this work as a way of bringing environmental activism to youth.

The two younger employees, Allison and Susan, are both White women. Susan has been working for the DEC for five years and completed her master’s degree thesis on the American eel; thus, she is very invested in the organism and in helping people appreciate the animal. Allison was a former high school volunteer with the Hudson Eel Project who has been working with the DEC for two years since graduating from college. Max, the high school teacher, has
been volunteering since the beginning of the project and talks about being “eel man #2”, since Colin is “eel man #1”. Also a White male, Max sees the project as a way to develop good relationships with his students while exposing them to doing actual science. DEC staff generally led the activities, while the Marist students supported the sampling, and the teachers usually watched from the shoreline. Marist College interns were not interviewed, as they did not consistently participate on any given day.

**Instruments**

Student data were collected before, during, and after the citizen science program in an effort to capture students’ change and the processes of this change. Adult interviews were conducted once, towards the end of the program, to provide context and understanding of the goals and accomplishments of the program. Each of the assessment tools will be described below, along with how they will be used to answer the research questions.

*Adult Interview Tool.* Adult leaders were interviewed at the end of the program to understand the goals they had for the student participants, the history of their involvement in the program, and their goals for the larger program (see Appendix A). These interviews were used to triangulate the student results.

*Observations.* The initial student assembly was videotaped (from behind the students so as to avoid collecting student images) and field notes were collected. This first day resulted in one hour of video and three pages of field notes. Over the course of the project, an additional eight hours of video was taken, and nineteen pages of field notes were taken. During the weekly meetings of the Hudson Eel Project, field notes were written while observing students who were working in the stream. The field notes included pieces of conversations, the students’ tone and physical interactions with each other, and their verbal interactions. Since the pilot study revealed
the importance of the students’ interactions, the field notes attempted to capture not only conversations but also feelings, conveyed through laughter, screams, jokes, etc. These verbal interactions also included informal conversations about friends and events in their lives, as well as specific directions to each other about the eels and the data collection, or comments and support while in the stream (helping each other walk in the water, holding the net or untying the knots, etc.). In addition, a video camera was set up on the sidewalk to capture interactions between students who were not in the stream but were collecting data about the eels. In these videos, students were engaged in counting the number of eels or weighing the eels, but sometimes students dropped eels and had to help each other put them back in the buckets.

*Student Interview Tool.* Ten students were interviewed during the first week of the program at their high school, either during a study hall or during their science class (with permission of their teacher). The interview included questions about students’ interests in school, their community, science, and the environment. It also asked specific questions about the eel program, its purpose, and the ecology of both the eels and the Hudson River. Students were asked to create a drawing of the sampling site and any organisms that they knew about who lived in or around the Hudson River. Specifically, they were asked to “Create a drawing of the Hudson River, and whatever that means to you”. Students were then prompted to add organisms if they did not include any; creating drawings has been shown to provide a window into students’ thinking (das Neves & Monteiro, 2014). These drawings provided a prompt for discussing students’ ecological content understanding, and also to see what was important to the students at the site. For example, some students who were on the crew team included the boat house or their crew boat on the river (see Appendix B for the entire interview).
After the program was finished, students were again interviewed; six of the initial students dropped out of the program, and thus only ten students were interviewed at the end. In the post-interview, students were asked about how the project affected their view of Poughkeepsie, whether they talked to others about the project, what they enjoyed, and why they participated. The other questions remained the same (see Appendix C). Students were also asked to create another drawing of the Hudson River, while reflecting on their original drawing. This provided a measure of member-checking during the interview, since students could reflect on what they had drawn at the beginning, and we could discuss their intentions. During this part of the interview, students often pointed out how their perspective had changed.

*Student Survey Tool.* The survey tool was created from a variety of existing tools and modified to reflect the local place (Batson et al., 2015; Bonney, Ballard, et al., 2009; Kaiser et al., 2007; Kudryavtsev, Krasny, et al., 2012; Stedman, 2002; Westheimer, 2015). Students completed the survey on the first and last days of the program; for students who missed the last day of the program, they completed the survey in school the following week (see Appendix D for the pre-survey, and Appendix E for the post-survey). There are five sections to the survey, each of which focuses on a different component of the research. The use of the survey enables this study to attempt to draw a quantifiable correlation between the citizen science program, specific concepts within sense of place, and willingness to engage in pro-environmental behaviors.

Part 1 asked about participants’ characteristics, including basic demographics, their interest in school, which classes they were taking or have taken in science, and their interest in other activities. There was also an open-ended question in which students can explain what they hope to do after high school. In the post-survey tool, students were asked about whether they
enjoyed the project, and why they participated, including internal and external motivating factors.

Next, there was a section which asked students to indicate how attached they felt to their place, which was modified from Kudryavtsev et al, 2012. These statements included both identity and dependence statements (five of each). For example, the statement “Poughkeepsie is the best place for what I like to do” is a dependence statement, while “Everything about Poughkeepsie reflects who I am” is an identity statement. There were both positive and negative statements in order to improve triangulation, and two questions were included to probe whether students felt proud to live in Poughkeepsie (Creswell, 2013).

The third and fourth parts of the survey focused on ecological place meaning. Students answered three open-ended questions about the eel, the other organisms in the Hudson River, the eel monitoring program, and their feelings about eels in general. These questions were designed to understand what students knew about the ecosystem and the eel at the start and end of the program. Two questions were added to this section to focus on whether the students liked the American eel, and whether they cared about it, to reflect the Batson empathy-altruism hypothesis (Batson et al., 2015). The survey questions in this section included eight which were modified from Kudryavtsev et al, 2012 (questions 16, 17, 18, 20, 21, 22, 23, 24). The remaining questions were designed to focus on the particular place – the Hudson River – and the particular organism – the eel – in this study.

In the final part of the survey, there were a set of questions that used a Likert-based scale to investigate students’ likelihood to engage in pro-environmental behaviors. These questions were designed using some existing examples from the literature (Kaiser et al., 2007; Stedman, 2002), but were organized to reflect Westheimer’s three levels of civic engagement (Westheimer,
First, there are personally responsible citizens who might recycle, turn off the lights, or carpool instead of drive their own car to work. Then, there are participatory citizens, who are willing to vote on environmental issues or attend a community hearing. Finally, there are social-justice oriented citizens, who are interested in changing the underlying problems in a collective manner within their community. This typology also aligns with Bonney’s 2009 report on citizen science outcomes, namely individual behavior change, community involvement, and civic action.

Using the above types of behaviors, three scenarios were developed, two of which had a local component. Each scenario included three-four related statements where students have to decide how likely they are to support something, do something, or participate in something. The actions were organized into personally responsible (individual behavior change) questions, participatory (community involvement) questions, and social-justice oriented (civic action) questions. Questions 1, 5, 7, and 8 were personally responsible questions. Some of these were potentially “easier” behaviors, because they were one-time events, such as participating in a cleanup (7), while others were more long-term behaviors, such as bringing a reusable shopping bag to the store. Questions 3, 4, and 10 were participatory questions. Questions 2, 6 and 9 were social-justice oriented questions.

**Data Collection**

During the introductory session given by the eel program coordinators at the high school, volunteers were recruited after a brief overview of the study. A parental consent form and student assent form was sent home with all students who were interested in volunteering. Signed consent and assent forms were returned to the coordinating teacher in a provided envelope. Student participants were assigned to volunteer on one day of the week based on their
preference, and they came to the sampling site on that day for the entire season (which means there was a Monday "crew" of students, a Tuesday "crew", etc).

In the week after the first sampling session at the creek, semi-structured interviews were conducted with each student at school during the student’s science class or study hall period. This interview lasted between 20-30 minutes and was audiorecorded. Interviews took place in the science department’s break room, which had an open door and was accessible to all adults who work in the building. During the interview, students were asked to make a drawing of the Hudson River ecosystem and the elements that were important to them in and around the sampling site. This could include both human and natural features, along with the organisms that lived in or around the river.

All students who consented took the survey on the first day of sampling at the creek. Based on feedback from the project coordinators, it was requested that the surveys take place immediately after the initial welcome activity, instead of at school, in order to “hook” the students into the program and not discourage them through paperwork before the program began. Surveys with all students have been done at the stream site for internal evaluation in previous years, so this was a fairly regular request of student participants. A Spanish language survey was available for any students who requested one. The survey took between 5-10 minutes.

Each weekly after-school sampling session was attended for observations and videotaping of the focal cohort (but not the rest of the survey group). The sampling season runs from early April through late May, depending on the migration of the American eels. When students were at the eel site, they were generally working in small groups of two or three, doing different tasks, either in the creek or on the shore. Students could choose whether they wanted to get on waders and go into the water to empty the net of eels, stay on the shore and count eels,
write down data, or monitor the eel mop (on the other side of the creek from the fyke net). The procedure of activities is outlined in the table below.

_Table 4: Details of daily activities at the creek during the spring eel sampling season._

<table>
<thead>
<tr>
<th>Timeline</th>
<th>Activities</th>
<th>Researcher activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>3:45-4pm</td>
<td>Students arrive at sampling site, put on waders and collect sampling gear. Students circle up and answer a “question of the day” posed by the adult leader.</td>
<td>Observations and field notes are taken while participating in the group circle.</td>
</tr>
<tr>
<td>4:00-4:30</td>
<td>One group of students enter the stream and begin removing eels from the fyke net and/or the eel mop Other students collect air and water temperature data</td>
<td>Observations and field notes are taken of students working in the stream.</td>
</tr>
<tr>
<td>4:30-5:00</td>
<td>Students begin counting and weighing eels next to the stream Other students clean the net and reset the net for the following day</td>
<td>Video camera captures students counting and weighing eels Observations and field notes are taken of students working in the stream</td>
</tr>
<tr>
<td>5:00-5:15</td>
<td>Students summarize data and put materials away, change out of waders and go home</td>
<td>Observations and field notes are taken.</td>
</tr>
</tbody>
</table>

A video camera was used for the small group on the shore, while field notes were taken for the group in the water. The students who were counting and entering data do not move very much, and since it was a small group, the camera could be fixed on a tripod and left relatively close by without disturbing their activities. Verbal and non-verbal interactions are important for understanding whether students are developing relationships with each other and the organism, gaining expertise with the activities, and becoming more confident in the field. It was hoped that leaving the video camera on, but without a person behind it, would reduce the concern about it’s presence.

Another semi-structured interview was conducted with each student in the focal cohort at the end of the program. All consented students completed the post-survey tool on the last day of
the sampling season, or at school during the week following the final sampling session. Observations were made of students at the eel celebration after the last day of sampling. Although not all students attended the eel celebration, it allowed for observations of the awards that were given to students and their excitement and enjoyment during the event.

The interviews of the DEC staff took place at their office, and lasted between 15-25 minutes, while the teacher interview took place at the high school. These interviews were audiotaped and transcribed.

Data Analysis

Data included student interviews, student drawings, adult interviews, video recordings, observations, and surveys. Because this was a mixed-methods study, both quantitative and qualitative factors are important. Examining the ten students within the larger cohort allows for a deeper understanding of how students develop a sense of place (Yin, 2017). The entire group of students was analyzed using the survey results, and the focal cohort’s sense of place was explored using the surveys, interviews, and observations.

Survey data (n=33) were entered into a spreadsheet and analyzed using SPSS to examine change over time. Each section of the survey addressed a separate research question. Part one provided background information and demographics, which was key to understanding the student population, how representative they were, and whether they had a positive or negative experience in the program. Place attachment questions were found in Part 2 of the survey, while section three provided insight into how students understood the local ecology (and, since this section included open-ended questions, the coding is discussed below). Part four focused on ecological place meaning, and part five looked at willingness to engage in pro-environmental behaviors. Consequently, the survey could explore whether there were changes from the start to
the end of the program using paired t-tests and Pearson correlation for the relationship between attachment, meaning, and pro-environmental behaviors.

There is significant discussion within the psychology literature about the validity of analyzing Likert-scale items using linear models (Liddell & Kruschke, 2018). Some scholars argue that Likert-scale surveys should not be analyzed using parametric tests such as the \( t \) test or Pearson correlation because Likert-scale data cannot be assumed to be continuous or normally distributed (Burkner & Vuorre, 2019). However, since my t-test results did not indicate significance (as will be shown in Chapter 5), and numerous researchers have found that both the 2-sample t-test and the non-parametric Mann-Whitney test have the same likelihood of detecting actual differences and giving similar error rates, I concluded that using parametric tests was acceptable (de Winter & Dodou, 2019; G. M. Sullivan & Artino, 2013).

The open-ended survey questions in part three were explored through grounded theory analysis in order to look for emergent themes and evidence of learning over time. Relevant quotes were grouped and coded, based on a learning progression approach to students’ ecological knowledge (Hokayem, 2016). In this approach, students who are at the lowest level of understanding can talk only about actors in an ecosystem and can use only one-step links in a food web. Students who were at higher levels of understanding included more detail, more accurate names of organisms, and more connections between the organisms. The drawings were examined to look for the number of specific organisms, the types and accuracy of organisms, and the numbers of connections students made between the organisms. In addition, the number of human or natural feature were counted, since the type of features provided an understanding of what was important to each student when they thought about the Hudson River.
The qualitative data included interviews, observations (both field notes and video recordings), and the open-ended questions from the survey. Interview data were aggregated using qualitative methods and were coded using Nvivo to identify patterns and themes. Pattern matching was used to explore how the results matched up with the initial hypotheses (Yin, 2017). Several rounds of coding were completed to create a codebook that captured the main ideas of the research project along with emergent themes that were discussed during the interviews (see Table 5). This codebook was revised multiple times over the course of the analysis. A second, independent researcher coded 10% of the interviews to ensure inter-rater reliability of 90%. Throughout the project, memos were kept to record ideas, thoughts, and patterns that emerged from the observations. To increase validity, multiple data sources were compared and checked for coherence. All data was stored on a password protected computer stored in a locked space.

Table 5: Coding scheme for qualitative data

<table>
<thead>
<tr>
<th>Main code</th>
<th>Subcode 1</th>
<th>Subcode 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attachment</td>
<td>Pride in place – positive statements about the importance of the creek, river, community</td>
<td>n/a</td>
</tr>
<tr>
<td></td>
<td>Empathy – statements that demonstrated care, concern, or perspective-taking for the eel</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Empathy – statements that demonstrated care and concern for the health of the creek/river</td>
<td></td>
</tr>
<tr>
<td>Ecological place meaning</td>
<td>Eels</td>
<td>Includes life cycle, recognition, threats (both natural and human)</td>
</tr>
<tr>
<td></td>
<td>River</td>
<td>Includes natural features, tides, organisms, perspective, threats (both natural and human)</td>
</tr>
</tbody>
</table>
Environmental worldview | Environment | Includes balance of nature perspective, change over time, humans as caretakers
---|---|---
Personal choices | Includes individual, community, and civic actions

| Experiences | Monitoring and saving the eels | n/a
| Animals, childhood experiences, outdoor experiences, residence time, sociocultural components | |

| Knowledge about the project | n/a |
| Internal | |
| External | |

The observations and video recordings formed a record of students' actions over the course of the sampling season. What students actually said during the sampling activities was just as important as non-verbal cues, such as gestures, posture, and their intonation and tone of speech. During the pilot study, I noticed that students became more comfortable over the course of the sampling season, and began to make more jokes with other students, laughed more, and provided more support for each other on sampling tasks. Consequently, video recordings were added to this study, and each video recording was watched for key events, which were then used as fragments for analysis. Actions, such as helping another student into the water or supporting another student to complete a sampling task are examples of key events, as is the use of boundary objects (Carlone et al., 2015). Comparing student actions, tone, and gestures between the beginning of the season and the end provided evidence for changes in confidence and knowledge. Triangulating the observations (either from the field notes or the video recordings, or both) with the survey results and interviews provided a robust collection of data to understand how the focal students’ sense of place changed over time.

Once interviews were transcribed and de-identified, the original audio recordings were destroyed. All individuals were given a code during the data analysis phase, and original names
were retained on a linking document that was stored on a password-protected computer and destroyed after the completion of analysis. Recordings will be destroyed after the dissertation process is complete.

Validity

This study used triangulation, purposeful selection, and rich data to ensure validity (Maxwell, 2013). The multiple sources of data in this study ensured that there were different ways to gain an understanding of how students feel about their place. The use of descriptive memos throughout the research process provided a way to help identify my own bias and illuminate previously unconsidered aspects of the study. These data were also sources of “rich data”, since they provided not just verbal reactions but also non-verbal observations which added context to the observations. Furthermore, the length of time with which I have been participating in the project allows for a thick description of not just the site, but also the types of interactions and motivations of different participants.

The selection of the students in this study was purposeful, as they were all attending a small urban school. It is possible that the students were not representative of the larger student body, as they self-selected to participate in an after-school program focused on science. However, student participation in the focal group was selected for convenience, and thus represented a generalizable subset of the student body (Creswell, 2013). Some students participated for internal reasons, while others participated because of external motivators such as extra credit or improving their resumes. As with all studies where participants interact with the researcher(s), there was the potential that this interaction created a bias, and that the participants changed their answers or even behavior (Anfara & Mertz, 2015; Maxwell, 2013).
With respect to content validity, the place attachment and place meaning questions were taken from a survey used by Kudryavtsev (2012) to measure sense of place in urban youth in New York City. To ensure validity, the survey was administered to three high school students before the start of the program to ensure that it was not too lengthy, and that the questions were understandable. The survey included both positively worded and reverse worded items, in an effort to avoid acquiescence bias, or the likelihood for participants to choose an item regardless of its content. In my survey, I reverse coded the items, so that the total scale score was bias-free (X. Zhang & Savalei, 2016).

The discussion about drawings at the post-interview allowed for a version of member-checking, where students reflected on how the experiences in the creek had changed their understanding of the river and its inhabitants. The post interviews also allowed me to confirm specifics about the students’ initial interviews, and review their survey answers with them, especially with respect to the pro-environmental behaviors.
Chapter 4
QUALITATIVE RESULTS

My qualitative data show that students developed a stronger sense of place through gaining knowledge about the American eel and its habitat, experiencing the creek, and participating in a socially mediated activity on a weekly basis. In this results chapter, I will describe the students’ sense of place and willingness to engage in pro-environmental behaviors before and after participation in the Hudson Eel Project. Finally, I will explore the contributing factors that I believe encouraged sense of place to develop. The quantitative results will be shared in the next chapter.

Place Attachment

Attachment includes place dependence and identity, and in this study was operationalized for empathy and pride, as these are also affective components of place. While empathy is similar to compassion, it is “a more general construct” which includes “perspective taking, emotional sharing, and a concern for others” (Pfattheicher et al., 2016). Pride in place is often linked to attachment, both with respect to identity and dependence, as being proud of the place one lives can result in a feeling of positive self-worth and protecting the place in a manner that makes maintaining the current activities and relationships possible (Korpela et al., 2009; Twigger-Ross & Uzzell, 1996). Pride is an emotion that can reinforce positive, prosocial behaviors (Tracy et al., 2007). In this section, I will describe how students connected with the river, the eels, and the environment in general, starting with their feelings at the beginning of the project, and how those changed over the course of the sampling season.

Before the Project

At the beginning of the project, students talked about the river as a setting for the activities that they enjoyed doing, such as visiting with friends or rowing crew. Their
dependence on the river was limited to it providing a place to hang out, a place to do sports, or a place to engage in leisure activities. As Manuel stated while describing his first drawing:

…thinking of the river I think about being in the river itself, like the bridges, and the animals being out, and all the crew people…people playing in the park, there’s always a lot of birds out, and there’s always people hanging out, like there’s the pavilion, like the overall scene it is pretty peaceful. I enjoy spending a lot of time down there, it is always nice.  - Manuel, pre-interview

Students would go to the park at the waterfront, or go to the Walkway over the river, and see the river while they were engaging in other activities. They did not think explicitly about the connections between the river and the life within it; instead, it was a destination or a tool to be used for a favored activity. Only one student, Maddox, recognized that the river was important to him because of the life that was in it: “Because without any animals, the Hudson River will just (like) be a big dump…I think all cities should have like one good and nice place to go.”

Students’ direct experiences of the river before the project were very limited - only one student had gotten to sample for fish in the river with a science class. Crew, the skate park, and walking along the waterfront were the main ways that students talked about experiencing the river:

…so these are all the trees, they are so pretty in the fall when the leaves are changing color. I have a lot more appreciation for it because with crew it’s the sport I really love doing, and its the only sport you can do on the river.  - Holly, pre-interview

Through these leisure activities, many students appreciated the beauty of the river and enjoyed visiting the river. For other students, the river was not a part of their thinking about their hometown at all. As an example, both Miles and James talked about their favorite places for taking visiting family as being indoors; they wanted to go to the mall or a local diner.

Besides leisure activities, other forms of dependence such as using the river for food, water, or transportation, were absent from student data. The main way that students depend on
the river – for drinking water - was not known to them. When this idea was brought up, students were generally surprised or repulsed, because for many, the river has always been dirty and polluted. When Miles found out he was drinking river water, he said, “Well that’s disgusting. That’s disgusting.” Whether students didn’t know that they were drinking water from the Hudson River, or whether that fact just wasn’t important to them, is unclear. Joshua, likely due to his childhood experience in an arid climate, was the only student who talked about Poughkeepsie’s proximity to the river as being of significance:

I was thinking, in US history, we did the Northern colonies, the ones that were near rivers because they were near rivers were like really successful…So I think that Poughkeepsie is very very, it is very lucky, to be located next to a river…and the Hudson, the river, it provides water for the whole Hudson Valley, right, and I think that symbolizes prosperity. Even though people do not realize it. - Joshua, pre-interview

The river does not provide sustenance through food or livelihood for these students, explaining why these forms of dependence were likely not mentioned.

Recognizing the eel, and the place where it lives – the tributary to the river – were the first steps in students’ development of sense of place. Most students didn’t know about the creek; only four students included the creek in their first drawing. While the Fallkill Creek runs through Poughkeepsie, it is almost impossible to interact with – it is either buried underground or surrounded by high walls. Some students mentioned having seen the creek when they had come down to the riverfront water park for other activities, such as to eat at a restaurant or hang out at the skate park, but they didn’t know it was the same creek that ran through the city. One student, Maddox, had been to the creek to “skip rocks”, while Manuel had come to the creek to see the waterfall (the site of an old mill). Adding the creek into their mental map of the area gave students a way to anchor their experiences with the eel in a familiar place.
All of the students in the focal group learned of the eel’s existence because of the project, and began to develop concern for the animal. Manuel said, “I didn’t know anything about the eels until the presentation.” Holly talked about not knowing that eels “were a thing in Poughkeepsie”, while some other students said they knew about eels in a larger context but not locally. For example, James said, “I think I knew they existed somewhere in the globe, but not here.” The eels’ small size and their delicate appearance motivated the students’ concern for the eel, and seemed to make the students feel empathetic towards them.

They’re very fragile. I can tell. They’re just like, to me, they’re like small and more fragile than worms… they’re like delicate, so predators can just easily attack them because they’re nothing like sharks and can fight back. – Taylor, pre-interview

Using live eels as a hook during the introductory assembly allowed students to experience the eel in a safe space, and encouraged some students to develop compassion for them. However, there were some students who were afraid of the eel, or at least, unsure of whether they wanted to touch them. During the assembly, students got to see both a glass eel and an adult eel, and volunteers were encouraged to touch both of the animals in a tank and report on the feeling. As one example, a student came up to the front of the room, and the presenter asked the student to name the first thing that comes to mind when they think of eels. The student answered “electric”. The presenter then asked the student to reach into the tank and test his prediction, which generated yelling and calls of warning from the other students in the auditorium. The student played along, acting scared, but ultimately did touch the eel and reported that it felt “slimy”. Similarly, Holly talked about touching the eels for the first time and how it allowed her to think differently about the animal:
… now that I’ve gotten to see and touch them they’re a lot smaller than I thought. I thought they would like electrocute people, but picking them up, they’re cute and they’re tiny and they’re gentle. – Holly, pre-interview

Being able to handle the animals was a key factor in dispelling some of the myths the students had about the eel, such as the idea that they could be harmful.

Students’ concern for the animals at the beginning of the project was evident in their answers for why they were participating, indicating that they wanted to support the project’s efforts in saving the eel. James wanted to preserve the species, and thought that the eels were being taken to a local college because “…they know what to do to prevent the eels from becoming extinct.” Maddox said that the project tags the eels (it doesn’t), and that this would “keep them safe”. Nadine wanted to make sure that the eel wasn’t going extinct.

I don’t want things to go extinct, I want them to stay around as long as possible for people to be able to enjoy them, because they’re like a really cool creature.
– Manuel, pre-interview

During the assembly, students were challenged to participate because they could help the environment by surveying for eels; staff repeatedly said that participation meant “you get to do something good for the environment”. This statement was repeated for each group who came to the assembly, and sometimes, it was repeated more than once. James said that he joined the project because he “wanted to make a positive difference in Poughkeepsie”, Holly said she wanted to get community service hours “in a meaningful way”, and Manuel said he joined because he wanted to “help out the environment”. The students were told that the eels were endangered, that the project was trying to figure out what was happening with the population over time, and that the project “couldn’t happen without you”. Alan said that he participated because he cares about the environment: “like one thing I am concerned about is the
environment.” Couching the project in a larger frame of saving the environment fostered a sense of group collaboration towards a goal of helping both the eels and the environment.

*During the project*

For most of the students, the project marked the first time they had been in the Hudson River or the creek, and the experience of getting into the water was both exciting and nerve-wracking. The first day, the tide was low, so students were able to easily walk into the water, although the slippery rocks still caused some students to lose their footing and slip a bit. Students talked to each other about how slippery the rocks were, how hard it was to walk in the water, and how cold the water felt. Over time, the students experienced different water levels, which affected how they felt about the water. When the water was really high, most of the students were noticeably cautious as they worked their way around the net, and a few noted that they “don’t want to fall in”. Two students used the high water levels as a way to have fun, splashing each other and attempting to go as far as possible into the stronger current, until an adult called them back. One day, Miles walked back and forth across the creek several times to get from the eel mop to the net, and encouraged Holly to do the same, because “it’s a hell of a rush crossing that stream”. As the weather got warm enough for shorts, students spent a lot of time talking about the feeling of the water pressure: “It feels super weird with shorts on” and “I have shorts on, the pants are super tight on me!” There was lots of giggling and joking in the water, and the students had fun being in the stream together.

Students seemed to empathize with the eels, and wanted to make sure that they weren’t causing them damage during the sampling. On the first day, students said things like “Oh, I dropped one, did I hurt them?”, “Am I hurting them?”, and “Will they die?” as they were taking
the eels out of the net. When they dropped an eel, they would help each other pick them up and get them back into the bucket. They were excited about the large numbers of eels, smiling and laughing as they pulled them out of the net, saying things like “There are so many!” and “Look at all those eels!”. Their small size was surprising: “Oh, they’re so little!” There were numerous comments during sampling about how “cute” the eels were.

All of the students wanted to touch the eels, even if it took some support in order to do so. “My turn! They feel tickly and slimy”, said James on his first day. Touching the eels at their own pace allowed the students to overcome their fears or nervousness, and to become stakeholders in the project as they gained confidence. Joshua, for example, was nervous at first, and asked “Will they bite?” He said he was nervous because “they look like a little snake to me”. He became more comfortable throughout the season, and eventually decided that it was Ok to touch them after all. Aaron, one of the veteran students, was very confident in helping other students at the net and during the counting process, talking the other students through the process and reassuring them. Aaron helped Joshua hold his first eels, encouraging him to take them out of the bucket, and answered his questions about them. Towards the end of the sampling sessions, students were often found crouched down next to the buckets, watching the eels move, observing them without talking. The small, wiggly, clear creatures created a mesmerizing swirl of life, and seemed fun for the students to watch.

After the project

For many students, once they knew that eels existed, it changed the way they thought about the place where the eels lived, including the river and their hometown. It was as if a
curtain was pulled back, and a mysterious world was revealed, where students could glimpse the complex life under the water.

I mean before eel project, I heard about it through my brother, but before that I didn’t know that eels were a thing in Poughkeepsie, in the river, I mean I knew what eels were but I never thought about it. – Holly, post-interview

Similarly, Alan pointed out that the project helped him recognize that the eels came through Poughkeepsie, because he hadn’t thought about this before. The river became important to the students in a different way, and the creek moved from being a place that was part of the backdrop of their lives to being a place they recognized and were comfortable in. It became a place that supported living creatures and that had its own set of changing characteristics.

The students’ drawings of the sampling site support the idea that they increased their awareness of the creek and the organisms that live in it. The number of students who included the creek in their post-drawings doubled, from four to eight. All students made more detailed drawings after the program was over, and for many, their perspective changed from focusing

Figure 5: Drawings by Manuel. The drawing on the left was created at the beginning of the project, and the drawing on the right was created after the project was over.
only on the Hudson River to including the Fallkill Creek tributary. Students did not have their first drawings to look at when they created their final drawings, but were shown the drawing afterwards as a discussion point. Some students, like Manuel, reflected on what he changed after creating his post-drawing (see Figure 5).

So I have like a lot of similarities, but this time I drew in the creek as opposed to just the river…because usually you think mostly about the river as opposed to the creek, but this time the creek became a bigger part of the nature of the river and the eels inside of it. More sea life and plant life and more plant life in general, as opposed to just human life and human activity. I mean I still see the monuments and bridges and playground everything like that but just overall the nature in the drawing. – Manuel, post-interview

As another example, while James had the creek as a small tributary in his first drawing, his second drawing focused on the creek from the perspective of where the sampling actually took Place (see Figure 6). By way of explanation, he said,

Well the first one I drew as more of a birds eye view of the area, this one is a lot more close-up, because it shows the sidewalk that you’d be on, the river, you can see the view across the gate, I never knew where it led to… – James, post

Figure 6: Drawings by James. The drawing on the left was drawn at the beginning of the project while the drawing on the right shows the post-program drawings which focuses on the creek.
Being next to the creek allowed the students to really see the space, so they could add details such as the trees, rocks, and both the living and non-living things in the area. For instance, Holly talked about how she added “beautiful” bridges to her mental map of the riverfront.

So I labeled both docks, and I think in this one I originally was just focused on crew, because I only went to the river for crew, so that’s all I really did at the river, whereas now, I see crew, and I see the eel project, but I also see the bridges more, because in the eel project you’re right there next to them, you just like appreciate how beautiful they are. And now that I’ve been doing the eel project also I’ve noticed, I’ve been noticing the river more, and how big of a symbol the Hudson bridge is in our community…

– Holly, post-interview

Some students, such as Taylor and Joshua, added words to their drawings to describe how they felt about the river and the project (see Figure 7). Joshua used the word “prosperity” to describe the waterfront, and explained that this is because the region was so green and full of water.

*Figure 7: Drawings by Taylor. The drawing on the left was created at the beginning of the project, and the drawing on the right was created at the end.*

Taylor changed the focus in her drawings from loving the river to loving the eels. When talking with her about the drawings, she explained, “…this [first] picture is the reason why I wanted to start, and this is how my experience went. And also, how the eels, they mean a lot to me.”

Sharing the students’ initial drawings during the final interview allowed the students to see how
their thinking had changed, and to acknowledge what they had gained by participating in the program.

The fact that the river was home to lots of different organisms supported students’ feelings that this river was valuable, and a place that was special.

I feel like I have grown a bit, because like before, like I said it was just a body of water, it was just there, but then now, it makes you think, what else could be in there, because there’s a whole bunch of things (laughing) and species and fishes and then the eels, which I never thought there would be eels in the river, so it’s nice to know. – Nadine, post-interview

These students now realized that the river housed unique animals, and were surprised that they hadn’t known this beforehand. Overall, the students came to see the creek and the river as connected, and as a habitat for the eel, and they began to notice the changes that took place over time because they were immersed in the stream, engaged and learning. They talked about recognizing the connections between the eel and other organisms in the river, as well as the natural features surrounding the creek. Manuel recognized that the living things that were in the river were new to him, and changed the way he thought about the river in general – demonstrating the way in which meaning and attachment are connected.

…because usually you don’t think too much about what’s inside the river, rather that the river is there, it’s weird to actually go and look at what’s actually inside as opposed to just outside and appreciate what’s actually in there. - Manuel, post-interview

Learning about the living things in the river allowed Manuel to develop a deeper connection to the ecosystem, revealing a hidden world that became visible only because he sampled the creek for the American eel.

Separating the attachment, or the fact that the students cared about the animals, with why they cared about them was often challenging, as students often talked about liking the eels with a
reason. Besides just learning that eels existed, as discussed earlier, students focused on the physical features of the animal as the reason they cared about them. For example, Taylor talked about learning about the eels’ existence, reflected on their size and unique features, and then explained that she wanted to take care of them in some way.

Well they’re a unique species and in my country I never heard of eels, well I heard of eels, but, moray eels in the ocean, they’re strong, but glass eels, but if I never came up here I wouldn’t know about them, I joined because they are unique creatures and they need more exposure and more care and I wanted to be a part of that. – Taylor, post-interview

Manuel also thought the eels were cool, and wanted to protect them so others could see them too. The empathy the students showed for the animals, and the place in which they lived, demonstrated their increase in place attachment. Students’ perspective-taking demonstrated their attachment to this specific place where the eel lives, and where they experienced a new connection to a world full of life beneath the river’s surface. How students described the project demonstrates a pride in place, as they were excited about what they discovered and how it illuminated a new understanding of the river.

**Students’ Ecological Place Meaning**

Ecological place meaning includes how students talked about the eels – their biology, migratory pathway, life cycle, and threats, and what they noticed about the creek – its natural features, tides, threats, and other organisms. In this section, I will explore how students changed their understanding of both the animal and its habitat over the course of the project. I will begin with how the students described the eel and its features, and then progress to other organisms in the creek and river, followed by how the students talked about the creek and the river. Again, some
statements link meaning and attachment very closely, because the unique features of the eel made the students express their feelings for them.

**Before the Project**

Students knew some basic facts about the eels, such as that they live in the water, they lay eggs, and that they are fish. Two students remembered from the introductory presentation that the female was larger, but the rest of the students did not know anything about the eel’s biology. Students had more background knowledge about the eel’s life cycle, and were able to describe their general migration pathway, possibly because this fact was mentioned during the introductory assembly. Six students had some ideas about where the eels traveled from, although most did not explain why or know much about the details. Alan, who had participated in the project for the past three years, was able to share more details about the eels than others:

…they come up here when they’re babies or like the glass eels and once they’re grown up they go back down to like below, a little bit south like below Florida. And then they lay eggs and stuff like that and then the cycle continues. - Alan, pre-interview

However, most students could only give a general explanation of where the eels came from. James said, “I’m told they migrate from somewhere south. But I don’t know where.” Nadine said, “I think they come from like the ocean or something.” Maddox knew that the eels migrated, and then gave birth and died, but couldn’t explain more than that.

The students had a lot of general information about threats to the eels, including both natural threats such as predators and strong currents, and man-made problems like pollution. The most common natural threat the students mentioned at the beginning of the project was predators, owing to the small size of the eels and the length of their journey. Taylor said,
“They’re (like) delicate, so predators can just easily attack them because they’re nothing like sharks and can fight back.” Two students mentioned possible temperature changes, because they could “freeze” in the water. Man-made problems included trash and other forms of pollution (discussed by six students) and climate change (discussed by three students). Most students talked about pollution in the form of garbage or litter. When probed, students also added details to their ideas of pollution such as “chemicals” and “oil”. Nadine said, “Like garbage and stuff, there’s a bunch of stuff floating in it, and like oil and stuff like that. Pollution in general.” The idea that the eels could get “stuck” in the trash was mentioned by two students. Students who mentioned climate change did so in a general way, and weren’t really sure how it might affect the eels. Joshua said, “Or another thing is global warming. I don’t know how that affects them but I think global warming is really bad.”

When asked about the organisms that live in the river besides the eel, students talked about general categories of animals, such as “fish” and “birds”. Most frequently mentioned were “fish”, although a few students thought that there were other fish such as bass or tuna in the river. When asked why, they said that these were the only fish they knew about, or that they had seen TV shows where people catch these fish. Three students included fish in their drawings, although they couldn’t explain what type of fish they had drawn. Maddox said that he knew “most of the fish come down here like, and then like go away, back to mate and do certain things.” A few students mentioned birds in the pre-interview, and two mentioned plants. Alan mentioned the seeds of the invasive water chestnut plant – “you know, the prickly things”, and Miles drew the water chestnut in his drawing, which he had learned about during his field trip the previous year to the river. Manuel talked about algae, and believed that the algae was part of the
food web of the river. Most students could not explain what the fish in their drawings ate, or what ate them, except for “bigger fish”.

With respect to the river’s ecology, only one student (Manuel) mentioned the fact that the river had tides. Manuel, as a rower for crew, had multiple experiences that he could draw on to explain what he knew about the river and its changes. Most students, when asked about the Hudson River as an ecosystem, described the aesthetic beauty of it. The long history of pollution in the river came up in two conversations, although students didn’t know the details of the contamination, instead just saying that the river was “dirty” from “chemicals”.

In general, the students saw the environment as a collection of plants and animals, and used general terms such as “nature” to describe the ecosystem. This focus on scenery and actors indicates a general understanding of how the natural world works, including general ideas about predators and prey. However, they could not provide specifics about any of the relationships in the ecosystem around them. For most students, the environment also included the city, people and the built environment. Manuel said the environment was “… like animals, plants, also like the people, buildings, like just overall the scene surrounding you, like your neighborhood, just generally the things around you and the things you have to watch out for…” In the students’ drawings of the river at the start of the project, all of them included people or aspects of people – the bridges, the buildings, boats, or people along the waterfront. Thus, they did not have a separation between the nature and the people in their city. This is important to consider, since many researchers have found that people tend to separate humans from the rest of the ecological system, when in fact we are very much a part of the ecosystem (Pickett et al., 2010). It has been posited that this separation is one potential reason why people don’t care about the natural world,
since it is seen as something different and separate from us, instead of something we are
connected to and rely on. It is possible that urban students have less of a separation between the
natural world and the built environment because the two are not seen as such extremes in their
lives, or perhaps because they do not conceptualize nature as something purely without humans.

During the Project

Being able to physically interact with the animal was a key way that the students learned
about the eel. After the initial excitement of seeing the eels for the first time, students started to
talk about what they noticed, including their coloration, which changes as they get older. By the
second week, students noticed the heartbeat inside the glass eels, their eyes, and their intestinal
tract, and one of the adult leaders showed students their gills. Miles said he liked the eels and
thought they were cool because they were “clear, not most animals are clear”, and Alan echoed
that, talking about being able to “see their hearts”. The first time the students saw an elver, they
were surprised at its color and size, saying “They’re huge!” Occasionally, the students saw dead
eels in the bucket, and they pointed out how their color was different.

With respect to other organisms, students added some animals to their mental map of the
river’s food web. They saw scuds, other fish, and birds during the season. On the first sampling
date, there were a number of scuds coating the inside of the net, prompting some kids to squeal
in fear (or disgust?), while Holly asked “Whoa, what are those?” Some students said they looked
like shrimp, but Alan explained that they were “scuds, just some water bugs”. Scuds are a
common name for small, freshwater amphipods that were often trapped with the eels in the
sampling nets. Students also found a juvenile fish in the net on the first day, and one of the adult
leaders pointed out that “he got munched on by someone”. Grackles were black birds that were
sometimes seen wading in the stream, looking for glass eels or other small fish to eat. These birds were the topic of conversation on one of the sampling dates, and because the birds were looking for the eels to eat, they were watched closely for the remainder of the day. Some students noticed the migrating herring, which were often visible in the creek as they moved upstream, and which had to be recorded in the data binder. Another day, Miles and Manuel arrived early at the site, and found a dead fish embedded with a discarded hook and line on the banks of the creek. Excited, they first tried to remove the fish from the hook, and, when that proved unsuccessful, used it to try and fish for other things, but returned to the sampling site without success.

Due to the tidal nature of the Hudson, students were able to experience the water level changes, sometimes navigating a creek that was ankle-deep, and other times, waist-deep. The speed and depth of the water was always the first thing the students talked about when they walked up to the creek. During the second week of sampling, not only was it raining very hard, but the water was also incredibly high. The students asked numerous questions about the water level, because the previous week, it had been ankle-deep. They wanted to know about the tides, what caused the tides, and how often it changed. They also noticed that the water was a different color than the previous week, and they could feel the temperature of the water pushing on them through their waders. There were several other weeks when the water level was really high, and Miles or Manuel would often test the strength of the current by walking out into the middle of the creek.

Throughout the project, students were encouraged to ask questions of any of the adults at the creek about what they noticed and wondered. They asked questions about where the eels
came from, what they ate, how long they lived, why their population numbers changed, and a host of questions about the stream and river itself. Sometimes, the adults ask the students to brainstorm an answer, but usually, the questions are answered by whoever is nearby. On the fifth week of sampling, the students were asked to describe the changes they had seen at the creek to date. They talked about the changing temperature, tides, vegetation, and how the eels they were catching looked larger, but that there were fewer of them as well. When the eels were placed in the zip-loc bag at the end of the session, the students wondered why they all swam together in the same direction.

After the Project

Gaining knowledge about the eel, such as where they are born, how and when they migrate, their color changes, and their place in the food web, were all ways that the students developed ecological place meaning. During the post-interviews, students reflected on the fact that the eel lived in their river, and added detail to their understanding of eels. Talking about the eels and the project during the interviews allowed students to reflect on how the experience had affected them and their relationship to the animals. As Alan said, “Now I know what they look like and feel like and where they’re from, their cycle of aging, and how they get there”. Students noticed how the eels’ coloration changed as they got older, because they caught both glass eels and elvers in the net during the sampling season. Elvers are not only larger, but also darker, and are no longer see-through like the glass eels:

Like I didn’t know that eels were as complex as they were, like I didn’t know that they started out as little baby glass eels and then they become elvers and then became yellow eels and then… – Holly, post-interview
I learned that there’s different kinds, there’s the small glass ones and the elvers. - James, post-interview

Touching and handling the eels allowed the students to notice differences between them, not just in terms of color or size but also in terms of health. Nolan, for example, noticed that some of the eels that were dead had a different coloration:

I remember I was counting, and there were a couple of dead eels, and instead of being clear, they were like cloudy … well I’m just guessing it is like their body, creating something, like inside of their body, like because they’re dead, I’m just thinking like, maybe it’s like, um, decomposition? – Nolan, post-interview

Several of the students pointed out the differences between the male and female eels, often returning to the fact that the female eels are larger.

I learned that, the female eel is bigger than the male eel, I never knew that, I find that really amazing. – Joshua, post-interview

And I learned that the females are bigger. And like, I’m actually happy, cause you know, the male is always taller in the animals the male species is always like bigger and stronger and you don’t really see females being big. It’s very weird. – Taylor, post-interview

Consequently, experiencing a species where the female was larger was memorable to them.

The eel’s physical features were captivating to the students. Although the eels are snake-like and slimy, most students thought they were “cool”, “unique”, and “cute”. The slime, or mucus, on the eels’ bodies was also noted by several students. Manuel recalled that the mucus allows the eels to “stay on land for a little while as long as they have a little bit of moisture…making sure they have mucus around their body”. The students also started thinking about what the eels ate, and what eats the eels. They didn’t have a lot of specifics about the eels’ diet, but thought that the eels must eat something small – either insects or plants.
I learned that they go into the net and they are trying to go upriver so that they can grow, and I guess they have food up there that they’re chasing? I know that they eat smaller like insects and stuff like that. – Holly, post-interview

The students remembered the birds around the stream who were looking for glass eels to eat.

Maddox said, “There are these birds, I forgot what they’re called, and they (like) fish for the eel, they come up here to fish for them.” Besides this, though, students didn’t share anything else they had learned about the eel’s diet or their predators.

The life cycle of the eel was one area where students deepened their understanding of the animal. All of the students described a migratory pathway in the post-interviews, recognizing that the adult eels laid their eggs somewhere in the ocean or in the Hudson River before the baby eels moved into the creek.

Well you don’t usually think too much about the life cycle, and the way they change from like the glass eels to the elvers, and they continue on like that, until it’s time to go back, … and ways they can actually stay on land for a little while…Basically learned about the eels, stuff you don’t really know unless you encounter them. – Manuel, post-interview

Some students, such as Alan and Joshua, had a good understanding of the entire life cycle, and could describe not only where they were born but also the correct pathway.

… the glass eel comes up here to sort of grow up so that when they reach, say adults they go back to – I think it’s pronounced - the Serengeti Sea to lay eggs and basically to then die, but then the new generation of eels comes back up, up here, to the Hudson River, and then down through the Fallkill and it just goes like that. – Alan, post-interview

They are born out in the Atlantic. They travel here as babies. With their mom. No. After their mom gives birth that is the end of their life. And…then they travel. So they travel, up to the Hudson River, where they spend most of their lives I guess? – Joshua, post-interview

For others, although they had added detail to their understanding of the migration of the eel, they were still unclear on the specifics. For example, Miles knew the babies were born out in the
ocean, but didn’t know what happened to the adults, and Taylor said “…they travel to the Hudson River, I forgot where they came from…”

Understanding how the project helped the eels was confusing for the students. While most students knew that the project was recording the numbers of eels in order to understand how the population was changing over time, few could explain what happened to the eels after they were counted. Some students thought that the eels were taken to one of the local colleges or institutions, where they would be taken care of and raised until adulthood. Maddox thought that “… they keep them in like, a conservatory or something.” Joshua thought they were taken somewhere, but then didn’t know what happened to them afterwards: “I think they uh, collect the eels from the Fallkill Creek, and then they probably take it, take them somewhere else, or they count them? And then do they mark them? I was wondering about that…” Only two students knew that the eels were being released above the dam in the creek after sampling.

When talking about the threats that the eels faced, students focused more on man-made threats in the post-interviews as compared to natural threats. Students talked about noticing the fluctuating numbers of eels each week and speculated about possible reasons related to temperature changes or predators in the area. Pollution remained the students’ largest man-made threat to the eels, although a few students mentioned climate change again and several mentioned fishing pressures. One of the staff shared a story about the illegal trade in glass eels, and people fishing at the river was a common sight.

…first I think…pollution. And I think pollution is a problem for every single organism out there…uh the second one I think it’s overfishing. Some people might just be fishing for fun, and not taking what they need, just take a lot, for fun. The other problem I think is global warming. – Joshua, post-interview
With respect to pollution, students mostly talked about litter in the creek, but also things like air pollution and chemicals that might be in the water. Three of the students talked about eels getting stuck in the trash in the river, or getting blocked by the trash, although there was no evidence that this actually happened.

Like chemicals, it can affect them biologically, because you know, we are breathing poisonous air we’re going to get sick, the eels are probably going to get sick if they’re in poisonous water. Whereas the Styrofoam…Like for the eels it’s more just the fact that it’s cluttering the water, well that’s an issue more for larger animals because they would eat the Styrofoam. And for the eels it would affect the environment where they can and can’t get into. Because you know if there’s like a block of Styrofoam, like, they can’t swim past it, and they can’t get into the creek. – Holly, post-interview

The focus on trash and litter returns as an important theme when students discussed how they would make positive environmental changes in their own lives.

Students’ familiarity with other organisms changed slightly between the pre and post-interviews, as students added scuds, herring, and grackles to their understanding of the river’s food web because of their direct experiences with the organisms. In their drawings, more students included the eels and fish after the program was over, and several students added in birds. Nadine talked about how sometimes, she could easily see fish “jumping out of the water”, and other times, she couldn’t. Holly mentioned that some weeks, her hand would be covered in scuds when she dug in the net for eels, while other weeks, there were no scuds at all.

In the post-interviews, students added detail and context to their descriptions of the river, derived from their first-hand experiences in the creek. They talked about how the creek changed color, speed, and temperature. Almost all of the students talked about the changing tides from week to week.
The changes in tide were kind of weird …we had times when it was extremely high and we could barely walk, and other times when it was really low and you could walk in really easily, I feel like how the tide works it is kind of weird. - Manuel, post-interview

…there are uh tides, which, one day we were at the creek, and then the water was like down below my boots, and then the next day it was up to my waist. – Joshua, post-interview

The fact that the Hudson River has tides is a unique aspect that is generally not noticed by people who are just walking by the river or viewing it from above; the volume of water is so high in the river that it is hard to notice the change unless you spend an entire tidal cycle next to the river, watch it carefully to notice the northward current, or visit often enough to see the river at both high and low tide. Thus, the creek offered a very visual – and physical – introduction to tides. Besides the water level, students also noticed changes that were associated with the tides, such as the color of the water and details such as the differences in densities of other organisms. Holly said, “…it changed color like day by day, (like) the clarity was different”, and Nolan said “I noticed there was a difference in color between the creek and the Hudson River”.

…it was always changing, it wasn’t always fast or slow, it was like varying week to week in current speed, and the amount of eels and number of fish we saw in there, some days we saw like more fish than other fish, different fish and stuff like that… – Manuel, post-interview

For Holly, the color changes plus the differences in the number of scuds from week to week prompted her to wonder about whether something was being dumped into the river.

It changed color like day by day, like the clarity was different, like I said there were different scuds some days, and some days there were none, so some days the water quality might have been worse one day versus another. Also sometimes the river smells really bad and other days it doesn’t have any smell, and that also probably has to do with the water quality, and it smells like a skunk sometimes. - Holly, post-interview
Students talked about recognizing the connections between the eel and other organisms in the river, as well as the natural features surrounding the creek.

I think more about relationships between everything, because now it’s not like only the water, but there’s land and dirt and things like trees but also there’s animals and different like species that we need like to acknowledge that are there and they’re all working together to keep everything the way it is and where we’re at… – Nadine, post-interview

Overall, the students came to see the creek and the river as connected, and as a habitat for the eel, and they began to notice the changes that took place over time because they were immersed in the stream, engaged and learning through experience. Learning to recognize the life in the stream, how it was connected to the larger ecosystem, and noticing the changes over time, deepened students’ knowledge about the place. This demonstrates the connection between meaning and attachment – the students learned what lived in the river, and how the river changed over time, and it positively affected how they felt about the ecosystem.

**Pro-environmental behaviors**

Caring for the environment went hand in hand with caring for the eels, and students’ concerns led them to talk about ways that they would improve things. In this section, I will describe how students discussed the three levels of environmental behaviors.

*Before the project*

Many students had a balance of nature perspective, indicating that they thought nature would be fine over time, or it would be once everything “returned” to a balanced state. Nadine said, “there’s animals and different (like) species that we need (like) to acknowledge that are there and they’re all working together to keep everything the way it is…” Another theme was
the focus on people as caretakers, not only of the eels but also of the environment in general.

Students talked about helping the eels, and they had a variety of thoughts about how this was happening – from saving the eels from predators, to feeding them and raising them into adulthood during the course of the project. For Joshua and Taylor, this perspective was linked to their religious beliefs. Taylor said, “Well whatever God creates, it is like whatever God given, you shouldn’t destroy or kill it, like every other animal, they do some good for us in a way.”

At the beginning of the project, some students said they thought of themselves as environmentalists, while others just said they cared about the environment or liked the environment. Taylor said she cared about the environment, Miles and Manuel both said they considered themselves environmentalists, and Nadine said that “I really love nature and I love to be out in nature, so I don’t like knowing that it is getting destroyed”. Alan said that in the future, he wanted to show his own kids “the environment”, although he cautioned that “if it is like destroyed and everything like that, well…there’s not much to do then”. James said he was doing the project because he thought it would help the environment, and he also mentioned that he had participated in the youth climate strike, and to his knowledge, was the only one from the school who had done so. He then laughed, and said that participating in the strike meant that he “just didn’t go to school that day”. Nolan said that he “would like to” be an environmentalist, but didn’t “know much about this stuff…I know kind of a little bit, I really want to learn more”.

When asked about specific environmental behaviors, most students said that they recycle. Alan said “Personally I just try to recycle as much as I can…” while other students only mentioned recycling when asked how they thought they were being environmentally responsible. Some talked about turning off the lights; a few students acknowledged that turning off the lights
was more connected to saving money at home as compared to saving the environment. All of the students were willing to participate in a riverfront cleanup. Manuel said that he considered himself an “environmentalist”, wanted to “make sure that things don’t get into the river in the first place”, and mentioned that his family grows vegetables in a garden in order to eat more locally. Both Nadine and Manuel talked about an annual cleanup at the riverfront that happened through their crew team. Holly said that she has been trying to buy things secondhand in order to “be more conscious”.

During the project

Over the course of the sampling season, there were a few instances when students demonstrated their willingness to engage in pro-environmental behaviors. One day, Miles noticed fishing line stuck in a nearby tree, and spent a good deal of time trying to get it down. He and Maddox had been trying to fish before the program started, and I mentioned to them to be sure to throw the line they had found away, because it can last for hundreds of years and cause problems for the animals in the water. Consequently, it’s possible that Miles’ attempts to remove the fishing line were due to this conversation. Several times, students began picking up trash that they noticed when they were at the sampling site. Aaron would often pick up pieces of trash, usually while he was waiting for the students to begin the eel count, since he generally took on the task of writing down the data on the shoreline. Nolan, Maddox, and Miles were also observed picking up trash as they walked around the sampling site.

One way that students began to reflect on the project was through talking with others about the project while at the site. Understanding more about the ecosystem allowed them to develop a story about the eels that they could explain to others. One day, the students talked to
several young children who had been visiting the Children’s Museum next door. The children were incredibly excited to see the animals in the bucket and watch their movements as they swirled around each other in the water. Most members of the public didn’t know that eels existed in the Hudson River, or that baby eels migrated up the local creeks, and were happy to listen and learn from the students.

After the project

At the end of the project, students shared the ways in which they wanted to change their own behaviors, because they wanted the creek and the area at the waterfront to be cleaner. First, I will discuss the individual behaviors, then community engagement, and finally, social justice actions. Students were asked about each of these types of behaviors during the post-interviews.

Engaging in the project was a basic action that many students mentioned was improving the environment. James said, “I wanted to do this, because like, I thought it would help, like, the Poughkeepsie environment, and particularly that area of the river, because it is taking place there…” Two of the students, Joshua and Taylor, talked about God as their reason for saving the eels and taking care of animals in general. Both wanted to make sure that all of God’s creatures were protected because “God commissioned Adam to care for the garden and care for the animals” and “whatever is God given, you shouldn’t destroy or kill it”. Students believed that helping with the project was a way to “preserve the eels” and “prevent them from becoming extinct”.

Besides the act of participating, most students focused on finding ways to eliminate trash in the water, which is something that was obvious each time they went to the creek.
…I don’t like throwing stuff on the floor no more, every single time I see something I pick stuff up…my awareness has gone up a lot from when I started because I never really like, did like, like that before, and like I saw like all the, the plastic and shoes and stuff in the river and stuff polluted and like made the water look all messy and not good, and I saw this second part of the water, and it got blocked off by garbage, and it was just this one little old part of stagnant water, and right next to it was this rushing waterfall, and it was just all garbage right there. And like my awareness of littering and pollution went up. - Nolan, post-interview

It is clear that what Nolan saw at the creek impacted how he thought about trash, and his own decision to pick up litter. Picking up trash became a tangible solution for multiple students:

Well, I notice now, that like I do, things like bother me now, like when I see [trash] on the floor outside, I’m like ugh, so I pick things up more, like they shouldn’t be there. – Nadine, post-interview

Other students, like Nadine, commented on the pathway of litter to the river, and wanted people to be more careful with their trash:

Well in Poughkeepsie, a lot of people don’t realize what they do, because you’ll see like garbage cans on the corner of the street, but right next to the garbage can there’s like garbage on the floor, and people don’t realize that their garbage is going to make it down to the river and it’s such a big problem. - Nadine, post-interview

Holly mentioned the connection between the Hudson River and the ocean, and thought that the trash might be entering the river from the ocean. Besides trash, several students talked about other individual changes they could make, such as avoiding the use of disposable straws or using reusable bags at the grocery store. Other students discussed being willing to do things like turn off the lights in their homes more often and use a reusable water bottle. Holly talked about changing her approach to clothes, stating that she wanted to stop buying “fast fashion” and start using reusable straws.

I mean, I’ve always cared about the environment, but I feel like I care just a little bit more now, like I’ve started using reusable bags, and I have t-shirts that I’m cutting and sewing
into bags and taking to the grocery store…and reusable produce bags. – Holly, post-interview

The next level of civic engagement focuses on community level behaviors, or “participatory” behaviors that engage people in community activities or organizations (Westheimer, 2015). Students frequently mentioned being willing to engage in a cleanup of the river or creek, or attending a meeting of a community group that was working on improving the creek. Some students, like Holly, wouldn’t go to something on their own, but said that she “would be more willing to do it if I had more people to go with me. Because if it’s just me, alone, they would be like ok, short little girl what do you want?” Holly did become more involved in environmental causes at the high school, eventually organizing a recycling process for the building and making sure that each classroom had recycling bins.

Besides these behaviors, students developed social capital over the course of the project, which several researchers argue is a component of broader community level outcomes as it can facilitate systemic change (R. C. Jordan et al., 2012a). Students wanted their friends to join the project, talked to their families and classmates about it, and talked to passersby at the riverfront. Every student in the project said that they talked with others about what they were doing, and shared what they had learned in some way.

[I’ll tell] anybody who will listen! Like anybody is like, what do you do outside of school, and I’m like “Eel project! Eel project!” – Holly, post-interview

Besides Holly’s enthusiastic endorsement of the project, Taylor, Nadine, Miles, Joshua, and Nolan all attempted to persuade other friends to join the project because they enjoyed it so much. Manuel said that he tried to encourage his crew teammates to join, and said “…I’m trying to get more people from crew to join, so I’m spreading the word about it. And [about] how much fun it
is.” Manuel pointed out that the Hudson Eel Project allowed him to talk to others about the life in the water.

…also like educate people, about what’s going on, like inside the water, because it is not just catching it and saving eel but showing people that there’s life underneath there that you need caring for. – Manuel, post-interview

The sharing of the eel’s story, especially with surprised strangers, reinforced the importance of the project and the students’ feelings of responsibility towards the eels and their work.

A few students indicated a willingness to engage in some forms of civic action. For example, Alan felt fairly discouraged at times, saying that cleaning up the riverfront had “no real point to it…” ‘cause like one time we were over picking up [like] trash in this area and next thing you know we left for [like] two hours and [like] then there was trash out of nowhere.” But, he went on to say that he wanted his friends to start using reusable bags, because “if you eliminate them in the first place then you don’t have to worry about them…” This suggests that Alan is thinking more systemically, and wanted to address the root causes of the trash issue instead of just doing a cleanup or recycling himself. Similarly, Joshua talked about reducing the use of plastic overall, because he had noticed the plastic waste at the waterfront and was worried about how it affected the eels.

Well, I mean a ban of plastics, I guess yes, ‘cause before the project I was like, I really did not care about plastic and all that, but after being in the river… I feel like, they should you know ban plastic near the river. Cause I can see how it affects the organisms in the river. – Joshua, post-interview

He also tied this comment back to his religious beliefs, stating that “in banning plastic we are caring for the animals and obeying God’s will”. Interestingly, while Joshua was willing to support broader change, he was less likely to make personal changes to his lifestyle. Most
students were the opposite - they didn’t feel like they could make a large change but felt that they could do something tangible and immediate. For some, things like using public transportation or carpooling weren’t an option because they felt it wasn’t safe or accessible. Alan said that he wouldn’t carpool because it would take too long, while Nadine thought that it wouldn’t be safe to ride with people she didn’t know. For others, advocating for a larger change felt like an insurmountable hurdle, or like too much effort. Despite the fact that the city’s government building was nearby, Manuel said: “…like just going to city hall, and like the expense of it, it’s kinda hard to do…” Nolan said that he would sign a petition on banning plastic if it was presented to him, “but if I had to like go somewhere and do the whole thing, probably not”. Despite these statements, students did not seem to understand the complexity of the issues facing the eels, and none of them discussed tackling climate change, larger scale pollution, or fishing pressures.

**Contributing factors for developing sense of place**

I have shown how students deepened their scientific knowledge about the eel and the ecosystem, and developed empathy for and pride in the eel and its habitat, and that this led them to be willing to engage in some pro-environmental behaviors. In this section, I argue that the experiential nature of the project, along with the use of specific aspects of self-determination theory, were essential as it supported students’ internal motivation to participate. The adults used extrinsic, nonacademic tools to encourage relatedness, including the celebration night (the “Eelebration”) with awards and t-shirts, and internal tools such as creating activities and procedures that supported students and helped them learn how to be independent at the sampling site. The experiences that were important include repeated visits to the stream, touching and
handling the eel, and learning how to use boundary objects like the waders and measuring tools. Embedding these experiences within a supportive atmosphere of mutual respect and teamwork allowed students to feel empowered and valued.

*Autonomy*

Autonomy was encouraged in the program as students chose whether to participate, and how to participate once they arrived at the sampling site. As was discussed in the introduction, most students participated in the project because they wanted to do so, and because they were interested in the animals or curious about the project as a result of the live presentation. When students were asked why they participated in the project, most shared internal motivators such as their personal interest, wanting to help the eels, or because they liked animals or the environment. Close to 80% of the reasons for participating were internal, with the remaining reasons referring to getting community service hours or extra credit for science class. Once at the site, students could choose whether they wanted to get into the water to get eels out of the net, collect other types of data, write down data, or count eels on the shore. Students were rarely redirected by the adult leaders or teachers, although there were occasional requests to stop a particular activity due to safety concerns (such as when Maddox and Miles wanted to walk across the stream during a particularly high tide). Thus, autonomy was high and remained so throughout the course of the program.

*Relatedness*

To understand the significance of relatedness within the program, it is important to begin by explaining the existing relationships in the group. In the focal group, there were two sibling pairs, one pair of romantically involved students, and several groups of friends who supported
each other in both verbal and non-verbal ways. For example, when getting into and out of the water, Holly was often helped by her brother, Alan, or her boyfriend, Manuel. Manuel sometimes encouraged Holly to come deeper and look into the net as he was looking for eels. There were multiple times when they were giggling together as they worked to remove eels from the net or carry the buckets out of the creek. Alan looked out for his sister often, made sure she was careful in the water, and checked in with her to make sure she was ok throughout. He said that “…it felt really good to actually have Holly out there this year.” Another time, Holly and Nadine (who were crew teammates, and also had Manuel in common as boyfriend/brother) held hands and supported each other in walking across the slippery rocks. The two were often giggling and talking quietly with one another while they looked for eels or worked on securing the net.

Besides the interactions between students who had existing relationships, there is evidence that all students supported one another. Students would help each other over the rocks when the water was high, share materials, or work together to hand buckets up from the creek to the shore. As another example, on a particularly cold and rainy day, Miles noticed Holly in the water and asked her if she wanted to go back up on shore, since she looked cold. When students asked each other questions, they answered respectfully, or looked to an adult for clarification. Some of these questions indicated nervousness on the part of a student, like when Joshua worried out loud that the eels could bite. No one dismissed his concern or made fun of him, and instead answered him honestly. Students also created fun while they were at the creek, splashing each other or joking together. For example, Joshua pretended to touch Taylor’s face after handling an eel, causing her to squeal in delight and fear. Another time, Nadine was next to Maddox in the creek, who was dramatically walking across the rocks and pretending to stumble into people, and
when he approached her, she jostled him with her elbow and threatened jokingly that “if he took her down…” This prompted both students to laugh, after which they returned to their task of collecting eels.

While the observations suggest that the students enjoyed working together, several also mentioned the novelty of getting to meet people from their school in a new context, one that was safe and enjoyable. Overall, students were very positive about their experience and cited the people who were involved as a major factor.

…because the types of people, because in the project there’s a lot of diverse categories of people that you meet, and then you find out more and you find out that they’re all pretty similar to you in certain ways and that they’re all genuine good people and they’re all interested in the same things. And so you get to talk to different people and become friends. – Nadine, post-interview

For Nadine, the project allowed her to realize that she could form relationships with other students in her school, even people with whom she wouldn’t have normally interacted. This was a pleasant outcome for her, and she was glad to know that students she hadn’t talked to in the past could share similar interests and enjoy the same activities. Holly was similarly pleased with meeting different people:

And it was really nice, everyone was so nice, and all the teachers and all the adults and all the students were really nice to me …and I didn’t have anybody being rude to me or nasty to me and there was no drama. It was just nice. It was just a nice positive experience. It was really fun and I’m going to do it again next year. - Holly, post-interview

Holly not only valued the experience as a whole, but pointed out that the project allowed her to avoid the “drama” that pervaded her other activities and experiences in high school. This suggests that the Hudson Eel Project acted as a refuge for her, a place where she could feel safe and relaxed. Fostering these connections between students, and ensuring that the site was a
positive place for all participants, encouraged students to continue coming to the waterfront and allowed them to enjoy the experience.

As was mentioned by Holly, besides the interpersonal relationships between students, there were also relationships between the students and the adults. The students enjoyed having the adults participate in the project, and some recognized that this was a strength for the program. Joshua said, “…the adults there, you can socialize with them, and you get to meet new people, not only from Poughkeepsie High School. And that, that was totally great, it widens your social network.” The adults worked hard to ensure the project had different opportunities for developing relatedness and competence.

The Eelebration, which took place on the last day of sampling, was an external motivator for relatedness that project staff and teachers used to maintain students’ interest and celebrate group accomplishment. The adults repeatedly talked up the celebration, which honored not only the students at the Poughkeepsie site but those from other sites as well. Project staff were cognizant of the fact that holding the celebration in Poughkeepsie, within steps of the sampling site, would make it easier for the Poughkeepsie students to attend since many wouldn’t have transportation to another site. Consequently, Poughkeepsie had the largest number of volunteers at the event, and the students were loudly supportive of their site and each other during the event, clapping and cheering for each other when called to the front. One award, called the “Ultimate Eeler Award”, was created for students who attended all of the sampling sessions throughout the season. While this isn’t something that students were heard discussing or coveting, teachers mentioned it to the students multiple times. One “Ultimate Eeler” who had graduated the previous year returned to help sample one day, and it was clear that the adults were happy to see him, and introduced him as an “Ultimate Eeler” to the current students. In addition to the
Ultimate Eeler award, all students received a certificate of recognition, and some received an additional award at the Eelebration. According to the project’s organizer, Colin, awards were started by Max, but other sites added awards as well, so now each site got at least one award. This included awards like “Most Eels Counted” and “Best Dressed”, which generated laughter and clapping from attendees. Max also provided awards for the eel students at their high school graduation as a way to share the project’s success with the rest of the school community.

The t-shirts everyone received were another tool to foster a sense of relatedness, as students were encouraged to stick with the program and come back in future years so that they could acquire multiple colors. The shirts were first mentioned during the assembly in early March, and both project staff and attending teachers often wore their shirts to the sampling site. Teachers showed off the shirts in a mock fashion show whenever they wore them, and took a group picture with all of the students in the shirts at the Eelebration. Staff believed that the shirts were a draw for the students, and mentioned having to secure outside funding some years to ensure that the shirts were free for all participants. In my post-interviews, two students who couldn’t attend the Eelebration asked me to bring them their shirts or help them get a shirt.

Having fun, and allowing the students to have fun, was also used to foster relatedness. Making sure the students had fun during the project was critical for the high school teachers. Max, along with several other teachers, wanted to make sure that students didn’t see the sampling as an extension of school, and often talked about how the project allowed them to develop relationships with the students that went beyond academics. “I want them (the kids) to get their hands wet, to have fun outside, and to see us teachers as different people”, said Max, “…and we could make it more academic, but that would turn people off”. It is notable that all of the science teachers in the school attended the sampling sessions at some point, and that they
didn’t get paid in exchange for this commitment. At one point, Max said that he thought the project was “literally saving lives”, because it gave kids who otherwise wouldn’t have had any positive connections with school a good experience.

As one example of supporting relatedness, teachers fostered the goofy attitudes of Maddox and Miles, who both proclaimed that they were “bad at school”. As friends, they walked down to the creek together, rather than getting a ride with a parent. They spent a good amount of time engaging in other activities that weren’t necessary for the sampling, such trying to fish or looking for other animals in the creek. They enjoyed being the center of attention, especially Maddox, who often pretended to fall in to the water or struggle to keep his footing as he moved across the rocks. Other students, teachers, and staff seemed to enjoy the boys’ antics, such as when Miles was working on tying the knot of the net, and Holly said she was “glad he was finally doing something”. One of the teachers who had the boys in class also encouraged their behaviors, laughing with them and shaking her head when they said or did something silly, sometimes at her own expense: “We might have more eels than your gray hairs!” The boys always waved to her when she arrived, and she commented that she was glad they were attending and enjoying themselves.

In an effort to encourage both competence and relatedness, staff asked students to “circle up” at both the beginning and ending of each sampling session. They wanted to make sure not only that everyone understood the directions for the day, but that everyone knew everyone’s names, and that a foundation of collaboration was laid. They always began the day by asking each student to answer one personal question, such as what their favorite dessert is or where to get the best food in Poughkeepsie. The ending circle was also used to field questions about the river, the creek, and the project in general.
Competence

The adult leaders encouraged students’ competence by allowing them to take more responsibility over time. Empowering students to take control of the activities at the creek was the main goal of two of the project staff, Allison and Susan. “I wanted the students to be more empowered at the site”, said Allison, and Susan said, “We talked a lot as a project about empowering students and fostering independence.” As evidence of increased competence, students prepared for the field work by themselves after learning what to do on the first day. Students were expected to get their own waders on, bring the bins of equipment down to the water, and organize themselves into smaller groups for sampling, counting, and recording data. Students gained competence as they repeated activities for the sampling and became more comfortable handling the animals and the tools required for sampling.

Several staff mentioned how important it was for them to see students come back repeatedly and grow over the course of not just one season, but multiple seasons. Susan said, “I love seeing each year the students taking over themselves, going from just being there to taking on leadership roles, seeing people blossom, which is really exciting.” One such student was Alan, who was participating for the fourth year in a row. A quiet young man, Alan assumed a leadership role during sampling, either directing activities from the shoreline or talking students through the sampling steps. He seemed to relish being able to provide information about the eels, and would jump in to answer other students’ questions without being asked directly. He helped students during the initial sampling sessions by showing them how to touch and hold the eels, and calmed Joshua’s worries about the eels biting him. He also tended to question others’ ability to do the work accurately, such as when he took the temperature of the water a second time, “just to be sure”, after Taylor had already reported her result. The others didn’t seem
bothered by his comments or concerns, and seemed relieved that he usually volunteered to take
the clipboard and write down results and observations. Since he took on this responsibility, he
would ask students to repeat what they had found or give him additional information.

Competence was enhanced by the experiences the students were having in the stream.
For example, on the first day, the students were all brought into the water, told to crouch down,
and put their hands into the creek. The project leader told me this was one of the ways in which
the staff had decided to “baptize” the students into the project, and it always provided lots of
exclamations of excitement. Competence was also fostered by students helping each other, both
with support when they were nervous or needed help walking in the water, and with sampling
activities, such as how to tie the knot or keep the equipment safe when the water level was high.
Besides Alan, the veteran eeler, other students shared what they learned with each other as they
worked on getting eels out of the net, counting, and weighing them. For example, the first time
Nadine, Maddox, and Miles were in the water together, Nadine showed the boys how to tie the
knots, and they told her about how the eels migrate up into the stream. These informal
interactions provided opportunities for more students to have power and responsibility, and thus
feel important to the project.

After the first foray into the water, staff trained students on the different tasks, such as
untying and retying the knots at the net, scooping out the eels, counting and weighing them, and
recording the data. By the fourth sampling date, staff assigned daily “leaders” and took more of
a supervisory role, rather than being directly in the creek with the students. For example,
Manuel was designated as the leader on one date, and the project leader repeatedly paused and
gave him space to give directions, or asked him “What should we do now?” As the sampling
season progressed, students took more responsibility of the activities at the net, and asked each
other questions about how to complete tasks instead of the adults. They communicated directly with each other when sharing sampling results or talking about what needed to get done. Towards the end of the project, there was one day when students completed all of the activities without asking for any help from the adults. Project staff also praised students for their competence, as when Nolan brought a collecting bucket down to the waterfront without being asked. He was told “Nolan, you’re perfect! Thank you for the bucket! How did you know?” This produced a small smile from Nolan, who replied, “I’m just like that.” Students who were working diligently at counting eels or dealing with equipment were praised for their efforts. Other times, project staff encouraged students to try something new, such as touching an eel or trying the net.

Summary

The four types of qualitative data – interviews, survey questions, observations, and drawings – support the idea that students developed a sense of place. This was demonstrated by the increase in students’ ecological place meaning, including their knowledge about the eels and the river, and their attachment to the river, through expressing their empathy for the eel and their pride in its home. Participation changed students’ relationship to the Hudson River ecosystem, as the project focused on an organism that was previously unknown to them. As part of the mechanism that affected students’ sense of place, direct and repeated experiences with the eel in the creek enhanced internal motivation via self-determination.

The eels were the key, as students were initially interested in the project because of them, and stayed engaged because of them. The project inherently encouraged student autonomy as it was an optional activity, but autonomy was also enhanced by allowing students to choose how they spent their time during the sampling sessions. Students’ competence increased as they
learned about the eel and the creek, shared what they learned with others, and became more confident in the sampling activities and in the environment of the stream. Relatedness was fostered through encouraging students to have fun, providing support within the group, and encouraging them to work together. Thus, the experiences, and the way in which they were structured to enhance internal motivation, succeeded in developing students’ sense of place.
Chapter 5
QUANTITATIVE RESULTS

In this chapter I will share the results of both the matched pre/post-survey results, along with the aggregate results from the pre/post-interviews for the focal group students. To determine whether and how sense of place changed as a result of participating in the Hudson Eel Project, place attachment, place meaning, and students’ willingness to engage in pro-environmental behaviors were assessed using a multi-part, Likert-scale survey tool, in addition to several open-ended questions. I also explored how these concepts changed through the interviews, through examining the types of language that students used before and after the program. In this chapter, I will describe each section of the survey results, and then share the details about the focal group students.

The quantitative results include matched pre/post survey results from 33 students who completed at least three weeks of the program, including the ten students who were part of the focal group. The survey results indicate students did not significantly change their attachment or willingness to engage in pro-environmental behaviors as a result of the program, but there were marginally significant increases in several measures of place meaning when comparing the pre and post program responses. One place meaning statement, “I like Poughkeepsie because of the eels” was statistically significant, which suggests that students felt more pride for Poughkeepsie after participating in the Hudson Eel Project. Additionally, the students increased their positive feelings for the eel, and named both more and more different types of organisms after the program was over. Since the survey also included open-ended questions, I will report those data in this section. These data provide evidence that the students in the focal group gave more information about the eels and the river after the program, and increased the number of words they used to talk about the animals and the environment in an empathetic manner. Most students
in the focal group showed a positive change in place attachment, meaning, and willingness to engage in pro-environmental behavior.

**Whole group data**

The pre-surveys were taken on the first day of the sampling season, and the post-surveys were taken on the last day, with the exception that students who missed the last day took the survey in school during the following week. The survey tool was separated into five different sections: part 1 included student demographics and basic questions about their school experiences, which was described in Chapter 3; part 2 was focused on place attachment; parts 3 and 4 focused on place meaning; and part 5 asked about willingness to engage in pro-environmental behaviors. There were several open-ended questions in part 4, which asked students to share what they knew about the Hudson Eel Project, list the organisms they knew about that lived in the Hudson River, and share how they felt about the eels. The bipolar scale for all questions was from 1 (strongly disagree) to 5 (strongly agree), except for the questions related to whether they liked and cared about the eels. Those two questions used a four-point scale ranging from “not at all” to “a lot”.

As was shared in the participant summary section of Chapter II, the majority of students participating in the project were minority (91%), and most were participating for the first time (82%). Most students said they were passing their science classes (87%), the majority said that math or science were their favorite classes at school (70%), and many wanted to pursue a career related to science or engineering (39%). When asked about their favorite activities to do outside of school, the majority of students said that they enjoyed playing sports (39%) or playing video games (18%). Only three students mentioned going outside, and two of those students said they did so with friends; only one student said their favorite thing was to go outside for hiking or
swimming. Other activities mentioned included sleeping, hanging out with friends, listening to music, reading, drawing, and going to church.

Before you can care about something, you have to know that it exists. In the pre-survey, almost half (42%) of students said that they had learned that eels existed because of the project, while several more gave very general information such as “they live in the water”, “they can’t kill you”, “it travels a far distance”. All of these statements are factual, and would have been shared during the initial presentation.

Place attachment composite mean scores in the pre/post-program surveys ranged from 2.97 to 3.03, which is the midpoint on the 5-point scale (see Table 6). The paired t-tests comparing the pre/post-survey results for place attachment showed that most statements had no significant positive increases, and the composite place attachment score did not increase significantly. Therefore, I failed to reject the null hypothesis and conclude that the citizen science program was not effective in changing students’ place attachment according to this survey.

There were a total of ten statements for place attachment, modeled on a previously validated survey used by high school students in New York City (Kudryatsev et al, 2012). Questions 5, 6, and 10 were negative statements. One statement, “Poughkeepsie is not a good place for what I enjoy doing”, saw a significant change from pre to post survey. This statement is an example of a negative statement, which was then reverse coded. Therefore, it indicates that students agreed more with the statement after the program was over. The statement “I don’t like telling people I live in Poughkeepsie” received the highest score, and since this is also an example of a negative statement and was reverse coded, it indicates that students like telling people that they live in Poughkeepsie. The discrepancies between the reverse coded questions
suggest that students may not have understood them or read them very carefully. The statement “Everything about Poughkeepsie reflects who I am” was the lowest scoring, and suggests that while students may like living in Poughkeepsie, they do not see themselves reflected in its people or places.

Table 6: Place attachment survey results. The survey included 10 items that were scored on a scale of 1=strongly disagree to 5=strongly agree, with three questions (items 5, 6, and 10) worded in reverse. The reverse coded item results were flipped, so that all questions below are on the same scale.

<table>
<thead>
<tr>
<th>Item</th>
<th>Pre-program</th>
<th>Post-program</th>
<th>Paired t-test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
</tr>
<tr>
<td>Composite pre/post statements</td>
<td>3.03</td>
<td>0.73</td>
<td>2.97</td>
</tr>
<tr>
<td>1. I feel like Poughkeepsie is part of me.</td>
<td>3.21</td>
<td>1.11</td>
<td>3.27</td>
</tr>
<tr>
<td>2. Everything about Poughkeepsie reflects who I am.</td>
<td>2.39</td>
<td>0.86</td>
<td>2.21</td>
</tr>
<tr>
<td>3. I am more satisfied in Poughkeepsie than in other places.</td>
<td>2.73</td>
<td>1.20</td>
<td>2.88</td>
</tr>
<tr>
<td>4. I identify myself strongly with Poughkeepsie.</td>
<td>2.97</td>
<td>1.29</td>
<td>3.03</td>
</tr>
<tr>
<td>5. Poughkeepsie is not a good place for what I enjoy doing.</td>
<td>3.76</td>
<td>0.96</td>
<td>3.27</td>
</tr>
<tr>
<td>6. There are better places to be than Poughkeepsie.</td>
<td>2.42</td>
<td>1.03</td>
<td>2.27</td>
</tr>
<tr>
<td>7. Poughkeepsie reflects the type of person I am.</td>
<td>2.48</td>
<td>0.83</td>
<td>2.52</td>
</tr>
<tr>
<td>8. I am proud to live in Poughkeepsie.</td>
<td>3.42</td>
<td>0.83</td>
<td>3.24</td>
</tr>
<tr>
<td>9. Poughkeepsie is the best place for what I like to do.</td>
<td>3.06</td>
<td>1.03</td>
<td>3.15</td>
</tr>
<tr>
<td>10. I don’t like telling people I live in Poughkeepsie.</td>
<td>3.82</td>
<td>0.95</td>
<td>3.85</td>
</tr>
</tbody>
</table>

Place meaning composite mean scores in the pre/post-program surveys ranged from 3.52 to 3.68, which is slightly above the midpoint on the 5-point scale. Using paired t-tests to compare pre/post-program mean scores for ecological place meaning, I found that the increase in
the composite mean score was marginally significant at a p-level of 0.10 (Table 7). Almost all the sixteen statements increased, indicating that students felt more positive about their place after the program was completed (see Figure 8). One of the statements (“Poughkeepsie is a place to enjoy nature’s beauty”) was marginally significant at a p-level of 0.10 (Table 7). Another statement, “I like Poughkeepsie because of the eels”, was statistically significant at a p-level of 0.05, and suggests that the experience of sampling for eels changed the way students felt about Poughkeepsie. The statement that students agreed with the most was that the Hudson River was an important part of the community, which suggests that students recognize the importance of the ecosystem not only for aesthetic reasons but also as a place for people to enjoy the river and each other, and a place that supports different organisms, including the eels. There were only two statements that saw very small (less than 0.05) decreases from the pre to post survey: “I can come to the Hudson River to enjoy nature” and “I would feel sad if eels went extinct in the water in Poughkeepsie”. These results are contrary to what was found in the qualitative results, and is also contradicted by the question asking students whether they liked and cared about the eels. Consequently, it suggests that students may not have read the survey questions carefully, that they may not have understood the question, or that the question was not worded in a way that made sense to them.

Table 7: Ecological Place Meaning Statements. The survey included 16 items that were scored on a scale of 1=strongly disagree to 5=strongly agree, with one question (item 1) worded in reverse. The reverse coded item result was flipped, so that all question results below are on the same scale.

<table>
<thead>
<tr>
<th></th>
<th>Pre-program</th>
<th>Post-program</th>
<th>Paired t-test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
</tr>
<tr>
<td>Composite pre/post statements</td>
<td>3.52</td>
<td>0.55</td>
<td>3.68</td>
</tr>
</tbody>
</table>
1. The Hudson River is something I don’t think about very much. 3.24 1.00 3.42 1.06 1.000 32 0.325
2. Eels are an important part of Poughkeepsie. 3.57 0.71 3.66 0.85 0.722 32 0.475
3. I like Poughkeepsie because of the eels. 2.45 0.87 3.00 1.00 3.946 32 0.000
4. I would feel sad if I couldn’t spend time at the Hudson River. 3.51 1.03 3.55 0.87 0.183 32 0.856
5. Waryas Park and the Hudson River are my favorite place to go in Poughkeepsie. 2.97 0.95 3.18 0.95 1.314 32 0.198
6. Poughkeepsie is a place to connect with nature. 3.39 0.97 3.63 0.82 1.543 32 0.133
7. Poughkeepsie is a place to watch animals and birds. 3.15 0.91 3.33 0.96 1.06 32 0.296
8. Poughkeepsie is a place where people can find nature. 3.45 0.87 3.57 0.97 0.78 32 .441
9. In Poughkeepsie, the Hudson River is an important part of the community. 4.18 0.73 4.33 0.82 1.00 32 0.325
10. Poughkeepsie is a place where people have access to the water. 3.79 0.89 4.00 0.90 1.314 32 0.198
11. Poughkeepsie is a place where people have access to parks. 4.00 0.89 4.06 0.93 0.32 32 0.751
12. Poughkeepsie is a place to have fun in nature. 3.51 0.75 3.67 0.89 0.926 32 0.361
13. Poughkeepsie is a place to learn about nature. 3.67 0.89 3.67 0.89 0.00 32 1.00
14. Poughkeepsie is a place to enjoy nature’s beauty. 3.54 0.97 3.85 0.97 1.971 32 0.057
15. I can come to the Hudson River to enjoy nature. 4.03 0.85 4.00 0.97 -0.19 32 0.851
16. I would feel sad if eels went extinct in the water in Poughkeepsie.

When looking at the mean changes for each question between the pre and post surveys, Figure 8 shows that there was a positive change for almost all of the questions, as a hypothesis of no change in response would be equal to 0 on the x-axis. The y-axis shows the individual questions listed in Table 7; question 1 is the first question in the table, and question 16 is the last question in the table. As mentioned earlier, questions 15 and 16 had a slight decline (0.03) between the pre/post survey means. Question 3 (“I like Poughkeepsie because of the eels”) showed the largest increase from pre to post-survey, followed by question 14 (“Poughkeepsie is a place to enjoy nature’s beauty”).

![Figure 8. Mean difference (pre-post) across respondents for all place meaning survey questions, with error bars showing the standard error.](image)

Besides the place meaning survey questions, students were asked open-ended questions to share what they knew about the eels, and in the post-survey, to explain what threats they knew about. In the pre-survey, the majority of students said they didn’t know anything about the eels,
or left the question blank. Some students knew about the eels’ migration, and that they changed color and size as they got older. In the post-survey, twice as many students (n=10) explained how the eels migrated, and twice as many (n=8) discussed how they changed over time. They also gave more details in the post-survey, and several students gave details about several aspects of the eels (migration and life cycle). For example, one student said “I know they migrate from Poughkeepsie to give birth then they pass away” in the pre-survey, and then said “The American eel migrates up the Hudson and into the creeks to grow to the next stage of their lives, they have their migration season from early to mid spring, from baby glass eels and the next stage are elvers” in the post-survey. With respect to threats to eels, 30% of students mentioned predators, and 27% mentioned pollution (some of these students are the same). A similar percentage (27%) did not answer the question or said that they didn’t know. In the survey results, it is unclear what students meant by pollution because they were not asked to explain their answers.

In the place meaning section of the survey, students were also asked whether they liked the eels and cared about the eels. There was an increase in the number of students who said they liked the eels a lot, and an increase in the number of students who said they cared about the eels a lot (see Figures 9A and 9B). There was a 70% increase in students who said they liked the eel “a lot”, which was a significant increase (p=0.008). There was a 13% increase in students who said they cared about the eel “a lot”, which was not statistically significant (p=0.35). There was a decrease in students who said they liked and cared for the eel “a little bit” and students who said “they weren’t sure”, indicating that students shifted from not knowing or caring to liking and caring a lot about the animal.
Figure 9A (left panel). Percentage of student responses to the question “Do you like the eels?” in the pre/post-surveys, n=33. Figure 9B (right panel). Percentage of student responses to “Do you care about the eels?” in the pre/post-surveys, n=33.

Also within this section, students were asked to list the organisms that they thought lived in the stream. In the pre-survey, students collectively mentioned 45 organisms; 19 of those were eels, and 11 were “fish” (Figure 10).

Figure 10. Types of organisms students thought lived in the Hudson River at the beginning of the program and at the end. There were significantly more organisms mentioned at the end of the program (p=0.049, n=33).

Five students listed sturgeon, while three mentioned crabs and two mentioned catfish. In the post-survey, 73 organisms were listed; 28 of those mentions were eels, 22 were fish, and 6 were herring. Plants were mentioned twice in the pre-survey and twice in the post-survey; no
microorganisms were named. While students still mentioned fish more times than specific types of fish, more students were able to identify that fish lived in the Hudson River, which suggests that the river became less of a mystery to them. According to a paired t-test, students mentioned significantly more organisms in the post-survey (p-value = 0.049). This demonstrates that students increased the number of organisms they thought lived in the Hudson River as a result of participating in the program.

The willingness to engage in pro-environmental behaviors composite mean scores in the pre/post-program surveys ranged from 2.46 to 2.52, which is above the midpoint on a 4-point scale. Using paired t-tests to compare pre/post-program mean scores for students’ willingness to engage in different types of environmental behaviors, I found that the increase in the composite mean score was not significant (Table 8). One statement was marginally significant, at p = 0.051, which asked students whether they would be willing to bring a reusable mug to a coffee shop instead of using a disposable one. This was categorized as a personal environmental behavior change, and indicates that students felt this was the most accessible change that they could make in their lives of the options presented. Students were most likely to turn off the lights when leaving a room, but this did not change significantly between the pre and post surveys.

Table 8: Environmental behavior survey results. The survey included 10 questions which were designed around three “scenarios” and organized by individual behaviors, community level behaviors, and civic actions.

<table>
<thead>
<tr>
<th></th>
<th>Pre-program</th>
<th>Post-program</th>
<th>Paired t-test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
</tr>
<tr>
<td>Composite pre/post statements</td>
<td>2.46</td>
<td>0.59</td>
<td>2.52</td>
</tr>
</tbody>
</table>
1. When you go to a store, how likely are you to bring your own reusable bag?  
   1.97 1.01 2.18 1.04 1.31 32 0.198
2. How likely are you to tell your friends and family to use reusable bags?  
   1.97 1.07 2.12 1.02 0.867 32 0.392
3. How likely are you to vote to support elimination of plastic bags?  
   2.94 2.85 0.97 1.20 -.475 32 0.638
4. Climate change is one of the main environmental problems in the world. How likely are you to sign a petition to require people to carpool?  
   2.03 0.95 1.97 0.92 -.421 32 0.677
5. Climate change is one of the main environmental problems in the world. How likely are you to turn off lights to save electricity when you leave a room?  
   3.39 0.78 3.48 0.91 0.620 32 0.540
6. Climate change is one of the main environmental problems in the world. How likely are you to go to City Hall and ask the city to require all homes use solar or wind power?  
   2.03 0.88 2.00 1.03 -.215 32 0.831
7. You notice that a lot of the trash in the Hudson River is Styrofoam. How likely are you to participate in a cleanup of Styrofoam on the riverfront?  
   3.03 0.92 2.91 1.04 -.812 32 0.423
8. You notice that a lot of the trash in the Hudson River is Styrofoam. How likely are you to bring a reusable cup when you go to Dunkin Donuts, instead of getting one of their foam cups?  
   2.33 1.09 2.76 1.09 2.03 32 0.051
9. You notice that a lot of the trash in the Hudson River is Styrofoam. How likely are you to start a campaign to ban the use of Styrofoam in Poughkeepsie?  
   2.09 1.10 2.03 1.07 -.360 32 0.721
10. You notice that a lot of the trash in the Hudson River is Styrofoam. Imagine that Poughkeepsie is proposing a ban
Students were more likely to engage in personal, individual pro-environmental changes (questions 1, 5, 7, and 8) as compared to community or participatory changes (questions 3, 4, and 10) and civic or social-justice oriented changes (questions 2, 6, 9). The average post-survey score for the four individual behaviors was 2.83 (SD=0.70), while the community behaviors were 2.56 (SD=0.87), and the civic behaviors were 2.05 (SD=0.86).

To understand if there was a relationship between attachment, behavior, and willingness to engage in pro-environmental behaviors, a series of correlation analyses were completed. As these are overall Likert scale scores, and therefore can be treated as interval data, a parametric test was used. A Pearson correlation coefficient was computed to assess the relationship between attachment and behavior \([r = .245, n = 33, p = .17]\). This suggests that although there is a small positive relationship, it is not statistically significant, so it is unlikely that attachment affects willingness to engage in pro-environmental behaviors. A Pearson correlation coefficient was computed to assess the relationship between attachment and meaning \([r = .484, n = 33, p = .004]\). This suggests that there is a significant, positive relationship between attachment and meaning. A Pearson correlation coefficient was computed to assess the relationship between meaning and behavior \([r = .573, n = 33, p < .000]\). This suggests that there is a significant, positive relationship between meaning and behavior.

**Focal group data**

Analyzing the interview responses allowed me to understand how the amount of discourse changed as a result of the program. With respect to place attachment, most students
increased the amount of discussion related to their empathy for and pride in the river and the eels. Any time a student talked about caring about the eel, wanting to save it, having pride in their river, or caring about the river, it was coded as a form of “attachment”. Many students didn’t talk about the river at all at the beginning of the project, but then discussed it in their final interviews, including Holly, James, Joshua, Maddox, Manuel, and Nolan. Two students, Holly and Manuel, did not increase the number of words related to attachment for the eel. However, Holly increased her attachment scores in the survey. Some students, like Miles and Taylor, didn’t talk about the river at all, even in the post-interviews, but did talk a lot more about the eels. Figure 11 shows how student discourse changed from the pre to the post-interviews. These results support other findings from the interviews and observations, which suggest that students became more attached to this place, and cared more about it and the organisms that live there.

Figure 11. Number of words coded for the pre and post-interviews for each student for two main measures of attachment – caring about the eel, and caring about the Hudson River.
All of the students in the focal group increased the number of words that they used to talk about the science of the eels when comparing their conversations from the beginning to the ending of the program. And, with the exception of two students (Maddox and Miles), all students increased the number of words they used to talk about the Hudson River. In Figure 12, all of the students’ answers about eels (eel biology, life cycle, threats to eels, and recognition of the eels existing in the Hudson) were combined into one category. Similarly, all of the students’ answers related to the Hudson River (natural features, organisms, tides, and threats) were combined into one category. Taylor was the only student who did not change very much in the amount of discourse about the eel, and also focused a lot on the animals as compared to the river in her interview. She was very concerned about the eel at the beginning, and remained so at the end, relating her concern to her religious training and wanting to protect “all of God’s creatures”. Many students showed a lot of change from their initial to their final interviews with respect to talking about the eel and what they had learned.

![Figure 12](image-url)

*Figure 12. Number of words coded that related to place meaning for each student during the pre and post-interviews.*
These results support the qualitative interview and observation results, suggesting that students gained a deeper understanding of the eels and the Hudson River.

When examining the pre/post changes in the survey responses for the focal group students, there are some interesting patterns to note (see Figure 13). Alan, Holly, James, Manuel, Nadine, and Nolan all had positive changes, with the exception of Manuel who had no change in his attachment scores and Nadine, who had no change in her behavior scores. Holly had the most positive changes as a result of participating. Joshua was positive in both meaning and behavior, but not attachment, which may be a result of his recent arrival to the U.S. Maddox had a negative change for both attachment and behavior, although when probed in the interviews, he said that he was participating in the project because he wanted to help save the eels, and he would do a cleanup of the river for trash. His survey answers were the most negative of all of the students. Miles had negative changes for all three components of the survey, despite the fact that he talked about how cool the eels were, that he had done the project for two years and said he would continue in the following year, and was concerned about the eels getting stuck in trash in the river. When asked about his behavior change choices, Miles admitted that he does sometimes use a reusable bag at the store, but said that he “must’ve missed that” on the survey. Taylor had negative changes for both attachment and meaning. This was a surprising result, since she spoke so favorably of the project and the eels during her interviews. She repeatedly mentioned her love for the eels and the program, and thus it is possible that she did not read the survey questions carefully.
Figure 13. *Mean change from the pre/post-surveys for composite scores for place meaning, place attachment, and willingness to engage in pro-environmental behaviors. A positive number indicates that the student increased their mean responses, while a negative number indicates that they decreased their mean responses.*

These discrepancies between what students reported on their surveys and what they shared in their interviews are examples of how different types of data can reveal different components of a student’s feelings.

In summary, most students showed an increase in their place meaning as a result of participating in the eel program. However, students did not show an increase in place attachment or willingness to engage in pro-environmental behaviors. There was an increase in how much students liked the eel, and how much they learned about it and their environment. This suggests that the Likert-scale survey questions may not have adequately captured students’ feelings about the eels or what they had learned. Students learned about more organisms in the river as a result of participating, and there was a positive relationship between students’ place meaning and their
willingness to engage in pro-environmental behaviors. There are discrepancies between the
survey results and the interviews, which suggests that the surveys may not capture the extent of
how sense of place changed for these students.
In this final chapter, I will summarize my findings in relation to my original research questions, present my study’s limitations and implications, and give suggestions for future research. In this study, I explored how participation in an informal citizen-science program supported the development of sense of place in urban youth, and whether this might encourage different types of pro-environmental behaviors. In what follows, I will discuss the results for each research question, and then synthesize my understanding of how the youth changed over the course of this project.

My work acknowledges sense of place as a multi-dimensional construct, incorporating both place attachment and meaning while accounting for individual factors and the importance of experiences affecting participants (see Figure 14). My model began with students learning about the existence of a new animal in their community, one which brought a sense of joy and wonder – not only because they got to experience a cool creature, but also because it lived in their creek. As students learned about the animal and its habitat, they became more comfortable exploring the creek and using the sampling tools. Through these activities, they developed a sense of pride in their place and empathy for the eel. I believe there are feedback loops between these components: as students learn more, they became more comfortable in the creek, and gained an appreciation for the eel and its home. Figure 14 is modified from my initial model, and documents how sense of place is connected to the other components in this study.
Figure 14. Revised conceptual model showing the connections between the construct of sense of place and its components: place meaning and attachment, self-determination theory, and pro-environmental behaviors. The first step for developing sense of place in this study was the recognition of the organism (indicated with a #1 on the diagram), which occurred through the experiences in the creek (#2) but were organized with the application of self-determination theory. Through these experiences, students developed both affectively and cognitively - place attachment and meaning (#3) - which were reinforced through a feedback loop between the concepts and the experiences. A main question of this study is whether students developed a willingness to engage in different types of pro-environmental behaviors (#4).

My research questions were as follows:

1. How does youth sense of place change as a result of this citizen science program?
   a. What are the prior experiences of youth with the flora and fauna of their local place, the stream where sampling is happening?
   b. How does youth attachment to place, and ecological place meaning, change as a result of this citizen science program?

2. How does youth willingness to engage in pro-environmental behaviors change as a result of this citizen science program?
3. Is there a relationship between place attachment, ecological place meaning, and likelihood to engage in pro-environmental behaviors? What kind of behaviors are students willing to engage in – individual, community level, or civic engagement oriented?

I hypothesized that students’ sense of place would increase as a result of the direct experiences in the creek and with the eel, supported by the use of self-determination theory by the adult leaders of the program. Sense of place was investigated using both quantitative and qualitative methods, and place attachment was operationalized with the concepts of empathy and pride. I believed that as sense of place increased, the likelihood of engagement in pro-environmental behaviors would increase as well, based on the relationships that have been demonstrated in other scholarship (Stedman, 2002; Vorkinn & Riese, 2001; Walker & Chapman, 2003).

I found that the repeated experiences in the creek, coupled with the uniqueness of the American eel - whose bodies are clear and who arrive in huge numbers - was changed students’ sense of place. I found a connection between increased ecological place meaning and a willingness to engage in some pro-environmental behaviors, although there were discrepancies between the qualitative data and the survey data in this regard. Students developed ecological place meaning as they learned about the ecosystem and the animal and had positive experiences in the creek in a supportive group setting. They were able to use this knowledge to become more confident in the sampling activities, develop positive feelings about the eel and the creek, and build social capitol. In addition to this, while students were willing to engage in some individual actions, they were not more willing to engage in community or civic level actions. Thus, as a result of this study, I will offer suggestions for citizen science programs that work with youth,
and how these programs might increase the likelihood that students will be willing to engage in pro-environmental behaviors.

*Factors influencing sense of place*

Scholars have pointed to a number of factors which influence sense of place and which were explored in this study. The type, duration, and frequency of outdoor experiences, the existence of an outdoor “special place” as a child, and residence time have all been documented as important factors in developing concern for the environment and sense of place (Chawla, 1998a; Hernández et al., 2007b; Kals et al., 1999; Pyle, 2002). Youth experiences with animals and their view of the natural world are also important in this project, as prior experiences with animals (particularly wild animals) can influence youth empathy along with one’s perspective of nature and how one view it (Kahn & Kellert, 2002). I cannot claim that these are all of the factors influencing sense of place, as the concept is nuanced and fluid; however, I focused on those that I believed were most relevant to this study.

Few youth in this study had sustained and positive experiences in the outdoors, especially as children and with a trusted adult. The majority of the students in this study did not spend a lot of time outdoors; only three of the students mentioned going outside as a favored activity on the survey, and two of those combined their going outside with hanging out with friends. In the focal group, students were asked about their outdoor experiences as children, and whether they had a “special place” outdoors, such as a fort or treehouse (Pyle, 2002). They were also asked who they went outside with, and for what purpose. Most students did not have special outdoor places as children or spend a lot of time outdoors in unstructured ways, with only one student mentioning that they remembered building a fort in their childhood. Several youth did mention
going outside with friends or family, and one student was a member of the Boy Scouts. These experiences, however, were to places outside of their immediate community, such as the Catskill and Adirondack mountains. This supports findings from other studies that youth spend minimal time outdoors, especially in natural settings (Gonzalez, 2019; Ray & Jakubec, 2018; Soga & Gaston, 2016a). The number of youth who have the opportunity to be in nature in a contemplative, individual manner, and who thus experience nature and the organisms of their place, are decreasing (Pyle, 2002; Soga & Gaston, 2016a).

How students viewed the environment is also important, as it suggests what is important to the students – in this case, the Hudson River, and the creek which flows through their city (Chawla, 2006). The theory of biophilia asserts that people rely on nature for survival, but also benefit from emotional connections with it - from fear and aversion to love and awe (Kahn & Kellert, 2002). If students have an emotional connection to their place, we might expect them to talk about how much they love the river. While focal group students did have a favorable view of the Hudson River, this was due to the river being a setting for positive experiences in their lives, mostly related to leisure. Seeing the world as disconnected from people, as static or “in balance” without humans, or only as a backdrop for favored activities, restricts one’s understanding of the natural world as a dynamic, complex, and “stochastic” (Chawla, 2006; Ladle & Gillson, 2008; Pickett et al., 2010). Most focal group students had a balance of nature perspective, and half of the students thought of humans as caretakers of nature (Kahn & Kellert, 2002). Many scholars have pointed out that most Western cultures, and particularly people living in urban areas, see nature as “separate” from humans (Coley & Solomon, 2002). However, students in the focal group did not see nature as a separate component of the landscape; in fact, the built environment was just as commonly depicted as the natural
environment in their drawings, suggesting that their view of the environment included both components. Thus, while the river and its environs were not viewed as ecologically important, it was a part of their lives and their community.

Learning about and experiencing animals in person provides youth with a way to gain empathy for non-human animals (Barthel et al., 2018; Carlone et al., 2015; Watson, 2006). Based on the results of the survey question where students were asked whether they liked and cared about the eel, this project helped them do that. This was supported by the observations during the sampling season. In the focal group, most students did not have direct experiences with animals before this program (besides their domestic pets). Consequently, the Hudson Eel Project was the first time students got to see and directly experience a wild animal, and their feelings for the eel became more positive as a result. Several students in the focal group successfully worked through their fear and discomfort in order to participate in sampling for the eels. Being able to repeatedly touch and observe wild animals helps youth foster positive attitudes towards them, even if they were previously afraid or disgusted by the animal (Myers & Saunders, 2002; Pitt & Shockley, 2014; Tomazic, 2011; Watson, 2006). As a result, this study supports previous work that suggests students need direct, sustained, and supportive experiences with wild animals in order to become more comfortable with them and care about them. This development of empathy also connects with their place attachment.

The longer someone lives in a particular place, the higher their attachment, although newly arrived residents can also be strongly attached (Hernández et al., 2007b; Lewicka, 2011). Only the focal group students were asked about their residence time, and while most had lived their entire lives in Poughkeepsie, three were recent arrivals, with two having emigrated from
abroad in the past year. Both of the students who came from abroad had very positive views of Poughkeepsie; more so, even, than the long term “resident” students. Based on the interviews, it is likely that due to the problematic nature of their home countries, they saw Poughkeepsie and the rest of the United States as a positive, prosperous place. They also thought of their schooling as an opportunity to improve their chances for college and jobs. Consequently, in the focal group, there was no relationship between length of residence time and attachment. Instead, students tended to speak more positively about their community if they reported doing well in school and participated in school-based activities like sports. This relationship will need to be explored in subsequent work.

*Sense of place - attachment*

The survey results suggest that students’ place attachment did not change, but the interview analysis and observations of the focal group students illustrate a more complicated situation. With respect to place dependence, focal group students did not recognize the dependence they had on the river for drinking water, and did not mention other forms of dependence. This did not change during the program, although students did recognize that some people fished in the river because they saw people engaged in these activities. Their place identity was linked mainly to leisure activities such as crew or enjoying walks along the water at the start of the program, but this changed to including the eel and its habitat. Expanding place identity to include compassion and empathy demonstrated how attachment changed for the students. This also allowed dependence to include the concept of pride in place, since the Hudson Eel Project necessarily requires the river and the creek.
The focal group students became more attached to the eel and the river as a result of the program, as evidenced by the use of more empathetic and prideful language afterwards. The students were observed worrying about the eels’ well-being, asking about whether they could touch them and hold them, and watching them as they moved. They helped each other if someone dropped an eel, and expressed concern if one was outside of the water. They talked about how small the eels were, how cool they looked, and how amazing it was that they had traveled so far. The focal group students also paid more attention to the creek and the river at the end of the sampling season, and were cognizant of the fact that they now noticed and recognized life in a place where they had never seen it before. They added words like “love” and “prosperity” to their final drawings, and wanted to share what they had done and learned with others.

Empathy includes the concepts of compassion and perspective-taking, and allows people to develop a caring relationship with others, including animals and the natural world (Greving & Kimmerle, 2021; Pfattheicher et al., 2016). In two recent studies which compared photographs of distressed animals with animals with normal photographs (bats, raccoons, and foxes), researchers found that participants were more likely to be willing to participate in citizen science projects and were more likely to engage in activities that protected the animals because the photographs inspired feelings of compassion (Greving & Kimmerle, 2021; Straka et al., 2020). However, these affective components have not received much attention in studies of participants in citizen science research, as most studies that investigate participant outcomes focus on knowledge or skills (Groulx et al., 2017; Peter et al., 2019). My study suggests that, similar to studies in which youth worked with other animals, repeated experiences and direct contact with
The eels in this citizen science project were essential for developing empathy in the form of compassion (Barthel et al., 2018; Carlone et al., 2015; Lumber et al., 2017).

In addition to empathy, students also developed a sense of pride in their place, which is part of place dependence. This was demonstrated by their concern for the habitat, their disdain for the litter they saw in it, their excitement at the presence of the eels and its existence in their city, and their interest in talking with others about the project. They wanted to make sure that the creek remained a good habitat for the eels, and several mentioned improving it in a variety of ways. Caring about the place and wanting to protect it suggest that the citizen science program was able to develop positive connections to place for the youth, which may lead to some pro-environmental behaviors (Lumber et al., 2017). These findings suggest that students developed compassion for the eel, and pride in its home.

The development of attachment within the qualitative results, however, contrasts with the lack of attachment change in the quantitative results. One possibility why these results differ is that the survey did not capture students’ change in attachment. This may be because the survey questions were not relevant to the students; although I conducted a validation of the survey with three students before the study began, I did not ask the students follow up questions to ascertain whether the questions actually captured their feelings of attachment. The questions were adapted from a validated survey used with urban youth in New York City, which in turn was adapted from a study by Jorgensen & Stedman (2001), but the statements remained broad in that they included the entire city of Poughkeepsie, instead of just the riverfront area (Kudryavtsev, Krasny, et al., 2012). It is also possible that students who had a negative view of Poughkeepsie because of their school experience, their home, or their peer group did not feel that the positive
experience of sampling for eels could erase their concerns. As only half of Poughkeepsie students graduate from high school, and the economic situation in Poughkeepsie is continually challenging, perhaps asking a question such as “Everything about Poughkeepsie reflects who I am” encouraged students to think about the entire city, and the area where the eel sampling took place was either not part of their thinking about Poughkeepsie or was not influential enough to change their feelings.

Other possibilities include that place attachment cannot be adequately captured in survey questions with youth. Work documenting how urban youth develop sense of place is often done through qualitative methods (Ardoin et al., 2014; Lim & Barton, 2010). Kudryavtsev et al. (2012) was able to find a change in ecological place meaning in urban youth in New York City, but was similarly unable to describe a change in place attachment, despite having the benefit of a control group and a larger sample size. Youth often hold multiple views of their place, some of which are positive, and some of which are negative (Kudryavtsev, Krasny, et al., 2012; Lim & Barton, 2010). The fact that some of the youth had very positive feelings about their city, while others shared more conflicted opinions, suggests that there are many different aspects of place affecting students’ emotions. They may have a positive connection with their friends and family, and yet have a negative attachment because of school, safety on their street, etc. Thus, it is possible that different questions or methods are needed to capture place attachment change in youth.

Sense of place – meaning

In order to care about something, you have to know both what it is and that it exists. All of the students in this study knew some organisms that lived in and around the Hudson River
before participating, but they did not know about the eel. They were unfamiliar with the eel’s ecology and the ecology of the Hudson River, but this changed as a result of the program, and thus increased their place meaning. This is supported in both the quantitative and qualitative results.

At the beginning of this study, the most common animal students mentioned in the survey was “fish”; few mentioned plants, and no students mentioned microorganisms. They did not see the river as a vibrant system that was home to a rainforest of organisms (Strayer & Dudgeon, 2010). This may not be surprising, as the river is generally a ruddy, turbid brown, and seeing anything living under the surface is challenging. Regardless, the students’ tendency to name obvious, general species is mirrored in a recent study of hundreds of students across the US, and in several other papers (Bermudez et al., 2015; Le et al., 2018; Wandersee & Schussler, 1999b). The Hudson Eel Project allowed the students to gain familiarity with some life in the river besides the eels, and at the end of the program, students named more different types of organisms. They also learned that the American eel existed, and that it wasn’t an electric eel but a different species that was harmless. It can be assumed that the majority of students, if not all, were not aware of the eel beforehand, since all of the focal group students said they learned about the eel only through the program. This noticing of a new animal was an important shift in how students thought about their place.

After students knew that the eel existed, they began to learn more about it, including how its color changed over time, where it migrated to and from, and why the project was tracking the population numbers. The survey demonstrated that students went from not being able to share anything about the eels to talking about how they changed over time, that they live in the Hudson
River, and that they migrate from the ocean. If students can recognize and name the organisms around them, they are more likely to appreciate them (Chawla, 2006; Lindemann-Matthies, 2005). The focal group students were able to talk more deeply about the eels and the river, and marveled at their features, especially since they could see their hearts and eyes inside their bodies. And, due to the experiential nature of the project, they noticed changes in the river such as tides and water color. They began asking questions about the eels and the river, such as wondering about the reasons for the changes in the population over time.

In this way, attachment and meaning are linked – as students learned about the eel, and about it habits, they started to look at the river differently. They asked questions about the things they noticed, such as the fluctuating water levels, or the color of the creek and the river. They observed birds and other fish in the water, and talked to others about what they had learned. As most did not know that the eel even existed before the program, the discovery of this miraculous creature and its migration literally steps away from their homes became a source of pride and wonder. Consequently, this previously murky, lifeless river which was a backdrop for students’ lives became a place where living things flourished, and encouraged students to wonder about the existence of other organisms in the water.

My findings suggest that even a relatively short citizen science program can positively affect a student’s place meaning, and encourage students to see life in new places, especially in a place that may have had a negative spatial stigma for them or may have been impossible to “see” (Graham et al., 2016; Lindemann-Matthies, 2002). The Hudson River was a place that didn’t figure into the lives of these students except for as a tool for recreation, and several thought it was dirty from pollution. Reframing their city as a place of natural wonder and beauty may
encourage them to engage in other ways of connecting with nature. The Hudson Eel Project helps counteract the extinction of experience that many youth are struggling with, and thus create a pathway of equity in their city, disrupting the narrative that urban spaces lack natural beauty and wildness (Carlone et al., 2015; Gruenewald, 2003a; Soga & Gaston, 2016a; Wandersee & Schussler, 1999b; Wason-Ellam, 2010).

*Pro-environmental behaviors*

The idea that sense of place could lead to a willingness to engage in pro-environmental behaviors was investigated by asking students to decide how likely they would be to participate in individual, community, and civic level actions. I found that while students’ willingness to engage in pro-environmental behaviors was not related to their place attachment, it was significantly related to their increase in place meaning. It is possible that the positive experiences the students had during the program increased their emotional affinity for nature, and thus may lead them to engage in pro-environmental behaviors (Kals et al., 1999). Specifically, their experiences with and their learning about the eel were essential to developing their ecological place meaning, which aligns with what scholars have found when students have opportunities to engage with wild animals in other settings (Carlone et al., 2015; Tomazic, 2011; Watson, 2006). Having time to learn about and experience the eel in its native habitat, even if the animal initially caused discomfort to some youth, could lead to a caring relationship, and encourage youth to want to protect its habitat (Lindemann-Matthies, 2005; Tomazic, 2011).

Using the framework from Westheimer (2015) to separate types of behaviors into individual, community or participatory, and civic or social-justice oriented behaviors, the surveys showed that students were more likely to complete individual behaviors. This mirrors what
numerous scholars have found when researching environmental education programs: youth are encouraged to believe that it is possible to make individual choices and thus solve the large, complex problems facing our globe (Chawla & Cushing, 2007b; Dillon et al., 2016; Schindel Dimick, 2015; Spannring, 2017). Schindel Dimeck (2015) calls this the “privatizing of environmental sustainability”, reinforcing the neoliberal narrative of the individual, and reducing the responsibility of the state. Empowering students through developing civic readiness or advocating for collective changes is generally eclipsed by the focus on personal, individual actions (Levine, 2007; Schindel Dimick, 2015; Westheimer, 2015). In the post-survey question asking about threats, the youth talked about the threats of predators and pollution at about the same frequency, and the focal group students expanded on their answers by talking about overfishing and types of pollution (trash and litter). This can be explained because of the types of threats that were discussed during the program: the only time global issues such as climate change or habitat loss were mentioned was at the initial assembly.

During the program, the adult leaders shared one story about overfishing, mentioned the dam that we were helping the eels get over by moving them upstream, and also pointed out the predation of the eels by the birds. The adults talked about pollution in a general way, and discussed how we could put our trash in a trash can or recycle it in order to keep it from getting into the river. There was no conversation about community or civic level actions that could potentially help improve the eel population numbers, or stop trash and litter in the first place. It is therefore understandable that students relied on common, individual actions such as recycling or picking up trash when asked about solutions. Interestingly, students insisted on “seeing” eels trapped in trash in the creek, when this was never something actually observed at the sampling site. It is possible that because the community struggles with litter, and picking it up is a
manageable (if frustrating and futile) individual action, this narrative saturated the students’ views of the project. Consequently, citizen science programs like the Hudson Eel Project should be mindful of the way in which they frame the environmental problems they are combatting, and be honest about the complexity of the challenges and the solutions, both individual and collective (Cantor et al., 2015; Danaia et al., 2013; Davies et al., 2015). The Hudson Eel Project leaders should discuss a range of both individual and collective actions that might help address the eel population decline, and support students in understanding how the project fits into understanding the ecosystem as a whole.

However, during the interviews, focal group students acknowledged that they were willing to engage in both individual and community changes. Their answers suggest that the survey questions did not capture the reasons why students may not have been willing to engage in a particular pro-environmental behavior. For example, some students were concerned about the potential safety impacts of carpooling, while others were worried about being alone and trying to challenge the status quo at a meeting run by adults. Convenience and economics were other factors that played into students’ responses, such as turning off the lights to save money or using a plastic water bottle because it is easier. It is also possible that social norms or students’ personal choices about how they express their identities through fashion or products affect their answers; wearing old shoes or having an old phone are not ways in which to climb the social ladder in high school (Schindel Dimick, 2015). At least one student said that he would not bring a reusable bag to the store unless his friends did. Several students, on the other hand, mentioned their agreement with avoiding plastic straws due to social media campaigns they had seen, which were often supported by celebrities. This suggests that having a safe space for thoughtful discourse, one in which students can reason through the challenges of different decisions,
critique the current norms, and offer ideas or solutions, may be the best way to understand students’ willingness to engage in pro-environmental behaviors.

Besides the pro-environmental behaviors, I also documented the development of social capital, which some researchers claim is a community level outcome that can lead to systemic change (Groulx et al., 2017; R. C. Jordan et al., 2012a; Krasny et al., 2015). The social nature of gathering scientific data outdoors was both an initial motivator and a way to persist in the activity, and allowed students to develop social capital. Students were internally motivated to participate in this project, and because they enjoyed it, they wanted to tell others about it (both family and friends). The focal group students were observed talking to strangers passing by, and many of them shared their efforts to get friends to join them in the sampling. They talked about how interacting with different students, outside of the school setting, was a way to get to know new people in a positive way. They also enjoyed meeting and working with the adults in the project, and enjoyed interacting with their teachers in an informal manner. As has been shown in other studies, being part of a social network working towards a collective goal fosters positive attitudes towards the environment (Chawla & Cushing, 2007b; Kals et al., 1999). Adult and peer role models who support youth as they work in a new, outdoor setting have been essential for developing positive youth connections with animals and nature (Calabrese Barton, 2012; Carlone et al., 2015; Hobson et al., 2016). These connections between the youth, and between the youth and the adult leaders, could be another way to begin to develop the networks for community change (Krasny et al., 2015; Stepenuck & Green, 2015).

As with the sense of place results, there are discrepancies between the survey results and the interview results for pro-environmental behaviors, and therefore it is important to step back
and think about the structure of the program and that of the survey and the questions therein. The eel program is a science-driven, contributory project, where participants support the researchers in gathering data. It is not collaborative or co-created, both structures of citizen science programs that have been suggested to provide more power for the participants and impacts beyond knowledge and skill development (Bonney, Cooper, et al., 2009; Dillon et al., 2016; Westheimer, 2015). In collaborative projects, the participants help answer questions, and while those might be collaboratively refined, the questions are asked by the scientists. Co-created projects are usually the result of some local issue, where community members have questions and then gather evidence to answer the question, often with scientific support. The Hudson Eel Project was designed primarily to obtain good count data on the American eel, albeit with some community level outcomes such as social capital. There is no space in the current program for youth to conduct their own inquiries or develop stewardship or communication projects that they might want to pursue. Consequently, while youth developed ecological place meaning, they did not wonder about the decline in the eel population or how human behaviors might be to blame.

Furthermore, the experience has the potential to be educative only if it challenges students’ view of the world, connects to their lives, fosters both psychological and logical learning, and includes reflection. As described by Dewey, education is “that reconstruction or reorganization of experience which adds to the meaning of experience, and which increases ability to direct the course of subsequent experience” (p.76, Dewey, 1916). Implicit in this statement is the importance of a purpose driving the experience, and of “psychologizing” that experience in order to make it truly educative. Dewey points out the need to connect current experience both forwards and backwards in a student’s life, which is what he calls continuity.
Finally, through reconstruction and reorganization, Dewey draws our attention to the importance of reflection, of thinking and responding to what one has experienced. Only by doing this can a student truly start to learn something, because struggling to understand and make it part of one’s view of the world is the only way learning truly happens. Dewey distinguishes, however, between two types of experiences: those which are without reflection, and those in which we work to connect the action and the response, or the “activity and consequence” (p.145, Dewey, 1916). Students can have experiences, but without reflection, not much learning takes place. The experience also has to have psychological and logical components, so that a student builds understanding via moments of psychological experience (Dewey, 1902). Creating situations where youth move from the psychological to the logical engrosses them as learners, encouraging educative experiences that are meaningful and transformative. In the Hudson Eel Project, students had an experience, but they were not encouraged to reflect on the experience in any way that was documented by my research. The interviews that I did with the students were, I believe, the first and last time an adult supported the students in thinking about what they had done, seen, and experienced.

Finally, it is possible that the questions which were asked constrained the students’ answers or discouraged them in some way. For example, although I wrote the questions with the Hudson Eel Project in mind, the fact that the changing climate might impact the eels, and therefore be important to address, might not have been known. In addition, the connection between eels and climate change is indirect at best, and as solving climate change is a wicked, complex challenge that often feels unsurmountable to all individuals, it is not surprising that the students did not connect with this example (O’Neill & Nicholson-Cole, 2009). Kals et al. (1999) found that indignation about insufficient nature protection was as important of an emotion
for increasing nature-protective behavior as emotional affinity and interest in nature. Since the eel program did not help students recognize the multitude of threats facing the eels, and the ways in which all of us are contributing plus the lack of international effort to mitigate these threats, students may not have felt motivated to answer the questions I posed because they didn’t seem relevant or inspire indignation. It is also important to acknowledge that declining eel population is a complex ecological problem, one with numerous, interrelated causes, and the relative importance of each cause is actively debated by scientists (Sneed, 2014). As such, it would be challenging for the students to understand how to help the eels in a way that would support the overall population as opposed to the individuals in the creek. Additionally, the phrasing or way in which the questions were asked may have affected students’ responses. As was noted earlier, some students were worried about safety or convenience, which trumped their environmental concern; perhaps, if the questions had been worded in a different manner, or gave different options for community level change, students may have answered more (or less) favorably (C. Martin & Czellar, 2016; Prévot et al., 2018b).

**Mechanisms**

The mechanisms that I believe affected students’ sense of place include the direct experiences with the stream and the animal, and the sociocultural nature of the project. Going outside, and having the time and encouragement to engage with a charismatic animal was the highlight for the students. The ability to touch, hold, and watch an unusual animal was essential, especially because the eel made several students uncomfortable at the outset. These students changed their opinion of the eel over the course of the project, going from being fearful or disgusted to feeling empathy and interest. Several researchers have noted that youth can change
their attitudes towards animals they consider dangerous or disgusting, if given time to engage with the animal in a positive environment (J. M. Morgan & Gramann, 1989; Tomazic, 2011). Morgan & Gramann investigated students’ feelings towards snakes, while Tomazic explored students’ feelings towards amphibians. Similar to these studies, the youth in this study were excited about the eel but sometimes apprehensive, and needed time and support to change their opinions of the animal. The youth also became comfortable in the stream and conducting the activities of the research project (Barthel et al., 2018). Both Carlone et al. (2015) and Barthel et al. (2018) found that young people needed time and support through the use of tools (such as waders and thermometers) to become comfortable in a new setting, especially if that setting is outdoors and connected to potential feelings of fear or unease. Most of the youth in the Hudson Eel Project had never been in the Hudson River before, had never worn waders, and were understandably excited about the feeling of walking in the water. Children of all ages enjoy being in water, and being able to do so after school and within walking distance of home makes the experience even more surreal and special.

I believe there was a reciprocal relationship between the direct experience with the eel in the creek and with the students’ empathy for the eel and the place. Handling an animal in the context of science can increase confidence in doing environmental research, which then increases content knowledge as one notices details about the organism, which then increases students’ science identity and care about a place (Carlone et al., 2015; Lindemann-Matthies, 2002). Learning facts about the eel, such as their long migration journey and the way they change colors over time, changed the students’ perspective on the eel. The animal’s unique features – such as its see-through body and small size – contributed to the feeling of care and a need to protect and save it. Similarly, other studies have found that direct interactions with
animals supports students’ positive feelings not only about the animal but about nature in general (Barthel et al., 2018; Myers & Saunders, 2002; Tomazic, 2011).

It was essential that students were encouraged and supported in going into the stream repeatedly, and provided with scaffolding to learn how to manage the project’s tasks on their own by the adults in charge of the program. The autonomy, competence, and relatedness created a positive feedback loop for participating in the project, as the students had fun and supported each other in the designated sampling activities (Deci & Ryan, 2012). The use of specific extrinsic, non-academic motivators such as group t-shirts and having a celebration ceremony allowed students to gain a sense of relatedness and belonging. The adult leaders also empowered students to take ownership over time, which allowed them to become more confident in the program, and to share their discoveries with others (Ardoin, 2006; Scannell & Gifford, 2010; Stepenuck & Green, 2015).

Limitations

The contradictions in my two types of evidence requires me to examine the strengths and limitations of each of these types of data. My qualitative data showed an increase in sense of place, but my survey data did not. Since sense of place work is often conducted with surveys, it is important to explore how surveys may make it challenging to detect the important changes taking place in participants, and to make recommendations for best practices when conducting sense of place survey work (B. S. Jorgensen & Stedman, 2006; Wit, 2013).

With respect to the quantitative data, there are several limitations. Firstly, although more than 50 students began the program, only 33 of those students finished with an attendance that
was deemed meaningful (three weeks of an 8 week program). Some students dropped out, others did not provide consent, some did not complete the pre or the post-survey, and some started too late, leading to a smaller than anticipated sample size ($n = 33$). This small sample size makes statistical analysis less powerful. Secondly, it is also possible that students answered the survey questions haphazardly – perhaps they had survey fatigue, or lacked buy-in to the study itself (Brazeal & Couch, 2017; Porter et al., 2004). This is supported by the contradictions in how the focal group students answered the survey as compared to how they talked about the eels and the project in the interviews. Survey fatigue is also common with Likert-scale surveys, as the students could have been tired of answering multiple questions and simply wanted to be done with the survey (Andrade et al., 2020). Finally, it is likely that another method, such as a retrospective pre-post survey, would have been a more accurate way to quantitatively gauge students’ change in sense of place over time since it could help avoid response-shift bias (Geldhof et al., 2018).

Besides survey fatigue, Likert-scale data have other limitations, including response bias, as participants avoid selecting extremes or disagreeing with statements. Another problem is that participants don’t choose answers based on the given scale, especially when there are no provided anchors for a set of questions, making the selections somewhat arbitrary. For example, it is possible that even though two students feel the same way about a particular item, one selects the value “2” while the other selects a “3” (Andrade et al., 2020). Or, a student wishes they could select an intermediate value between “2” and “3”, but that choice simply isn’t available to them; although the response options are numerically labeled, and may represent equal intervals to us, it does not indicate equal intervals to all participants (Liddell & Kruschke, 2018). Finally,
it is possible that the use of reverse worded items caused confusion and could have led to
carelessness among participants’ choices (X. Zhang & Savalei, 2016).

Finally, there is significant discussion within the psychology literature about the validity
of analyzing Likert-scale items using linear models (Liddell & Kruschke, 2018). Some scholars
argue that Likert-scale surveys should not be analyzed using parametric tests such as the t test or
Pearson correlation because Likert-scale data cannot be assumed to be continuous or normally
distributed (Burkner & Vuorre, 2019). However, since my t-test results did not indicate
significance, and numerous researchers have found that both the 2-sample t-test and the non-
parametric Mann-Whitney test have the same likelihood of detecting actual differences and
giving similar error rates, I concluded that using a parametric test was acceptable (de Winter &

Besides the methodological issues, it is also possible that a program with such a short
duration and time commitment (6-8 weeks, 1-2 hours per week), and no requirement for
attendance, means that students didn’t have the amount of exposure necessary to affect a change
in sense of place (Kudryavtsev, Krasny, et al., 2012). However, the strong qualitative data
suggest that this program does actually impact sense of place, and therefore, lead me to believe
that a pre/post survey may not capture students’ true attitudes.

Suggestions for future research

This study demonstrated that for urban youth, it is possible to develop some aspects
within the sense of place construct over the course of a relatively short period of time. Future
research should focus on what place attachment means for urban youth, and how it might be
more accurately measured in survey work, especially with regards to citizen science. I believe that operationalizing place attachment would also benefit from additional research, as explaining exactly what demonstrates place attachment in urban youth is not well defined. Adding the concepts of empathy and pride should be considered in future studies, especially those that focus on citizen science programs in natural settings. How these concepts should be framed, especially in survey work, is crucial, especially in studies with youth who may have contradictory place attachment feelings. If we are seeking to develop citizen science programs that encourage a wide range of participants, and hope to offer ways for these participants to engage in pro-environmental behaviors that move beyond individual actions, we need to include this objective in our citizen science outcomes. Future research should explore how citizen science programs might engage with their participants on solving wicked environmental issues, and empower them to solve them in collective ways.

Implications for Citizen Science Programs

As we strive to create opportunities for youth that foster a sense of place and build empathy for and pride in the places in which they live, it is critical that we understand whether and how citizen science programs might serve such a purpose. Researchers have suggested, and funding support has followed suit, that citizen science programs can be a way to develop people who care about a particular place and thus want to protect it for future generations (V. Y. Martin, 2017). Some evidence exists that participating in citizen science programs increases participants’ awareness of their own place, and that youth participants increase their content knowledge and became more confident with specific science process skills (Ballard et al., 2017; Evans et al., 2005; Haywood et al., 2016). However, the lack of opportunities for urban youth to
interact with nature in their neighborhoods is a social justice issue and reinforces the misconception that urban areas are not valuable in terms of wildlife, nature, or beauty. If we are to strive for equity and foster an ethic of care for our planet, urban youth deserve to be exposed and have access to the same opportunities as youth in wealthier or more rural areas (Bang & Marin, 2015; Pandya, 2012). Combatting the extinction of experience for all youth, and encouraging them to explore and wonder about the place where they live, will help foster positive emotions about the environment (Louv, 2008; Pyle, 2002; Soga & Gaston, 2016a).

This study demonstrates that a citizen science program can increase the sense of place for urban youth, especially if the program allows for repeated experiences with other peers and trusted adults as they explore an animal in a novel ecosystem. The eel program benefits from being located in the community where youth live, and being easy to get to on foot, allowing youth to decide if and when they want to participate. As a long-running program, it allows friends and siblings to encourage each other to participate over the years. It is also supported by the school system, in that it is introduced to youth in their school and has been running for over a decade, developing a network of alumni participants. Participation is organized and encouraged by students’ science teachers, who also attend every sampling session and create a positive, fun climate. Thus, it is not seen as an unfamiliar activity that is only done by others or outsiders – instead, it is located in their community, and run with their community’s support. If programs for urban youth are to be successful, I think having these features are essential.

Besides the setting, program structure and support are important. While this program did not allow for a collaborative experience between scientists and participants, it did encourage youth to be active and empowered to take ownership over the course of the sampling season.
Providing a structure where students could develop autonomy, competence, and relatedness was a key way for the citizen science program leaders to support the urban youth. The adult leaders made sure that youth learned how to do the different tasks, and then gave them the responsibility to do so by themselves. They also encouraged the youth to have fun and treated them as peers, fostering a sense of collaboration and mutual respect. If possible, citizen science programs should strive to find ways to engage participants in the entire study process, and to take the time to make sure that participants understand the rationale for the study, along with the ways in which their data will impact the overall project.

The eel program benefits from being focused on an organism that is unique and charismatic and interests students, even if they are somewhat apprehensive or fearful. It is truly a “cool” animal. It was also an animal that was unknown to students beforehand, which provided an element of surprise and wonder. Being able to become comfortable with the animal over time and observe it up close, and to be trusted to handle the animal with care, were also important elements of this program. The overall atmosphere of respect for living things and discovery of the natural world supported the youth in their experience.

However, if citizen science programs want to empower youth to engage in pro-environmental behaviors beyond personal, individual changes, it will be important for the programs to not only include the threats to the organism and ecosystem, but have conversations about the community and civic level actions. Furthermore, programs need to provide space for reflection, which is essential for an experience to be educative. Youth should be encouraged to think about their actions and the project as a whole, and reflect on how the project develops not only their own competence but also helps the eels. As was mentioned previously, the lack of
reflection in the current program means that youth do not have a supported mechanism for combining the logical and psychological aspects of this experience, and the experience, while meaningful, cannot be truly educative.

For the Hudson Eel Project, the program could be amended to focus not only on data collection but also on the implications of the data. This could be done by creating a running data table that displays eel count results over the course of the sampling season and in comparison to previous years, and allows youth participants to add the current day’s results to the graph/data table. The program staff could brainstorm which threats to the eels they would like to focus on with the volunteers, and which solutions make sense for counteracting the decline of the eel. They could encourage youth to share what they have learned with the larger community, or investigate community or civic engagement actions of their own choosing, to help address the lack of understanding about collective solutions. Beyond that, developing a subsequent program where youth are the architects of the research process would allow them to apply what they have learned from the Hudson Eel Project and find ways to involve more members of their community in problem-solving (Cantor et al., 2015; Hobson et al., 2016). Such a program should include not only science outcomes but also community level outcomes and involve experts who can help design and structure a program for developing environmental citizenship.

Regardless of the modifications this citizen science program might make, it is essential that we remain mindful of the importance of exposing youth to an amazing natural wonder in their own community. Generating a sense of wonder and joy by seeing a migration in its natural environment is something that should not be lost, nor should the celebration of teamwork, fun, and excitement. If we want youth to care about their place, they deserve to have the kinds of
experiences that the Hudson Eel Project affords, where they can explore, splash, giggle, and gaze in awe at a miraculous, other-worldly creature that traveled hundreds of miles on an ocean current.
EPILOGUE

This study has allowed me, as a researcher and a person, to come full circle. As a child, I used indignation and emotional affinity for nature as I became an environmentalist and attempted to encourage others to “save the world”. I spent a lot of time outdoors, exploring the woods and stream behind my house, but I was also guided by my parents, who had very strong opinions about protecting animals, even bugs. I distinctly remember my mother jumping the fence at the local pool to throw towels over their giant bug zappers, which had been left on overnight. I put up pictures of beaten baby harp seals and elephants whose tusks had been cut out to raise money at my school. As I learned more in high school and college, I retained my indignation but added cognition to my arsenal, developing a more nuanced understanding of what was happening in the world and how to change things. I attended protests and led environmental groups, but focused my energy after college on bringing environmental education into urban schools as I began to understand more about the connection between people’s actions and the environment.

Next, I began my job at the Cary Institute, where I developed a love for the cognitive side of environmentalism. I reveled in the facts and details about the natural world, and the connections I was able to make with scientists who could tell stories about how the world worked and teach me things I had never learned. Deepening my knowledge was wonderful, and led me to get another degree in science. But my focus on content drove my interests, and even as I began my doctoral studies, I was still entirely focused on what students knew and could do, not how they felt. As I observed the eel students, I came to realize that while they were learning about the river and about this unique organism, what they were really gaining was larger than that – it was an ethic of care, and a return to the wonder that the natural world holds secrets that are yet to be discovered. Their excitement and curiosity about the living creatures that swim
through their community was, quite simply, fun to be around. The youth’s discoveries were a reminder that nature is surprising and incredible, and all of us deserve to have experiences where we enjoy being outside, have fun together, and learn to love and respect the creatures that share this world.
Appendix A: Adult Interview

Name: __________________

1. Tell me a little bit about how you became engaged in this project.
2. What are your goals for the program, for the kids? What do you think is the most important thing for students to learn as a result of participating in this program?
3. What are your goals for the program, for yourself? The school?
4. How have your goals changed over time?
5. What are you most proud of, with respect to this program? What are you excited about?
6. What do you think the kids get out of the program?
7. What more would you like to do, if you had the time/staff/resources?
Appendix B: Student Pre-Interview

Semi-Structured Interview Protocol (Pre)

Student name: ______________________

___ Male  ____ Female  ____ n/a  _______ Age

Ethnicity

___ white/Caucasian  ___ black/African-American

___ Hispanic/Latino  ___ Asian

___ Pacific Islander/Hawaiian  ___ American Indian/Alaskan native

___ Other

1) Could you tell me about yourself as a student? What is your favorite subject in school? What do you like to do in your free time?

2) Can you tell me about Poughkeepsie? How would you describe Poughkeepsie to someone who is not from Poughkeepsie? How long have you lived here? What do you like about Poughkeepsie? What is your favorite thing to do in the city?

3) When you hear the word “environment”, what do you think about?

4) Can you tell me about your experiences being outside? Do you have a favorite place that you go when you’re outside? When you were a child, was there a favorite place that you went? What kinds of things do you do when you’re outside?

5) Do you have any pets? If so, what kinds? Do you have experience with any other animals? Can you tell me about that?

6) Please tell me as much as you can about the Hudson River. What lives in the river? How does the river change over the course of the year? How has the river changed over time?
a. Please pick one organism that lives in the river, using your drawing, and tell me as much as you can about it (what it eats, where it lives, how it interacts with the environment). What happens to your organism when it dies? Where does your organism get its energy to survive?

7) Have you been to this creek before? If so, when? What do you like about it? What do you notice about it?

8) What do you know about eels? Did you know about eels before the assembly by the DEC staff? Have you participated in this project before? If so, when, and why?

9) What do you want to get out of doing this work with the eels? Why did you decide to participate in this project?

10) Think about the eel sampling that you are doing here. Why are we sampling for eels? What can we learn about the Hudson River ecosystem by sampling for eels?

11) What are some problems that eels face? (*On their journey here, once they are here.*)
   a. Of these, what do you think is the most significant problem facing eels?
   b. How do you know that this/these problems are important to eels?
   c. What do you think is the most important thing you can do to protect the eels?
   d. Do you care about these issues? Why or why not?
   e. Does participating in the Hudson Eel Project help the environment/eels? How?

12) Are there any environmental problems that you are aware of? Are there any environmental problems you are concerned about? Why or why not?

13) Do you try and do anything in your personal life to help the environment? If so, what kinds of things?
Appendix C: Student Post-Interview

Semi-Structured Interview Protocol - post

Student name: _______________________

1) Has anything changed about school in the last two months, since we last talked? How are you feeling about your science class?

2) Has the project changed your view of Poughkeepsie? Of the river? Can you describe the changes?

3) Have you talked to people about the project? What have you told them? Are you proud that you participated in the project? Why?

4) Did you enjoy the project? What did you like about it? What did you learn, or what benefitted you the most?

5) When you hear the word “environment”, what do you think about?

6) I’m going to ask you to create another drawing of the Hudson River. Let’s think back to what you drew at the beginning of the program. How has your knowledge of the Hudson River changed? Let’s rate your knowledge then, and now, using a scale of 1-5. What do you think was important for changing your ideas about the river?

7) Please tell me as much as you can about the Hudson River. What lives in the river? How does the river change over the course of the year? How has the river changed over time?

a. Please pick one organism that lives in the river, using your drawing, and tell me as much as you can about it (what it eats, where it lives, how it interacts with the
environment). What happens to your organism when it dies? Where does your organism get its energy to survive?

8) Can you tell me about the creek? What kinds of things did you notice about it over the course of the sampling season?

9) What do you know about eels? What do you think you learned about them?

10) Think about the eel sampling that you are doing here. Why are we sampling for eels? What can we learn about the Hudson River ecosystem by sampling for eels?

11) Did we catch a lot of eels this year? How do you know? What else would you like to know about the eel numbers?
   a. Ex: One day last year, the Fallkill students caught 989 eels, and another day, they caught 82. Why does this change so much? Why is it important to sample for the entire migration season?
   b. What might affect the numbers of eels that are caught in the Fallkill? In the Hudson River?

12) What are some problems that eels face? (On their journey here, once they are here.)
   f. Of these, what do you think is the most significant problem facing eels?
   g. How do you know that this/these problems are important to eels?
   h. What do you think is the most important thing you can do to protect the eels?
   i. Do you care about these issues? Why or why not?
   j. Does participating in the Hudson Eel Project help the environment/eels? How?

13) Are there any environmental problems that you are aware of? Are there any environmental problems you are concerned about? Why or why not?
14) Do you try and do anything in your personal life to help the environment? If so, what kinds of things? Has this project made you more aware, and if so, how?
Appendix D: Student Pre-Survey

Part 1: Tell us about yourself!

Your name: _____________________

1. ___ Male  ____ Female  ____ Prefer not to say

2. _____ Age

3. Ethnicity: *feel free to check more than one*

___ white/Caucasian  ___ black/African-American
___ Hispanic/Latino  ___ Asian
___ Pacific Islander/Hawaiian  ___ American Indian/Alaskan native
___ Other  ___ Prefer not to say

4. Are you currently passing your science class? (circle)  Yes  No  I don’t know

5. What is your favorite thing to do outside of school?

6. What is your favorite subject in school? _____________________

7. How long have you been participating in the Hudson Eel Project?
   a. _____ This is my 1st year
   b. _____ This is my 2nd year
   c. _____ This is my 3rd year
   d. _____ I’ve been doing this for more than 3 years

8. What science classes have you taken at PMS or PHS? Check all that apply.
   a. _____ Living Environment
   b. _____ Earth Science (HS)
   c. _____ Earth Science (MS)
   d. _____ Environmental Science
   e. _____ Forensics
   f. _____ AP Bio
   g. _____ Chemistry
   h. _____ Physics
   i. _____ Life science (MS)
   j. _____ Physical science (MS)
   k. _____ Other:

____________________
9. What do you hope to do after high school?

Part 2: Below, please decide how you feel about each of the following statements.

<table>
<thead>
<tr>
<th>Please decide how you feel about the following statements, with 1 being strongly disagree, and 5 being strongly agree.</th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. I feel like Poughkeepsie is part of me.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>2. Everything about Poughkeepsie reflects who I am.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>3. I am more satisfied in Poughkeepsie than in other places.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>4. I identify myself strongly with Poughkeepsie.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>5. Poughkeepsie is not a good place for what I enjoy doing.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>6. There are better places to be than Poughkeepsie.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>7. Poughkeepsie reflects the type of person I am.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>8. I am proud to live in Poughkeepsie.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>9. Poughkeepsie is the best place for what I like to do.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>10. I don’t like telling people I live in Poughkeepsie.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

Part 3: Please answer each question to the best of your ability.

1. Please tell us what you already know about the American eel.

2. List any other living things you know about that live in the Hudson River or Fallkill Creek.
3. Why are we monitoring the eels in the Fallkill?

4. Please decide how you feel about the American eel using the next two questions.

<table>
<thead>
<tr>
<th>No!</th>
<th>I’m not sure</th>
<th>A little bit</th>
<th>A lot</th>
</tr>
</thead>
<tbody>
<tr>
<td>Do you like the American eel?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Do you care about the American eel?</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Part 4: Choose one of the categories for each of the statements below.

<table>
<thead>
<tr>
<th>Please decide how you feel about the following statements, with 1 being strongly disagree, and 5 being strongly agree.</th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>11. The Hudson River is something I don’t think about very much.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>12. Eels are an important part of Poughkeepsie.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>13. I like Poughkeepsie because of the eels.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>14. I would feel sad if I couldn’t spend time at the Hudson River.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>15. Waryas Park and the Hudson River are my favorite place to go in Poughkeepsie.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>16. Poughkeepsie is a place to connect with nature.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>17. Poughkeepsie is a place to watch animals and birds.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>18. Poughkeepsie is a place where people can find nature.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>19. In Poughkeepsie, the Hudson River is an important part of the community.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>20. Poughkeepsie is a place where people have access to the water.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>21. Poughkeepsie is a place where people have access to parks.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>22. Poughkeepsie is a place to have fun in nature.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>
Part 5: Choose one of the categories for each of the following situations.

<table>
<thead>
<tr>
<th>Situation</th>
<th>Not at all likely</th>
<th>Somewhat unlikely</th>
<th>Somewhat Likely</th>
<th>Extremely likely</th>
</tr>
</thead>
<tbody>
<tr>
<td>You know that plastic bags are one of the main causes of plastic pollution.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. When you go to a store, how likely are you to bring your own reusable bag?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>2. How likely are you to tell your friends and family to use reusable bags?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>3. How likely are you to vote to support elimination of plastic bags?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Climate change is one of the main environmental problems in the world.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. How likely are you to sign a petition to require people to carpool?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>5. How likely are you to turn off lights to save electricity when you leave a room?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>6. How likely are you to go to City Hall and ask the city to require all homes use solar or wind power?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>You notice that a lot of the trash in the Hudson River is Styrofoam.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. How likely are you to participate in a cleanup of Styrofoam on the riverfront?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>8. How likely are you to bring a reusable cup when you go to Dunkin Donuts, instead of getting one of their foam cups?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>9. How likely are you to start a campaign to ban the use of Styrofoam in Poughkeepsie?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
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<tr>
<td>10. Imagine that Poughkeepsie is proposing a ban on Styrofoam. How likely are you to go to a meeting to show support?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>
Appendix E: Student Post-Survey

Part 1: Tell us about yourself!

Your name: _____________________

1. Did you enjoy participating in the Hudson Eel Project? (circle) Yes   No   A little bit       

2. Why did you participate in the Hudson Eel Project? Rank these choices from 1 – 9, with #1 being your top reason. 
   _____ It is fun to learn about eels. 
   _____ It is fun to be outside in the stream. 
   _____ It is fun to be with my friends. 
   _____ For the recognition or respect I’ll get from others – my friends, teachers, parents. 
   _____ I am required to participate by others – my teachers, parents. 
   _____ It will help me achieve things that are important to me, like getting extra credit. 
   _____ People I look up to think it’s good to participate in the Hudson Eel Project. 
   _____ I enjoy participating in the Hudson Eel Project. 
   _____ I believe that doing the Hudson Eel Project will help me in some way (in school, for my resume). 

Part 2: Below, please decide how you feel about each of the following statements.

<table>
<thead>
<tr>
<th>Please decide how you feel about the following statements, with 1 being strongly disagree, and 5 being strongly agree.</th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. I feel like Poughkeepsie is part of me.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>2. Everything about Poughkeepsie reflects who I am.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>3. I am more satisfied in Poughkeepsie than in other places.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>4. I identify myself strongly with Poughkeepsie.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>5. Poughkeepsie is not a good place for what I enjoy doing.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>6. There are better places to be than Poughkeepsie.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>7. Poughkeepsie reflects the type of person I am.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>8. I am proud to live in Poughkeepsie.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>9. Poughkeepsie is the best place for what I like to do.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>10. I don’t like telling people I live in Poughkeepsie.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>
Part 3: Please answer each question to the best of your ability.

1. Please tell us what you know about the American eel.

2. List any other living things you know about that live in the Hudson River or Fallkill Creek.

3. Why are we monitoring the eels in the Fallkill?

4. What are some challenges the eels are facing?

5. Please decide how you feel about the American eel using the next two questions.
   - Do you like the American eel?
   - Do you care about the American eel?

Part 4: Choose one of the categories for each of the statements below.

<table>
<thead>
<tr>
<th>Please decide how you feel about the following statements, with 1 being strongly disagree, and 5 being strongly agree.</th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. The Hudson River is something I don’t think about very much.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>2. Eels are an important part of Poughkeepsie.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>3. I like Poughkeepsie because of the eels.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>4. I would feel sad if I couldn’t spend time at the Hudson River.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>5. Waryas Park and the Hudson River are my favorite place to go in Poughkeepsie.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>
6. Poughkeepsie is a place to connect with nature.  | 1 | 2 | 3 | 4 | 5
7. Poughkeepsie is a place to watch animals and birds.  | 1 | 2 | 3 | 4 | 5
8. Poughkeepsie is a place where people can find nature.  | 1 | 2 | 3 | 4 | 5
9. In Poughkeepsie, the Hudson River is an important part of the community.  | 1 | 2 | 3 | 4 | 5
10. Poughkeepsie is a place where people have access to the water.  | 1 | 2 | 3 | 4 | 5
11. Poughkeepsie is a place where people have access to parks.  | 1 | 2 | 3 | 4 | 5
12. Poughkeepsie is a place to have fun in nature.  | 1 | 2 | 3 | 4 | 5
13. Poughkeepsie is a place to learn about nature.  | 1 | 2 | 3 | 4 | 5
14. Poughkeepsie is a place to enjoy nature’s beauty.  | 1 | 2 | 3 | 4 | 5
15. I can come to the Hudson River to enjoy nature.  | 1 | 2 | 3 | 4 | 5
16. I would feel sad if eels went extinct in the water in Poughkeepsie.  | 1 | 2 | 3 | 4 | 5

Part 5: Choose one of the categories for each of the following situations.

<table>
<thead>
<tr>
<th>1. When you go to a store, how likely are you to bring your own reusable bag?</th>
<th>Not at all likely</th>
<th>Somewhat unlikely</th>
<th>Somewhat likely</th>
<th>Extremely likely</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. How likely are you to tell your friends and family to use reusable bags?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>3. How likely are you to vote to support elimination of plastic bags?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>4. How likely are you to sign a petition to require people to carpool?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>5. How likely are you to turn off lights to save electricity when you leave a room?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>6. How likely are you to go to City Hall and ask the city to require all homes use solar or wind power?</td>
<td>1</td>
<td>2</td>
<td>3</td>
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</table>
You notice that a lot of the trash in the Hudson River is Styrofoam.

<table>
<thead>
<tr>
<th></th>
<th>How likely are you to participate in a cleanup of Styrofoam on the riverfront?</th>
<th>1</th>
<th>2</th>
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<td>7</td>
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<table>
<thead>
<tr>
<th></th>
<th>How likely are you to bring a reusable cup when you go to Dunkin Donuts, instead of getting one of their foam cups?</th>
<th>1</th>
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